Knowledge Management Research & Practice (2017) 15, 23–33

www.palgrave.com/journals

Creating knowledge within a team: a socio-technical interaction perspective

Jinwon Hong[1]
One-Ki (Daniel) Lee[2] and
Woojong Suh[1]

[1]Department of Business Administration, Inha University, Incheon, Korea (South)
[2]Department of Management Science and Information Systems, University of Massachusetts Boston, Boston, MA

Correspondence: Woojong Suh, Department of Business Administration, Inha University, Incheon, Korea (South).
Tel: +82 32 860 7755;
E-mail: wjsuh@inha.ac.kr

Abstract
Creating knowledge within a team for developing new products and services is considered a primary means for improving organizational performance. Drawing upon the socio-technical perspective, we investigate the blended effects of social (learning culture, teamwork quality, and knowledge complexity) and technical (IT support) factors on team-level knowledge creation and team performance. We propose a model that features synergetic interactions between social and technical factors in this knowledge creation process. The model was tested by utilizing data from a field survey of industry managers. The results show significant interactions between social and technical factors, which influence team-level knowledge creation and, in turn, team performance. Our findings can be used to develop socio-technical initiatives to enhance the process of creating team-level knowledge within firms.
Knowledge Management Research & Practice (2017) **15**(1), 23–33.
doi:10.1057/kmrp.2015.27; advance online publication, 11 January 2016

Keywords: team-level knowledge creation; socio-technical perspective; IT complementarities; interaction effects

Introduction

In today's competitive business environment, organizational knowledge creation is considered a primary means for improving firm performance and enhancing competitive advantage (Esterhuizen *et al*, 2012). Knowledge creation helps firms develop new products and services to respond quickly to market requirements. Organizational knowledge is typically compiled through collective efforts within teams, such as R&D or service-development teams (Chen *et al*, 2008). Prior research shows that team-level knowledge has positive impacts on various aspects of organizational performance in terms of product development, customer relationship management, and revenue creation (e.g., Menguc *et al*, 2013). Therefore, it is vital to strengthen teams' knowledge creation process to improve organizational performance (Nonaka, 1994; Sabherwal & Becerra-Fernandez, 2003).

Various social factors, such as culture and teamwork, influence teams' knowledge creation (e.g., Dayan & Benedetto, 2009; Yoon *et al*, 2010). At the same time, as today's organizational processes become more digitized, the role of the information technology (IT) environment in the knowledge creation process is receiving special attention (Alavi & Leidner, 2001). In particular, researchers argue that these social and IT factors should be harmonized to nurture the knowledge creation process within teams (Thomas *et al*, 2001). These studies are based on the socio-technical perspective, which highlights the co-presence of social and technical factors involved in a work system and their interactive relationships for creating and improving organizational values (Leavitt, 1976). Several extant studies

Received: 15 August 2014
Revised: 26 August 2015
Accepted: 10 December 2015

in this stream of research have identified various factors influencing organizational knowledge creation (e.g., Bhatt, 2001). Most of these studies, however, have focused on social factors (e.g., Mitchell *et al*, 2009; Choo, 2011), and only a few studies have addressed the role of technical factors in teams' knowledge creation (e.g., Parent *et al*, 2000). Moreover, the interactions between social and technical factors at the team level have seldom been investigated and thus remain ill-understood (Kankanhalli *et al*, 2011).

Such interactive relationships between IT and non-IT factors within firms have been discussed from the perspective of complementarity (Zhu, 2004; Tanriverdi, 2006). When IT resources (e.g., IT infrastructure and service) complement non-IT resources (e.g., organizational structure, culture, and leadership), they generate synergetic outcomes, thus 'producing greater returns in the presence of another resource than by itself' (Zhu, 2004, p. 177). This perspective is deemed adequate to explain the interactive relationships between certain social and technical factors for generating synergetic outcomes in a team's knowledge creation process.

Through this study, we investigate how a team can create knowledge and thus improve its performance in today's digitized business environment. As a basis for our research, we adopt the socio-technical perspective and identify the influencing social and technical factors of team-level knowledge creation. Drawing upon the IT complementarity perspective, we investigate the synergetic relationships between social and technical factors. Our theoretical development and empirical findings extend the extant literature by revealing how social and technical factors interact in the process of creating team-level knowledge.

In the next section, we develop the study's hypotheses. We then present the details of our research method and analysis. In the following section, we discuss the study's implications. Potential contributions and future research are discussed in the conclusions.

Hypothesis development

Our hypothesis development consists of three aspects of the knowledge creation process at the team level: (a) effects of a team's knowledge creation on its performance, (b) direct effects of socio-technical factors on a team's knowledge creation, and (c) interaction effects between the social and technical factors.

Team's knowledge creation and performance

Knowledge creation refers to 'the development of new ideas that reflect a significant elaboration or enrichment of existing knowing' (Mitchell & Boyle, 2010, p. 69). Prior research has shown that team-level knowledge creation is a vital process to achieve superior performance in various team settings. In a new product-development team, for example, combination processes for tacit and explicit knowledge creation enhance new product success, product quality, and project efficiency (Schulze & Hoegl, 2006). Customer knowledge creation within a sales team is also positively related to its customer relationship performance and financial performance (Menguc *et al*, 2013). Consistent with these studies, we propose the following hypothesis:

H1: *A team's knowledge creation is positively associated with its performance.*

Social and technical factors for team's knowledge creation

The socio-technical perspective emphasizes 'the joint optimization of the social and technical systems' (Mumford, 2006, p. 321) in designing and explaining changes in work and information systems (Leavitt, 1976). On the basis of this perspective, Pan & Scarbrough (1998) argue that knowledge management systems should take into account such human and social factors as rules, culture, and social relationships. Bhatt (2001) also argues that interactions among personal experience, social relations, and technologies (i.e., socio-technical interactions) should be carefully coordinated to achieve organizational knowledge management.

