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The Effects of Technological, Organizational, and People Characteristics on Absorptive Capacity and Innovation Performance in IT Industrial Clusters

Jae Kwon Bae

Department of Management Information Systems, Keimyung University
jkbae99@kmu.ac.kr

Abstract

In the modern IT industrial cluster environment, IT cluster companies increasingly depend on external sources of information to promote innovation and improve their performance. In doing so, IT cluster companies should first enhance their absorptive capacities to increase their abilities to evaluate, assimilate, and apply external knowledge to their industries. Absorptive capacity is what enables companies to effectively acquire and utilize external as well as internal knowledge, which affects the company's ability to innovate and adapt to its changing environment. However, no prior studies have explored the influences of external and internal factors on the absorptive capacities and innovation performance of IT clusters. Therefore, we have demonstrated the relationship between IT cluster characteristics and the innovation performance of firms located in those clusters through an empirical investigation of IT firms based in the Teheran, Guro, and Daedeok Valleys, which are South Korea's three major IT clusters. This study developed a research model to explain the effects of IT industrial clusters and collected 114 survey responses from CEOs or managers in the three major IT clusters. The empirical results of this study showed that support technologies, management advocacy, and staff expertise had positive effects on absorptive capacity, and absorptive capacity had a positive effect on innovation performance. This study contributes to the understanding of the antecedents and outcomes of absorptive capacity by providing cross-sectional data that presents important theoretical and practical implications.

Keywords: *IT cluster characteristics, Absorptive capacity, Innovation performance, Support technologies, Management advocacy, Staff expertise, South Korean IT clusters*

1. Introduction

The creation of regional industrial clusters has recently become a widely sought approach to increasing regional and industrial competitiveness. Efforts to strengthen regional and industrial competitiveness through regional industrial clusters have led to the development of regional resources. These agglomerations of resources focus on specific industries by organically connecting them with each other. Furthermore, they have become a new business model for regional economic development.

The international community has already reached the age of cluster competition. The United States (US) for instance, is pushing forward with its policies to foster industrial clusters at the government level. As of 2012, the US was drawing up around 40 industrial cluster road maps while moving forward with its cluster mapping project. Similarly, South Korea is building innovation clusters focusing on the information technology (IT) industry. The Silicon Valley has become the benchmark for the nation's IT clusters including the

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Teheran, Guro, and Daedeok Valleys, as well as for other big cities that are planning to build IT clusters. The Teheran Valley was formed in the early 1990s when cutting-edge high tech firms, including electronics, information and communications, and software companies, progressively moved into an area along Teheran Road in Seoul's Gangnam District. This area was transformed from a neighborhood into a venture town [27]. In 2011, the cluster was populated by some 1250 venture firms and employed approximately 150000 workers. The Guro Valley located in Seoul's Guro and Geumcheon Districts, started as a manufacturing industrial complex focused on textile and machinery in 1964, and has turned into South Korea's largest knowledge industry venture business complex. In 2011, the cluster was populated by some 10000 firms (1300 venture firms) and employed approximately 120000 workers. With US $8.23 million in total annual sales, the Guro Valley is arguably South Korea's largest IT venture agglomeration. The Daedeok Valley, on the other hand, is a state-sponsored, planned cluster established in 2000 in an area adjacent to Daedeok Science Town, a state research complex founded in 1976. Currently, about 1000 companies in IT-related industries reside in the Daedeok Valley, alongside state research institutes such as Electronics and Telecommunications Research Institute (ETRI), Korea Advanced Institute of Science and Technology (KAIST), and several dozen other private and state research organizations.

In the contemporary IT industrial cluster environment, IT cluster companies increasingly depend on external sources of information to promote innovation and improve their performance [14, 18]. As previously mentioned, the establishment of an IT industrial cluster is regarded as an approach to increasing regional and industrial competitiveness both at home and abroad. However, while individual countries are continuously pushing forward with their policies to cultivate such clusters, the academic community has failed to properly conduct quantitative studies on the achievements of such industrial clusters.

