

Knowledge sharing behavior among community members in professional research information centers

Information Development

1–18

© The Author(s) 2015

Reprints and permission:

sagepub.co.uk/journalsPermissions.nav

DOI: 10.1177/0266666914566512

idv.sagepub.com

**KyeongNam Yeon**

Korea Advanced Institute of Science and Technology

Siew Fan Wong

Sunway University

Younghoon Chang

Sunway University

Myeong-Cheol Park

Korea Advanced Institute of Science and Technology

Abstract

South Korea is a world leader in human capital and research investment. However, compared to other countries with similar levels of resource input, Korea has relatively weaker output performance. This is a concern for the Korean government and the funding agencies that invest heavily in R&D activities. Since knowledge sharing among members influences the output performance within an R&D sector, this paper investigates the factors that affect the knowledge sharing intention and behavior among members of a national R&D center in Korea. A total of 286 members in the Biology Research Information Center participated in a survey. The results show that intrinsic and extrinsic motivations significantly influence the members' intention to share knowledge. Cognitive and relational capital also exert significant effects on the members' knowledge sharing intention. Structural capital, however, does not have any significant effect on intention. The members' intention to share knowledge links significantly to their actual knowledge sharing behavior.

Keywords

knowledge sharing, social capital, research centers, R&D investment, community

Enjoyment in helping others has the strongest influence on intention to share knowledge.

Introduction

South Korea is one of the top research and development (R&D) investment nations in the world (Battelle, 2013). In 2013, its total R&D investment was USD16.5 billion, which ranked it top, ahead of the USA, China, Japan, and Germany (Battelle, 2013), and above that of the G7 nations of France and the United Kingdom (Battelle, 2013). Its ratio of R&D spending to gross domestic product (GDP) was 3.6 percent, which was second only to Israel (Battelle, 2013). The number of scientists and engineers per 1 million persons in the country is ranked 4th in the world (Battelle, 2013). Clearly, South Korea is a world leader in human capital and research

investment as well as in infrastructure spending, which positions it high on key innovation input indicators (Battelle, 2013; Dutta and Lanvin, 2013).

However, despite its enormous R&D investment, South Korea sees weak output performance, as indicated in its ratio of input for innovation to output performance from innovation (Dutta and Lanvin, 2013; Ministry of

Corresponding author:

Younghoon Chang, Department of Information Systems, Sunway University, No. 5, Jalan Universiti, Bandar Sunway, 47500 Selangor, Malaysia. Tel: +60374918622 Ext: 3209.

Email: younghoonc@sunway.edu.my

Science, ICT and Future Planning, 2014). In 2013, it was only ranked 18th among the 142 nations in the Global Innovation Index (GII) with a position of 12th in scientific performance and 54th in creative performance (Dutta and Lanvin, 2013). These numbers indicate that South Korea is weak in transforming knowledge input into intangible output assets, creative products and services, and online creativity (Dutta and Lanvin, 2013). Korea's poor output performance in innovation is a concern to the Korean government and to the funding agencies that are eager to see the nation thrive in global competition (Ministry of Science, ICT and Future Planning, 2014). Unless specific reasons behind such low performance are identified, continuous investment will not be fruitful; rather, it will go to waste. In the R&D sector, cooperation and knowledge sharing among the members are important in influencing output performance (Wen and Kobayashi, 2001; Polt et al., 2001; Hanaki et al., 2010), idea promotion and implementation (Mura et al., 2013) and innovation (Hu and Randel, 2014). Therefore, it is essential to know the reasons that may affect knowledge sharing behavior as this will constitute the first step toward increasing the output performance of the R&D centers. This paper aims to assist the effort by investigating the factors that influence the intention to share knowledge and the actual knowledge sharing behavior among members of the Biological Research Information Center (BRIC) – a Specialized National Research Information Center. The study bases its research model on social capital theory to explore how different types of capital contribute to knowledge sharing along with intrinsic and extrinsic motivations.

Literature review

Specialized National Research Information Center

Recognizing the role of information technology (IT) as a research infrastructure, Korea launched a government-directed research information infrastructure development project, the Specialized Research Information Center (SRIC), in 1995 (Jung, 1996). The SRIC aims to support basic, applied, and multidisciplinary research by providing valuable research information. Its main function is to develop and provide specialized contents for each field, such as research trends and a research information database for each subject area. In order to build the best research network in each area, the Korean government selected active research groups from universities and public sectors. In 1995, 12 SRICs were established. This number was

later expanded to 21. As of 2014, 15 SRICs are still operating after the integration and closure of some of them.

Each of the SRICs is hosted in a university selected by the government. Grants are given to the hosting universities to run the SRICs. A governing committee led by researchers in the hosting university is formed to manage the SRICs. The committee members are well-known researchers in the subject area from universities in Korea. The public are free to join the SRICs as members. While the majority of the members reside in Korea, some are Koreans who work in foreign countries and also foreigners who are interested in the same research field. In essence, each SRIC is an online research network facility. It does not have a formal organizational boundary like a typical traditional organization. Rather, it is a virtual community of members who have similar interests, goals, needs, and practices. Therefore, the SRICs can be regarded as a meeting point for the community to share and exchange research specific information. Even without a traditional organizational boundary, the presence of a governing body positions the SRICs somewhere between a typical organization with a formal boundary and an open market with no boundary.

Information technology has altered the information sharing and cooperation processes of R&D activities among the members. Instead of the traditional manual paper sharing, members now use online Internet tools. Examples of these tools are OpenScience, Summit, Researchgate, MathOverflow, Public Library of Science (PLOS), and arXiv. In a strategic recommendation proposed in 2013, the National Science Foundation (NSF) in the USA equated the need of cyber infrastructure in the knowledge economy to that of physical infrastructure in the industrial economy (Atkins 2003). Cyber infrastructure provides ubiquitous, comprehensive knowledge environments in which research teams can share and cooperate regardless of time, distance, organizations, and academic research areas (Atkins et al., 2003). This makes specific research communities functionally complete in terms of people, data, information, tools, and devices (Atkins et al., 2003). In the USA, such cyber infrastructure-based communities operate under the names of Collaboratory, Co-laboratory, Grid Community, Science Gateway, and Science Portal (Cummings et al., 2008). In Korea, these communities come under the umbrella of the SRICs.

Biological Research Information Center

Among the existing SRICs in Korea today, the Biological Research Information Center (BRIC) is regarded

as a representative example of an online research network facility along with Database Space overseas and the ‘Science and Technology Society Village’ in Korea (Kim et al., 2007). The BRIC facilitates information exchange and cooperation among life sciences researchers in Korea and other countries by collecting, processing, integrating, and distributing research information on the topic area (Kim et al., 2007). The goal is to lead a creative research culture that transforms information into knowledge. As of 2013, the BRIC has 45,808 members, 8,832 of which are doctoral degree holders, and it collected and disseminated 49,741 records (Biological Research Information Center, 2013).

There are a number of popular and high-quality websites around the world that provide databases and analysis tools for life sciences projects. Among them are the National Center for Biotechnology Information (NCBI) in the USA, the European Bioinformatics Institute (EBI) in Europe, the DNA Data Bank of Japan (DDBJ), the Center for Computational Biology and Bioinformatics (CCBB) of the Korea Institute of Science and Technology (KIST), the Korean Bioinformation Center (KOBIC) of the Korea Research Institute of Bioscience and Biotechnology, and the BRIC (Ahn and Lee, 2009). The BRIC stands out as the one of best research information centers that provides a community function in addition to the typical data processing and research information sharing activities. Hence, the BRIC also serves as an interactive forum to discuss any issue of concern to the biological research community (Kim et al., 2007). The stem cell research conducted by Professor Hwang Woo-suk became a worldwide scandal after it was triggered by discussions in the BRIC online community forum (Chong and Normile, 2006). In addition, the BRIC is characterized by researchers constructing their own contents (Ahn and Lee, 2009). The portion of the databases constructed by the users amounted to 81 percent of all research information databases provided by the BRIC as of 2013 (Biological Research Information Center, 2013).

