

The Determinants of Technology Commercialization Performance of Technology-based SMEs

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Abstract

This study is intended to examine the roles of the social capital and absorptive capacity in technology-intensive firms and verify these roles in an empirical way for the purpose of improving the technology commercialization performance in technology-intensive firms. To achieve the purpose, this study examined the concept and dimensions of social capital through a literature review, empirically verified the effect relationship between the social capital, and absorptive capacity, and technology commercialization performance in technology-intensive firms. This study is meaningful in that it has determined the importance in the formation of social capital and the enhancement of absorptive capacity and suggested strategic directions to improve technology commercialization performance.

Keywords: Technology Innovation, Social Capital, Absorptive Capacity, Technology Commercialization Performance, Technology-Based SMEs

“A preliminary version of this paper was presented at ICONI 2016, and was selected as an outstanding paper.”

1. Introduction

Today, firms are enhancing their R&D and expanding its cooperation with external networks to reduce the uncertainties and time in the development of technologies and reduce the time for technology development and thereby improve the efficiency of R&D in response to fast-paced technology, market conditions and uncertainties [1]. Firms require continuous technological innovation to ensure the competitiveness and maintain the competitive advantage on a continuous basis, and the technical cooperation network between firms is becoming an important channel for firms to obtain information and enhance their competences [2, 3].

The concepts frequently mentioned in recent literature (e.g. technological cooperation, strategic technology alliances, technology innovation networks and open innovation) have the same purpose that aims the cooperation with external entities through proactive approach to technological innovation event though there are slight differences in the perspectives and scope in the achievement of technological innovation. The competition between the networks based on the cooperation to promote the creation, diffusion, use and learning of knowledge provides important opportunities and risks at the same time [4].

The SME accounts for the highest portion of the core components of the cooperation network, but they have difficulties in creating innovations due to a lack of professional manpower and its limited technology compared to large firms. Therefore, there is the need to extend the availability of the resources needed to achieve innovation based on the technology cooperation network [5]. SMEs are able to quickly acquire technological knowledge and information and reduce uncertainties that may occur during the R&D relating to products and processes through the technological cooperation network, which will enable them to reduce cost and acquire technological breakthroughs. In addition, SMEs are able to understand the needs of consumers through the technological cooperation network and develop new markets through the development of new products [6]. Therefore, suggesting the importance of the capacity to absorb knowledge to the SMEs that lack the capacity to absorb knowledge through the verification of the necessity of absorbing and accumulating external resources and information by using the technological cooperation network actively will provide them with important implications.

In order for the firms to achieve innovation through the technological cooperation network, the cooperative activities of all the members of social network as well as the individual roles of them are to entailed, so the formation of social capital is required to facilitate the mutual cooperation based on goal sharing, trust and high connectivity between the members [7]. In other words, the social capital in the technological cooperation network is a set of the relationships in the network based on the relationship between the members [8], so the social capital promotes the sharing of information and knowledge between the participants in the network [9]. In addition, it maintains the interdependency between them based on a partnership, serving the role of social control mechanism [10]. The firms in the technological cooperation network agree that the absorptive capacity of the firms that can use the knowledge from the external sources of technological cooperation effectively are closely associated with their performance.

In other words, the utilization of knowledge in SMEs experiencing a lack of capital and high-quality manpower in the knowledge-based economy plays a critical role in achieving innovation. Given that innovation can be achieved through the utilization of knowledge in the knowledge-based economy, in-depth studies on the utilization of knowledge as an effective

innovation driver in achieving the innovation performance of the social capital in technology cooperation network are required. Nevertheless, it has been pointed out in previous studies that many Firms ignore the importance of social capital and absorptive capacity in achieving technology innovation performance [11, 12].

In addition, in the previous studies of existing Firms and technology innovation, only internal factors such as technology management competence, technology competitiveness, technology marketing, technology commercialization competence, technology value, technology transfer, and innovation activities were considered to be main factors influencing innovation performance, whereas the environmental factors through collaboration with external network were not considered to be such factors. Especially, in the technology-intensive industries, of which importance is increasing in today's rapidly changing global business environment, empirical studies on how Firms form social capital and acquire knowledge-based resources and internalize them for achieving desired performance are required [13].

