

An Exploratory Study on Success Factors of Technology-based start-ups

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ABSTRACT

This study was conducted to empirically verify the effect of the technological entrepreneurship, network capability and technological innovation capability on the innovative performance of technology-based start-ups with the aim of determining the success factors of technology-based start-ups by defining the success of technology-based start-ups as the innovative performance through technology innovation activities. For the significance of this study, it suggested the importance of technology innovation as a survival strategy of technology-based start-ups, verified the dimensions, relationship and roles of technological entrepreneurship, network capability and technology innovation capability, thereby proving the theoretical expansion. This study has determined the success factors of technology-based start-ups and thereby suggested the strategic directions for enhancing the competitiveness of technology-based start-ups.

✉ keyword : Technology-based start-ups, Innovation Performance, Technological Entrepreneurship, Network Capability, Technology Innovation Capability

1. Introduction

Under the 21st century global competition, technology-based start-ups attract our attention in that they can create new demands and high values and contribute to improving employment, acting as a new national growth driver. The successful technology-based start-ups can create and change the industrial ecosystem, so it has national significance. Since the global financial crisis, major advanced economies emphasize the importance of starting up new businesses and entrepreneurship as a survival strategy for countries and endeavors to secure future growth driver by promoting the establishment of new businesses. Recognizing the technology-based start-ups as a new growth driver, South Korea also promotes a variety of supportive policies to promote the establishment of technology-based start-ups, but the qualitative growth is inadequate compared to the quantitative growth [2][29].

In today's rapidly changing business environment, only innovative companies that create new customer values constantly can survive; therefore, the ability to find an opportunity for technology innovation and to build and use technology innovation based on the innovation capability of an organization for creating new value is urgently required [3][16][28]. Technology innovation is recognized as the most important driver to enhance the competitiveness of a company and lead the company to success as an activity to develop new products or improve existing products to create new markets and customers or to increase market share [22]. Technology innovation activities enable start-up companies to enter markets successfully and provide existing companies with opportunities to respond to new technologies and enhance organizational capabilities [4]. Entrepreneurship in the technology innovation activities of companies is an important driver of innovation activities. Linked with the creation, development, and management of resources, it differentiates these companies from competitors and enables the companies to capture market opportunities and create new products and processes [12][5]. In the case of technology-based start-ups, resources that can be utilized are limited compared to those of existing companies. Therefore, the companies that do not strategically respond to the difficulties arising from such as lack of funds and various

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capabilities for technology commercialization will fail [32]. Therefore, technology-based start-ups require the ability to utilize external resources to overcome the difficulties caused by the absolute lack of management resources, thereby being able to maximize their performance by utilizing external resources [13][33].

Under today's fast-paced business environment, only the companies that evolve and create new customer values on a continuous basis can survive; therefore, the technology innovation is regarded as an essential element for companies to have competitive advantages or enter new markets. Under the fast-paced business environment, where competition intensifies, there are growing needs for systematic responses and relevant studies but the outcomes are insufficient [16]. Therefore, this study was conducted to empirically verify the effect of the technological entrepreneurship, network capability and technological innovation capability on the innovative performance of technology-based start-ups with the aim of determining the success factors of technology-based start-ups by defining the success of technology-based start-ups as the innovative performance through technology innovation activities.

2. Theoretical Background and Hypotheses

2.1 Technological Entrepreneurship

Today, there is an urgent need for creative and innovative entrepreneurship that can leverage the crisis in a rapidly changing business environment. With increased uncertainty in the business environment and intensified market competition, only companies that are innovating and constantly creating new customer values can create competitive advantage and achieve sustained growth [2]. Linked with the creation, development, and management of resources, entrepreneurship differentiates these companies from competitors and enables the companies to capture market opportunities and create new products and processes [12][5]. In other words, entrepreneurship is a key driver of corporate innovation, and today's success of companies depends on technological innovation activities that create new technologies and values and innovative entrepreneurship that drives these innovation

activities. Therefore, this concept of entrepreneurship is being expanded to the concept of technological entrepreneurship which emphasizes the importance of technological innovation activities in today's technology-based industrial environment, which is expanding day by day [9][12].