The popularity of the BRIC is further elevated by its online communication network called ‘Voice Plaza.’ Since the stem-cell scandal (Chong and Normile, 2006), many other issues such as the welfare of graduate students and investment in basic research have been heard through the Voice Plaza of the BRIC. This provides a good example of the BRIC’s advancement into diverse discussion topics.

Social capital theory

Social capital is “the sum of the actual and potential resources embedded within, available through, and derive from the network of relationships possessed by an individual or social unit” (Nahapiet and Ghoshal, 1998: 243). Its central tenet is the ‘networks of relationship’ that serve as a productive resource for the conduct of social affairs to enable the achievement of specific goals (Coleman, 1988; Bourdieu, 1986; Nahapiet and Ghoshal, 1998). As a resource, social capital can be mobilized through networks (Bourdieu, 1986). It is possessed as soon as the connections are established among the members of the community (Nahapiet and Ghoshal, 1998). Social capital is important to facilitate the development of intellectual capital by influencing the conditions necessary for exchange to take place (Nahapiet and Ghoshal, 1998). The more social capital is integrated within an organization, the more advantageous it is for the creation and sharing of intellectual capital such as idea promotion, idea implementation, team innovation, and product and service innovation (Auh and Menguc, 2013; Hu and Randel, 2014; Mura et al., 2013).

Nahapiet and Ghoshal (1998) categorized social capital into structural, relational, and cognitive dimensions. Structural social capital refers to “the overall pattern of connections between actors – that is, who you reach and how you reach them” (Nahapiet and Ghoshal, 1998: 244). Relational social capital is “the kind of personal relationships people developed with each other through a history of interaction” (Nahapiet and Ghoshal, 1998: 244). Cognitive social capital is “those resources providing shared representation, interpretation, and systems of meaning among parties” (Nahapiet and Ghoshal, 1998: 244). Even though the three dimensions are separated analytically, Nahapiet and Ghoshal (1998) recognized that many of the features are highly interrelated. In fact, all three dimensions constitute some aspects of the social structure and facilitate the actions of individuals within the community (Nahapiet and Ghoshal, 1998; Coleman, 1988).

Social capital and knowledge sharing

Previous studies (Chiu et al., 2006, Tsai and Ghoshal, 1998; Wasko and Faraj, 2005. Yli-Renko et al. 2001) have investigated the role and the impact of social capital in facilitating resource exchange (see Appendix A for a summary). While the studies recognize the impact of social capital on resource exchange and knowledge management activities in organizational

settings, the same agreement does not extend to online communities. Chiu et al. (2006) and Wellman et al. (2001) argued for a positive influence of the Internet on social capital, but Putnam (2000) suggested a negative influence, and Uslaner (2000) found no influence.

The interaction among the members in a virtual community differs from the traditional organizational setting in that it takes place only through online communication (Chiu et al., 2006). Unlike the general Internet users, the members of virtual communities are brought together by shared interests, goals, needs, and practices (Chiu et al., 2006). In the BRIC, the area is biology. Yet, these members do not necessarily know each other personally and have very few, if any, face-to-face contacts. In this virtual community, knowledge sharing is very different from that of the offline environment. Also, there is no concrete reward system in place that could reinforce mutual trust, interaction, and reciprocity among the members to encourage sharing (Chiu et al., 2006). Since knowledge sharing behavior in a virtual community is different from that in traditional organizational settings, it warrants further investigation.

Structural dimension

The collective action examined in this study is the knowledge sharing intention among the members of the BRIC. As the members interact more, it is likely that they will develop a “habit of cooperation” and act collectively (Marwell and Oliver, 1993). This habit will influence their willingness to share knowledge. The linkages among the members are the channels for information and resource flows that allow them to gain privileged access to information (Tsai and Ghoshal, 1998). As the linkages become denser and stronger, information sharing becomes easier and effortless. In the BRIC, information and knowledge about specific biology-related areas can be ‘niche’ and hence difficult and expensive to obtain. The presence of the linkages in the BRIC network enables the members to source information and share knowledge more effectively and cost efficiently. The linkages also provide the opportunity to combine and exchange knowledge (Nahapiet and Ghoshal, 1998).

Previous research has measured structural capital using social tie (Chiu et al., 2006; Tsai and Ghoshal, 1998). The strength of a social tie is determined using a combination of the strength of the relationships, the amount of the time spent, and the communication frequency among the members (Chiu et al., 2006). The

more social interaction undertaken by the BRIC members, the greater the intensity, frequency, and breadth of the information exchange.

H1: Social tie will positively affect the intention of the BRIC members to share knowledge.

Relational dimension

In this study, we examine the trust dimension of the relational capital since it is the key aspect of relational capital and a facilitator of collective action (Coleman, 1988). Trust is a belief toward the ability, integrity, benevolence of another party (Gefen et al., 2003). It is developed through favorable past events that lead to positive expectation toward future activities. Social exchange theory underscores the importance of interpersonal trust to the exchange of information (Burt, 1992). When trust exists, an atmosphere of knowledge sharing is formed which increases the willingness of the members to engage in cooperative knowledge sharing interaction, resource acquisition, and knowledge contribution (Nahapiet and Ghoshal, 1998; Chang and Chuang, 2011). In online settings (Ridings et al., 2002) and in technology R&D teams (Huang, 2009), trust has been found to contribute to knowledge sharing behaviour. The BRIC embraces the online setting environment and inherits the characteristics where contributions are volitional and may not be linked to any external rewards (Bartol and Srivastava, 2002; Chiu et al., 2006). In this environment, trust is essential to encourage knowledge sharing and exchange among the members. Therefore, we hypothesize,

H2: Social trust will positively affect the intention of the BRIC members to share knowledge.

Cognitive dimension

The presence of cognitive capital is essential for meaningful exchange of knowledge to take place (Nahapiet and Ghoshal, 1998). One way to establish shared interpretations and meanings is to have a shared vision (Tsai and Ghoshal, 1998). A shared vision is “a bonding mechanism that helps different parts of an organization to integrate or to combine resources” (Tsai and Ghoshal, 1998: 467). It makes cooperative actions possible and easier. In online communities, shared vision is very important to facilitate knowledge sharing (Chiu et al., 2006). Since the members of the BRIC shared similar research goals, they are likely to see similar meaning and advantage of their knowledge sharing,

this will increase their intention to share knowledge with others in the BRIC network.

H3: Shared vision will positively affect the intention of the BRIC members to share knowledge.

While one is motivated to share knowledge, having the requisite expertise and knowledge to contribute is essential for sharing to take place. This is especially the case in the R&D and the academic societies (Wasko and Faraj, 2005) where niche knowledge is often required. Research has found that individuals with higher levels of expertise are more likely to provide useful advice on computer networks (Constant et al., 1996). These individuals are confident toward their capability and have higher knowledge self-efficacy (Wasko and Faraj, 2005). We hypothesize the same for the BRIC members.

H4: Knowledge self-efficacy will positively affect the intention of the BRIC members to share knowledge.

Intrinsic and extrinsic motivation

Motivation is a salient factor that influences one's behavior (Deci and Ryan, 1987) in technology adoption (Wu and Lu, 2013; Chang et al., 2014) and knowledge sharing (Lin, 2007; Olatokun and Nwafor, 2012). Intrinsic and extrinsic motivations affect people's attitude toward knowledge sharing and contribution in the communities where they belong (Wasko and Faraj, 2005). In the Internet community, individual knowledge sharing primarily occurs when the individuals have the motivation to perform activities such as joining the community, reading the blogs or newsfeeds, and answering and responding to the questions raised (Wu and Lu, 2013). In the organizational context, Lin (2007) found that reciprocal benefit (an extrinsic motivation) and enjoyment in helping others (an intrinsic motivation) significantly affect attitude toward knowledge sharing. Reciprocal benefit refers to the benefits from the artifacts generated by individual exchange of both economic and socio-emotional resources (Lin, 2007). When individuals perceive the benefits of exchange, it will affect their attitude and knowledge sharing behavior. Enjoyment in helping others refers to unrestricted behavior or altruism that helps those who need assistance in certain task or problem (Wasko and Faraj, 2005). People who enjoy helping others have the intrinsic motivation to share knowledge to solve problems (Lin, 2007). Thus, in the BRIC, both reciprocal benefit and enjoyment in

helping others will positively influence the members' intention to share knowledge.

