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EFFECTS OF TECHNOLOGY INNOVATION ACTIVITY INVESTMENTS FOR SMALL AND MEDIUM MANUFACTURING ENTERPRISES TO BUSINESS PERFORMANCE: FOCUSING ON THE SOUTHEAST AREA IN SOUTH KOREA

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Abstract: *For continuous growth and development of small and medium-sized enterprises (SMEs), their technology innovation activities are identified as the main variable. In this sense, the interaction among the principals of innovation activities within the company and the investments made in innovation activities is important in company's performance, but the importance of R&D is not equally high in all companies and all innovation activities don't lead to innovative performance.*

The domain of this study is small and medium manufacturing enterprises in the southeast area. In this study, the cost of technological innovation activity consists of 4 categories, including internal R&D, external R&D, introduction of capital goods such as machinery/equipment and software, and introduction of outside knowledge/technology. Achievements of company were classified as successful elements of technological competitiveness and those of manufacture improvement.

As a result, the study revealed that cost of all technological innovative activity had nothing to do with the successful elements of manufacture improvement. When it comes to successful elements of technological competitiveness, cost of capital goods such as machines/equipment or software and that of external R&D activity had an effect in order.

Base on the results of the study, the government should take action to improve technological competitiveness improvement of small and medium sized-manufacture enterprises, and manufacture improvement. It will promote a company's investment on technological innovative activity and enhance a company by preparing a system for commercialization, and further national development.

Keywords: *Technology Innovation, Business Performance, Manufacturing Enterprises, SMEs*

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1. INTRODUCTION

Recently, Korean economy is facing a lot of difficulties. Economic polarization has been fortified because the economic growth rate and employment rate is low, and the gap between companies is increasing. The approach to overcome the national economic difficulties - to empower SMEs is attracted attention largely. According to data released by Korea Federation of Small and Medium Business (2014), the reinforcement of technical competitiveness on for Small and Medium Enterprises (SMEs) accounting for 99% of Korean total enterprise and 88% of total employment is expected to playing a pivotal role in leading the creative economy. But Korean SMEs are currently struggling in the world market as well as in the domestic market. Even companies with superior technology are experiencing a lot of difficulties in commercializing them and reaping the economic performance.

"The comments for improvement of competitive power of SME" to economic expert 151 people were investigated by Korea Chamber of Commerce and Industry. The biggest problem of domestic SMEs by experts was 'innovation capacity insufficient (33.8%)', and followings were 'petty scale (30.5%)', 'globalization insufficient (15.9%)' in Figure 1.

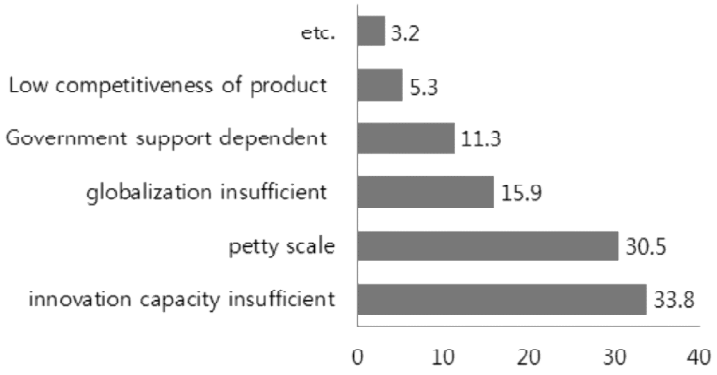

Figure 1: Problem of SMEs (%)

So the relationship between technological innovation and business investment activities in Korea's southeastern SMEs was analyzed in this paper.

2. BACKGROUND

In this study, the relationship between technological innovation activities investment and management performance of small and medium manufacturing enterprises is analyzed. In the previous research related to this paper, the result and the variable is identified.