To this effect, this study is intended to provide policy implications by analyzing the effects of the social network formation in technology-intensive firms on the innovation competence and technology commercialization of the Firms. This study is meaningful in that it attempts to examine the role of social capital and the importance of absorptive capacity enhancement in the technology-intensive firms, that have not revealed until now, in achieving the technology commercialization. This study aims to confirm the importance of social capital formation and absorptive capacity enhancement for improving technology commercialization and to suggest strategic directions for enhancing competitiveness of technology-intensive firms.

2. Theoretical Background

2.1 Social Capital

Forming a dynamic relationship within a society, individuals and organizations are germinated in social relations [14]. The individuals and organizations belonging to this germinated relationship are the resources derived from a network, and acquire the social capital [9, 15]. In other words, the social capital, the core resource directly related to the survival of the organization, could be refer to as a set of social capital that is derived from the network and creates company's competitive advantage.

Defining the social network as a set of the actual and potential resources that have derived from the relational network of individuals or society members and are available to use, Nahapiet and Ghoshal [9] distinguished the social capital into structural, relational and cognitive dimensions. The social capital as structural capital is the capital value arising from the connectivity pattern between the members of the social network, focused on the form of the network of members, the density of the network form, and the patterns of connectivity, strata and suitable organizations [16, 17, 18]. Therefore, the structural capital is a relationship that can enhance the accessibility and the binding between social network members; necessary information and resources are shared through the social network; and this interaction creates new knowledge, thus enhancing the competitiveness of the organization [19]. The cognitive capital means a cognitive system shared by members in the social network and provides the resources enabling it to understand the common meanings between network members through shared vision and values, shared goals, shared language or semantics, and promote the ways they behave [9]. In other words, in the social network, the human capital causes the commonality spreading throughout the network to be recognized and various activities to be

consistent, so the members can understand and cooperate with each other based on shared vision and goals [20]. The relational capital is a set of the relationships between members that are formed between network members through interaction [9]. Since it indicates the quality of relationship between members, it is considered trust, norms, obligations, expectations and so on that guarantee the social interaction [9, 21]. In the social network, the relational capital between members promotes organizational activities and facilitates collaborative behaviors between members, thus contributing to the performance of the organization by reducing transaction costs and conflicts, etc. [22]. In other words, the social capital promotes the sharing of information and knowledge based on the partnership, serving as a social control mechanism [9, 23, 24].

Therefore, in the technical cooperation network, the social capital is a set of relationships in the network formed based on the relationship between company members. This asset induces the behaviors of network members and provides the opportunities for the members to have access to information and knowledge among members through cooperation [2]. This study approached according to the social capital of Nahapiet and Ghoshal [9], which is widely accepted as the sub-components of the social capital.

2.2 Absorptive Capacity

Today, firms promote innovations by acquiring new information and knowledge needed in business management. Firms are able to achieve specific results through successful innovative activities by making the best use of a variety of information and knowledge [25, 26].

The absorption capacity means the ability of company to acquire the necessary information and utilize it effectively [27]. Cohen and Levinthal [28] conceptualized the learning capacity of company needed for environmental adaptation as the absorptive capacity and defined the absorptive capacity as the ability to explore and recognize the knowledge existing outside the company, transform it as internal knowledge and learn it. When the company encounters new knowledge, the results in recognizing it and understanding its value vary depending on the diversity of the relevant knowledge retained by the company and backgrounds. The accumulation of knowledge and experience retained by the company acts as an important factor in the absorption capacity, and this causes new knowledge to be absorbed. Therefore, for the company to gain competitive advantage, the learning capacity relating to the current environmental adaptation and its adaptability to the future environment are critical [29, 30]. Through a literature study on the absorption capacity, Zahra & George [31] has extended the concept of absorption capacity to the company's dynamic capacity based on strategic changes and flexibility. The previous studies of the absorption capacity focused on prior knowledge and skills of the company and emphasized a uniform and formal development path, whereas Zahra & George [31] suggested multidimensional, atypical and flexible development paths based on a variety of factors including the complementarity of company's experience and knowledge and the diversity of knowledge sources, etc. Lane et al. [29] defined the absorptive capacity as a process of understanding new knowledge and transforming it to suit the organization through learning process. They said the activities to develop and advance the absorptive capacity would lead to the creation of company's knowledge, which would in turn become the source of competitive advantage in the long run.