From the human information processing perspective, we identify social and technical factors within the context of team-level knowledge creation. According to Schroder *et al* (1967), certain social and technical factors help advance a team's information processing. In particular, learning culture promotes information acquisition, distribution, and interpretation of information processing (Huber, 1991). Teamwork quality also promotes information sharing and integration of information among team members (Kleinsmann *et al*, 2010). Moreover, the level of information processing is affected by the information complexity of the tasks that a team must complete. Information complexity refers to the amount and uncertainty of requisite information for decision making and innovation (Schroder *et al*, 1967). This complexity also is related to the inter-correlations among the pieces of information. IT support is essential for semi-structured communication, as well as for sharing structured documents in information processing within a team (Premkumar *et al*, 2005). On the basis of prior research on information processing, we propose learning culture, teamwork quality, and knowledge complexity as key social factors and IT support as a vital technical factor that facilitate a team's knowledge creation.

Learning among team members has been discussed as leading to a higher level of knowledge creation (Choo, 2011). Learning culture refers to the extent to which an organizational environment encourages the learning of its members (Baker & Sinkula, 1999). Employees' positive learning attitudes and a self-renewal climate for continuous change are major parts of learning culture (Jaw & Liu, 2003). Such cultures for learning have positive effects on team creativity by enhancing team members' work quality and team innovativeness (Choo, 2011). Accordingly, learning culture should be fostered to effectively promote knowledge creation. On the basis of these arguments, we propose the following hypothesis:

H2a: *Learning culture is positively associated with a team's knowledge creation.*

Teamwork quality comprises the quality of communication and coordination, balance of contributions, and mutual support with cohesion among team members. It represents a team's 'ability for task-related interaction and networking' (Hoegl *et al*, 2004, p. 43). Teamwork quality has positive effects on various aspects of team activities, such as project commitment, team collaboration, team growth, and coordination with other teams (e.g., Hoegl *et al*, 2004; Brinckmann & Hoegl, 2011). In particular, good relationships and trust among team members positively affect their collaborative knowledge creation in terms of speed and quality (Dayan & Benedetto, 2009). This social factor is becoming increasingly important for team-level knowledge creation, as contemporary firms are facing a more cross-functional and multi-cultural collaboration environment. On the basis of these arguments, we propose the following hypothesis:

H2b: *Teamwork quality is positively associated with a team's knowledge creation.*

Knowledge complexity refers to the extent to which team members recognize the amount of knowledge elements required to complete their team's tasks (Minguela-Rata *et al*, 2009). In the context of knowledge work, knowledge complexity can motivate organizational innovations (Pérez-Luño *et al*, 2011). This is because team members may feel a 'sense of challenge that stimulates creativity' (p. 88) when their team is confronted with high knowledge-complexity requirements (Choo, 2011). Thus, knowledge complexity can be a driving force of employees' active participation in new knowledge creation when engaging in team-level tasks, such as new product development (Oldham & Cummings, 1996; Bstieler & Gross, 2003). On the basis of these arguments, we propose the following hypothesis:

H2c: *Knowledge complexity is positively associated with a team's knowledge creation.*

IT support refers to the extent to which a team has requisite IT-based services for communication, collaboration, and information processing. Within a contemporary firm, IT provides a digitized platform of data and interpersonal communications and knowledge-sharing among employees (Alavi & Leidner, 2001). In line with this, organizational IT support has been considered useful in facilitating organizational learning and generating social relationships and interpersonal interactions among employees (Palvalin *et al*, 2013). Group support systems, for example, enhance both the quality and quantity of team-level knowledge creation by providing an IT-based collaboration platform (Parent *et al*, 2000). Therefore, IT enhances knowledge creation activities within a team. On the basis of these arguments, we propose the following hypothesis:

H2d: *IT support is positively associated with a team's knowledge creation.*

Synergetic interactions between social and technical factors

Concerning the contribution of IT to organizational outcomes, the IT complementarity perspective investigates the synergetic interactions between IT factors and non-IT factors (Kohli *et al*, 2003; Zhu, 2004). This perspective is based on the theory of complementarities, which holds that a combination of complementary resources leads to synergetic outcomes and that the combination has more value than the sum of two resources (Wade & Hulland, 2004). Feng *et al* (2012), for example, show a synergetic relationship between a firm's customer-orientation and new IT implementation in reducing the amount of time to market a new product. Similarly, certain organizational factors, such as the degree of decentralized decision-making systems, the level of job training, and the quality of human capital have been discussed as having synergetic relationships with organizational IT investments (Powell & Dent-Micallef, 1997; Dedrick *et al*, 2003). This is mainly because a firm's IT value depends on processes that involve both IT and these organizational factors. Combining this perspective with the socio-technical perspective, we propose synergetic relationships between the social and technical factors.

The effects of organizational culture can be strengthened by IT support (Kohli *et al*, 2003). Workflow management systems, for example, reinforce customer-oriented culture and flexibility through a change or an improvement in the way employees proceed with their tasks (Doherty & Perry, 2001). Effective IT support provides a better digitized learning environment within a team that utilizes various IT-based tools for communications, information access, and knowledge repository (Alavi & Leidner, 2001; Kankanhalli *et al*, 2011). This enhanced learning environment potentiates the role of a team's learning-oriented culture to create knowledge. On the basis of these arguments, we propose the following hypothesis:

H3a: *Learning culture and IT support have a synergetic interaction effect on a team's knowledge creation.*

Teamwork quality is also expected to have a synergetic relationship with organizational IT support. A team with high-quality teamwork is active in collaboration among its team members, and information technologies facilitate the process of team collaboration. Group support systems, for example, have been discussed as facilitating member participation and open-minded interactions among team members (Perez-Alvarez & Watad, 2004). According to Nakata & Zhu (2006), under a high-trust environment, for example, when the level of teamwork is high, team members readily adopt and utilize IT tools and are more apt to produce collaborative activities than they do under a low-trust environment. This indicates a synergetic interaction between trust among employees and their use of IT. On the basis of these arguments, we propose the following hypothesis:

H3b: *Teamwork quality and IT support have a synergetic interaction effect on a team's knowledge creation.*

Last, we argue that the level of knowledge complexity required to perform a firm's tasks has a synergetic relationship with organizational IT support in creating knowledge. According to Perez-Alvarez & Watad (2004), a team can generate more creative solutions to cope with its challenging business environment when it has appropriate IT-based coordination mechanisms provided by a group support system. Similarly, task complexity (i.e., knowledge complexity in our study) and appropriate IT supports (e.g., interactive and visualization tools) are also argued to have a synergetic relationship that leads to organizational learning outcomes. According to Nicholson *et al* (2008), interactive communication tools increase team members' engagement with the task environment, which provide them with better mental models of given tasks. In a more complex task environment, having better mental models helps team members reduce their cognitive load to perform the tasks and thus increase the level of their performance. Consistent with these arguments, we propose the following hypotheses:

H3c: *Knowledge complexity and IT support have a synergetic interaction effect on a team's knowledge creation.*

Figure 1 presents our research model based on the proposed hypotheses.