H5: Enjoyment in helping others will positively affect the intention of the BRIC members to share knowledge.

H6: Reciprocal Benefit will positively affect the intention of the BRIC members to share knowledge.

Knowledge sharing intention and behavior

The Theory of Reasoned Action and the Theory of Planned Behavior state that one's intention to perform an action will lead to his/her actual behavior (Ajzen and Fishbein, 1980). An individual's intention to share knowledge also has strong positive effect on his/her actual knowledge sharing behavior (Chen et al., 2009; Lin and Lee, 2004). Following the literature, we hypothesize,

H7: Intention to share knowledge will positively affect the BRIC members' knowledge sharing behavior.

Figure 1. shows the research model for this study.

Methodology

Measurement development

The measurement items in this study were adapted from validated instruments in the literature to fit our research context (Table 1). The items for reciprocal benefits were adapted from Lin (2007) and measured the belief that sharing knowledge would lead to future request to exchange knowledge. Knowledge self-efficacy instrument was adapted from Lin (2007), Lin et al. (2009), and Chen and Hung (2010) and it measured the perception of one's ability and confidence to share knowledge. Items for enjoyment in helping others were adapted from Lin (2007), and Wasko and Faraj (2005) to measure the perceptions of pleasure obtained through sharing knowledge with other members. Social trust was operationalized as the perception of social integrity between members and these items came from Lin, et al. (2009), Chen and Hung (2010), Chow and Chan (2008), and Chiu et al. (2006). Social interaction tie was operationalized as the network tie which can provide access to social resources and these items were adapted from Chiu et al. (2006), and Tsai and Ghoshal (1998). Social vision instrument was adapted from Chiu et al. (2006) and measured the perception of the collective

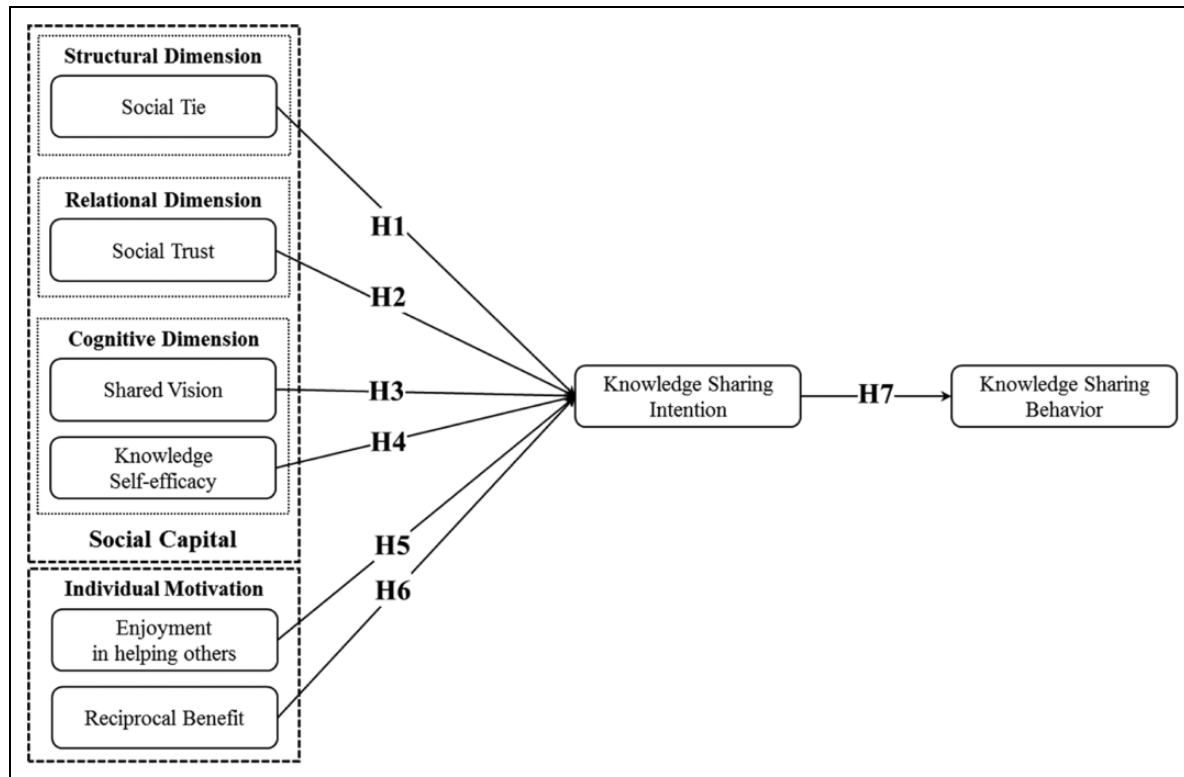


Figure 1. Research Model.

goal and aspiration of the community. The items for the intention to share knowledge were adapted from Chow and Chan (2008). The items for knowledge sharing behavior came from Chow and Chan (2008) which measured the actual behavior of knowledge sharing by asking information on the actual number of knowledge contribution and collecting behaviors.

A pilot test with 60 samples was carried out to establish the reliability and validity of the measurement items. All the construct reliability, convergent validity, and discriminant validity achieved the standard requirements suggested by previous research (Hair et al., 2009).

Data collection

An online survey was conducted to collect the data from BRIC members. The administration team of the BRIC was engaged to send out email requests for participation along with the survey links to all 42,000 members. A total 303 members responded to the survey. A 5,000 Korean Won (equivalent to USD 5 dollar) coupon was given to those who completed the survey as a token of appreciation. After removing the responses with incomplete answers and outliers, we have 286 useful data points for further analysis.

Table 2 shows the demographic characteristics of the participants.

To check the homogeneity of our sample with the population (the BRIC), we conducted a Chi-square homogeneity test. The results of the Chi-square test shows that the p-value of gender (p-value: 0.157), education (p-value: 0.241), and occupation (p-value: 0.224) are all greater than 0.05 (95 percent). Therefore, we concluded that there is no difference between our sample's demographic characteristics and the population's demographic characteristics. Therefore, our sample well represents the population of this study.

Results

Measurement model

We used Smart PLS 2.0 (<http://www.smartpls.de>) to analyze the measurement model to ensure construct reliability, convergent validity, and discriminant validity. Table 3 shows that the Cronbach's alpha and the composite reliability for all the constructs are greater than the recommended cut-off value of 0.7 (Hair et al., 2009). All item loadings of the constructs also exceed the recommended level of 0.7 suggesting more variance is shared between an item and its

Table 1. Construct definition and measurement items.