In Seonghwa & Geuntae (2012), Research and Development (R&D) investment is a necessary element in achieving the corporate performance. But they suggested

that strengthening technology commercialization capabilities is necessary because the management performance is influenced by the technology commercialization capabilities. In their paper, technology commercialization capabilities as the parameters are composed of the broad definition and narrow definition in technology commercialization capabilities.

Focusing on open innovation in Chisu & Yungdug (2011), Anggadwita & Dhewanto (2015) and Bernik, Azis, Kartini & Harsanto (2015), the open innovation activities was compsed of the introversive and extraversive innovation. And the empirical analysis was performed to the influence factors as environmental factors, firm characteristics and system. In their study, the introversive innovation was influenced by the market competition and the technological change.

In Taekyung (2002), the resources and skills was divided into as the tangible resources and the intangible resources. Tangible variables were the financial independence, the debt ratio, firm size, and capital integration. Also intangible variables were the R&D manpower and the ratio of exports. The dependent variable was the innovation activity and the inputs were the R&D expenditure and the number of patents as the performance index. The meaningful determining factors are the firm size variable in the tangibles and the R&D manpower in the intangible resources. In this study, to analyze the role of the business resources and capabilities based on 'the resource perspective', the internal characteristics of the company was emphasized.

However, there are limitations these studies. First, R&D factors are not considered important in all enterprise and the effect is different based on the size and innovation capability of the company. Second, the type of innovation is divided into the product innovation and process innovation. But the purpose about the studies for the process innovation and product innovation was not identified. Thus, the relationship between investments factors related to innovation activities and performance to the purposes of the innovation activities in manufacturing SMEs in the Southeast Area in South Korea in this study. **So,** the efficiency of enterprise technology innovation will be increased by the understanding of the purpose of innovation activity and the factors influencing the respective investment. In addition, the result can be used as the back data that can set up the innovative direction and goals of the enterprise, as promotion for the innovation investment activities of Korean manufacturing SMEs and, as improvement of the competitiveness and the productivity through technology innovation.

3. METHODS

3.1 Data collection

Technological innovations are used as an objective and quantifiable evidence in the decisions of the government and enterprises. In this study, the data of "2012

Korea Technology Innovation of the survey: the manufacturing sector" of Science and Technology Policy Institute (STEPI, the national research institute) was utilized.

The population of this survey is the manufacturing companies more than 10 employees. 4,105 companies responded to this survey. First, the SMEs (3,933 companies) excluding big business were extracted. Second, the Southeast Area (Busan, Ulsan and Gyeongnam) companies in South Korea were extracted firms (791 companies). Finally, 131 companies that the budget to innovation activity of product innovation and process innovation was spent were analyzed. In this survey, the product innovation means that the sales are influenced by the release of a completely different product or significantly improved product about the performance or function compared to existing products. Process innovation means that the reduction of production and logistics costs or improved quality etc. are influenced by a new approach or greatly improved approach about the production processes and logistics.

3.2. Definitions of Variable

3.2.1. Investment of technical innovation activities

Investment of technical innovation activities is an independent variable. it consists of the investment for internal R&D and external R&D. In addition to R&D activity, it is divided into the introduction of capital goods as the machine/equipment and software and, the introduction of the external knowledge / technology. Each definition is shown in Table 1.

Table 1
The Definition of Independent Variables

Independent Variables	*Definition*
Investment for internal R&D	All internal creative R&D activities for increasing the intellectual property (new or improved product and process development)
Investment for external R&D	Other companies or organizations (public and private institutions) performed(outsourced) R&D activities as the same purpose of the Internal R&D
Introduction of Capital Goods	Fulfillment of new machinery or equipment (including computer hardware) or software
Introduction of external knowledge/technology	Purchased patents, licenses, know-how and technical services of other company or institution

Independent variable (Investment in technical innovation activities) was divided into the above 4 factors. The sum of the 4 factors cost are 100% and each factor was measured with a 5-point scale.

3.2.2. Business Performance

Performance according to the results shown in innovation activities was configured by 9 factors; each factor was measured by a 4-point scale as shown in Table 2.