Research method

Measures

On the basis of guidelines from prior research (Moore & Benbasat, 1991), we developed survey items through the following three steps. First, existing measurements of relevant constructs in the literature were reviewed to develop our initial measurements of the principal research constructs. In the second step, a card-sorting method was conducted to assess the validity and reliability of the initial measurements. This included two rounds of a structured sorting, which involved judges who are academics and industry managers from the information systems areas. In each round, four judges were employed to sort the items based on the given definitions of principal research constructs. Necessary changes were then made to the survey instrument. The final results of the card-sorting test showed that the measurements had sufficient construct validity and potential reliability; the Cohen's κ scores exceeded 0.65, and the item placement ratio reached over 90%. Finally, a pilot test to assess internal consistency of the research variables was conducted with 39 cases from office workers. The results showed a good validity of the measurements; the Cronbach's α scores exceeded 0.7 (Hair *et al*, 2006, p. 137). All items are listed in Table 1. Items were measured using a five-point Likert scale, ranging from strongly disagree (score 1) to strongly agree (score 5). Our research model also included two control variables: size of team (measured by the number of team members) and size of organization (measured by the number of employees).

Data collection

A field survey was used to collect data for testing the proposed model. A total of 201 respondents holding managerial positions in knowledge-oriented work teams (e.g., strategy development and planning, R&D, and engineering project teams) from 82 firms in South Korea completed the survey. This approach (i.e., using respondents in managerial positions) has been well-validated for team-level studies (e.g., Sharfman & Dean, 1997; Sethi *et al*, 2001). For the appropriate setting of our team-level survey, we provided a clear definition of 'my team' – a group organized to work together to achieve shared objectives in a project – in our questionnaire. Table 2 shows the characteristics of our final sample for the model analysis.

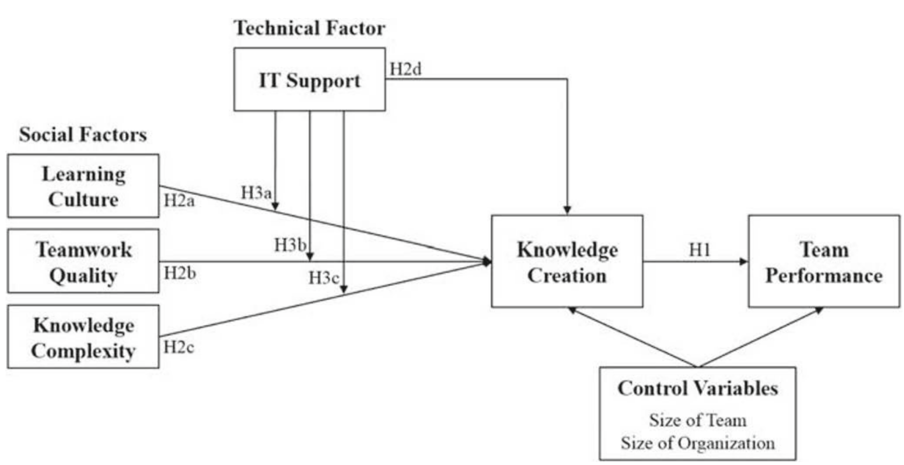

Figure 1 Research Model.

Table 1 Measurement items for principal research constructs

Constructs	*Items*	*Sources*
Team performance	TP1: My team yields high work quality TP2: My team handles a large amount of work well TP3: My team produces excellent performance TP4: My team accomplishes tasks in the required amount of time. TP5: My team responds quickly to problems	Liden *et al* (2006)
Knowledge creation	KC1: My team creates new knowledge which is useful for its decision process KC2: My team has an excellent level of creativity KC3: My team creates new knowledge to help develop new products/services	Kao *et al* (2011)
IT support	ITS1: My company provides a supportive IT environment (e.g., information systems, applications, hardware equipment, etc.) for collaborative work regardless of time and place ITS2: My company provides a supportive IT environment for searching for and accessing necessary information ITS3: My company provides a supportive IT environment for systematic information storing	Lee & Choi (2003)
Learning culture	LC1: Managers basically agree that our business unit's ability to learn is the key to our competitive advantage LC2: The sense around here is that employee learning is an investment, not an expense LC3: Our culture is one that make employee learning a top priority.	Baker & Sinkula (1999)
Teamwork quality	TWQ1: My team members communicate intensively TWQ2: Important information and ideas are openly shared among the members of my team TWQ3: A collaborative atmosphere characterizes the team interaction in my team	Brinckmann & Hoegl (2011)
Knowledge complexity	KCP1: The knowledge used in my team requires prior learning in related knowledge KCP2: The knowledge used in my team is sophisticated and difficult to implement KCP3: The knowledge used in my team is complex	Pérez-Luño *et al* (2011)

With regard to potential non-response bias and common method variance, we conducted an independent sample *t*-test (Armstrong & Overton, 1977) and a Harman's one-factor test (Podsakoff & Organ, 1986), respectively. The results showed that neither non-response bias nor common method variance was a problem in the present study.