Construct		Items		Reference
Reciprocal benefits	The belief that sharing knowledge would provide one with benefits in the future request for knowledge exchange.		When I share my knowledge with members of the research information center, ...	Lin (2007)
		RB1	I strengthen the ties between the existing members of the research information center and myself.	
		RB2	I expand the scope of my association with other members in the research information center.	
		RB3	I expect to receive knowledge in return when necessary in the future.	
Knowledge self-efficacy	Perception of one's ability and confidence to share knowledge	RB4	I believe that my future requests for knowledge will be answered.	Lin, (2007); Lin, et al. (2009); Chen and Hung (2010).
		KSE1	I am confident in my ability to provide knowledge that other members in the research information center would consider valuable.	
		KSE2	I have the expertise required to provide valuable knowledge for other members in the research information center.	
		KSE3	I have confidence in responding or adding comments to messages or articles posted by other members in the research information center.	
Enjoyment in helping others	Perception of pleasure obtained through sharing knowledge with other members	KSE4	It does not really make any difference whether I share my knowledge with other members in the research information center. (Reverse coded)	Lin, H. F. (2007); Wasko and Faraj (2005)
		EH1	I enjoy sharing my knowledge with members in the research information center.	
		EH2	I enjoy helping members in the research information center by sharing my knowledge.	
		EH3	It feels good to help other members in the research information center by sharing my knowledge.	
		EH4	Sharing my knowledge with members in the research information center is pleasurable.	
Intention to shared knowledge	The intention to share knowledge with others	EH5	It feels good to help other members in the research information center solve their problems.	Chow and Chan (2008)
		ISK1	I intend to share my research, work reports and related documents with the members in the research information center more frequently in the future.	
		ISK2	I plan to share my manuals, methodologies, and models with the members in the research information center in the future.	
		ISK3	I have the intention to share my experience or know-how from work with the members in the research information center in the future.	
		ISK4	I plan to share my know-where or know-whom at the request of the members in the research information center in the future.	
		ISK5	I intend to share my expertise obtained from education and training with the members in the research information center in a more effective way in the future.	

(continued)

Table 1. (continued)

Construct		Items		Reference
Social Trust	Perception of social integrity between members.	STR1	Members in the research information center have reciprocal faith-based and trustworthy relationships.	Lin, et al. (2009).; Chen and Hung (2010); Chow and Chan (2008); Chiu et al. (2006)
		STR3	Members in the research information center always keep promises that they make to one another.	
		STR4	I know that the members in the research information center will always try and help me out if I get into difficulties.	
		STR5	I can always trust the members in the research information center to lend me a hand if I need it.	
		STR6	I can always rely on the members in the research information center to make my research and job easier.	
Knowledge Sharing behavior	Actual behavior of sharing knowledge	KCB1	Average volume of knowledge contributed per month (converted to a seven-point scale) 1 time; 2 to 3 times; 4 to 5 times; 6 to 7 times; 8 to 9 times; 10 to 11 times; more than 12 times	Chen and Hung (2010)
		KCB2	Average volume of knowledge collected per month (converted to a seven-point scale) 1 topic; 2 to 5 topics; 6 to 10 topics; 11 to 15 topics; 16 to 20 topics; 20 to 25 topics; more than 26 topics	
Social interaction ties	The network tie which can provide access to social resources	SIT1	I maintain close social relationships with some members in the research information center.	(Chiu et al., 2006); (Tsai and Ghoshal, 1998)
		SIT2	I spend a lot of time interacting with some members in the research information center.	
		SIT3	I know some members in the research information center on a personal level.	
		SIT4	I have frequent communication with some members in the research information center.	
Shared vision (Shared Goal)	Perception of the collective goal and aspiration of the community	SVG1	The members in the research information center share the vision of helping others solve their professional problems.	(Chiu et al., 2006)
		SVG2	The members in the research information center share the same goal of learning from each other.	
		SVG3	The members in the research information center share the same value that helping others is pleasant.	

construct than there is error variance (Hair et al., 2009). Furthermore, the average variance extracted (AVE) scores in Table 3 are all greater than recommended cut-off value of 0.5 (Fornell and Larcker, 1981). For discriminant validity, Table 4 shows that the square roots of the AVE for all constructs are greater than the cross-correlations with other variables. Table 5 shows that each item loads highest on its intended construct than on any other constructs. Based on the results of these tests, we concluded that our measurement model has appropriate reliability, convergent validity, and discriminant validity.

Multicollinearity and common method bias

To evaluate the potential presence of multicollinearity, we checked the variance inflation factor (VIF) score using a regression analysis. The results show that the range of the VIF score for independent variables are between 1.3 and 2.5. Since the VIF scores are lower than 10, there is no serious multicollinearity problem in this study (Lee, 2009).

We also conducted the Harman's one-factor test using exploratory factor analysis with un-rotated solution to assess the possible existence of common-method bias

Table 2. Demographic characteristics of the respondents.

		N=286	
Respondents		Frequency	Percent (%)
Gender	Male	122	42.7
	Female	164	57.3
Age	20 ~ 29	133	46.5
	30 ~ 39	108	37.8
	40 ~ 49	34	11.9
	50 ~ 59	9	3.1
	60 ~ older	2	0.7
Education level	High School diploma	2	0.7
	Associate degree	2	0.7
	Bachelor degree	34	11.9
	Master student/ Candidate	68	23.8
	Master degree	54	18.9
	Doctoral student/ Candidate	53	18.5
	Doctoral degree	73	25.5
Occupation	Research	80	28.0
	Post doc./Research professor	29	10.1
	Professor/Senior researcher	23	8.0
	Company employee	11	3.8
	Government worker	2	0.7
	Medical doctor/ Nurse	2	0.7
	University student	133	46.5
	Others	6	2.1
Affiliation	University	153	53.5
	Medical institute	16	5.6
	Research institute	69	24.1
	Government office	14	4.9
	Large size company	6	2.1
	Small and medium size company	15	5.2
	Startup venture company	8	2.8
	Etc.	5	1.7
Work Experience	Less than 0 ~ 2 years	91	31.8
	Less than 2 ~ 5 years	74	25.9
	Less than 5 ~ 7 years	28	9.8
	Less than 7 ~ 10 years	29	10.1
	Less than 10 ~ 15 years	37	12.9
	Less than 15 ~ 20 years	13	4.5
	More than 20 years	14	4.9

(CMB). Since all single factor variances are below 50 percent (Hazen et al., 2011), there is no issue of CMB.

Structural model

Before analyzing the structural model, we examined the effect of demographic control variables on knowledge sharing behavior. We found that none of our control variables significantly affects

knowledge sharing behavior, which is the dependent variable.

For the structural model, we assessed the exploratory power of our research model by checking the R^2 values of knowledge sharing intention and knowledge sharing behavior. Knowledge sharing intention accounts for 60.6 percent and knowledge sharing behavior accounts for 43.7 percent of the variance in the model (Figure 2). These high R^2 values provide

Table 3. Descriptive statistics and convergent validity.

Construct	Item	Loading	Mean	SD	AVE	CR	α
EH	EH1	0.900	5.38	1.07	0.871	0.971	0.963
	EH2	0.945					
	EH3	0.953					
	EH4	0.940					
	EH5	0.926					
ISK	ISK1	0.896	5.33	1.02	0.837	0.963	0.951
	ISK2	0.919					
	ISK3	0.929					
	ISK4	0.914					
	ISK5	0.916					
KSE	KSE1	0.712	5.18	0.96	0.568	0.840	0.751
	KSE2	0.702					
	KSE3	0.796					
	KSE4	0.798					
KS	KS1	0.933	5.13	1.06	0.865	0.927	0.844
	KS2	0.927					
RB	RB1	0.737	4.92	1.02	0.615	0.864	0.796
	RB2	0.721					
	RB3	0.835					
	RB4	0.836					
SIT	SIT1	0.948	2.85	1.63	0.909	0.976	0.967
	SIT2	0.950					
	SIT3	0.947					
	SIT4	0.969					
STR	STR1	0.804	4.63	1.06	0.732	0.931	0.908
	STR3	0.847					
	STR4	0.906					
	STR5	0.897					
	STR6	0.818					
SVG	SVG1	0.894	5.14	1.10	0.831	0.937	0.899
	SVG2	0.923					
	SVG3	0.918					

Note: SD: Standard Deviation; AVE: Average variance extracted; α : Cronbach's alpha; CR: Composite reliability.

Table 4. Discriminant validity.