Dorf and Byers (2005) defined technological entrepreneurship as a type of leadership that involves activities to discover technical business opportunities with high growth potential, create needed resources such as talented people and capital, and manage rapid growth and significant risks [27]. Petti and Zhang (2011) claimed that technological entrepreneurship plays a role in coupling the technical and commercial domains of companies, and therefore, if new products and production processes are developed using simple technologies that did not have commercial potential, it will provide commercial values through technology innovation [34]. Bailetti (2012) argued that technology entrepreneurship is an investment in a project that possesses and manages professional and heterogeneous assets to create value and create value for the enterprise. He also noted that technological entrepreneurship involves the development of scientific and technical knowledge and the joint experimentation and production of new products, assets and attributes that are closely related to the company's ownership of assets [2]. In other words, technological entrepreneurship is an entrepreneur's will and activity pattern that finds opportunities for technological innovation and creates new value despite the high uncertainty and risk in the future by utilizing innovative capabilities and technological systems [3][34][2].

In the previous studies of entrepreneurship, entrepreneurship was suggested as a multidimensional variable such as innovativeness, proactiveness, risk-taking, autonomy, and competitive aggressiveness [10]. Therefore, this study was intended to examine innovativeness, proactiveness, and risk-taking that have been suggested as the main determinants of entrepreneurship in the previous studies from a technical perspective by considering the technological entrepreneurship as an extended concept of entrepreneurship.

First, technological innovativeness means the intention to introduce new technologies through creative processes with the aim of developing new products, services and new

processes [10]. Innovation is a process by which a company develops new means and methods by deviating from existing management activities, thereby creating new products and new markets and consequently generating profits. This is more important in the sense that it provides the foundation for the survival and sustainable success of an organization [10]. In addition, technological initiatives tend to acquire the advantages of acquiring technology preoccupation ahead of competitors by predicting future opportunities and taking actions in a goal-oriented manner [10]. In other words, proactiveness is the pursuit of innovation by launching or providing a new product or service ahead of competitors, and a proactive company is not a follower but a market leader that seeks the advantages of the first mover in the market [35][10]. And technical risk-taking means a tendency of boldly challenging the norm, even though uncertain outcomes are predicted, as well as a tendency to make decisions and devote resources to take actions even if future outcomes are uncertain [10].

In this way, entrepreneurship is a starting point for a company's sustainable competitive advantage and value creation [38], thereby playing an important role in the pursuit of business opportunities for innovative companies [2]. In other words, technological entrepreneurship is the entrepreneur's will and activity pattern that finds opportunities for technological innovation and creates new value despite the high uncertainty and risk in the future by utilizing innovative capabilities and technological systems, thereby playing an important role in the development and commercialization of technology [3]. Therefore, this study established hypotheses as follows:

H1. Technological entrepreneurship will have a positive effect on technology innovation capability.

H2. Technological entrepreneurship will have a positive effect on innovation performance.

2.2 Network Capability

The role and importance of an innovation network to maintain a company's continued competitiveness in an uncertain business environment is being emphasized. Since it is impossible for companies to procure all the necessary resources for corporate innovation to acquire and maintain a competitive advantage, there is a growing interest in utilizing

external network resources as resources for corporate innovation [30][36].

A company's network capability means the holistic capability to find and connect appropriate network entities to absorb external resources and adapt them to the situation of the company [17]. Network capability enables it to acquire resources and organizational capabilities from external networks that will be used to organize strategic activities and create value in the companies [1]. Efficient network building is an effective alternative to reduce the administrative costs as well as the costs associated with trading in the marketplace. In other words, the network capability connects companies to external network resources and enables access to external network resources such as strategic knowledge or technology, leading to enhancement of performance [25].

Therefore, the network capacity has been studied from various perspectives according to the interests of the industry and researchers. In previous studies, Ritter and Gemunden (2003) defined network capacity as an enterprise-level capability that utilizes inter-organizational relationships. They also identified resource accessibility, human resource management policies, integration of communication structures, and the impact of cultural openness on network capacity and innovation success [15]. Walter et al. (2006) define network capacity as a firm's ability to develop and utilize relationships among organizations within a network, and examine the impact of relationship development on maintenance and utilization of technology services firms [17]. Jian and Wang (2013) defined network capacity as the ability of an enterprise to develop and manage relationships with core suppliers, customers, and other organizations. They identified the impact of network capacity on knowledge sharing and service innovation performance for high-tech companies [8]. Kenny and Fahy (2013) defined network capacity as the ability to interact with other companies, the degree of reciprocity and intimacy between firms, and the impact of relationship capacity, trust and ties on the international performance of high-tech firms. Fang (2014) defined network capacity as the companies' ability to gather, integrate, and deploy network resources to improve business performance and gain a competitive advantage [25]. They identified the IT maturity, culture acceptance, management

system, and network activity experience of high-tech firms in network capacity and innovation performance.