Analysis and results

The Partial Least Squares (PLS) structural equation modelling technique was used to conduct hypothesis tests. PLS is suitable for this study when considering the complexity of our research model, which involves multiple interaction effects between IT support and three social factors (Chin *et al*, 2003). Using SmartPLS 2.0 M3 (Ringle *et al*, 2005), we assessed both the measurement and structural models.

Measurement model

We first evaluated the measurement model's reliability and validity. Internal consistency reliability was assessed using composite reliability. Composite reliability scores above 0.7 are adequate (Henseler *et al*, 2009). For validity, we tested convergent and discriminant validity. For convergent validity, the values of the standardized outer loading scores should be higher than 0.7 with statistical significance, and the scores of the average variance extracted (AVE) of the research constructs should be higher than 0.5 (Chin, 1998). Table 3 shows that our measurement model satisfied reliability and convergent validity.

Next, the Fornell-Larcker criterion was tested to assess the discriminant validity of our measurement model (Chin, 1998). The results in Table 4 show that the square roots of each construct's AVE were higher than its correlations with other constructs. Therefore, we concluded that our measurement model satisfied discriminant validity.

Structural model

To test the proposed research model, estimated path effects and associated *t*-values were calculated using the Bootstrapping routine in PLS. Following Chin *et al* (2003), we tested the interaction effects between the social and technical factors using item-level interaction terms. Figure 2 shows the results of the model test.

Table 2 Sample characteristics

Characteristics	*Types/Categories*	*Count*	*Percentage*
Gender	Male	144	71.64
	Female	57	28.36
Age	20s	14	6.97
	30s	133	66.17
	40s	47	23.38
	50s	7	3.48
Career	⩽5 year	42	20.90
	6–10 year	74	36.82
	11–15 year	57	28.36
	16–20 year	20	9.95
	⩾21 year	8	3.98
Number of employees	1–299	98	48.76
	300–999	48	23.88
	>1,000	55	27.36
Number of team members	⩽5	75	37.31
	6–10	55	27.36
	11–15	36	17.91
	16–20	16	7.96
	⩾21	19	9.45
Annual sales[a]	<US$1 million	62	30.85
	$1–5 million	36	17.91
	$5–15 million	41	20.40
	$15 million–1 billion	31	15.42
	>$1 billion	31	15.42

[a]Measured in Korean Won, but transformed into US dollar ($1=1,000Won).

Table 3 Results of the reliability and convergent validity tests

Constructs	*Items*	*Loadings[a]*	*Composite Reliability*	*Cronbach's α*	*AVE*
Team performance	TP1	0.828	0.912	0.880	0.675
	TP2	0.832			
	TP3	0.840			
	TP4	0.797			
	TP5	0.811			
Knowledge creation	KC1	0.855	0.907	0.847	0.766
	KC2	0.883			
	KC3	0.887			
IT support	ITS1	0.886	0.897	0.829	0.744
	ITS2	0.843			
	ITS3	0.857			
Learning culture	LC1	0.898	0.924	0.877	0.803
	LC2	0.925			
	LC3	0.865			
Teamwork quality	TWQ1	0.934	0.930	0.891	0.817
	TWQ2	0.858			
	TWQ3	0.918			
Knowledge complexity	KCP1	0.737	0.888	0.808	0.727
	KCP2	0.906			
	KCP3	0.903			

[a]All loadings were significant at the 0.001 level.

As shown in Figure 2, all proposed links, except one, were significant. First, knowledge creation was found to be a significant determinant of team performance ($P<0.001$), explaining 23.9% of the variance of team performance. Therefore, H1 was supported. Second, learning culture, knowledge complexity, and IT support were significant determinants of team-level knowledge creation ($P<0.01$), while teamwork quality was not. Therefore, H2a, H2c, and H2d were supported, and H2b was rejected. Third, all the interaction effects between the social and technical factors were significant in determining team-level knowledge creation (at least $P<0.05$), explaining 37.9% of the variance of team-level knowledge creation. Therefore, H3a, H3b, and H3c were supported.

To better understand the interactive relationships between IT support and other social factors, we further conducted a hierarchical model analysis (Aiken & West, 1991) and assessed the effect sizes (f^2) of the socio-technical interactions (Chin *et al*, 2003).

The results in Table 5 show that the effect size of the interaction model (Model 3) was slightly above the medium size ($f^2=0.161$), which indicates that the socio-technical interactions had a synergetic outcome. None of the control variables were significant in determining knowledge creation and team performance (also see Figure 2).

The following simple slope analysis results in Figure 3 further confirmed the positive (i.e., synergetic) interaction relationships between the proposed social and technical factors (Aiken & West, 1991).

Discussion

A team can be seen as 'a shared space that serves as a foundation for knowledge creation' (Nonaka & Konno, 1998, p. 40). Hence, knowledge creation at the team level is a salient management topic. In today's digitized business environment, the role of IT in this team-level knowledge creation process is receiving more attention, because IT serves as a business platform for communication, collaboration, and information processing among employees. Drawing upon the socio-technical perspective, we propose that learning culture, teamwork quality, knowledge complexity (as the social factors), and IT support (as a technical factor) enable team-level knowledge creation and team performance. We further propose that the social and technical factors have synergetic interactions in this team-level knowledge creation process.

The results of our empirical analysis confirm most of our hypotheses. Specifically, the results confirm that all of the proposed social and technical factors, except teamwork quality, lead to team-level knowledge creation; all of these findings are statistically significant. In turn, knowledge creation has a positive effect on team performance.

