The Effects of IT SMEs' Utilizing Industry-Academia Collaboration Network and Relationship Bond on The Acquisition of IT Technological Knowledge and Performance

Youngshim Kim
National Program of Excellence in Software Center
/Chosun University
South Korea
kys4779@chosun.ac.kr

ABSTRACT

The main objective of the present study was to investigate the effects of IT small and medium-sized companies' using industry-academia collaboration network on relationship bond and their acquisition of technological and market knowledge. Moreover, the study attempted to examine whether the acquisition of IT technological and market knowledge positively affect firm performance, mediated by IT technology development performance. Questionnaires were administered with 182 IT small and medium-sized companies. The study found that use of industry-academia collaboration network positively affected relationship bond and the acquisition of IT technological and market knowledge and that the acquisition of technological and market knowledge positively affected firm performance, mediated by IT technology development performance. The findings of the study imply that in order to maximize their IT technology development capacity small and medium-side companies with limited infrastructure and capacity need to establish partnership and improve the quality of relationship with academia.

KEYWORDS

IT SMEs, Industry-academia Collaboration, Relationship Bond, Acquisition of IT technological knowledge, IT Technology development performance

1 INTRODUCTION

In the past companies operated under the old paradigm that they manufactured products by adopting the existing technology. Nowadays, however, they have realized that they cannot survive without developing technology on their own. Nevertheless, due to their poor financial situations most small and medium-sized enterprises are limited in their capacity to develop technology for themselves [16]. Therefore, they have to seek ways to utilize outside sources or knowledge, one of which is industry-academia collaboration. Industry-academia collaboration refers to industry and academic institutes collaborating on R&D of new technology and transferring the technology to industry, supported by the national or local government.

In order to develop their industry most developed countries have formed a cluster in a particular region (e.g., the Silicon Valley in the U.S. and Sophia Antipolis in France) to develop industry, establishing a communication system to transfer the competencies of academic institutions. Accordingly, research attention has been paid to this form of cluster-based industry-academia collaboration. The trend of previous research includes: 1) research on the effects of human resources collaboration and collaborative activities between academia and [8,12,14,16]; 2) studies of developing and sharing innovative technology for the commercialization of fundamental principles and improving R&D systems [11,17,19]; 3) studies on the effects of industry-academia collaboration on reinforcing the competence of academia [1].

Most previous research was focused on firm performance as the results of collaborative relationships. Little research has been conducted to investigate the process of knowledge transfer within the industry entities or the quality of relationships. In fact, industry often questions the effectiveness of industry-academia collaboration due to possibly different objectives and the technological gap between industry and academia, and the lack of academia competence [16]. Industry is not sure whether its efforts to absolve the competence of academia can actually lead to technology development or improved firm performance[18]. Therefore, it is necessary to investigate whether joint R&D and the collaboration system successfully transfer related market trend and technological knowledge. Moreover, whether the

relationship actually helps industry to accumulate knowledge, resulting in technology development performance also should be examined. Furthermore, the quality of relationship is yet to be explored. That is, when a mutually positive partnership (relationship bond) is formed, we need to know whether the bond will activate the acquisition of market trend and technological knowledge, which will have a positive effect on firm performance.

The specific objectives of the study are: 1) to investigate the effects of using industry-academia collaboration network by small and medium companies on their relationship bond and acquisition of IT technological and market information; 2) to examine the effects of relationship bond on the acquisition of IT technological and market knowledge; 3) to look into the effects of the acquisition of IT technological and market knowledge on IT technology development performance; and 4) exploring the effects of IT technology development performance on firm performance.

2 THEORETICAL BACKGROUND

2.1 Use of Industry-accademia Collaboration Network and Relationship Bond

Industry-academia collaboration refers to joint R&D by industry and academia supported by the national or local government [5]. In this study the use of industry-academia collaboration network is defined as industry establishing network with academia, sharing resources for joint R&D projects, or conducting collaborative research for technological knowledge and information [13]. Bond is defined as efforts or processes of forming close relationships based on trust with partners [15]. It can also be defined as the state of expecting a continued relationship in the future [2]. Therefore, relationship bond is operationally defined in this study as efforts or processes of forming a close relationships between industry and academia and expectation of a long-term relationship in the future [19].