IT cluster companies should first enhance their absorptive capacities to increase their abilities to evaluate, assimilate, and apply external knowledge to their industries. More specifically, they should first enhance their absorptive capacities to systemize a variety of ideas, information, and knowledge obtained from cooperative relationships among cluster companies. The concept of absorptive capacity is gradually gaining recognition as a key driver of firm competitive advantage [16]. Absorptive capacity is what enables companies to effectively acquire and utilize external as well as internal knowledge, which affects a company's ability to innovate and adapt to its changing environment [6]. However, no prior studies have explored the influences of external and internal factors on the absorptive capacities and innovation performance of IT clusters. Most studies on industry clusters are focused on the factors motivating cluster formation [19, 30, 35].

This study addresses two research issues. First, are the technological, organizational, and people characteristics of IT cluster companies positively associated with absorptive capacity? Second, is absorptive capacity the mediator between the three antecedents (technological, organizational, and people characteristics) and the consequent, innovation performance?

The remainder of this paper is organized as follows. A literature review is discussed in Section 2, and four hypotheses are also proposed in this section. Section 3 describes the methodology, sample and data collection, and the measurements of constructs. Next, the descriptive statistics, reliability of the measurement, correlations between constructs, and the results of *PLS* are shown in Section 4. Finally, the conclusions and implications are mentioned in Section 5.

2. Theoretical Background and Hypotheses

2.1. The Positive Effects of Technological, Organizational and People Characteristics on Absorptive Capacity

Since Wernerfelt [33] made the resource-based theory public, studies searching for the foundations of company success from among internal resources rather than the external environment have been actively conducted by organization and strategy experts [17, 22]. These scholars have maintained that a company that is effectively making use of its own resources and abilities could be more competitive and that its absorptive capacity plays a crucial role in remaining more competitive.

For an organization's absorptive capacity to go smoothly within IT clusters, the internal environmental factors of the company should be understood. These factors include technological, organizational, and people characteristics. This research intends to present the characteristics of these three factors as the antecedents of absorptive capacity, with technological characteristics representing the use of support technologies, organizational characteristics comprising management advocacy, and people characteristics referring to staff expertise.

Henderson and Cooprider [10] define support technologies in terms of production, coordination, and organizational dimensions. According to the authors, production technology has three components: conducting activities related to representing information requirements, analyzing information flows and data relationships, and transforming these views into program codes. Coordination technologies enable control and cooperative functionalities. Organizational technologies reflect support and infrastructure functionalities. Several reports have noted that such support technologies do indeed have a noticeable impact on the process, task, psychological, and organizational outcomes of systems development [1]. For example, Johar [12] describes how an intelligence-based support technology can improve the problem-solving capabilities of IT companies. Moreover, Post, Kagan, and Keim [24] assert that adequate development equipment and tools have an indisputable effect in determining the success or failure of many IT projects. Koschaltzky and Sternberg [13] conducted a study on research and development (R&D) cooperation in the innovation systems of industrial clusters. They clarified that technological characteristics (support technologies) are vital in enhancing absorptive capacity because they systemize various ideas, information, and knowledge acquired through cooperative relationships among companies within a cluster. Thus, it is expected that the use of support technologies will determine the absorptive capacities of IT cluster companies. This study argues that technological characteristics (use of support technologies) can positively influence absorptive capacity. Therefore, this study proposes the following hypothesis:

Hypothesis 1. Technological characteristics (use of support technologies) of IT cluster companies are positively associated with their absorptive capacity.

Management advocacy refers to the willingness of management to provide the resources and authority required for an IT project to succeed [23]. Researchers have reached a consensus regarding the importance of management advocacy for favorable innovation and financial performance [1]. Management approval of an IT project and the resultant commitment and advocacy for this work can make human, monetary, and other important resources available to the IT project, leading to a conductive and superior problem-solving environment. Ravichandran and Rai [26] concluded that top management leadership can increase the likelihood of IT product quality and efficiency. Lane, Koka, and Pathak [15] assert that organizational characteristics exemplify

organizational structures and processes, whereas management advocacy develops and advances an organization's absorptive capacity. Thus, management advocacy is expected to determine the absorptive capacity of IT cluster companies. Therefore, this study proposes the following hypothesis:

Hypothesis 2. Organizational characteristics (management advocacy) of IT cluster companies are positively associated with their absorptive capacity.