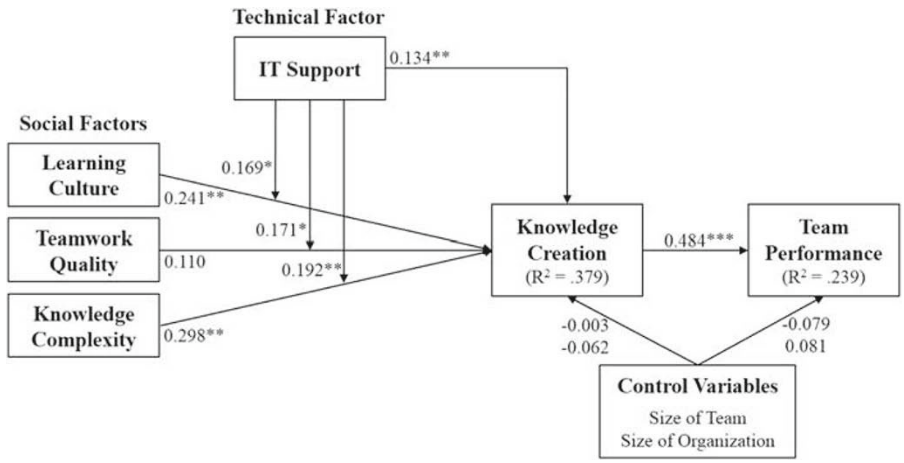

Figure 2 Results of the Structural Model Analysis.
***p<0.001, **p<0.01, *p<0.05

Table 4 Correlation matrix and results of the discriminant validity test

Constructs	*TP*	*KC*	*ITS*	*LC*	*TWQ*	*KCP*	*ST*	*SO*
Team performance (TP)	**0.822**[a]							
Knowledge creation (KC)	0.478	**0.875**[a]						
IT support (ITS)	0.271	0.298	**0.863**[a]					
Learning culture (LC)	0.415	0.375	0.421	**0.896**[a]				
Teamwork quality (TWQ)	0.409	0.257	0.382	0.367	**0.904**[a]			
Knowledge complexity (KCP)	0.294	0.429	0.204	0.275	0.152	**0.853**[a]		
Size of team (ST)	−0.202	0.065	0.114	0.084	0.086	0.110	**1.000**[a]	
Size of organization (SO)	0.068	0.000	0.133	0.118	0.022	0.026	0.229	**1.000**[a]

[a]Bold numbers on the diagonal are the square roots of AVE.

Table 5 Results of the hierarchical model analysis

Constructs	*Criterion Variable: Knowledge creation*		
	Model 1	*Model 2*	*Model 3*
Controls			
Size of team (ST)	0.072 (t=1.424)	0.005 (t=0.147)	−0.003 (t=0.087)
Size of organization (SO)	−0.021 (t=0.473)	−0.052 (t=1.122)	−0.062 (t=1.131)
Main effects			
IT support (ITS)		0.116* (t=2.010)	0.134* (t=2.050)
Learning culture (LC)		0.208* (t=2.550)	0.241** (t=2.631)
Teamwork quality (TWQ)		0.086 (t=1.262)	0.110 (t=1.683)
Knowledge complexity (KCP)		0.336*** (t=4.705)	0.298*** (t=4.977)
Interaction effects			
LC × ITS			0.169* (t=2.013)
TWQ × ITS			0.171* (t=2.265)
KCP × ITS			0.192** (t=3.211)
R^2	0.039	0.279	0.379
f^2		0.333	0.161

*** P<0.001, ** P<0.01, * P<0.05.
Note: f^2=0.02, small effect; f^2=0.15, medium effect; f^2=0.35, large effect.

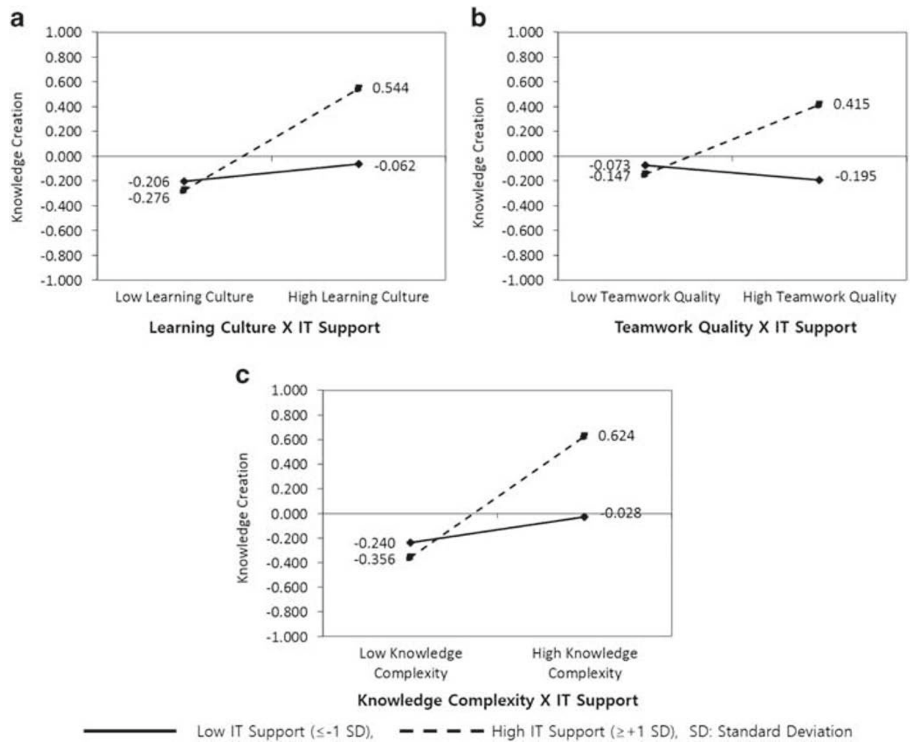

Figure 3 Results of Simple Slope Analysis for Socio-Technical Interactions.

The results also confirm that IT support and all other social factors have positive interaction effects on team-level knowledge creation.

Our findings have several important implications for research. We found significant impacts of not only the proposed social and technical factors but also their synergetic interactions on team-level knowledge creation. This indicates that the knowledge creation process within a team needs to be understood from the socio-technical perspective. In particular, our findings confirm that a team's learning culture, knowledge complexity, and IT support have significant direct effects on team-level knowledge creation. Both learning culture and knowledge complexity are important social factors that characterize a team's work environment (Oldham & Cummings, 1996; Yoon *et al*, 2010; Choo, 2011). Therefore, to stimulate the team-level knowledge creation process, these social factors should be properly designed and managed (Elsbach & Hargadon, 2006).

