

IT SME Ventures' External Information Network Diversity and Productivity Improvement : The Mediating Role of the Production Period Reduction

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IT 중소벤처기업의 외부 정보 네트워크의 다양성과 생산성 향상 : 생산 기간 단축의 매개적 역할

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This study empirically analyzes the effect of IT SME ventures' external information network diversity on their production period reduction and productivity improvement generated from technology development. This research constructs a mediating model based on the open innovation perspective and tests it with the 138 samples of South Korean IT SME ventures based on the ordinary least squares regression. This research is expected to make a good contribution by shedding a new light on the following three points about the critical role of IT SME ventures' external information network diversity in increasing their production period reduction and productivity improvement generated from technology development which has scarcely been illuminated in the extant studies in the field of the management of technology for SMEs. First, IT SME ventures' external information network diversity positively influences their production period reduction. Second, the external information network diversity positively influences IT SMEs' ventures' productivity improvement. Third, IT SME ventures' production period reduction partially mediates the influence of IT SME ventures' external network diversity on their productivity improvement. These three fresh points are expected to provide useful theoretical and practical implications. Related to the theoretical implication, this research provides a fresh implication that IT SME ventures' external information network diversity positively influences not only their production period reduction but also productivity improvement generated from technology development. Concerning the practical implication, this study suggests that the CEOs in IT SME ventures make strategic efforts to use more diverse external information sources in order to increase their production period reduction and productivity improvement generated from technology development.

Keywords : IT SME Venture, External Information Network Diversity, Production Period Reduction, Productivity Improvement, Technology Development

1. Introduction

The external information network diversity of the small and medium-sized enterprises (SMEs) plays a vital role in not only increasing their important capabilities such as technology development, technology commercialization, production management, and manufacturing capability [9, 10] but also making a critical performance such as cost reduction [12]. Therefore, various studies have dealt with the effect of the external information network diversity on SMEs' capabilities and performances up to now but they have hardly shed a light on the impact of the external information network diversity on IT (Information Technology) SME ventures' production period reduction and productivity improvement generated from technology development. The production period reduction and productivity improvement are crucial performances that can generate and sustain firms' competitive advantages for their survival and success in the market [16, 17, 24], which has made this study conduct an empirical analysis of the influence of the external information network diversity on IT SME ventures' production period reduction and productivity improvement generated from technology development. In line with this research motivation, this study address two research questions as follows;

- (i) What is the effect of IT SME ventures' external information network diversity on their production period reduction generated from technology development?
- (ii) What is the impact of IT SME ventures' external information network diversity on their productivity improvement generated from technology development?

In order to answer the two research questions, this study constructs a mediating model on the theoretical basis of the open innovation perspective [4, 5] and empirically tests it based on the Sobel [23]'s and the Baron and Kenny [2]'s mediating effect testing method by using the firm level samples collected from 138 IT SME ventures in the Republic of Korea.

2. Theoretical Background and Research Model Development

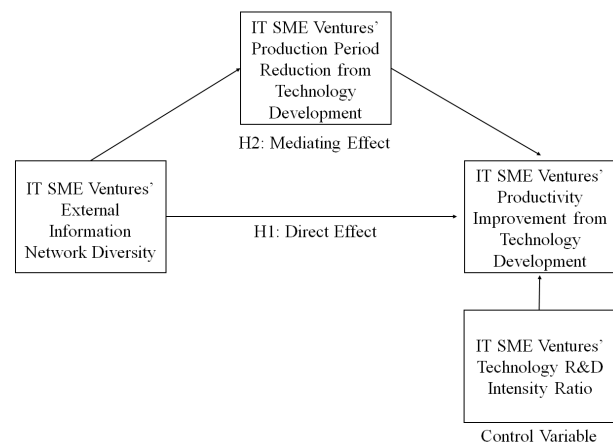
2.1 Theoretical Background

The research model for this study is theoretically based

on the open innovation perspective [4, 5]. The essential logic of the open innovation perspective puts the stress on the point that firms with weak internal R&D capacities and resources can make their technology development more productive by using various external information or knowledge [4, 5]. This essential logic is so meaningful and applicable to the technology development of SMEs [9, 10, 12, 19] that a lot of prior studies on SMEs including Remon [21], Metwally [18], Rahman and Ramos [20], Juntunen [15], and Rahman and Ramos [19] have its theoretical roots in the open innovation perspective [4, 5], which has driven this study to develop the research model based on the open innovation perspective [4, 5].

2.2 Research Model Development

This research develops the two hypotheses on the basis of the open innovation perspective [4, 5]. One is concerned with the direct impact of IT SME ventures' external information network diversity on their productivity improvement generated from technology development. The other is related to the mediating role of IT SME ventures' production period reduction between their external information network diversity and productivity improvement generated from technology development as shown in the <Figure 1>.