Past research suggests that experience and knowledge, as well as the resulting familiarity with encountered problems, can be important determinants of IT project outcomes. A capable project with appropriate staff expertise means that it enjoys a diversity of abilities and experiences. Intuitively, an IT project that possesses a significant inventory of experience and skills is more likely to solve problems, better than one that does not enjoy the same privilege [1]. Hollenbeck and Klein [11] theorize that people characteristics, including ability, are important antecedents of goal commitment and, consequently, better performance. Tziner and Eden [31] provide empirical evidence in a tank crew setting, showing that individual ability is a significant determinant of a working unit's performance. Moreover, they reported that for tasks that were highly interdependent (such as in the case of software projects), work group performance was likely to be positively related to the aggregate capabilities of all members. In their research on cluster performance, Alavi and Leidner [2], Schultze and Leidner [28], and Lane, Koka, and Pathak [15] assert the importance of absorptive capacity, along with the information technology variable. They add that the expertise of an organization's members is essential to developing and advancing absorptive capacity. O'Dell and Grayson [21] emphasize that even if the expertise of an organization is high, it is difficult to transfer if individuals are not armed with absorptive capacity. Moreover, Lane, Koka, and Pathak [15] mention that the professional knowledge (expertise) of an organization's members is important if the organization finds and understands new knowledge within clusters, while simultaneously properly modifying and applying it to the organization. Thus, staff expertise is expected to determine the absorptive capacity of IT cluster companies. Therefore, this study proposes the following hypothesis:

Hypothesis 3. People characteristics (staff expertise) of IT cluster companies are positively associated with their absorptive capacity.

2.2. The Positive Effect of Absorptive Capacity on Innovation Performance

Absorptive capacity is defined as a set of organizational routines through which firms acquire, assimilate, transform, and exploit knowledge to produce dynamic organizational capacities [34]. Knowledge acquisition, assimilation, transformation, and exploitation are important for organizational innovation. Absorptive capacity appears to be one of the most important determinants of a firm's ability to acquire, assimilate, and profitably utilize new knowledge to increase its innovation performance [3]. Cohen and Levinthal [4], for example, relate absorptive capacity to innovative capabilities and innovation performance, among other outcomes. Their core rationale is that absorptive capacity promotes the speed, frequency, and magnitude of innovation, which, in turn, may produce knowledge that becomes part of an industrial cluster company's future absorptive capacity [34]. Fichman [7] and Vinding [32] point out that absorptive capacity is the ability to acquire, assimilate, transform, and exploit knowledge that may determine the level of organizational innovation and competence. Further, an organizational unit's absorptive capacity to learn depends on its endowment of relevant technology-based capabilities [20]. Cohen and Levinthal [4] suggested that the ability

to utilize external knowledge is often a byproduct of R&D investment. Organizational units with high levels of absorptive capacity invest more in their own R&D and have the ability to produce more innovations. This study focuses specifically on this relation, examining whether absorptive capacity translates into innovation performance. Therefore, this study proposes the following hypothesis:

Hypothesis 4. Absorptive capacities of IT cluster companies are positively associated with their innovation performance.

2.3. Research Framework

This study proposes four hypotheses, and displays the research framework in Figure 1. No previous research has explored the effects of the factors that influence absorptive capacity. The three antecedents of the research framework in this study are the support technologies, management advocacy, and staff expertise of IT cluster companies; the consequent is innovation performance; and the full mediator is absorptive capacity.