Our findings also confirm that within teams, effective IT support is an important enabler of the knowledge creation process (Alavi & Leidner, 2001). Moreover, our interaction-term tests reveal significant interaction effects between IT support and all other social factors on team-level knowledge creation. These results suggest that the role of IT in the process can be better understood from a socio-technical interaction perspective. In particular, our results in Figure 2 and Table 5 show that IT support has positive interaction effects with all other social factors, and the effect size of their interactions is above medium size. The results indicate the synergetic outcome of socio-technical interactions (i.e., super-additive value synergies) (Tanriverdi, 2006). Our findings suggest that IT serves as a tool that enables team-level knowledge creation by providing a knowledge repository and information processing. In addition, IT facilitates various social behaviours and contexts as their complementary factor. According to Zhu (2004, p. 193), integration of IT and non-IT resources within a firm can produce a 'performance-enhancing resource bundle', and such integration incurs better performance by enhancing 'connectivity and responsiveness of firms' IT'. This implies that appropriate interactions among IT resources and other organizational resources can improve a team's performance by increasing the connectivity of its members and facilitating the knowledge creation process among them. To achieve these outcomes, IT resources and team practices for motivating knowledge creation should be well-aligned with other social factors or resources. This synergetic role of IT in creating team-level knowledge, however, has seldom been discussed in the literature.

In this study, teamwork quality has a significant interaction effect with IT support in determining knowledge creation but not a direct effect. This finding appears to be inconsistent with findings from previous research (e.g., Hoegl *et al*, 2004). According to our results, teamwork quality can generate a positive effect on knowledge creation only with a proper and sufficient level of IT support. This implies that without technology-based systematic support for communication and collaboration, team members' interpersonal relationships may not be sufficient to generate productive knowledge for the team. Our results suggest an alternative role of teamwork quality in knowledge creation within contemporary teams, which are becoming more distributed across different locations and departments, and more oriented to operating in a short-term time frame.

To better understand the impacts of team characteristics on the proposed relationships among the social and technical factors, team-level knowledge creation, and team performance, we further conducted a multi-group analysis using team size (Henseler *et al*, 2009). The results revealed an interesting finding: The interaction effect between knowledge complexity and IT support in smaller-sized teams ($\leqslant 5$, $n=75$) was significantly stronger than that in larger-sized teams (>5, $n=126$). This finding suggests that team size should be carefully determined to optimize the effectiveness of IT support in facilitating the team-level knowledge creation process, particularly, for a work environment requiring highly complex knowledge.

Our findings also have implications for practitioners to better understand the enhancement of the knowledge creation process and thus performance within their teams. When considering the positive relationship between knowledge management effectiveness at the team and organization levels (Sabherwal & Becerra-Fernandez, 2003), our findings suggest that top management and team managers need to establish organization-wide initiatives to effectively support team-level knowledge creation. In particular, team managers should establish effective IT support (e.g., specialized applications for collaboration and network-based communication, effective knowledge repository, sufficient networking capacity, and efficient IT services) to enhance the team-level knowledge creation process. Top management should invest strategically in organizational IT support to develop a better environment for team-level knowledge creation. At the same time, it is important for top management to actively promote and nurture learning culture and teamwork throughout the firm. Team managers can further promote their teams' knowledge creation efforts by assigning challenging tasks. In all, our findings indicate that organizations should construct an appropriate socio-technical system, by incorporating all of these factors, to support their teams' knowledge creation.

Conclusion

This study identifies the influential social (i.e., learning culture, teamwork quality, and knowledge complexity) and technical (i.e., IT support) factors of team-level knowledge creation, and reveals their synergetic interaction relationships that positively influence a team's knowledge creation process and, in turn, team performance. The findings suggest that to facilitate their knowledge creation process at the team level, organizations must pay more attention to their IT-based support.

The key contribution of our study lies in its theoretical and empirical extension of the extant knowledge management literature by investigating an important, yet less-explored aspect of the organizational knowledge creation process at the team level. In this study, we propose that team-level knowledge creation should be regarded as a socio-technical system. Most prior studies on team-level knowledge creation have focused only on social factors (e.g., Mitchell *et al*, 2009; Choo, 2011). Thus, the role of technical factors in the team-level knowledge creation process has been ill-understood, though IT has been considered as a vital platform of organizational knowledge management (Alavi & Leidner, 2001). Our findings confirm the significant effects of both social and technical factors on team-level knowledge creation.

Drawing upon the IT complementarity perspective, we further investigate the effects of socio-technical interactions on team-level knowledge creation. Our findings confirm synergetic interactions between the proposed social and technical factors in creating knowledge within a team. When considering the lack of theoretical and empirical examinations of such socio-technical interactions in prior research (Kankanhalli *et al*, 2011), our study provides an important extension to the repository of research on organizational knowledge management, particularly, at the team level.

Our conceptualizations and findings serve as a base for future research. First, our model can be extended by considering more complex and dynamic team settings. Today's team environment is becoming more globalized, geographically distributed, and virtualized. Further consideration of multi-cultural and multi-locational factors will be interesting and useful. Second, the investigation of interaction effects among alternative types of socio-technical factors (e.g., organizational types, levels of expertise, and emerging technologies) could also lead to useful implications for designing effective knowledge creation processes as a socio-technical system at the team level.

This study has some limitations that should be addressed in future studies. First, the data used in this research were collected within Korean firms. Thus, the findings of the study could be subject to the influence of certain characteristics of this specific region. According to Hofstede (1980), for example, Korea is characterized with lower individualism and higher long-term orientation than North American and European countries. Owing to these characteristics, the teams in Korean companies may focus more on team-based collaboration, relationships, and performance than the other regions do. Second, we proposed specific socio-technical factors drawing upon the human information processing perspective. Though this approach provided a theoretical lens to identify influencing factors for team-level knowledge creation, the proposed social and technical factors could be limited in explaining team-level knowledge creation.

References

Aiken LS and West SG (1991) *Multiple Regression: Testing and Interpreting Interactions*. SAGE Publications, Thousand Oaks, CA.