The industry and the academic institute that signed an agreement for their needs want to establish mutual network and create value they both need.[5,20]. In this process, the industry depends on the academic institute to transfer its competence, during which process trust can be formed, which in turn, leads both parties to continue the relationships [8]. Moreover, they both want to maintain the relationship to achieve their common goals [10]. Accordingly, if industry sets up an industry-academia consortium supported by the government, it will maintain the contact with academia in order to commercialize the new technology and make attempts to solve problems by constant contact with the university faculty that are involved. The constant contact will develop closeness for both sides and mutual dependence can be built up through solving problems together as the project progresses. Therefore, we hypothesized the following:

H1 : Use of industry-academia collaboration network will positively affect relationship bond.

2.2 Use of Industry-academia Collaboration Network, Acquisition of IT Technological Knowledge, and Acquisition of Market Knowledge

The acquisition of technological knowledge is defined as obtaining and learning implicit information on product-manufacturing-related technology development or product development technology[9,19]. On the other hand, the acquisition of market knowledge refers to obtaining general information on the needs of customers or the trend among competitors[20]. Mutually positive collaborative network maintains continuing communication between industry and academia [10]. Since the main objectives of industry for industry-academia collaboration is R&D, it will maintain communication with the university faculty and the involved personnel in order to acquire knowledge about technology development processes, which is hard to obtain, and implicit knowledge [9]. What industry expects from the network with academia is not just IT technology development through research. The main purpose for research in industry is the commercialization of technology. As discussed before, the ultimate goal of the industry is market value and more profits. Thus, they come to learn on their own how the market is moving from the technology development project that are currently being operated and how to make an approach.

When trust is form between partners, a partnership will be formed, and knowledge exchanges can occur more easily in this kind of environment than in a difficult relationship[7]. [9] posits that when one perceives the other as an important partner who can provide necessary information, a reciprocal beneficiary relationship is formed letting them share their knowledge in depth. This indicates that when industry and academia forge bonding relationships, they share information on technology and the market trend more sincerely [3]. Accordingly, we hypothesized the following:

H2-1 : Use of industry-academia collaboration will positively affect the acquisition o f IT technological knowledge.

H2-2 : Use of industry-academia collaboration will positively affect the acquisition of market knowledge.

H3-1 : Relationship bond will positively affect the acquisition of IT technological knowledge.

H3-2 : Relationship bond will positively affect the acquisition of market knowledge.

2.3 Acquisition of IT Technological Knowledge, and Acquisition of Market Knowledge, IT Technology Development Performance, and Firm Performance

Technology development performance refers to the overall improvement in the quality of new products or in technology development competence by researching the market and/or technology trend [11]. On the other hand, firm performance refers to an increase in the firm's revenue, market share, and growth rate, which means improvement in overall performance of the firm through new product development [13]. Knowledge is the underlying factor for new product development and innovation [11], and various kinds of knowledge are crucial for successful development of a new product [14]. Moreover, failure in new product development is often caused by information uncertainty about technology or market circumstances, which can be attributed to uncertainty of overall information and the late acquisition of product development knowledge [3]. On the other hand, if industry adopts a novel idea of the development process, it will be able to speed up production by reducing or simplifying product development procedures and gain competitiveness in the market by early release of a new product. When a company acquires the know-how of technology development, it can improve product quality and technology development capability, resulting in manufacturing products that can satisfy their customers [12]. Therefore, we can hypothesize that IT technology development performance will positively affect overall firm performance in the form of gradual increases in its revenues or market share. Therefore, the following hypotheses were generated:

H4 : The acquisition of IT technological knowledge will positively affect IT technology development performance.

H5 : The acquisition of market knowledge will positively affect IT technology development performance.

H6 : IT Technology development performance will positively affect firm performance.

3 RESEARCH METHODOLOGY

3.1 Sample of the Study and Data Collection

IT Small and medium-sized Korean companies in the capital and local participated in the study. The respondents of the questionnaires were those in managerial positions or in charge of technology development who had sufficient knowledge of industry-academia collaboration and their company's overall situations. Questionnaires were distributed by visiting each company and each company answered only one questionnaire. A total of 186 questionnaires were collected, and 182 questionnaire were used in the final analysis excluding 4 that were not complete or show serious errors.