In the previous studies on the absorptive capacity, the absorptive capacity was addressed in that it acquires new knowledge, transforms it to other knowledge, gains competitive advantage by utilizing it, and thus creating business performance. This is considered as close association with the concept of social capital. The company can acquire a variety of information (e.g. unpredictable environmental changes, market and policy changes, preferences, customers,

etc.), knowledge and complementary resources, and so on, when it builds trust and shares by establishing an external social network. Furthermore, the company can transform a variety of information (e.g. unpredictable environmental changes, market and policy changes, preferences, customers, etc.), knowledge and complementary resources and so on, into the forms available to use in its business when it forms the social capital inside the company.

For the components of the absorptive capacity, Zahra & George [31] suggested 'acquisition', 'assimilation', 'transformation', and 'exploitation'. They also categorized 'acquisition' and 'assimilation' as the potential absorptive capacity, and 'transformation' and 'exploitation' as the realized absorptive capacity. The potential absorptive capacity is to identify new external knowledge, evaluate it, and acquire it. The acquired information is developed into a process and routine through an analysis, and becomes assimilated. The realized absorptive capacity is to expand and increase the existing capacities, i.e. exploitation, as well as reconstruct, combine and develop the existing knowledge and newly assimilated knowledge, i.e. transformation. Lane et al. [29] approached the absorptive capacity in three dimensions - exploratory learning, transformative learning and exploitative learning- while explaining the absorptive capacity as a series of learning processes. According to them, the exploratory learning is to recognize and understand the new external knowledge with potential value; the transformative learning is to internalize and assimilate the valuable knowledge; and the exploitative learning is to create results through the assimilated knowledge. Unlike the studies by Zahra & George [31], Todorova & Durisin [32] saw the assimilation and transformation as the interactive relationship placed in parallel. They saw the value of knowledge was recognized, assimilated or transformed, and exploited. They said the externally acquired knowledge becomes assimilated if the cognitive structure of organizational members remained unchanged and the acquired knowledge changed the existing knowledge of the members, so the newly created knowledge was transformed. Therefore, this study approached according to the definition of Zahra and George [31], which is widely accepted as a sub-component of the absorptive capacity.

2.3 Technology Commercialization Performance

In the technology commercialization, the directions, purposes, application and business process vary widely depending on the types of technology, degree of commercialization, competitiveness, and the degree of exploitation, etc. Therefore, the existing studies suggested a variety of concepts for technology commercialization according to the objectives and directions of studies. Furthermore, the technology commercialization performance was measured by multi-dimensional standards such as non-financial dimensions (e.g. product innovations, marketability of new products, launch rate of new products and the frequency of launch, the number of patent and so on) as well as financial dimensions (e.g. revenue, yield, market shares, and so on) [33, 34, 35]. The non-financial dimensions to measure the technology commercialization performance is the progress contributing to the profit and success of business rather than the results indicating the actual profit and success of business. In the financial dimension to measure the technology commercialization performance, the empirical results serve as a visible and realistic standard for the company, but it, in general, is regarded as corporate performance or management performance rather than technology commercialization performance [33]. Therefore, to measure the company's process of contributing the profit and success of business, this study suggests the technology commercialization as non-financial dimension.