Alavi M and Leidner DE (2001) Review: knowledge management and knowledge management systems: conceptual foundations and research issues. *MIS Quarterly* **25**(**1**), 107–136.

Armstrong JS and Overton TS (1977) Estimating nonresponse bias in mail surveys. *Journal of Marketing Research* **14**(**3**), 396–402.

Baker WE and Sinkula JM (1999) The synergistic effect of market orientation and learning orientation on organizational performance. *Journal of the Academy of Marketing Science* **27**(**4**), 411–427.

Bhatt GD (2001) Knowledge management in organizations: examining the interaction between technologies, techniques, and people. *Journal of Knowledge Management* **5**(**1**), 68–75.

Brinckmann J and Hoegl M (2011) Effects of initial teamwork capability and initial relational capability on the development of new technology-based firms. *Strategic Entrepreneurship Journal* **5**(**1**), 37–57.

Bstieler L and Gross CW (2003) Measuring the effect of environmental uncertainty on process activities, project team characteristics, and new product development. *Journal of Business & Industrial Marketing* **18**(**2**), 146–161.

Chen M-H, Chang Y-C and Hung S-C (2008) Social capital and creativity in R&D project teams. *R&D Management* **38**(**1**), 21–34.

Chin WW (1998) The partial least squares approach to structural equation modeling. In *Modern Methods for Business Research* (Marchoulides GA, Ed), pp 295–336, Lawrence Erlbaum Associates, Mahwah, NJ.

Chin WW, Marcolin BL and Newsted PR (2003) A partial least squares latent variable modeling approach for measuring interaction effects: results from a Monte Carlo simulation study and an electronic-mail emotion/adoption study. *Information Systems Research* **14**(**2**), 189–217.

Choo AS (2011) Impact of stretch strategy on knowledge creation in quality improvement projects. *IEE Transactions on Engineering Management* **58**(**1**), 87.

Dayan M and Benedetto CAD (2009) Antecedents and consequences of teamwork quality in new product development projects: an empirical investigation. *European Journal of Innovation Management* **12**(**1**), 129–155.

Dedrick J, Gurbaxani V and Kraemer KL (2003) Information technology and economics performance: a critical review of the empirical evidence. *ACM Computing Surveys* **35**(**1**), 1–28.

Doherty NF and Perry I (2001) The cultural impact of workflow management systems in the financial services sector. *The Service Industries Journal* **21**(**4**), 147–166.

Elsbach KD and Hargadon AB (2006) Enhancing creativity through 'mindless' work: a framework of workday design. *Organization Science* **17**(**4**), 470–483.

Esterhuizen D, Schutte CSL and du Toit ASA (2012) Knowledge creation processes as critical enablers for innovation. *International Journal of Information Management* **32**(**4**), 354–364.

Feng T, Sun L, Zhu C and Sohal AS (2012) Customer orientation for decreasing time-to-market of new products: it implementation as a complementary asset. *Industrial Marketing Management* **41**(**6**), 929–939.

Hair JF, Black WC, Babin BJ, Anderson RE and Tatham RL (2006) *Multivariate Data Analysis*, 6th edn, Pearson Education, Upper Saddle River, NJ.

Henseler J, Ringle CM and Sinkovics RR (2009) The use of partial least square path modeling in international marketing. In *Advances in International Marketing* (Sinkovics RR and Ghauri PN, Eds), Vol. 20, Emerald Insight, Bingley, United Kingdom, pp 277–319.

Hoegl M, Weinkauf K and Gemuenden HG (2004) Interteam coordination, project commitment, and teamwork in multiteam R&D projects: a longitudinal study. *Organization Science* **15**(**1**), 38–55.

Hofstede G (1980) Culture and organizations. *International Studies of Management & Organization* **10**(**4**), 15–41.

Huber GP (1991) Organizational learning: the contributing processes and the literatures. *Organization Science* **2**(**1**), 88–115.

Jaw B-S and Liu W (2003) Promoting organizational learning and self-renewal in Taiwanese companies: the role of HRM. *Human Resource Management* **42**(**3**), 223–241.

Kankanhalli A, Lee O-KD and Lim KH (2011) Knowledge reuse through electronic repositories: a study in the context of customer service support. *Information & Management* **48**(**2–3**), 106–113.

Kao S-C, Wu C and Su P-C (2011) Which mode is better for knowledge creation? *Management Decision* **49**(**7**), 1037–1060.

Kleinsmann M, Buijs J and Valkenburg R (2010) Understanding the complexity of knowledge integration in collaborative new product development teams: a case study. *Journal of Engineering and Technology Management* **27**(**1–2**), 20–32.

Kohli R, Sherer SA and Baron A (2003) Editorial – IT investment payoff in e-business environment: research issues. *Information Systems Frontiers* **5**(**3**), 239–247.

Leavitt HJ (1976) Applied organization change in industry: structural, technical, and human approaches. In *Reader in Operations Research for Libraries* (Brophy P, Ed), pp 50–60, Information Handling Services, Englewood, CO.

Lee H and Choi B (2003) Knowledge management enablers, processes, and organizational performance: an integrative view and empirical examination. *Journal of Management Information Systems* **20**(**1**), 179–228.

Liden RC, Erdogan B, Wayne SJ and Sparrowe RT (2006) Leader-member exchange, differentiation, and task interdependence: implications for individual and group performance. *Journal of Organizational Behavior* **27**(**6**), 723–746.

Menguc B, Auh S and Uslu A (2013) Customer knowledge creation capability and performance in sales teams. *Journal of the Academy of Marketing Science* **41**(**1**), 19–39.

Minguela-Rata B, López-Sánchez JI and Rodríguez-Benavides MC (2009) The effect of knowledge complexity on the performance of franchise systems in the service industries: an empirical study. *Service Business* **3**(**1**), 101–115.

Mitchell R and Boyle B (2010) Knowledge creation measurement methods. *Journal of Knowledge Management* **14**(**1**), 67–82.

Mitchell R, Nicholas S and Boyle B (2009) The role of openness to cognitive diversity and group processes in knowledge creation. *Small Group Research* **40**(**5**), 535–554.