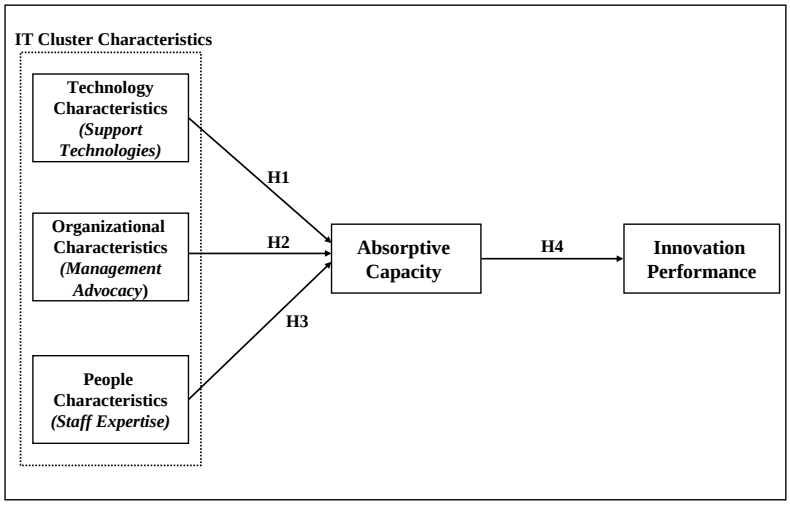

Figure 1. Research Framework

3. Methodology and Measurement

3.1. Data Collection and the Sample

The unit of analysis in this study is the business level. This research conducts an empirical study through the questionnaire survey method. The research objects are the companies operating in South Korean IT clusters. We chose to examine the Teheran, Guro, and Daedeok Valleys, arguably the three most important IT clusters in the country. Before mailing the questionnaires to the respondents, ten experts and scholars were asked to modify the questionnaire in the first pretest. Subsequently, in the second pretest, the questionnaires were randomly mailed to twenty chief executive officers (CEOs) or executive officers of IT, finance, manufacturing, marketing, purchasing, human resources (HR), or R&D departments in the three IT clusters. They were asked to fill out the questionnaire and identify any ambiguities in terms, meanings, and issues. The respondents of the questionnaires included CEOs or managers of the IT, finance, manufacturing, marketing, purchasing, HR, or R&D departments of South Korean IT cluster companies. To increase the valid survey response rate, prior to mailing the

questionnaires, we called each company sampled in our analysis, explaining the objectives of the study and the content of the questionnaire, as well as confirming the names and job titles of the respondents. The respondents were asked to return the completed questionnaires within two weeks via mail. The questionnaire items in this study were measured on a five-point Likert scale ranging from "strongly disagree" to "strongly agree." The dataset for the empirical analysis was collected over a period of five months, from May 2012 to September 2012. This study sent out 151 questionnaires. There were 114 valid and 25 invalid responses, representing an effective response rate of 75.49%.

3.2. Definitions and Measurements of the Constructs

The questionnaire comprised four sections. The first section collected descriptive company data (including the number of employees, year founded, industrial sector, *etc*.,); the second section measured the support technologies, management advocacy, and staff expertise of IT cluster companies; the third section measured absorptive capacity; and the fourth section focused on innovation performance. The definitions and measurements of the constructs were defined as follows.

3.2.1. Support Technologies, Management Advocacy, and Staff Expertise: The support technologies scale employs Henderson's and Cooprider's [10] three-component functional model of planning and design aids. Production technology incorporates representation, analysis, and transformation capabilities. Coordination technology covers control and cooperative functionalities. Organizational support technology refers to functionalities that deal with infrastructure and support issues.

Slevin and Pinto [29] provided the items for the management advocacy scale. The five items forming this measure address such issues as management responsiveness to requests from IT projects, the sharing of responsibility, support for the project in times of crisis, and delegation of authority to the IT project.

Rasch and Tosi [25] provided a two-item measure of staff expertise. The two items reflect IT cluster members' intellectual capabilities and the quality of their education/training. Although objective measures, such as years of experience, may seem to be more accurate measures of ability, the adopted approach was, in fact, more reflective since the number of years alone captures neither an individual's intellectual capabilities nor the quality of his or her education/training [1].

3.2.2. Absorptive Capacity and Innovation Performance: This study defines absorptive capacity as the ability to acquire, assimilate, transform, and exploit knowledge that may determine the level of organizational innovation and competence [3, 4, 6]. The questionnaire items related to the measurement of absorptive capacity in this study include: (1) whether the company has the ability to apply new external knowledge commercially and invent a new product; (2) whether the company of the corporation has the ability to understand, analyze, and interpret information gained through external knowledge; (3) and whether the company has the ability to combine existing knowledge with newly acquired and assimilated knowledge [3, 4, 6].