<Figure 1> Research Model

The open innovation perspective [4, 5] puts an emphasis on the point that firms such as SMEs whose internal R&D capability is relatively insufficient to achieve the desirable performances generated from technology development should make their strategic efforts to absorb the external information for technology development so as to supply the insufficiency in their R&D capability. The external information from di-

verse sources is very effective in increasing firms' performances from technology development [13]. The productivity is referred to as the proportion of the outputs produced by firms to the inputs used by them [6]. Technical advances can be an important source of firms' productivity improvement [6] and the diverse external information enables firms to increase the effectiveness in their technology development [4, 5, 9, 13]. Therefore, this study generates the hypothesis 1 about the direct and positive effect of the IT SME ventures' external information network diversity as follows;

H1 : IT SME ventures' external information network diversity positively influences their productivity improvement generated from technology development.

According to Hau [9], SMEs' external information network diversity has a positive and direct influence on their technology development capability. Firms' technology development can result in such an important technology innovation as process innovation [1, 25]. Process innovation can eliminate the redundancy among firms' processes and support more efficient information flows in firms [24, 25], which enables firms to reduce their production period [17, 24, 25]. Moreover, in terms of the inputs for the productivity, time is one of the essential inputs for the outputs made by firms [6, 17]. This means that firms' production time is one of the denominators of the formula used to calculate their productivity [6, 24, 25]. This makes firms' production period reduction decrease the denominator of the formula to calculate their productivity, which means the increases in the productivity, *ceteris paribus*. Accordingly, considering both the positive influence of the external information network diversity on the production period reduction and the positive effect of the production period reduction on the productivity improvement, this study generates the hypothesis 2 about the mediating role of the IT SME ventures' production period reduction as follows;

H2 : IT SME ventures' production period reduction mediates the positive influence of their external information network diversity on the productivity improvement generated from technology development.

In addition to the three variables in the hypothesis 1 and 2, this research makes use of the IT SME ventures' technology R&D intensity ratio as the control variable in the research model.

3. Analysis Methodology

3.1 Analyzed Samples and Measurement

This study used a kind of the secondary data resulting from the survey run by the Small & Medium Business Administration and the Korea Federation of Small and Medium Business (KBIZ) in 2013, which was named as the 2013 SMEs' Technology Statistics (2013 SMETS). This study analyzed the 138 samples of the SME ventures belonging to the IT sector in the 2013 SMETS to empirically test the research model.

With regard to measuring the variables in the research model, this study measured the degree of the IT SME ventures' external information network diversity by adapting Watson [26]'s measurement for the technology development-related context of South Korean IT SME ventures. More specifically, by making use of the Watson [26]'s measurement adapted for this study, this research checked the number of the heterogeneous types of the external information sources such as (1) governmental research institutes (2) rivals (3) expos, seminars, and conferences, (4) consulting companies or private research institutes (5) suppliers (6) universities, (7) users and (8) special books or journals from which each IT SME venture got the technology development-conducive idea or information from 2011 to 2012. The degrees of the IT SME ventures' production period reduction and productivity improvement generated from technology development from 2011 to 2012 were measured by using the five-point scale ranging from 1 (very little including nothing) to 5 (very large). The IT SME ventures' technology R&D intensity ratio was calculated by the amount of each IT SME venture's technology R&D investment divided by the amount of its total sales from 2011 to 2012. The <Table 1> outlines the samples in terms of the independent, mediating, and dependent variable in the research model.

<Table 1> The Outline of the Samples Analyzed

Variable	Mean	Standard Deviation	Max	Min
IT SME Ventures' External Information Network Diversity	1.98	1.49	8	0
IT SME Ventures' Production Period Reduction from Technology Development	1.44	1.06	5	1
IT SME Ventures' Productivity Improvement from Technology Development	1.57	1.14	5	1

3.2 Analysis Method

This research applied the Baron and Kenny [2]'s and Sobel [23]'s mediating impact testing method to testing the research model. According to the Baron and Kenny [2], IT SME ventures' production period reduction can prove to be a significant full or partial mediator if the four conditions are satisfied; (I) the external information network diversity must significantly influence the productivity improvement, (II) the external information network diversity must significantly influence the production period reduction, (III) the production period reduction must significantly influence the productivity improvement when the effect of the external information network diversity on the productivity improvement has been taken into consideration, (IV) the significant influence of the external information network diversity in the condition (I) must be changed into the insignificant influence for the production period reduction to be a significant full mediator or the size of the influence of the external information network diversity in the condition (I) must be reduced in the condition (III) for the production period reduction to be a significant partial mediator. Therefore, this study checked whether the research model satisfied the Baron and Kenny [2]'s four conditions or not.