Construct	EH	ISK	KSE	KS	RB	SIT	STR	SVG
EH	0.933							
ISK	0.652	0.915						
KSE	0.567	0.547	0.754					
KS	0.590	0.661	0.445	0.930				
RB	0.512	0.593	0.514	0.454	0.784			
SIT	0.249	0.262	0.211	0.200	0.290	0.954		
STR	0.493	0.610	0.380	0.495	0.575	0.465	0.855	
SVG	0.552	0.644	0.476	0.604	0.531	0.263	0.657	0.912

Numbers in bold represent the square root of the AVE while numbers in italics represent the correlations.

Table 5. Loadings and Cross-Loadings.

Item	KS	EH	KSE	ISK	RB	SIT	STR	SVG
KS1	0.933	0.593	0.427	0.626	0.411	0.192	0.448	0.569
KS2	0.927	0.502	0.401	0.603	0.434	0.180	0.473	0.553
EH1	0.522	0.900	0.520	0.587	0.479	0.251	0.458	0.493
EH2	0.539	0.945	0.535	0.620	0.462	0.253	0.463	0.515
EH3	0.565	0.953	0.552	0.619	0.498	0.220	0.474	0.543
EH4	0.536	0.940	0.511	0.605	0.477	0.230	0.455	0.498
EH5	0.588	0.926	0.528	0.608	0.473	0.208	0.450	0.525
KSE1	0.261	0.335	0.712	0.344	0.359	0.237	0.263	0.332
KSE2	0.276	0.311	0.702	0.342	0.305	0.243	0.236	0.300
KSE3	0.376	0.478	0.796	0.457	0.420	0.044	0.282	0.399
KSE4	0.402	0.540	0.798	0.479	0.445	0.158	0.352	0.389
ISK1	0.638	0.626	0.524	0.896	0.560	0.249	0.587	0.612
ISK2	0.570	0.571	0.462	0.919	0.522	0.270	0.592	0.554
ISK3	0.624	0.575	0.502	0.929	0.524	0.193	0.540	0.564
ISK4	0.603	0.602	0.517	0.914	0.538	0.207	0.530	0.610
ISK5	0.586	0.605	0.494	0.916	0.567	0.282	0.541	0.607
RB1	0.277	0.407	0.342	0.369	0.737	0.405	0.469	0.352
RB2	0.286	0.374	0.352	0.375	0.721	0.437	0.492	0.341
RB3	0.430	0.391	0.468	0.548	0.835	0.081	0.420	0.467
RB4	0.396	0.441	0.426	0.526	0.836	0.113	0.455	0.476
SIT1	0.220	0.251	0.228	0.262	0.301	0.948	0.460	0.259
SIT2	0.190	0.232	0.200	0.269	0.296	0.950	0.459	0.267
SIT3	0.166	0.229	0.177	0.207	0.228	0.947	0.409	0.230
SIT4	0.181	0.235	0.196	0.253	0.270	0.969	0.437	0.241
STR1	0.424	0.458	0.395	0.565	0.601	0.381	0.804	0.614
STR3	0.379	0.387	0.330	0.490	0.450	0.384	0.847	0.514
STR4	0.426	0.453	0.335	0.543	0.479	0.419	0.906	0.562
STR5	0.498	0.461	0.317	0.540	0.505	0.412	0.897	0.585
STR6	0.378	0.330	0.231	0.455	0.399	0.389	0.818	0.519
SVG1	0.502	0.475	0.442	0.561	0.472	0.244	0.578	0.894
SVG2	0.547	0.466	0.428	0.577	0.460	0.251	0.590	0.923
SVG3	0.598	0.564	0.433	0.622	0.517	0.226	0.626	0.918

evidence that the research model has enough exploratory power.

We also assessed the path coefficient value β and the p-value of each hypothesis. As shown in Figure 2, all hypotheses are supported with the exception of H1 – the link between social tie and knowledge sharing intention. Knowledge sharing intention was determined by individual motivation: enjoyment in helping others and reciprocal benefits; relational social capital: social trust; and cognitive social capital: shared vision and knowledge self-efficacy. Knowledge sharing intention significantly influences knowledge sharing behavior.

Discussion

This study aims to test a model of knowledge sharing among BRIC members. It focuses on social capital and

motivational factors that contribute to the intention to share. The results provide support for the theoretical model and for all hypotheses with the exception of the relationship between structural capital and intention to share knowledge. The main contribution of the study comes from its application of social capital theory to the knowledge sharing context of a national research information center established by the government, hosted in a university, and run voluntarily by the community. The governing body is held responsible for the established outcome of the center. Hence, this is a unique environment for the operation of an R&D center. Since there is little research adopting similar context, the contribution of this study is eminent.

Consistent with previous research (Wasko and Faraj, 2005; Chiu et al., 2006), the results provide evidence that cognitive and relational capital play vital

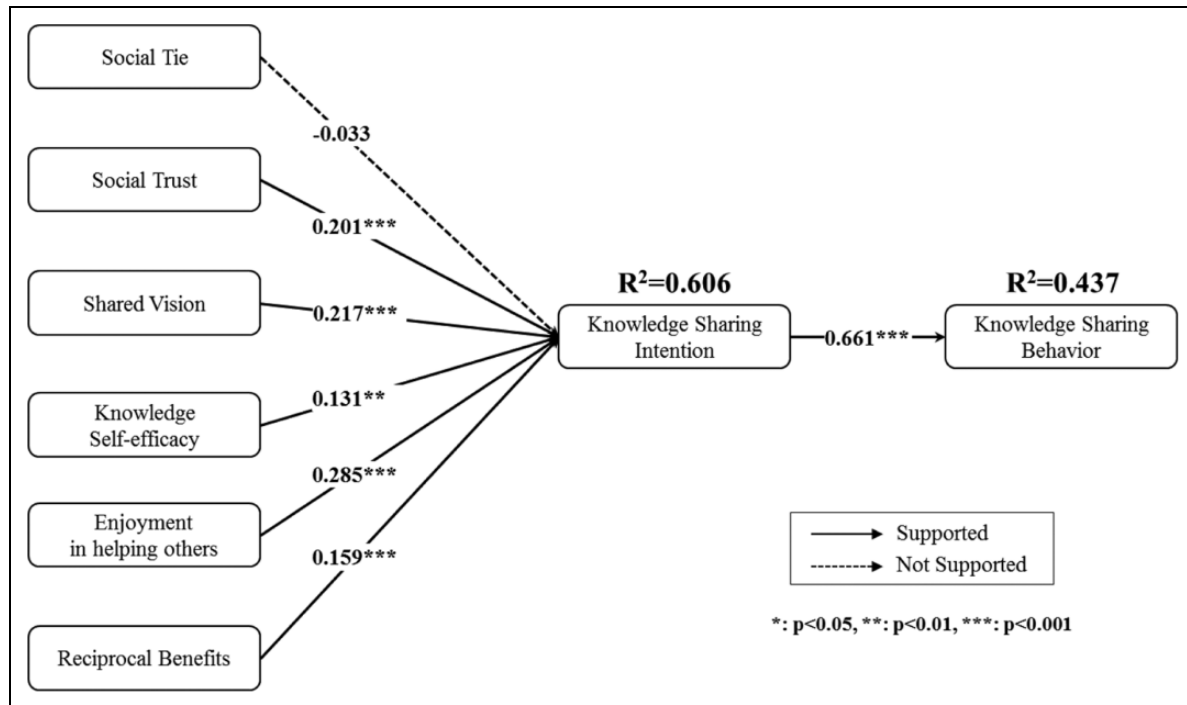


Figure 2. The results of the path analysis.

roles underlying knowledge sharing. In a virtual R&D environment with members mostly holding academic profiles, individual confidence toward their own knowledge level and their capability to contribute to others will determine their intention to share their knowledge. Furthermore, since the R&D community is essentially a community of practice with the members joining the groups voluntarily, an individual's self-rated expertise is important to the volume of knowledge contributed (Wasko and Faraj, 2005; Brown and Duguid, 1991).