Table 2
Measure of the Dependent Variable

Dependent variable	*Evaluation*
Diversification of product, Substitution of existing product/process Development of new markets or Expansion of market share, Improvement of product quality, Improvement of production flexibility, Expansion of production capacity, Reduction of raw material and energy costs, Improvement of bad environment, Improvement of work environment and safety	High Medium Low No effect

3.3. Establishing Hypothesis

Internal R&D activities - an important factor in the performance of enterprises means the ability that integrates totally and controls effectively the strategy, project, portfolio and investment related to R&D. It supports to maximize the company performance for the rapid product development, the empowerment of the market dominance, and the accumulation of the technical know-how.

Based on the theory of internal R&D activities, the hypothesis 1 is established to confirm whether internal R&D activities can make a various performance. In reality, it is almost impossible to develop all the skills needed to business because of the shortening of the technology life cycle and the intensifying competition. Overcoming this situation, the typical method is to achieve the synergy of R&D by consolidating the external technology and the internal technology. Thus, the hypothesis 2 is established to confirm whether external R&D activities can make a various performance. In the case of manufacturing enterprises, there exists the industry that innovation activity by the internal capability and R&D of enterprises is important. Also there exists the industry that has the opportunity of innovation by using efficiently the production equipment and facility. Thus, the hypothesis 3 is established to confirm whether the plant and equipment investment in manufacturing enterprise as the important measure in determining the improvement of the production and quality can achieve a performance. Besides, the external introduction of the technology increase the technical ability in the short term by the selection of the company needed technology and knowledge. Therefore it is important to the activity of R&D development in the method of technical acquisition. The hypothesis 4 is established to confirm whether the external knowledge and introduction of the skills have an influence on the outcome of enterprises.

- **Hypothesis 1.** Investment for internal R&D will affect the business performance.
- **Hypothesis 2.** Investment for external R&D will affect the business performance.
- **Hypothesis 3.** Introduction of capital goods will affect corporate performance.
- **Hypothesis 4.** Introduction of external knowledge/technology will affect the business performance.

4. RESULTS

The analysis of the results – basic statistics is suggested by the SPSS 23, and then the 9 dependent variables are extracted as typical factors by through the factor analysis and the reliability of each factor is carried out. And the path analysis indicating a causal relationship between the investment of technical innovation and the performance of enterprises is carried out by SPSS Amos 23. The basic statistics about the investment of technical innovation and the performance of enterprises is shown in Table 3.

Table 3
Basic Statistics

Variable	*Mean*	*S.D.*
Investment for internal R&D	3.21	1.466
Investment for external R&D	1.48	0.923
Introduction of capital goods	2.49	1.531
Introduction of external knowledge/technology	1.40	0.838
Diversification of product	2.10	1.318
Substitution of existing product / process	1.95	1.227
Development of new markets or expansion of market share	2.21	1.222
Improvement of product quality	3.00	1.102
Improvement of production flexibility	2.18	1.212
Expansion of production capacity	2.24	1.245
Reduction of raw material and energy costs	1.73	1.058
Improvement of bad environmental	1.55	0.962
Improvement of work environment and safety	1.82	1.135

Looking at the descriptive statistics, the external R&D costs is invested twice more than the internal R&D costs in the company performing the R&D activity. Also, the acquisition cost of the capital goods is much more than the external knowledge / technologies. Based on these basic statistics, the relationship between the investment of technical innovation of enterprises and the performance of enterprises will be analyzed.

4.1. Factor analysis and reliability analysis

In this study, 9 variables indicating the outcome of enterprises are represented as summarized key inherent factors. To extract common information between the variables as representative factors, the factor analysis and then the reliability analysis were carried out for each factor using the SPSS Statistics 23, Table 4. Principal component analysis as Factor analysis is carried out (the method of varimax rotation method - orthogonal rotation). And Cronbach's alpha factor (á) as reliability analysis was used in order to check out the reliability of the internal consistency for the items in each factor.