Therefore, this study established hypotheses as follows:

H3. Network capability will have a positive effect on technology innovation capability.

H4. Network capability will have a positive effect on innovation performance.

2.3 Technology Innovation Capability

Technology innovation is a set of all activities that develop new products and services or improve existing products and services with the aim to create new markets (or customers) or increase market share, and is recognized as the most important driver that will enhance the competitiveness of a company, thereby leading the company to success [22]. Technology innovation activities enable start-up companies to enter the market successfully and provide existing companies with opportunities to respond to new technologies and enhance organizational capabilities [4].

Technology innovation capability means a comprehensive ability to make decisions and perform other activities related to technology change, such as the introduction and absorption of new technologies, the convergence of existing and new technologies, and the development of new products or production processes. By continuously accumulating technology innovation capability, companies can strengthen their technology base to secure technological superiority in future market competition, and to develop new technologies that complement deficiencies in existing technologies, thereby being able to enter new markets [37]. In other words, technology innovation capability is a key factor that determines the sustainable growth and survival of the company as a management resource that promotes and supports the innovation of company and the important result of innovation activities [3]. As such, technological innovation capability is recognized as a key factor that has a significant influence on the innovation performance of companies in today's intensifying global competition [7][18][3][16].

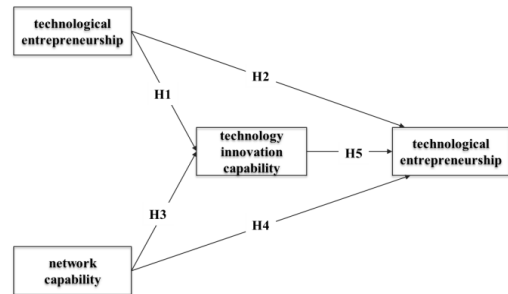
In previous studies on technology innovation, technology innovation capacity was defined including product innovation, product improvement, external technology utilization capacity, R & D capability, and innovative decision making capability. Also, the study suggests that

technological innovation capacity has a significant effect on a firm's financial performance and innovation performance [21][7][20][18][39].

Therefore, this study established hypothesis as follows:

H5. Technology innovation capability will have a positive effect on innovation performance.

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



(Figure 1) Research Model

3. Research Method

3.1 Sample

To verify the proposed hypotheses, we conducted a questionnaire survey on technology-intensive venture companies located in the metropolitan area and collected a total of 300 data. Of the data collected, 25 cases with missing or inadequate responses were removed and the 275 cases were finally used for empirical analysis. The characteristics of the samples participating in the survey are listed in Table 1.

(Table 1) Sample Characteristics

Category and Items		Sample Size	Ratio (%)
Operating Years	Less than 1 yrs	37	13.5
	1 yrs ~ 3 yrs	83	30.2
	3 yrs ~ 5 yrs	112	40.7
	More than 5 yrs	43	15.6
Number of Employees	Less than 10	31	11.3
	10 ~ 30	124	45.1
	30 ~ 50	85	30.9
	More than 50	35	12.7
Industry	Computer/Electronics	34	12.4
	IT/Software	80	29.1
	Machinery/Metal	26	9.5
	Energy/Chemicals	37	13.5
	Bio/Medical	18	6.5
	Science/Technology Service	32	11.6
Etc.		48	17.5

3.2 Measure

To ensure the content validity of the measurement tool, this study used the measurement items verified in the existing literature by revising and supplementing them according to the purpose of this study.

This study reviewed previous studies and defined technological entrepreneurship as "the willingness and activity of an entrepreneur to discover new opportunities for technological innovation and to create new value by utilizing innovative capabilities and technological systems". Also, technological entrepreneurship (innovativeness, proactiveness, risk-taking) was constructed into 3 items each in reference to the studies by Lumpkin and Dess (1996) [11], Lassen et al. (2006) [10], Burgelman et al. (2009) [3], and Bailetti (2012) [2], which were measured using the 7-point Likert scale (Strongly disagree ~ Strongly agree).

Network capacity is defined as "the ability of a company to develop and utilize relationships among organizations within the network". Also, Network Capability was constructed into 4 items in reference to the studies by Ritter and Gemunden (2003) [15], Watson (2007) [19], and Jian and Wang (2013) [8], which were measured using the 7-point Likert scale.