3.2 Sample Characteristics

A frequency analysis showed the general status of the firms that participated in the study as follows: As to their total revenues in 2019 (until May), 35 firms (19.2%) earned between 0.1 and 1 billion won (approximately 0.1 - 1 million dollars), 32 firms (17.6%) between 1.1 and 2 billion won (1.1 - 2 million dollars), 18 firms (9.9%) between 2.1 and 3 billion won (2.1 - 3 million dollars), 15 firms (8.2%) between 3.1 and 4 billion won (3.1 - 4 million dollars), 46 firms (25.3%) between 4.1 and 5 billion won (4.1 - 5 million dollars), and 36 firms (19.8%) made over 5 billion won (5 million dollars). The companies whose revenues were under 5 billion won accounted for 80 percent of the total participants, showing their revenues fell into the small-sized company category in general. The analysis of their personnel size showed that 66 firms (36.3%) had 6~25 employees, 50 firms (27.5%) had 26~50, 37 firms (20.3%) had 51~75, and 29 firms (15.9%) had 76 employees, confirming that the companies can be categorized as small-sized companies that the study intended to investigate.

3.3 Measurement of Variables

The variables used in the study were adopted from previous related studies, and the validity and reliability of the variables have already been established. The variables were properly modified for the study. A 5-point Likert-type scale was used to measure the variables, 5 being "Strongly Agree" and 1 being "Strongly Disagree."

Use of industry-academia collaboration network was measured by 4 items, including establishing network with universities, joint R&D with the collaborating university, a joint project with a university, and technology development with the collaborating university. Modifying the question items in [18], relationship bond was measured by 3 items, including maintaining close relationships with universities that are major suppliers of technology, expectation of maintaining the relationship in the future, intent to put efforts for collaborative relationships on a voluntary basis. The acquisition of IT technological knowledge and market knowledge was measured by modifying the question items in [17,18]. The acquisition of IT technological knowledge had 3 items: Understanding how to access product technology development, receiving the know-how on new product development, and understanding product development processes. The acquisition of market knowledge was measured by 3 items: Finding research topics related to new product development for the market, obtaining the competitor's R&D plan, and getting information on customer needs. Technology development performance was measured by 3 items, modifying the question items for new product

development performance in [14]: improvement in the quality of new products, improvement in product IT technology development, and improvement in product-making process. Firm performance was measured by 3 items modifying the question items in [17]: increase in sales amount, increase in the market share, and increase in growth rate.

4 DATA ANALYSIS

4.1 Validity and Reliability Test

Confirmatory factor analysis was conducted to guarantee the validity and reliability of variable. The results showed the following indexes: X^2=127.26, df=75(p=.00), GFI=.91, AGFI=.86, NFI=.93, RMR=.044, implying that all variables had convergent and discriminant validity. The results are shown in Table 1. Testing reliability with Cronbach's coefficients, all the coefficients were with the range of .607~.921, showing the reliability of the construct variables.

Table 1: Result of Confirmatory Factor Analyses

Variables	Standard loading	Measure-ent error	t-value	Cronbach's α	Goodness of fit
Industry-academia collaboration X1 X2 X3	 0.73 0.85 0.77	 0.07 0.07 0.07	 10.71*** 13.07*** 11.50***	.828	X^2=127.26 df=75 (p=.00) GFI=.91 AGFI=.86 NFI=.93 NNFI=.96 RMR=.044
Relationship Bond Y1 Y2	 0.92 0.87	 0.06 0.06	 14.69*** 13.66***	.892	
Acquisition of IT technological knowledge Y3 Y4 Y5	 0.67 0.90 0.94	 0.07 0.06 0.06	 9.97*** 15.12*** 16.25***	.871	
Acquisition of market knowledge Y6 Y7	 0.32 0.87	 0.11 0.22	 3.00** 3.92***	.607	
IT Technology development performance Y8 Y9 Y10	 0.85 0.94 0.88	 0.06 0.06 0.06	 13.89*** 16.56*** 14.80***	.919	
Firm performance Y11 Y12	 1.00 0.86	 0.06 0.07	 16.28*** 13.13***	.921	