The Sobel [23] test requires the z-value from the following formula to check whether the production period reduction is a significant mediator, which has made this study calculate the z-value to test the significance of the mediating effect of the production period reduction in the research model :

$$Z = \frac{RC_1 \times RC_2}{\sqrt{RC_2^2 \times SE_1^2 + RC_1^2 \times SE_2^2}}$$

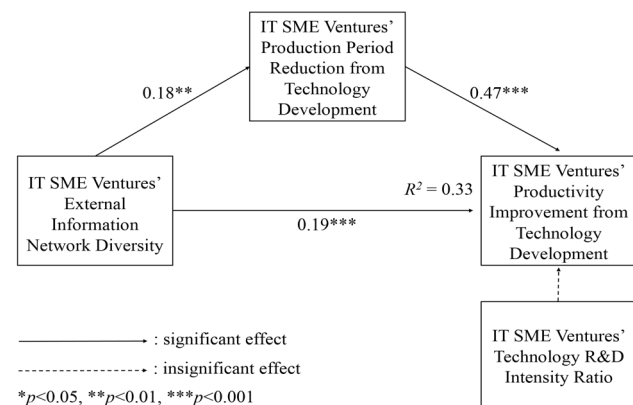
In the above formula for the z-value, RC_1 stands for the unstandardized regression coefficient of the external information network diversity on the production period reduction, SE_1 for the standard error of the RC_1 , RC_2 for the unstandardized regression coefficient of the production period reduction on the productivity improvement, and SE_2 for the standard error of the RC_2 in the research model.

This study ran the ordinary least squares (OLS) regression by using the IBM SPSS version 23 to provide the empirical results necessary for the Baron and Kenny [2]'s and Sobel [23]'s mediating effect testing method.

4. Analysis Results

According to the empirical results from the OLS regression

in this study, IT SMEs' external network diversity has a significant and positive influence on their productivity improvement generated from technology development at the significant level of 0.05 (the regression coefficient = 0.28, t-value = 4.74), which has supported the hypothesis 1 and satisfied the condition I for the Baron and Kenny [2]'s mediating impact test. The empirical results show that the external information network diversity has a significant and positive impact on the production period reduction generated from technology development (the regression coefficient = 0.18, t-value = 3.19), which has met the condition II for the Baron and Kenny [2]'s mediating impact test. The results reveal that the production period reduction has a significant and positive effect (the regression coefficient = 0.47, t-value = 5.98) and the external information network diversity has a significant and positive influence (the regression coefficient = 0.19, t-value = 3.55) on the productivity improvement, which has satisfied the condition III for the Baron and Kenny [2]'s mediating impact test. The significant effect size of the external information network diversity in the condition I is 0.28 and this effect size has been reduced to 0.19 in the condition III, which has met the condition IV for the significant partial mediator in the Baron and Kenny [2]'s mediating impact test. In a word, the empirical results have confirmed that all of the four conditions for the Baron and Kenny [2]'s mediating impact test have been satisfied, meaning that the hypothesis 2 has been supported. The empirical results indicate that the 33% of the variance of the productivity improvement is explained by the research model in this study ($R^2 = 0.33$). Moreover, the z-value from the formula for the Sobel [23]'s test is 2.80, confirming the significance of the mediating impact of the production period reduction in the research model. The <Figure 2> illustrates the research model testing results.



<Figure 2> Research Model Testing Results

5. Conclusion

5.1 Discussion

Technology development is so essential for the management of technology [1, 25, 3] that a lot of studies including Han, Kang and Hong [8], Han and Hong [7], and Hwang and Lee [14] have paid special attention to it. And, a lot of studies on SMEs including Remon [21], Metwally [18], Rahman and Ramos [20], Juntunen [15], Rahman and Ramos [19], and Shin and Lee [22] have been conducted on the open innovation perspective [4, 5]. This research is expected to make a good contribution by shedding a new light on the following three points about the important role of IT SME ventures' external information in increasing their production period reduction and productivity improvement generated from technology development which has scarcely been illuminated in the extant studies in the field of the management of technology for SMEs based on the open innovation perspective [4, 5]. First, IT SME ventures' external information network diversity positively influences their production period reduction. Second, the external information network diversity positively influences IT SMEs' ventures' productivity improvement. Third, IT SME ventures' production period reduction partially mediates the influence of IT SME ventures' external network diversity on their productivity improvement.

The three fresh points which this study has revealed are expected to provide useful theoretical and practical implications. Concerning the theoretical implication, this research widens the recent research stream related to the significant role of the external information network diversity in increasing SMEs' capabilities and important performances such as manufacturing capability [10], technology development capability [9], technology commercialization capability [11], and cost reduction [12]. This study widens the research stream by providing a fresh implication that IT SME ventures' external information diversity positively influences not only their production period reduction but also productivity improvement generated from technology development.

Related to the practical implications, this study suggests that the CEOs in IT SME ventures make strategic efforts to use more diverse external information sources in order to increase their production period reduction and productivity improvement generated from technology development. According to this study, the more various an IT SME makes

its external information network diversity, the more production period reduction and productivity improvement generated from technology development it can make.

5.2 Limitations

The three points which this study has revealed can be meaningful only to the IT SME ventures in the Republic of Korea. Therefore, careful interpretation of the three points is required on the case that they are applied to IT SME ventures in the contexts of foreign nations. More potential and various factors can influence IT SMEs' productivity improvement. So, taking them into consideration will enable future studies to make better implications than the implications from this study.

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