To capture the various aspects of innovation performance, this study built the construct measuring product, process, and overall organizational innovation based on several criteria that were conceptualized and used in previous empirical studies on innovation [3, 5]. The measurement of innovation performance included three items: (1) whether the company can improve its product quality through innovation; (2) whether the company can accelerate the

pace of new product commercialization through innovation; and (3) whether the company can develop new technology to improve operational processes [3, 5, 9].

4. Empirical Results

4.1. Model and Analysis

This study utilized *SmartPLS 2.0* to verify the research framework and hypotheses. The three antecedents of the research framework in this study are the support technologies, management advocacy, and staff expertise of IT cluster companies, and the consequent is innovation performance, while the full mediator is absorptive capacity. Through a flexible interplay between theory and data, the structural equation model approach brings together theoretical and empirical knowledge to create a better understanding of the real world. In the structural equation model of this study, we examined two level of analysis - the measurement model and the structure model.

4.2. The Results of the Measurement Model

Table 1 shows the means, standard deviations, and correlation matrix of this study. In Table 1, there were significantly positive correlations among support technologies, management advocacy, staff expertise, absorptive capacity, and innovation performance.

Several measurements confirm the reliability and validity of the constructs. One measure of reliability involves examining the loadings of each of the constructs' individual items. With respect to the quality of the measurement model in relation to the sample, the loadings (λ) of the items of the constructs listed in Table 2 are significant. Cronbach's α is the other measure of reliability. Table 2 lists the Cronbach's α values for the constructs, and showed that Cronbach's α of support technologies was 0.676; that of management advocacy was 0.873; that of staff expertise was 0.791; that of absorptive capacity was 0.933; and that of innovation performance was 0.824. Because the Cronbach's α coefficients of all constructs were greater than 0.6, the measurements in this study exhibited acceptable reliability. In addition, it is also important to verify whether the validity of the measurements in this study was acceptable. This study applied Fornell and Larcker's [8] measure of average variance extracted (AVE) to access the discriminate validity of the measurements. The AVE measures the amount of variance captured by the construct through its items relative to the amount of variance resulting from measurement error. To satisfy the requirements for discriminate validity, the square root of a construct's AVE must be greater than the correlations between the construct and other constructs in the model. For example, in Table 2, the respective square roots of the AVEs of two constructs, support technologies and management advocacy, are 0.768 and 0.893, which are greater than the correlation, 0.539, between those in Table 1. This demonstrates there is adequate discriminate validity between the two constructs. The square roots of all the constructs' AVEs, listed in Table 2 were also greater than the correlations among all constructs in Table 1. Therefore, the discriminate validity of the measurements in this study was acceptable. Additionally, if the AVE of a construct is greater than 0.5, it means that it exhibits convergent validity. As shown in Table 2, the AVEs of support technologies, management advocacy, staff expertise, absorptive capacity, and innovation performance were 0.590, 0.797, 0.705, 0.882, and 0.740, respectively, indicating that there was convergent validity in this study. In sum, adequate reliability and validity are shown in this study.

Table 1. Means, Standard Deviations, and Correlations of the Constructs

Constructs	Mean	Standard deviation	1	2	3	4	5
Support technologies	3.190	1.162	1.000				
Management advocacy	3.435	1.083	0.539	1.000			
Staff expertise	3.315	1.220	0.258	0.464	1.000		
Absorptive capacity	3.245	0.997	0.476	0.500	0.318	1.000	
Innovation performance	3.391	0.845	0.451	0.465	0.361	0.543	1.000