The members' knowledge contribution also needs to be underlined with a shared vision toward the goal of the research community and its betterment as well as toward the value of knowledge sharing. To this end, the governing agency of the research centers could establish the vision for the community of practice. By having a common aspiration of sharing information with others, the members will be more willing to contribute and exchange knowledge with others within the group.

Trust is found to be important to members' knowledge sharing intention. However, trust is often built over time via shared history, frequent interaction, and co-presence (Cohen and Prusak, 2001; Nahapiet and Ghoshal, 1998). Research centers can organize activities such as small group meetings for specific research fields through social network functions to

support continuous and close relationships among the members. Such frequent interaction will help to establish trust among the members.

The lack of a significant relationship between structural capital and the intention to share knowledge goes in contrast to most findings in the literature that shows a positive significant effect (Wasko and Faraj, 2005; Chiu et al., 2006). However, some previous literature do have the same insignificant findings (Mura et al., 2013; Chang and Chuang, 2011). A plausible explanation for this finding lies in the strength of the social ties and relationships among the members in the BRIC. Auh and Menguc (2013) empirically showed that relationship quality has a significant effect on knowledge sharing in the Internet community. In a big community or within a large research group, it is very difficult for the members to form close relationship and good relationship quality with others (Hansen, 1999). In the BRIC, where members can come from different parts of Korea or even different corners of the world, forging a close relationship is impossible. Furthermore, the fluidity of the BRIC boundary and the fact that the BRIC is only an online entity influences one's perception toward the amount of time spent with members and the communication frequency among the members. All these reasons nullify the importance of social tie and its effect on knowledge sharing intention. Therefore, the BRIC or other NRICs managers

should strategize to improve the social tie among the members. For example, they could organize small discussion groups or research groups to enhance the interaction among the members. Chang and Chuang (2011) insisted that when the members have intense interactions and a sense of belonging, they will participate more in knowledge sharing activities.

As expected, motivation, both intrinsic and extrinsic, influences one's intention to share knowledge. In fact, enjoyment in helping others has the strongest influence on intention to share knowledge. In a virtual context where participation is voluntary, it is crucial that members find and receive pleasure in the process of exchanging their knowledge. Only then will they continue to contribute to the knowledge forum.

Besides that, members also expect some forms of extrinsic return from their sharing of knowledge. These extrinsic returns can be both economic and socio-emotional resources. The reciprocity does not need to be in a dyadic form, rather it takes the generalized reciprocity format where one's giving is not reciprocated by the recipient but by a third party (Ekeh, 1974). In the virtual R&D environment, members only expect the community as a whole to assist them when they have questions rather than anticipating responses from the specific individual whom they might have helped previously. The finding on the importance of reciprocal benefits is consistent with prior studies (Lin, 2007).

Since motivation strongly affects knowledge sharing, policies that can maintain such motivation should be established. For example, knowledge sharing events and seminars can serve as an avenue for researchers to communicate with each other and to share positive outcomes and practical achievements of their research areas. The sharing that takes place can be a form of socio-emotional resource that members desire especially when they receive recognition from their achievements.

Overall, the SRIC is an important initiative of the Korean government. To promote knowledge sharing as an effort toward better output performance, the government should devise clear guidelines and assistance on how knowledge exchange and sharing could and should take place among the members in the community. The government should also devise measures to determine the rate at which the research information centers are being utilized for communication and

knowledge exchange among the researchers. By having objective measures, the government will have a better understanding on the success of its initiatives.

Limitations and future research

As with any piece of research, this study has limitations. One limitation is that we only studied one successful research center. While all virtual communities may share similar behavioral characteristics, it is possible that the members of different communities have dissimilar group cultures that influence their behaviors. However, since our research model is founded on solid social capital theory, we are confident of its value and contribution. Nevertheless, future research could still investigate the behaviors of the members in other research centers to further establish the validity of our research model. Future research could also study research centers that have failed to function and compare and contrast the factors with those found in this study. This will help to better understand the knowledge sharing patterns in research centers and the mechanisms by which the patterns relate to output performance. Furthermore, future research could relate the history of an R&D center (i.e., its length of establishment) with the members' intention to share knowledge.

Another limitation is that this study did not directly link knowledge sharing activity of the members with the actual R&D deliverables such as the number of papers published and the number of patents obtained. Instead, the study built on findings from previous research that knowledge sharing is important in influencing R&D output performance (Wen and Kobayashi, 2001; Polt et al., 2001; Hanaki et al., 2010). Future research could collect information on the actual output to establish the link between knowledge sharing in a R&D center and the deliverables. Since the BRIC is a high quality research center with the majority of the respondents having received higher education, it is possible that the intention to share knowledge is already strong. However, in research centers, there are also passive members who only receive knowledge but have never contributed to knowledge sharing. This study included all members regardless of whether they are active or passive. Future research can compare the differences between these two groups.

Appendix A*Prior research on knowledge sharing with social capital theory (2011–2014)*

Reference	Research Subjects (Country)	Method	Social Capital			Variables
			RL	ST	CG	
Abdullah et al. (2011)	Academicians in Public University (Malaysia)	Empirical	X			Rational psychological contract, Trust, Collaboration, Knowledge sharing
Auh and Menguc (2013)	Industrial salespeople (USA)	Empirical	X			Pay-for-performance, Strength of Knowledge sharing norms, Co-worker relationship quality
Chang and Chuang (2011)	Internet-related virtual community users (Taiwan)	Empirical	X	X	X	Social Interaction, Trust, Identification, Reciprocity, Shared language, Participant involvement, Knowledge sharing behavior
Choi and Scott (2013)	Facebook users (USA and South Korea)	Empirical	X			SNS usage intensity, Trust, Norms, Obligations, Identification, Knowledge sharing, eWOM quality
De Clercq et al. (2013)	Technically oriented and commercially oriented managers from 1500 companies (Canada)	Empirical	X		X	Entrepreneurial orientation, Internal knowledge sharing, Trust, Goal congruence, Formalization
Fulk and Yuan (2013)	Enterprise social networking systems	Conceptual	X	X		Location (transaction memory theory), Costs and benefits (Motivation), Social capital (structural and relational)
Hau and Kim (2011)	Online game user community (South Korea)	Empirical	X	X	X	Expected extrinsic benefits, Expected intrinsic benefits, Expected relational benefits, Social ties, Social trust, Shared goals, Attitude, Intention, Subjective norm, Self-efficacy, Innovation-conductive knowledge sharing, Community membership period
Hau et al. (2013)	Corporate members of knowledge management research center community (South Korea)	Empirical	X	X	X	Organizational rewards, Reciprocity, Enjoyment, Social tie, Social trust, Shared goals, Tacit knowledge sharing intention, Explicit knowledge sharing intention
Hu and Randel (2014)	Middle and senior level managers of companies (China)	Empirical	X	X	X	Relational social capital, Cognitive social capital, Structural social capital, Extrinsic incentives, Explicit knowledge sharing, Tacit knowledge sharing, Team innovation
Kim et al. (2013)	Employees of 14 top tier hotels (South Korea)	Empirical	X	X	X	Structural social capital, Relational social capital, Cognitive social capital, Knowledge collecting, Knowledge donating, Organizational performance
Lin (2011)	Members of virtual team in IT industry (Taiwan)	Empirical	X	X	X	Job effectiveness, Knowledge sharing, Team commitment, Structural social capital, Cognitive social capital, Relational social capital
Mura et al. (2013)	Employees of four hospices and palliative care organizations (Italy)	Empirical	X	X		Knowledge sharing best practice, Sharing mistakes, Relational capital, Structural capital, Idea promotion, Idea implementation

(continued)

Appendix A (continued)

Reference	Research Subjects (Country)	Method	Social Capital			Variables
			RL	ST	CG	
Sheng and Hartono (2013)	Company online community (USA)	Conceptual	X	X	X	Knowledge creation and sharing, Structural dimension, Relational dimension, Cognitive dimension
Tsai et al. (2014)	Team leaders of IT industries (Taiwan)	Empirical	X	X	X	Trust, Shared vision, Social Interaction, Positive affective tone, Knowledge sharing
Wang et al. (2014)	Employees of Chinese software company (China)	Empirical	X			Extraversion, Agreeableness, Conscientiousness, Neuroticism, Openness, Knowledge sharing
Yoon and Wang (2011)	Internet-related virtual community users (South Korea)	Empirical	X	X	X	Altruism, Conscientiousness, Sportsmanship, Courtesy, Civic virtue, Social interaction ties, Trust, Norm of reciprocity, Identification, Shared goals, Knowledge quality, Knowledge sharing
Yu et al. (2013)	Team member of Knowledge-intensive work (China)	Empirical	X	X	X	Network density, Cognition commonality, Cooperative norms, Betweenness centrality, shared cognition, Affective commitment, Knowledge sharing behavior

Note: RL=Relational Dimension, ST=Structural Dimension, CG=Cognitive Dimension.