*** p<.001, ** p<.01

4.2 Discriminant Validity Analysis

Discriminant validity was assessed with the analysis of correlation matrix(Φmatrix) that checks the measured difference as among the theoretical different constructs. The analysis result shows that the correlation coefficient value of "1" [calculated with correlation ± (2×standard error)] out of range correlative coefficient among all the variables. Other method of testing discriminant validity was employed with average variance extract(AVE). The AVE's value was .722~.930, establishing the reliability at an acceptable level[6

4.3 Results of Hypotheses Testing

The analysis of the goodness of fit indexes of the research model showed X^2=141.32, df=82(p=.00), GFI=.91, AGFI=.86, NFI=.92, RMR=.062, suggesting the superiority of the research model. The results of the analysis of causal relationships among the variables are shown in Table 2.

Table 2: Result of Analyses on The Research Model

Hypot-hesis	Path	Path Coefficient (Standard error)	t-value	Hypothe-sis Acceptan-ce
1	Industry-academia collaboration→ relationship bond	0.51(0.09)	5.59***	Support-ed
2-1	Industry-academia collaboration→ Acquisition of IT technological knowledge	0.41(0.08)	4.85***	support-ed
2-2	Industry-academia collaboration→ Acquisition of market knowledge	0.28(0.14)	2.05*	support-ed
3-1	Relationship bond→Acquisition of IT technological knowledge	0.44(0.08)	5.26***	support-ed
3-2	Relationship bond→Acquisition of market knowledge	0.23(0.13)	1.80n/s	rejected
4	Acquisition of IT technological knowledge→ IT Technology development performance	0.48(0.09)	5.47***	support-ed
5	Acquisition of market knowledge→ IT Technology development performance	0.03(0.09)	0.38n/s	rejected
6	IT Technology development performance→	0.56(0.08)	6.68***	support-ed

	Firm performance			
Goodness of fit		x^2=141.32 df=82(p<.00) GFI=.91 AGFI=.86 NFI=.92 RMR=.062		

1. * p<.05, ** p<.01, *** p<.001 2. n/s : not significant

5 CONCLUSION AND IMPLICATION

The summary of findings in this study and their implications are as follows:

First, use of industry-academia collaboration network had a significant effect on relationship bond. The results suggest that when industry is involved in a IT technology development project with an academic institute, it needs to make contact and interactions with the academic institute with constructive and collaborative attitude to handle the tasks and assignments related to the collaborative project.

Second, use of industry-academia collaboration network had a greater effect on the acquisition of IT technological knowledge than on the acquisition of market knowledge. Still, use of industry-academia collaboration network showed a certain impact on the acquisition of market knowledge, which suggests an managerial implication that industry should be ready to grasp the changes and trends in the marketplace and their customers.

Third, relationship bond had a significant effect on the acquisition of IT technological knowledge but not on the acquisition of market knowledge. The results seem to indicate that the greater the quality of relationships becomes, the stronger the two-way communication becomes for implicit IT technology knowledge and competence gain. The finding also implies the significance of wise reciprocal communication since it is important to acquire market knowledge for reinforcing competence as well as to improve the quality of relationship.

Fourth, the acquisition of IT technological knowledge significantly affected technology development performance but the acquisition of market knowledge did not. The finding seems to indirectly show that after all IT technological knowledge begins with understanding the needs of customers.

Fifth, IT technology development performance had a significant impact on firm performance. Since new product development and IT technology development information learned through IT industry-academia collaboration affect the firm's ultimate goal of firm performance, it is recommended that industry make specific and viable plans for industry-academia collaboration to a serious extent.

Finally, unlike the existing research framework the present study investigated the relationships among the variables, that is, the causal link from relationship bond through the acquisition of IT technology and market knowledge to performance. The study made a contribution to discovering the process of internal knowledge transfer in a company and the flow of knowledge competence, which has rarely been investigated in previous studies.