The variables indicating the outcome of enterprises were divided into two factors such as the outcome of technical competitiveness and the improvement of manufacturing activity. The Kaiser-Meyer-Olkin (KMO) measure is the degree of good description by other variables judged about the correlation between variables. If KMO value is greater than 0.5, it was satisfactory. And if KMO value is bigger, it is better. In this study, KMO value is 0.855, so it seems suitable. To find the internal consistency of the each factors (two factors by the results of the factor analysis), And Cronbach's alpha factor (α) as reliability analysis was performed. $\alpha > 0.6 \sim 0.7$ means high reliable. In this study, α of technical competitiveness is 0.836 and á of the improvement of manufacturing activity is 0.824. So, there are no problems in the reliability.

Table 4
Factor Analysis and Reliability Analysis

	Variable	*Factor*		*Cronbach's*
		1	*2*	*α*
Technical competitiveness	diversification of Product	.779	.212	.836
	Improvement of production flexibility	.774	.271	
	Expansion of production capacity	.716	.275	
	Improvement of product quality	.670	.186	
	substitution of existing product/ process	.659	.133	
	Development of new markets or Expansion of market share	.655	.196	
Improvement of manufacturing activity	Improvement of work environment and safety	.226	.857	.824
	improvement of bad environmental	.256	.833	
	Reduction of raw material and energy costs	.235	.790	
Eigen value		3.201	2.336	
Covariant (%)		35.563	25.959	
Accumulative value (%)		35.563	61.522	

KMO=. 855, Bartlett's χ^2= 479.805(p<.01)

4.2. Hypothesis Testing

In this study, path analysis by SPSS Amos 23 as a method for hypothesis testing was performed. Path analysis is used to confirm the effect of variables that has a causal relationship between variables by applying a regression analysis repetitively. Path of the path model starts from the causal variable and ends to the affected (endogenous) variable, and path shows the direct effects of the impact between the two variables. The direct effect is determined on the standardized estimates. Non- standardized coefficients are used in the regression equation, but the standardized coefficients favorable to judge the impact between each variables is used in the path analysis is used for. The path analysis is divided to two methods. One is a method to analyze based on the average value of the measurement item after the factor analysis and the other is a method to analyze based on the values stored in the variable after the factor analysis. A method to analyze based on the average value has the disadvantage that an arithmetic mean arbitrarily calculated by the researcher is used. So, in this study the values stored in variables in the factor analysis was used to get more accurate.

Figure 2 is the result of the path model that describes a causal relationship between the dependent and independent variables. Investment of technical innovation activity as the independent variable was the survey data values, and the outcome of enterprises as the dependent variable was made as the path model based on a factor analysis.