Moore GC and Benbasat I (1991) Development of an instrument to measure the perception of adopting an information technology innovation. *Information Systems Research* **2**(**3**), 192–222.

Mumford E (2006) The story of socio-technical design: reflections on its successes, failures and potential. *Information Systems Journal* **16**(**4**), 317–342.

Nakata C and Zhu Z (2006) Information technology and customer orientation: a study of direct, mediated, and interactive linkages. *Journal of Marketing Management* **22**(**3–4**), 319–354.

Nicholson J, Nicholson D and Valacich JS (2008) Examining the effects of technology attributes on learning: a contingency perspective. *Journal of Information Technology Education* **7**(**1**), 185–204.

Nonaka I (1994) A dynamic theory of organizational knowledge creation. *Organization Science* **5**(**1**), 14–37.

Nonaka I and Konno N (1998) The concept of 'Ba': building a foundation for knowledge creation. *California Management Review* **40**(**3**), 40–54.

Oldham GR and Cummings A (1996) Employee creativity: personal and contextual factors at work. *The Academy of Management Journal* **39**(**3**), 607–634.

Palvalin M, Lonnqvist A and Vuolle M (2013) Analysing the impacts of ICT on knowledge work productivity. *Journal of Knowledge Management* **17**(**4**), 545–557.

Pan SL and Scarbrough H (1998) A socio-technical view of knowledge-sharing at buckman laboratories. *Journal of Knowledge Management* **2**(**1**), 55–66.

Parent M, Gallupe RB, Salisbury WD and Handelman JM (2000) Knowledge creation in focus groups: can group technologies help? *Information & Management* **38**(**1**), 47–58.

Perez-Alvarez C and Watad M (2004) The impact of process standardization and task uncertainty on creativity in GSS environments. *Academy of Information and Management Sciences Journal* **7**(**1**), 89–96.

Pérez-Luño A, Medina CC, Lavado AC and Rodríguez GC (2011) How social capital and knowledge affect innovation. *Journal of Business Research* **64**(**12**), 1369–1376.

Podsakoff PM and Organ DW (1986) Self-reports in organizational research: problems and prospects. *Journal of Management* **12**(**4**), 531–544.
Powell TC and Dent-Micallef A (1997) Information technology as competitive advantage: the role of human, business, and technology resources. *Strategic Management Journal* **18**(**5**), 375–405.
Premkumar G, Ramamurthy K and Saunders CS (2005) Information processing view of organizations: an exploratory examination of fit in the context of interorganizational relationships. *Journal of Management Information Systems* **22**(**1**), 257–294.
Ringle CM, Wende S and Will A (2005) *SmartPLS 2.0 (M3) Beta*. SmartPLS GmbH, Hamburg.
Sabherwal R and Becerra-Fernandez I (2003) An empirical study of the effect of knowledge management processes at individual, group, and organizational levels. *Decision Sciences* **34**(**2**), 225–260.
Schroder HM, Driver MJ and Streufert S (1967) *Human Information Processing: Individuals and Groups Functioning in Complex Social Situations*. Holt, Rinehart and Winston, New York.
Schulze A and Hoegl M (2006) Knowledge creation in new product development projects. *Journal of Management* **32**(**2**), 210–236.
Sethi R, Smith DC and Park CW (2001) Cross-functional product development teams, creativity, and the innovativeness of new consumer products. *Journal of Marketing Research* **38**(**1**), 73–85.
Sharfman MP and Dean JW (1997) Flexibility in strategic decision making: informational and ideological perspectives. *Journal of Management Studies* **34**(**2**), 191–217.
Tanriverdi H (2006) Performance effects of information technology synergies in multibusiness firms. *MIS Quarterly* **30**(**1**), 57–77.
Thomas JC, Kellogg WA and Erickson T (2001) The knowledge management puzzle: human and social factors in knowledge management. *IBM Systems Journal* **40**(**4**), 863–884.
Wade M and Hulland J (2004) Review: the resource-based view and information systems research: review, extension, and suggestions for future research. *MIS Quarterly* **28**(**1**), 107–142.
Yoon SW, Song JH, Lim DH and Joo B-K (2010) Structural determinants of team performance: the mutual influences of learning culture, creativity, and knowledge. *Human Resource Development International* **13**(**3**), 249–264.
Zhu K (2004) The complementarity of information technology infrastructure and e-commerce capability: a resource-based assessment of their business value. *Journal of Management Information Systems* **21**(**1**), 167–202.

About the authors

Jinwon Hong is a Lecturer in the Department of Business Administration at Inha University and also a Principal Researcher in the Core Knowledge Development Center at the Core Knowledge Networks, Inc. He received his Ph.D. from the Inha University of South Korea. His research interests include knowledge-based business model, knowledge integration, knowledge representation, and enterprise social software. His research has been published in *Online Information Review, Journal of Knowledge Studies, Information Systems Review*, *Journal of Information Technology Applications and Management, Journal of the Korea Industrial Information System Society*, and *The Journal of Industrial Innovation* (E-mail: jinwon.hong@coreknet.com).

One-Ki (Daniel) Lee is an Associate Professor in the Management Science and Information Systems Department at the University of Massachusetts, Boston. He received his Ph.D. from the City University of Hong Kong. His research interests include IT ambidexterity, business agility, organizational knowledge management, agile project management, and social software. His work has appeared in several leading IS journals such as *Information Systems Research, Communications of the ACM, Information and Management, Journal of Global Information Management*, and *Online Information Review* (E-mail: daniel.lee@umb.edu).

Woojong Suh is a Professor of MIS/e-business in the Department of Business Administration at Inha University, Korea. He received his Ph.D. in management information systems from the Graduate School of Management at the Korea Advanced Institute of Science and Technology (KAIST). His research interests include knowledge management, social media business, Web engineering, and virtual communities. His research has been published in many journals including *Journal of Knowledge Management, Online Information Review, International Journal of Electronic Commerce, Journal of Organizational Computing and Electronic Commerce*, and *Information and Software Technology*, as well as in a book he edited, *Web Engineering: Principles and Techniques*.