Technology innovation capacity is defined as "organizational capacity for acquiring or using technology-based knowledge". Also, Technology Innovation Capability was constructed into 4 items in reference to the studies by Yam et al. (2004) [21], Guan et al. (2006) [7], and Wang et al. (2008) [18], which were measured using the 7-point Likert scale.

Innovation performance was defined as "the excellence and ripple effect of technology, growth potential, degree of achievement of goals, and customer satisfaction". Innovation Performance was constructed into 4 items in reference to the studies by Xu et al. (2007) [20], and Duhamel & Santi (2012) [6], which were measured using the 7-point Likert scale.

3.3 Analysis Method

In this study, multiple regression analysis was conducted using SPSS 22.0 and the results were analyzed to verify

empirically the determinants effect on the innovation performance of technology-based start-ups.

4. Analysis and Results

4.1 Reliability and Validity

In this study, we validated the reliability and validity of measurement items. Reliability was determined by using Cronbach's Alpha and it was judged to exist when Cronbach's Alpha coefficient was 0.6 or more. The validity was determined by factor analysis and it was judged to be significant when the eigenvalue was 1.0 or more and the factor load value was 0.5 or more. All items satisfied the reference values, so the assessment was that the reliability and validity of the data are secured in this study. The results of the reliability and validity tests are listed in Table 2.

4.2 Correlations among Variables

To verify the correlations among variables, a correlation analysis was performed. As a result, the correlations among variables corresponded to the study model suggested in this study, suggesting that the in-depth analysis of the study model was valid. The analysis of correlations among variables in this study is summarized in Table 3.

4.3 Hypotheses Test

The purpose of this study is to examine the effect of technological entrepreneurship on technological innovation capacity and technological innovation performance of technology-based start-ups. The analysis results are as follows.

(Table 2) Reliability and Validity

	Measurement Items	Factor L.D.	Crb. Alpha
TE1	Check the customer's desire it is not satisfied.	.804	.834
TE2	New approach to the technical problem	.856	
TE3	Creation of the new ideas	.775	
TE4	Try for the technology preoccupation	.766	.868

Measurement Items		Factor L.D.	Crb. Alpha
TE5	search of the information about the market and technology	.860	.800
TE6	Activities to secure technological competitive advantage	.838	
TE7	Endure of the potential loss and risk.	.789	
TE8	Risk-taking for technology development performance	.842	.821
TE9	Attempts to develop technology to pursue growth rather than stability	.773	
NC1	Exchange of knowledge and information with cooperating partners	.782	
NC2	Exchange of knowledge and information with customers	.800	.845
NC3	Exchange of knowledge and information with external experts	.825	
NC4	Exchange knowledge and information with same line of business or related company	.836	
TIC1	Organization and operation of R & D team	.853	.784
TIC2	Core technology holding about the product	.863	
TIC3	Objective establishment about the future technology development	.862	
TIC4	Construction of the technological innovation structure	.736	.788
IP1	Improvement of the development speed of the technology and product	.828	
IP2	Saving of the development cost of the technology and product	.789	
IP3	Increase of technology and know-how	.729	
IP4	Increase in application and registration of intellectual property rights	.788	

TE = Technological Entrepreneurship,
NC = Network Capability, TIC = Technology
Innovation Capability, IP = Innovation Performance

(Table 3) Correlations among Variables

Variables	1	2	3	4
1	1			
2	.475**	1		
3	.496**	.364**	1	
4	.602**	.331**	.577**	1

**p<.01

1 = Technological Entrepreneurship,
2 = Network Capability, 3 = Technology
Innovation Capability, 4 = Innovation
Performance

(Table 4) Relationship between Technological
Entrepreneurship and Technology
Innovation Capability

Independent Variable	Dependent Variable		t
Technological Entrepreneurship	Technology Innovation Capability	.496	9.436***
R ² = .246, Adj R ² = .243, F = 89.037, P = .000			

*p<.05, **p<.01, ***<.001

In terms of the effects of Technological Entrepreneurship on Innovation Performance, Technological Entrepreneurship (t = 12.436, p = .000) had a significant effect on Innovation Performance, adopting hypothesis H2.