3. Research Methods

3.1 Research Model and Hypotheses

3.1.1 Structural Relationship of Social Capital

The social capital is formed based on a relationship between the social network members, and the enhanced social network enhances the interaction between members more [36]. The social interactions between network members serve to facilitate the sharing of vision and norms. The members form and expand a consensus through social interactions and thus share values, attitudes, and goals [37]. More specifically, the social interaction enables network members to form common goals and values, playing a critical role in sharing these goals and value [16]. In addition, the social interaction between network members has a positive effect on trust. The trust relationship develops and evolves through the social interaction [37], and the strong social relationship between members cause them to interact more often, thus increasing the level of trust [36]. Furthermore, the sharing of vision and goals between network members serve to bind them into one, thus contributing to forming trust [9]. The shared visions and goals and the sharing of norms facilitate harmony between mutual understanding and interests, thus promoting trust formation. Therefore, it is expected that the formation of a social network incite members to share organizational vision and goals, thus contributing to formation of a trust relationship.

H1: The structural capital will have a positive effect on the cognitive capital.

H2: The structural capital will have a positive effect on the relational capital.

H3: The cognitive capital will have a positive effect on the relational capital.

3.1.2 Relationship between Social Capital and Absorptive Capacity

In order for the company to achieve results through the social network, the cooperative activities of network members as well as the individual capacity are important. Therefore, it is required to form the social capital that will cause the network members to cooperate based on the sharing of goals, trust and well-established relationship [2, 7, 38]. The company can acquire a variety of information (e.g. unpredictable environmental changes, market and policy changes, preferences, customers, etc.), knowledge and complementary resources when it builds trust and shares by forming an external social network [39]. More specifically, the company can achieve the absorption capacity through various interactions between external environment and organizational members and the active sharing of information and knowledge between organizational members [40].

H4: The cognitive capital will have a positive effect on the potential absorptive capacity.

H5: The cognitive capital will have a positive effect on the realized absorptive capacity.

H6: The relational capital will have a positive effect on the potential absorptive capacity.

H7: The relational capital will have a positive effect on the realized absorptive capacity.

3.1.3 Structural Relationship of Absorptive Capacity

The potential absorption capacity and realized absorptive capacity are separate from each other, but they complement one another [31]. If the company fails to acquire knowledge or if the company failed to transform and exploit it even if it acquired and assimilated knowledge, the knowledge cannot contribute to achieving performance [41]. In other words, the potential absorptive capacity and realized absorptive capacity perform different roles from the perspective of the effect of absorptive capacity, but they bond to each, thus forming the absorptive capacity [31].

H8: The potential absorptive capacity will have a positive effect on the realized absorptive capacity.

3.1.4 Relationship between Absorptive Capacity and Technology Commercialization Performance

The absorptive capacity of the company means the organizational ability of acquiring, assimilating, transforming and exploiting new and external information and knowledge [31]. The absorptive capacity as dynamic capacity resets and expands the organizational capacity and making the best use of the existing component. Moreover, it creates new things through knowledge transfer and acquisition, thus leading to positive changes in the strategic framework and directions of organization [42]. In short, the absorptive capacity is the organizational ability to recognize the value of new knowledge, accumulate and reconstruct it so that it can contribute to achievement of business goals [28]. The activities to develop and advance the absorptive capacity can materialize the knowledge creation of the organization, thus serving as the source of competitive advantage [43].

H9: The potential absorptive capacity will have a positive effect on the technology commercialization performance.

H10: The realized absorptive capacity will have a positive effect on the technology commercialization performance.

Based on the above hypotheses, study model in this study has been suggested as shown in shown in Fig. 1.