Acknowledgement

This research was funded by the MSIP (Ministry of Science, ICT & Future Planning), Korea in the ICT R&D Program 2014.

References

- Abdullah NL, Hamzah N, Arshad R, Isa RM and Ghani RA (2011) Psychological contract and knowledge sharing among academicians: mediating role of relational social capital. *International Business Research* 4: 231.
- Ahn B-Y and Lee E-B (2009) A comparative analysis of bioinformation website services. *Journal of Information Management (KISTI)* 40: 157–181.
- Ajzen I and Fishbein M (1980) *Understanding Attitudes and Predicting Social Behavior*. Englewood Cliffs, NJ: Prentice-Hall.
- Atkins DE, Droegemeier KK, Feldman SI, et al. (2003) Revolutionizing science and engineering through cyberinfrastructure: Report of the National Science Foundation blue-ribbon advisory panel on cyberinfrastructure. *Report of the National Science Foundation Blue-Ribbon Advisory Panel on Cyberinfrastructure*. National Science Foundation.
- Auh S and Menguc B (2013) Knowledge sharing behaviors of industrial salespeople: An integration of economic, social psychological, and sociological perspectives. *European Journal of Marketing* 47: 1333–1355.
- Bartol KM and Srivastava A (2002) Encouraging knowledge sharing: The role of organizational reward systems. *Journal of Leadership and Organization Studies* 9: 64–76.
- Battelle (2013) 2014 Global R&D Funding Forecast. *R&D Magazine*. Battelle.
- Biological Research Information Center (2013) Annual Report of Biological Research Information Center. <http://bric.postech.ac.kr/myboard/list.php?Board=bric_board>. Access April 30, 2014.
- Bourdieu P (1986) The forms of capital. In: Richardson J (ed) *Handbook of Theory and Research for the Sociology of Education*. New York: Greenwood, 241–258.
- Brown JS and Duguid P (1991) Organizational learning and communities-of-practice: Toward a unified view of working, learning, and innovation. *Organization Science* 2: 40–57.
- Burt RS (1992) *Structural Holes*. Cambridge, MA: Harvard University Press.
- Chang HH and Chuang S-S (2011) Social capital and individual motivations on knowledge sharing: Participant involvement as a moderator. *Information & Management* 48: 9–18.
- Chang Y, Wong SF and Park M-C (2014) A three-tier ICT access model for intention to participate online: A comparison of developed and developing countries. *Information Development*. Published online before print April 10, 2014, doi:10.1177/0266666914529294.

- Chen CJ and Hung SW (2010) To give or to receive? Factors influencing members' knowledge sharing and community promotion in professional virtual communities. *Information & Management* 47: 226–236.
- Choi JH and Scott JE (2013) Electronic word of mouth and knowledge sharing on social network sites: A social capital perspective. *Journal of Theoretical and Applied Electronic Commerce Research* 8: 69–82.
- Chen CM, L.J.C and KinShuk (2009) Examining the factors influencing participants' knowledge sharing behavior in virtual learning communities. *Journal of Educational Technology & Society* 12: 134–148.
- Chiu CM, Hsu MH and Wang ET (2006) Understanding knowledge sharing in virtual communities: An integration of social capital and social cognitive theories. *Decision Support Systems* 42: 1872–1888.
- Chong S and Normile D (2006) How young Korean researchers helped unearth a scandal. *Science* 311: 22–25.
- Chow WS and Chan LS (2008) Social network, social trust and shared goals in organizational knowledge sharing. *Information & Management* 45: 458–465.
- Cohen D and Prusak L (2001) *In Good Company: How Social Capital Makes Organizations Work*. Boston, MA: Harvard Business School Press.
- Coleman JS (1988) Social capital in the creation of human capital. *American Journal of Sociology* 94: S95–S120.
- Constant D, Sproull L and Kiesler S (1996) The kindness of strangers: The usefulness of electronic weak ties for technical advice. *Organization Science* 7: 119–135.
- Cummings J, Finholt T, Foster I, et al. (2008) Beyond being there: A blueprint for advancing the design, development, and evaluation of virtual organization. *Final Report from Workshops on Building Effective Virtual Organizations*. Arlington, VA: National Science Foundation 58.
- De Clercq D, Dimov D and Thongpapanl NT (2013) Organizational social capital, formalization, and internal knowledge sharing in entrepreneurial orientation formation. *Entrepreneurship Theory and Practice* 37: 505–537.
- Deci EL and Ryan RM (1987) The support of autonomy and the control of behavior. *Journal of Personality and Social Psychology* 53: 1024–1037.
- Dutta S and Lanvin B (2013) The Global Innovations Index 2013: The local dynamics of innovation. In: Dutta S and Lanvin B (eds.) *The Global Innovations Index 2013: The Local Dynamics of Innovation*. Geneva, Ithaca, and Fontainebleau: Cornell University, INSEAD, WIPO, 1–393.
- Ekeh PP (1974) *Social Exchange Theory: The Two Traditions*, Cambridge, MA: Harvard University Press.
- Fulk J and Yuan YC (2013) Location, motivation, and social capitalization via enterprise social networking. *Journal of Computer-Mediated Communication* 19: 20–37.
- Gefen D, Karahanna E and Straub DW (2003) Trust and TAM in online shopping: An integrated model. *MIS Quarterly* 27: 51–90.
- Hair JF, Black WC, Babin BJ and Anderson RE (2009) *Multivariate Data Analysis*. New Jersey: Upper Saddle River, Pearson Prentice Hall.
- Hanaki N, Nakajima R and Ogura Y (2010) The dynamics of R&D network in the IT industry. *Research Policy* 39: 386–399.
- Hansen MT (1999) The search-transfer problem: The role of weak ties in sharing knowledge across organization subunits. *Administrative Science Quarterly* 44: 82–111.
- Hazen BT, Cegielski C and Hanna JB (2011) Diffusion of green supply chain management: Examining perceived quality of green reverse logistics. *The International Journal of Logistics Management* 22: 373–389.
- Hau YS and Kim YG (2011) Why would online gamers share their innovation-conducive knowledge in the online game user community? Integrating individual motivations and social capital perspectives. *Computers in Human Behavior* 27: 956–970.
- Hau YS, Kim B, Lee H and Kim YG (2013) The effects of individual motivations and social capital on employees' tacit and explicit knowledge sharing intentions. *International Journal of Information Management* 33: 356–366.
- Hu L and Randel AE (2014) Knowledge sharing in teams: Social capital, extrinsic incentives, and team innovation. *Group & Organization Management* 39: 213–243.
- Huang C-C (2009) Knowledge sharing and group cohesiveness on performance: An empirical study of technology R&D teams in Taiwan. *Technovation* 29: 786–797.
- Jung H (1996) Special Report: Specialized Research Information Center Project. *Digital Library* 3: 46–51.
- Kim TT, Lee G, Paek S and Lee S (2013) Social capital, knowledge sharing and organizational performance: What structural relationship do they have in hotels? *International Journal of Contemporary Hospitality Management* 25: 683–704.
- Kim Y, Jeong J and Lee S (2007) A study on operational model of subject-based online community for open access system – with special reference to community service functions and researcher's participation will. *Journal of the Korean Society for information Management* 24: 5–31.
- Lee MC (2009) Factors influencing the adoption of Internet banking: An integration of TAM and TPB with perceived risk and perceived benefit. *Electronic Commerce Research and Applications* 8: 130–141.
- Lin CP (2011) Modeling job effectiveness and its antecedents from a social capital perspective: A survey of virtual teams within business organizations. *Computers in Human Behavior* 27: 915–923.
- Lin H-F (2007) Effects of extrinsic and intrinsic motivation on employee knowledge sharing intentions. *Journal of Information Science* 33: 135–149.