(Table 5) Relationship between Technological
Entrepreneurship and Innovation
Performance

Independent Variable	Dependent Variable		t
Technological Entrepreneurship	Innovation Performance	.602	12.463***
R ² = .363, Adj R ² = .360, F = 155.336, P = .000			

*p<.05, **p<.01, ***<.001

In terms of the effects of Network Capability on Technology Innovation Capability, Network Capability (t = 6.461, p = .000) had a significant effect on Technology Innovation Capability, adopting hypothesis H3.

(Table 6) Relationship between Network Capability and Technology Innovation Capability

Independent Variable	Dependent Variable		t
Network Capability	Technology Innovation Capability	.364	6.461***
$R^2 = .133$, Adj $R^2 = .129$, $F = 41.744$, $P = .000$			

* $p < .05$, ** $p < .01$, *** $p < .001$

In terms of the effects of Network Capability on Innovation Performance, Network Capability ($t = 5.792$, $p = .000$) had a significant effect on Innovation Performance, adopting hypothesis H4.

(Table 7) Relationship between Network Capability and Innovation Performance

Independent Variable	Dependent Variable		t
Network Capability	Innovation Performance	.331	5.792***
$R^2 = .109$ Adj $R^2 = .106$, $F = 33.546$, $P = .000$			

* $p < .05$, ** $p < .01$, *** $p < .001$

In terms of the effects of Technology Innovation Capability on Innovation Performance, Technology Innovation Capability ($t = 11.672$, $p = .000$) had a significant effect on Innovation Performance, adopting hypothesis H5.

(Table 8) Relationship between Technology Innovation Capability and Innovation Performance

Independent Variable	Dependent Variable		t
Technology Innovation Capability	Innovation Performance	.577	11.672***
$R^2 = .333$, Adj $R^2 = .330$, $F = 136.238$, $P = .000$			

* $p < .05$, ** $p < .01$, *** $p < .001$

The results of hypotheses test are summarized in Table 9.

(Table 9) Hypotheses Test Results

Hypotheses Path		Supported/ Not Supported
H1	Technological Entrepreneurship → Technology Innovation Capability	Supported
H2	Technological Entrepreneurship → Innovation Performance	Supported
H3	Network Capability → Technology Innovation Capability	Supported
H4	Network Capability → Innovation Performance	Supported
H5	Technology Innovation Capability → Innovation Performance	Supported

5. Conclusions

This study was intended to identify the factors influencing the technological innovation performance of technology-based companies. To achieve the purpose of this study, we suggested technological entrepreneurship and technology innovation capability as the influential variables of technology innovation performance based on literature review and empirically verified the relationship between them.

The results of this study are summarized as follows. First, the technological entrepreneurship of technology-based companies has a positive influence on technological innovation capability. Technological entrepreneurship is the process with which innovative companies strategically integrate organizational resources and technical systems to pursue business opportunities [26]. Therefore, in this study, it is once again found to be an important driver to drive innovation activities for sustainable competitive advantages and value creation of technology-based companies. Second, it has a positive influence on technological entrepreneurship and technology innovation performance. Entrepreneurship influences corporate performance, such as new technology development, new product launches, technology and product development cost reduction, technology and know-how accumulation, product quality level enhancement, quality

versus price competitiveness, product image and customer satisfaction [31][27]. Therefore, in this study, the technological entrepreneurship was confirmed to be an important factor in organizational success such as the survival, profitability, growth and improvement of technology-based companies. Third, the technological innovation capability of technology-based companies has a positive effect on technological innovation performance. Technological innovation capability creates new markets and customers or increases market share by developing new technologies and new products or improving existing ones [21][7][18]. Therefore, in this study, the technology innovation capability of the technology-based startup company was confirmed to be a key factor in determining technological innovation performance.

The implications of this study are as follows. First, in this study, we examined the importance of technology innovation and the role of technical entrepreneurship and network capability as a survival strategy for technology-based companies, proving the theoretical expansion. For this, we defined the success of technology-based startups as technology innovation performance, and empirically verified the factors that influence the success of technology-based companies, which is considered the academic significance of this study. In addition, in this study, we suggested the importance of technology-intensive innovation, which is attracting attention as a new growth driver in today's global competition system, and strategic directions for enhancing technological innovation capability, which is considered practical implication of this study.

In this study, we suggested the importance of technology innovation as a competitive strategy for technology-based start-ups to enhance the competitiveness, but we could not fully examine the result of the study because there are not many studies conducted on technology-based start-ups. In the future, we hope that we will be able to understand more broadly the role of technology innovation capability in improving the technology-based start-ups' business performance by supplementing these points.

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