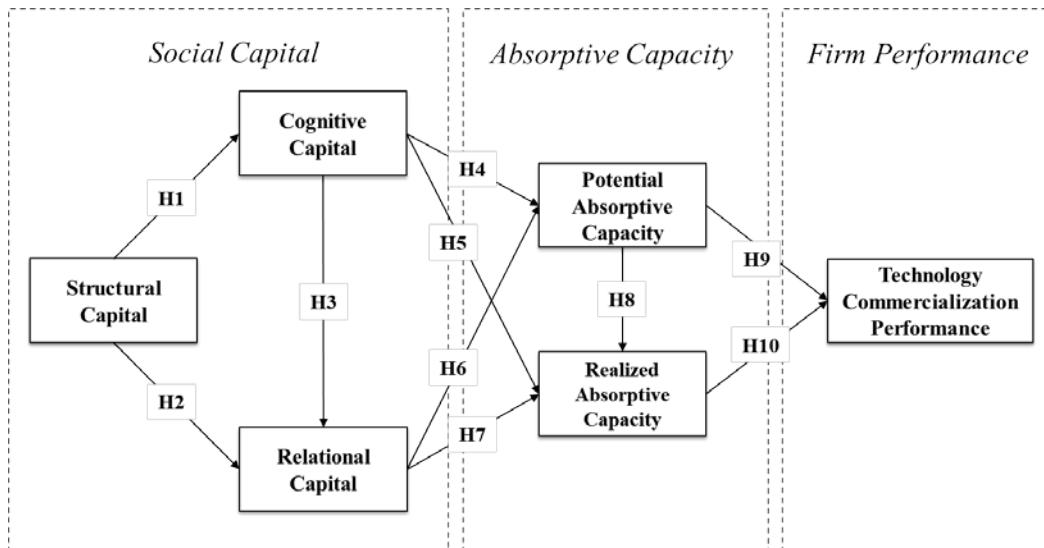


Fig. 1. Research Model

3.2 Samples

To determine the effects of the social capital on the technology commercialization performance in technology-based firms, this study collected the data through a questionnaire survey with technology-based firms and conducted statistical analysis. A total of 350 questionnaires were conducted to remove the questionnaires with missing or inadequate answers, and the final 335 cases were selected as valid samples. **Table 1** summarizes the sample of this study.

Table 1. Sample Characteristics

Category and Items	Sample Size	Ratio (%)	
Operting Years	Less than 5 yrs	82	24.5
	5 yrs ~ 10 yrs	123	36.7
	10 yrs ~ 20 yrs	72	21.5
	20 yrs ~ 30 yrs	42	12.5
	More than 30 yrs	16	4.8
Number of Employees	Less than 10	26	7.8
	10 ~ 30	87	26.0
	30 ~ 50	116	34.6
	50 ~ 100	83	24.8
	More than 100	23	6.9
Annual Sales	Less than \$ 4.3 M	38	11.3
	\$ 4.3 M ~ \$ 8.7 M	71	21.2
	\$ 8.7 M ~ \$ 26.3 M	126	37.6
	\$ 26.3 M ~ \$ 43.8 M	57	17.0
	More than \$ 43.8 M	43	12.8
Industry	Computer/Electronics	56	16.7
	IT/Software	82	24.5
	Food and Beverages	29	8.7
	Mechinery/Metal	39	11.6
	Energy/Chemicals	27	8.1
	Bio/Midical	30	9.0
	Science/Technolgy Service	37	11.0
	Etc.	35	10.4

3.3 Measures

This study developed measurement items by adopting reliable measurement items of previous literatures and adjusting them properly for this study's purpose. First, the sub-dimensions of social capital, which consist of structural capital, cognitive capital and relational capital, were constructed into 4 items each in reference to the studies by Nahapiet & Ghoshal (1998), Chiu et al. (2006), Villena et al. (2011), Martinez-Canas et al. (2012) and Yu et al. (2013), and were measured using 7-point Likert scale (Strongly disagree ~ Strongly agree). Also, the sub-dimensions of absorptive capacity social, which consist of potential absorptive capacity and realized absorptive capacity, were constructed into 4 items each in reference to the studies by Zahra & George (2002) and Jansen, et al. (2005), and were measured using 7-point Likert . Technology commercialization performance was constructed into 4 items in reference to the studies by Zahra & Nielsen (2002) and Li, et al. (2008), and was measured using a 7-point Likert scale. The measurement items in this study is summarized as **Table 2**.