- Lin H-F and Lee G-G (2004) Perceptions of senior managers toward knowledge-sharing behaviour. *Management Decision* 42: 108–125.
- Mura M, Lettieri E, Radaelli G and Spiller N (2013) Promoting professionals' innovative behaviour through knowledge sharing: The moderating role of social capital. *Journal of Knowledge Management* 17: 527–544.
- Marwell G and Oliver P (1993) *The Critical Mass in Collective Action: A Micro-Social Theory*, New York: Cambridge University Press.
- Ministry of Science, ICT and Future Planning (2014) 2012 National R&D Projects Performance Report, Ministry of Science, ICT and Future Planning. <http://www.msip.go.kr/www/brd/m_158/down.do?brd_id=w_g0303&seq=281&data_tp=A&file_seq=1>. Access April 30, 2014.
- Nahapiet J and Ghoshal S (1998) Social capital, intellectual capital, and the organizational advantage. *The Academy of Management Review* 23: 242–266.
- Olatokun W and Nwafor CI (2012) The effect of extrinsic and intrinsic motivation on knowledge sharing intentions of civil servants in Ebonyi State, Nigeria. *Information Development* 28: 216–234.
- Pol W, Gassler H, Schibany A, et al. (2001) Benchmarking industry—science relations: The role of framework conditions. *Science and Public Policy* 28: 247–258.
- Putnam RD (2000) *Bowling Alone: The Collapse and Revival of American Community*. New York: Touchstone.
- Ridings C, Gefen D and Arinze B (2002) Some antecedents and effects of trust in virtual communities. *Journal of Strategic Information Systems* 11: 271–295.
- Sheng M and Hartono R (2013) An exploratory study of knowledge creation and sharing in online community: A social capital perspective. *Total Quality Management & Business Excellence* (ahead-of-print), 1-15.doi:10.1080/14783363.2013.776769.
- Tsai W and Ghoshal S (1998) Social capital and value creation: An empirical study of intrafirm networks. *Academy of Management Journal* 41: 464–476.
- Tsai YH, Ma HC, Lin CP, Chiu CK and Chen SC (2014) Group social capital in virtual teaming contexts: A moderating role of positive affective tone in knowledge sharing. *Technological Forecasting and Social Change* 86: 13–20.
- Uslaner EM (2000) Social capital and the net. *Communications of the ACM* 43: 60–65.
- Wang S, Noe RA and Wang ZM (2014) Motivating knowledge sharing in knowledge management systems a quasi-field experiment. *Journal of Management* 40: 978–1009.
- Wasko MM and Faraj S (2005) Why should I share? Examining social capital and knowledge contribution in electronic networks of practice. *MIS Quarterly* 29: 35–57.
- Wellman B, Quan-Haase A, Witte J, et al. (2001) Does the Internet increase, decrease, or supplement social capital? Social networks, participation, and community commitment. *American Behavioral Scientist* 45: 437–456.
- Wen J and Kobayashi S (2001) Exploring collaborative R&D network: some new evidence in Japan. *Research Policy* 30: 1309–1319.
- Wu J and Lu X (2013) Effects of extrinsic and intrinsic motivators on using utilitarian, hedonic, and dual-purposed information systems: A meta-analysis. *Journal of the Association for Information Systems* 13: 153–191.
- Yli-Renko H, Autio E and Sapienza HJ (2001) Social capital, knowledge acquisition, and knowledge exploitation in young technology based firms. *Strategic Management Journal* 22: 587–613.
- Yoon C and Wang ZW (2011) The role of citizenship behaviors and social capital in virtual communities. *Journal of Computer Information Systems* 52: 106–115.
- Yu Y, Hao JX, Dong XY and Khalifa M (2013) A multilevel model for effects of social capital and knowledge sharing in knowledge-intensive work teams. *International Journal of Information Management* 33: 780–790.

About the authors

KyeongNam Yeon is a PhD candidate in the Department of Business and Technology Management at the Korea Advanced Institute of Science and Technology (KAIST). She is also a director of the Office of Creativity & Character Education in Korea Foundation for the Advancement of Science & Creativity. She received her BS and MS degree in Agricultural Biology from Seoul National University. KyeongNam's research interests include national R&D strategy, knowledge sharing, and social impact of ICT. Contact: Department of Business & Technology Management, KAIST, #5108, N22, 291 Daehak-ro, Yuseong-gu, Daejeon, 305-701, Republic of Korea. Tel: +82423506332. Fax: +82423506339. Email: yeonkn@kaist.ac.kr

Siew Fan Wong is an associate professor in the Department of Information Systems at Sunway University, Malaysia. She received her PhD degree in MIS from the University of Houston, Texas. Her research includes IT outsourcing and organizational IT strategy. Recently, she starts working on projects that look at the impacts of social media usage and digital divide. Her publications have appeared in journals such as Information Development, Entree Journal of Information Technology, and International Journal of Business Data Communications and Networking. Contact: Department of Information Systems, Sunway University, No. 5, Jalan Universiti, Bandar Sunway, 47500 Selangor, Malaysia. Tel: +60374918622 Ext: 8315. Email: siewfanw@sunway.edu.my

Younghoon Chang is a lecturer in the Department of Information Systems at Sunway University, Malaysia. He received his PhD degree in Business & Technology Management from the Korea Advanced Institute of Science and Technology (KAIST), South Korea. Younghoon's research interests include digital divide, Information privacy, e-business, business analytics and knowledge sharing in social network service. His articles have appeared in *Information Development*, *Telematics and Informatics*, *Entrue Journal of Information Technology*, and *Telecommunications Review* as well as in the proceedings of international conferences. Contact: Department of Information Systems, Sunway University, No. 5, Jalan Universiti, Bandar Sunway, 47500 Selangor, Malaysia. Tel: +60374918622 Ext: 3209. Email: younghoonc@sunway.edu.my

Myeong-Cheol Park is a professor in the Department of Business and Technology Management at the Korea Advanced Institute of Science and Technology (KAIST). He is a board member of CPRsouth (Communication Policy

Research South) and former President of Korea Technology Innovation Society. He has published numerous papers in the areas of telecommunications management strategy and economics in *Telecommunications Policy*, *Information Economics and Policy*, *Internet Research*, *Journal of Global Information and Management*, *Scientometrics*, *Information Technology and Management*, *Information Systems and e-Business Management*, *Management Decision*, and *ETRI Journal*. One of his papers published in *Telecommunications Policy* is now honored as the most-cited paper since his publication from 2004. Before joining KAIST, he worked for Electronics and Telecommunication Research Institute (ETRI), one of the largest Korean government research institutes. He received his BS and MA degrees from Seoul National University, and his PhD degree in business administration from the University of Iowa (USA). Contact: Department of Business & Technology Management, KAIST, #504, N22, 291 Daehak-ro, Yuseong-gu, Daejeon, 305-701, Republic of Korea. Tel: +82423506313. Fax: +82423506339. Email: imcpark@kaist.ac.kr