4.3. The Results of the Structural Model

This section presents the main results of this research. The results of the structural model are presented in Table 3. All four estimated paths are significant. The use of support technologies has a positive effect on absorptive capacity, thus supporting Hypothesis 1. This result is the same as those of previous studies asserting that support technologies can help companies develop their absorptive capacities [12, 13]. Management advocacy has a positive effect on absorptive capacity, thus supporting Hypothesis 2. This result is the same as those of previous studies asserting that management advocacy can help companies develop their absorptive capacities [15, 26]. Staff expertise has a positive effect on absorptive capacity, thus supporting Hypothesis 3. This result is the same those of previous studies asserting that staff expertise can help companies develop their absorptive capacities [2, 15, 28]. Additionally, the effect of absorptive capacity on innovation performance is also highly significant, thus supporting Hypothesis 4. These results support the argument of Daghfous [6] and Chen, Lin, and Chang [3] that absorptive capacity enables firms to effectively acquire and to utilize external and internal knowledge, positively affecting innovation performance. If companies without absorptive capacity obtain knowledge or technology, they cannot perform well in the area of innovation.

Table 2. The Loadings (λ) of the Items and the Cronbach's α Coefficients and AVEs of the Constructs

Construct	Items	λ	Cronbach's α	AVE	The square root of AVE
Support technologies			0.676	0.590	0.768
	ST1	0.727			
	ST2	0.801			
	ST3	0.826			
Management advocacy			0.873	0.797	0.893
	MA1	0.894			
	MA2	0.895			
	MA3	0.889			
Staff expertise			0.791	0.705	0.839
	SE1	0.879			
	SE2	0.891			
	SE3	0.807			
Absorptive capacity			0.933	0.882	0.939
	AC1	0.947			
	AC2	0.954			
	AC3	0.916			
Innovation performance			0.824	0.740	0.860

	IP1	0.910			
	IP2	0.922			
	IP3	0.914			

Table 3. Structural Model Results

Hypothesis	Path coefficient	*t*-value	*p*-value	Results
Support technologies → Absorptive capacity (H1)	0.265	1.888	0.0616	H1 is supported
Management advocacy → Absorptive capacity (H2)	0.256	2.158	0.0330	H2 is supported
Staff expertise → Absorptive capacity (H3)	0.318	3.785	0.0002	H3 is supported
Absorptive capacity → Innovation performance (H4)	0.543	7.076	0.0000	H4 is supported

5. Conclusions

In this study, we have demonstrated the relationship between IT cluster characteristics and the innovation performance of firms located in those clusters through an empirical investigation of IT firms based in the Teheran, Guro, and Daedeok Valleys, South Korea's three major IT clusters. The empirical results of this study showed that support technologies, management advocacy, and staff expertise had positive effects on absorptive capacity, and absorptive capacity had a positive effect on innovation performance. In other words, support technologies, management advocacy, and staff expertise are three positive determinants of absorptive capacity and innovation performance, and absorptive capacity mediates the relationship between the three positive determinants and innovation performance. This study therefore contributes to the understanding of the antecedents and outcomes of absorptive capacity by providing cross-sectional data that presents important theoretical and practical implications.

The empirical results of this study present practical implications for the working group and executive officers of IT cluster companies in other regions or countries. Such implications relate to technological support, including IT, the continuous management advocacy of top executives and managers, and education and training to enhance the professional knowledge of employees, which affects their innovation and business performance.

Despite its contributions, the present work has a number of limitations that future research should seek to address. First, this study focused on IT clusters in South Korea. Future studies can focus on other industrial clusters or countries and compare those results this study. Second, this study verified the hypotheses through a questionnaire survey, thus providing only cross-sectional data. Hence, this study cannot observe dynamic changes in absorptive capacity and innovation performance in the process of development of the IT clusters in South Korea through cross-sectional data. Therefore, future research can conduct longitudinal studies to discover differences in absorptive capacity and innovation performance in the different stages of IT cluster development in South Korea.

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Author

Jae Kwon Bae is an assistant professor in the Department of Management Information System, at the Keimyung University in Korea. He received a BA in Management Information Systems from Hannam University, Korea, in 2004 and a MS in Finance and a PhD in Management Information Systems from the Sogang University, Korea in 2006 and 2009. His research interests include knowledge-based systems design and development, decision support systems, intelligent systems, data mining, and AI applications for business and electronic commerce.