Table 2. Measurement Items

Dimensions	Variables	Items	Sources
Social Capital	Structural Capital (SC)	The frequency of contacts with partners (official)	[9], [17], [19], [44], [45]
		The frequency of contacts with partners (informal)	
		Communication with partners	
		Interaction with partners	
	Cognitive Capital (CC)	Goals shared with partners	
		Shared vision with partners	
		The similarity of the organizational culture and values	
		Efforts to achieve common goals	
	Relational Capital (RC)	Trust with partners	
		Respect for the partners	
Reciprocity with partners			
friendship with partners			
Absorptive Capacity	Potential Absorptive Capacity (PAC)	Information collected through official channels	[31], [46]
		Gathering information through informal channels	
		Quickly recognize changes in the market	
		Quickly analyze and understand market demands and changes	
	Realized Absorptive Capacity (RAC)	Record or store the new knowledge or information	
		Determine the usefulness of new knowledge or information	
		Use and application of new information and knowledge	
		Implementation of new products and services	
Technology Commercialization Performance (TCP)		Marketability of new products	[33], [47]
		Rate of new product launches	
		The frequency of new product introductions	
		The number of patents	

4. Analysis and Results

4.1 Measurement Model

Before structural model analysis, this study conducted confirmatory factor analysis to ensure the content validity of the measurement tool. For this, χ^2 , standard $\chi^2(\chi^2/df)$, RMSEA, GFI, TLI, CFI, TFI were used to check fitness. As a result, initial model did not exceed standard fitness threshold, so modified indices analysis were conducted [48], and measurement items that lowers unidimensionality were deleted(SC3, CC2, RC2, PAC1, RAC3, TCP1). As a result of confirmatory factor analysis of modified measurement model, $\chi^2 = 269.385(P=.000)$, $\chi^2/df=2.245$, RMSEA=0.061, GFI=0.920, TLI=0.956, CFI=0.965, IFI=0.966, all indices suggested the measurement model used were fit. After verifying measurement model's fitness, reliability and validity were analyzed. For reliability, construct reliability should appear above 0.7, and average variance extract should be above 0.5. Additionally, for validity, two latent variables' AVE1 and AVE2 should bigger than squared value of its correlation. As a result of analysis, reliability and validity were verified and the detailed results are presented in **Table 3** and **Table 4**.

4.2 Structural Model

As measurement model's fitness, and reliability and validity of measurement items were verified, structural model analysis were conducted. As a result of structural model's fitness test, $\chi^2=339.324$ ($P=0.000$), $\chi^2/df= 2.715$ was above threshold 3, and RMSEA=0.072 was below standard of 0.08. Moreover, GFI=0.900, TLI=0.939, CFI=0.950, IFI=0.951 all of indices appeared above recommended value of 0.9 and therefore, the structural model' fitness of the research model was verified.

Table 3. Confirmatory Factor Analysis based on Reliability

Variables	Measurement Item	Std. Loading	Std. Error	C. R.	Construct Reliability	Cronbach's α
Structural Capital	SC1	.881			.780	.769
	SC2	.672	.071	12.717		
	SC4	.671	.059	12.712		
Cognitive Capital	CC1	.668			.855	.854
	CC3	.935	.091	14.323		
	CC4	.856	.091	13.687		
Relational Capital	RC1	.842			.823	.824
	RC3	.730	.061	14.622		
	RC4	.782	.054	16.053		
Potential Absorptive Capacity	PAC2	.897			.919	.900
	PAC3	.902	.045	23.028		
	PAC4	.811	.052	19.277		
Realized Absorptive Capacity	RAC1	.903			.904	.915
	RAC2	.866	.044	22.486		
	RAC4	.883	.042	23.377		
Technology Commercialization Performance	TCP2	.820			.924	.915
	TCP3	.932	.056	20.913		
	TCP4	.903	.056	20.247		

Table 4. Discriminant Validity

Variables	SC	CC	RC	PAC	RAC	TCP
SC	.546*					
CC	.124	.666*				
RC	.507	.516	.608*			
PAC	.174	.347	.436	.791*		
RAC	.536	.349	.582	.421	.758*	
TCP	.144	.318	.181	.250	.212	.803*

*AVE(Average Variance Extract)

SC = Structural Capital, CC = Cognitive Capital, RC = Relational Capital, PAC = Potential Absorptive Capacity, RAC = Realized Absorptive Capacity, TCP = Technology Commercialization Performance