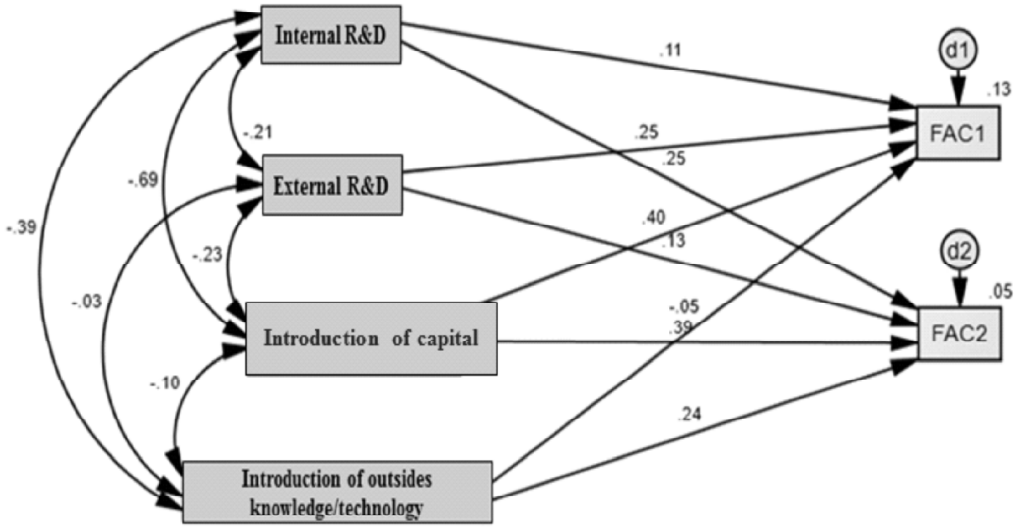

Figure 2: Path Analysis Model

Goodness-of-fit of the model has a value between 0 and 1 and the range that satisfies the fitness criteria was set in the path.

Table 5
Goodness-of-fit of the Path model

Division		*Range*	*Fitness*	*Result*
AbsoluteFitness	CMIN(χ^2)		3 below	.227
	GFI	0~1	.9 above	.999
	RMR	0~1	.05 below	.008
	RMSEA	0~1	.05 below	.000
Incremental	NFI	0~1	.9 above	.999
Fitness	RFI	0~1	.9 above	.988
	CFI	0~1	.9 above	1.000

Looking at the path coefficient value of the final path model in Table 6, the investment about the internal R&D activity and the acquisition of the external knowledge / technologies were shown to have no significant influence to the outcome of technical competitiveness and manufacturing activity improvement. The investment of external R&D activity and acquisition of the capital goods is not significant, but the outcome of technical competitiveness is significant. The path coefficient of the acquisition cost of the capital goods (0.395) was higher than the path coefficient of the investment of external R&D activity (0.251). As a result, it was shown that the acquisition cost of capital goods has the biggest influence on the outcome of technical competitiveness.

Table 6
Path Coefficient of the path model

Variable	*Technological competitiveness*	*Improvement of manufacturing activity*
Internal R&D	.109	.249
External R&D	.251*	.128
Introduction of capital goods	.395*	.387
acquisition of external knowledge/technology	-.053	.240

5. CONCLUSION

In this study, the relationship between the company's technical innovation investment and corporate performance was investigated. The data of the technical innovation questionnaire from STEPI was used for analysis. And the analysis was carried out based on the data of technical innovation survey to manufacturing published in 2012.

Investment about technical innovation activities of small and medium manufacturing company consists of four items: internal R&D, external R&D, acquisition of capital goods and acquisition of external knowledge/ technology. The enterprise outcome about these items consists of technological competitiveness and improvement of manufacturing activity. The result of empirical analysis showed that the 4 investment items do not have influence on improvement of manufacturing activity. And the investment activity that has influence on technical competitiveness was the acquisition investment of capital goods and investment for external R&D activity. Therefore, among the hypothesis of this study, hypothesis 1 and 4 are not supported and hypothesis 2 and 3 was partially supported. Through the empirical analysis, the investment about the technical competitiveness of external R&D activity and the acquisition of capital goods has the significant impact on outcome of enterprises. Among these, the investment about the acquisition of capital goods was the bigger impact on outcome of technical innovation activity. The investment about the internal R&D activity showing the highest investment ratio in this study do not influence on corporate performance, which shows that the internal R&D activity is not competitive. And every technical innovation activity was shown to have no outcome about improvement on manufacturing activity, which means that the institutional support to carry out the technical innovation activities is needed considering the ecological and environmental characteristics of small and medium enterprise. In addition, the investment strategy of the capital goods associated with the internal and external R&D activities is needed in order to produce high value-added products. Based on the results of this study, the Government should prepare the policy for the upgrade of the technical competitiveness and the improvement of the manufacturing activities for the small and medium enterprise.

However, in this study, there are the following limitations: First, the most important limitations is the data related to the study. The Technology Innovation Activity Questionnaire of STEPI (2012) was constructed that the costs of the innovation activities in the last three years (from 2009 to 2011) consist of four items and the sum of the total percentage was 100%. Second, the objective data by the company is needed because the data of STEPI is likely to be the subjective opinion of the enterprise. The further research is needed to compensate for this limitation.

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