ACKNOWLEDGMENTS

This research was supported by the MIST(Ministry of Science, ICT), Korea, under the National Program for Excellence in SW) supervised by the IITP(Institute for Information & communications Technology Promotion)"(2017-0-00137)

REFERENCES

[1] Anand, B. N. and Khanna, T.(2000), "Do Firms Learn to Crate Value? The Case of Alliance," *Strategic Management Journal*, 21, 295-315.

[2] Anderson, J. C. and D. W. Gerbing(1988), "Structural Equation Modeling in Practice : A Review and Recommended Two-Step Approach," *Psychological Bulletin*, 103(3), 411-423.

[3] Ashwin, W., Joshi and Sanjay Sharma(2004), Customer Knowledge Development : Antecedent and Impact on New Product Performance," *Journal of Marketing*, 68(October), 23-46.

[4] Bania N., R. Eberts and M. Forgarty(1993), "Universities and the Startup of New Companies: Can We Generalise from Route 128 and Silicon Valley?," *The Review of Economics and Statistics*, 75, 761-766.

[5] Dodgson, M.(1992), "The Strategic Management of R&D Collaboration," *Technology Analysis & Strategic Management*, 4(3), 227-244.

[6] Fornell, Claes and David F. Lacker(1981), "Evaluating Structural Equation Models with Unobservable Variables and Measurement Error," *Journal of Marketing Research*, 18(1), February: 39-50.

[7] Frenzen, Jonathan and Kent Nakamoto(1993), "Structure Cooperation, and the Flow of Market Information," *Journal of Consumer Research*, 20(Dec.), 360-75.

[8] Ganesan Shankar(1994), "Determinants of Long-Term Orientation in Buyer-Seller Relationships," *Journal of Marketing*, 58(4).

[9] Geisler, E. and A. Rubenstein(1989), " University-Industry Relations: A Review of Major Issues, in Link, A. N. and G. Tassey(eds.), Cooperative Research and Devlopment," The Industry-University-Government Relationship, Boston, MA.: Kluwer Academic Publishers.

[10] Hamel, G.(1991), "Competition for Competence and Inter-partner Learning within International Strategic Alliances," *Strategic Management Jounal*, 12(Summer special issue), 83-103.

[11] Kotabe, Masaaki and Scott Swan(1995), "The Role of Strategic ALLIANCES IN High Technology New Product Development," *Strategic Management Journal*, 16(4), 621-36.

[12] Lukas, Bryan A.(1999), "Strategic Type, Market Orientation, and Balance Between Adaptability and Adaptation," Journal of Business Research, 45(2), 147-156.

[13] Madhavan, Ravindranath and Rajiv Grover(1998), "From Embedded Knowledge to Embodied Knowledge: New Product Development as Knowledge Management," *Journal of Marketing*, 62(Oct.), 1-12.

[14] Matsuno, Ken and John T. Mentzer(2000), "The Effects of Strategy Type on the Marketing Orientation-Performance Relationship," Journal of Marketing, 64(October), 1-16.

[15] Morgan, R. T., and Hunt, S. D.(1994), "The Commitment-Trust Theory of Relationship Marketing, *Journal of Marketing*, 58(July), 20-38.

[16] Olson, Eric M., Orville C. Walker Jr., and Robert W. Ruekert(1995), "Organizing for Effective New Product Development: The Moderating Role Product Innovativeness," *Journal of Marketing*, 59(January), 48-62.

[17] Reinfleisch, Aric and Christine Moorman(2001), "The Acquisition and Utilization of Information in New Product Alliances: A Strength of Ties Perspective," *Journal of Marketing*, 65(April), 1-18.

[18] Selnes, F., and Sallis, J.(2003), "Promoting Relationship Learning," Journal of Marketing, 67, 80-95.

[19] Shemwell, Donald J. Jr. J. Joseph Coronin Jr., and William, R. Bullard(1994), "Relational Exchange in Service : An Empirical Investigation of Ongoing Customer Service-

Producer Relationships," *International Journal of Service Industry Management*, 5(3), 57-65.

[20] Sternberg, Rolf(1999), "Innovative Linkages and Proximity: Empirical Results from Recent Surveys of Small and Medium Sized Firms in German Regions," *Regional Studies*, 33(6), 529-540.