4.3 Hypotheses Test

After structural model's fitness was confirmed, research hypotheses were tested. As a result, first, for social capital's structural relationship, structural capital appeared to have effect on cognitive capital, $C.R.=5.350(p=.000)$, and relational capital, $C.R.=10.814(p=.000)$, thus H1 and H2 were supported. Also, cognitive capital had positive effect on relational capital, $C.R.=9.654(p=.000)$, and therefore, H3 was supported too. Second, for relationship between social capital and absorptive capacity, cognitive capital had significant effect on potential absorptive capacity, $C.R.=3.195(p=.001)$, realized absorptive capacity, $C.R.=-.201(p=.045)$, while relational capital had effect on potential absorptive capacity, $C.R.=3.195(p=.001)$, realized absorptive capacity, $C.R.=9.204(p=.000)$, thus H4, H6, H7 were supported while H5 was not supported. Third, for relationship between potential absorptive capacity and realized absorptive capacity, potential absorptive capacity appeared to have positive effect on realized absorptive capacity, $C.R.=9.204(p=.000)$, thus, supporting H8. Lastly, for relationship between absorptive capacity and technology commercialization performance, both potential absorptive capacity, $C.R.=4.911(p=.000)$, and realized absorptive capacity, $C.R.=3.256(p=.001)$ had positive effect on technology commercialization performance, therefore, H9 and H10 were supported. The results of hypotheses test are summarized in [Table 5](#) and [Fig. 2](#).

Table 5. Hypotheses Test Results

Hypotheses	Path	Path Coefficient	Std. Error	C.R. (t)	Supported/ Not Supported
H1	Structural Capital → Cognitive Capital	.296	.055	5.350***	Supported
H2	Structural Capital → Relational Capital	.578	.053	10.814***	Supported
H3	Cognitive Capital → Relational Capital	.661	.068	9.654***	Supported
H4	Cognitive Capital → Potential Absorptive Capacity	.288	.090	3.195**	Supported
H5	Cognitive Capital → Realized Absorptive Capacity	-.201	.100	-2.004	Not Supported
H6	Relational Capital → Potential Absorptive Capacity	.419	.077	5.427***	Supported
H7	Relational Capital → Realized Absorptive Capacity	.912	.099	9.204***	Supported
H8	Potential Absorptive Capacity → Realized Absorptive Capacity	.257	.073	3.536***	Supported
H9	Potential Absorptive Capacity → Technology Commercialization Performance	.359	.073	4.911***	Supported
H10	Realized Absorptive Capacity → Technology Commercialization Performance	.188	.058	3.256**	Supported

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

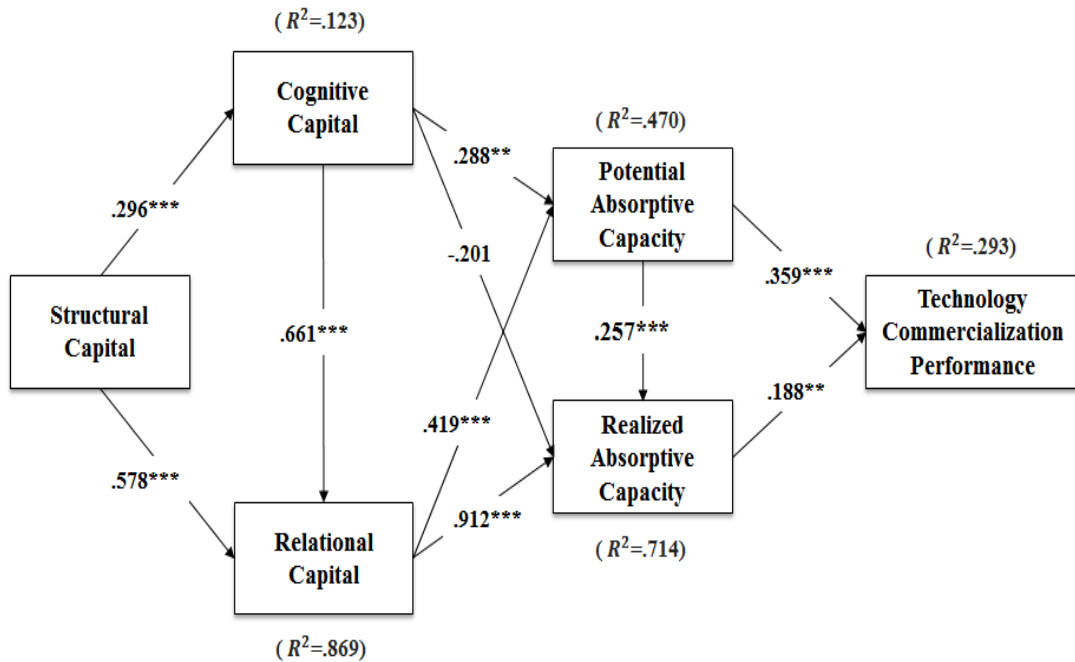


Fig. 2. Research Model and Path Analysis

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$,

5. Conclusion

To identify the factors that influence the technology commercialization performance of technology-based firms, this study reviewed the roles and dimensions of the social capital and absorptive capacity through a literature review. Based on these findings, this study empirically verified the casual relationship between the social capital, absorptive capacity and technology commercialization performance of the technology-intensive company. As a result, significant results were revealed as follows:

First, the structural capital as social capital had a positive effect on the cognitive capital and relational capital, and the cognitive capital had a positive effect on the relational capital. The members of the social network share vision and norms through social interactions, thus forming a trust relationship [37]. This indicates that the social interactions between the technology-intensive company and its partners have a positive effect on the sharing of values and goals and the formation of trust between members. Second, it was found that the cognitive capital and relational capital as social capital had a positive effect on the potential absorptive capacity, and the relational capital had a positive effect on the realized absorptive capacity. This indicates that the company can acquire a variety of external information and knowledge and complementary resources, and exploit them as internal resources when it shares value and goals and builds trust with network members through social interactions [39]. On the other hand, the cognitive capital appeared to have a negative effect on the realized absorptive capacity. This indicates that an emphasis on the common values and goals and norms increases the company's dependency on the external resource and limits flexible bonding, thus causing a negative effect on the exploitation of the external source [46]. Third, the potential absorption capacity as absorptive capacity had a positive effect on the realized absorptive capacity. The

externally acquired knowledge becomes assimilated and transformed the existing knowledge, thus creating new knowledge [31]. Fourth, in the relationship between the absorptive capacity and technology commercialization performance, the potential absorptive capacity and realized absorptive capacity had a positive effect on the technology commercialization performance of the company. The absorptive capacity as the dynamic capacity of the company means the company's ability of acquiring new knowledge and exploiting it effectively [27]. This indicates the absorptive capacity enables the technology-intensive company to acquire new knowledge from the external network, transform it to new knowledge and exploit it, thus serving as the sources of competitive advantage contributing to achieving performance.

In this study, it was found that technology-intensive firms are able to utilize knowledge from a series of processes through the technology cooperation network, leading to innovation performance. In other words, through this study, it was confirmed that the effective utilization of knowledge should be increased in order for technology-intensive firms to achieve technology commercialization, and it becomes possible through the formation of social capital in the technology cooperation network.

The implications derived from this study can be summarized as follows: First, this study provides important data for the basic studies on the role of social capital and absorptive capacity to improve technology commercialization performance of technology-intensive firms. Second, by defining innovation performance of technology-intensive companies as technology commercialization performance, this study has empirically confirmed the influence relationship between social capital, absorption competence and technology commercialization performance and proved its theoretical extension. For this purpose, this study has presented the social capital concept as an antecedent of absorption competence of technology - intensive companies and confirmed the structural relationship between social capital dimension and between social capital and absorption competence. In addition, this study has presented the concept of absorption competence as an antecedent of the technology commercialization performance of technology-intensive companies, and confirmed the structural relationship between absorption competence dimension and the influence relationship between absorption competence and technology commercialization performance. Third, this study has confirmed the importance of social capital formation and absorptive capacity enhancement, and then presented the strategic directions for enhancing competitiveness of technology-intensive Firms to improve their technology commercialization performance. In particular, this study is meaningful in that it has presented the policy implications for the SMEs among technology-intensive Firms experiencing a lack of knowledge resources to expand knowledge resource base.

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