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Effectiveness of SMEs Support by Retired Scientists and Engineers

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Abstract

Technology and knowledge are emerging as core elements of competitiveness for businesses. SMEs lack technology and knowledge, and are also limited in their ability to absorb external knowledge. The government is supporting SMEs' absorption of external knowledge by utilizing retired scientists and engineers, but related research is insufficient. Thus, this study conducted an empirical analysis on the effects of support by retired scientists and engineers at SMEs. Specifically, the study confirmed the effects of company competitiveness and technology development capacities at each stage of technology commercialization. Results of the study confirmed that in an environment where technology competitiveness of SMEs are emphasized, the support of retired scientists and engineers has some effect on the competitiveness of SMEs and their technology development capacity. Therefore, this study suggests important implications for future policy development and execution of related projects.

Keywords: SMEs, Retired scientists and engineers, ReSEAT, Technology Commercialization.

1. Introduction

The key factors that determine a company's competitiveness are changing with the times. In South Korea as well, these factors are gradually shifting from capital-centered factors to technology and knowledge. Especially, as the market environment and customers' desires change rapidly due to the harmonization of the world economy, the acquisition of new technologies and knowledge becomes more important. However, SMEs lack skills and knowledge as business resources.

In order to overcome the problem of information asymmetry of these SMEs, the government is operating various policies. Despite this, SMEs have limited ability or access to external knowledge, and because they have limited internal capability to absorb external information, there are not many cases of SMEs using external knowledge for open innovation. In 2002, a government program was introduced to supplement these problems and raise the morale and social contribution of retired scientists and engineers.

Programs that utilize retired scientists and engineers are also implemented in the US, China, Japan, etc. However, they are limited to education or policy advisory according to national policies, or they are utilized in the field of technology commercialization in the public sector. This is the reason for lack of research related to SME support. Therefore, this study analyzes the effects of support by retired scientists and engineers at SMEs. Specifically, the study examines at what stage of technology commercialization the support activities of retired scientists and engineers influence corporate competitiveness and technology development capacity of SMEs.

This paper is organized as follows. Chapter 2 reviews the ReSEAT program and previous studies as programs that utilize retired scientists and engineers. Chapter 3 explains research methods such as the research model, research hypothesis, and analysis data. Chapter 4 presents the results of statistical analysis on the competitiveness of companies and the effectiveness of technology development capacity. Chapter 5 discusses implications and implications of this study.

2. Literature review

2.1. ReSEAT Program

ReSEAT is a program that works with retired scientists and engineers. The South Korean government began the program in 2002 to boost morale and strengthen the application of retired scientists and engineers. The K agency that runs the program opened its homepage in 2003 and branded the project with the name: "ReSEAT program" in 2006.

The ReSEAT program has two main directions. The first is science education for youths, and the second is research and development support. Youth science education provides explanations for exhibits at science museums and mentoring to help cultivate creative thinking and problem-solving skills for youths of the next generation who dream of becoming scientists. On the other hand, research and development support is divided into SME technology mentoring and research and development success/failure case studies and proliferation. Technical mentoring for SMEs is closely related to the K agency's 'technology commercialization centered development strategy' implemented since 2009. This led to the collaboration of retired scientists and engineers in mentoring SMEs in technical information analysis.

The ReSEAT program will be developed in 2013 as a government policy tool. Combined with the creation economic policy for discovering new growth engines under the Park Geun-hye administration, collaboration with scientists and engineers was used as the core driving force of the creative economy. Also, a support center for scientists and engineers has established, and the scope of support has expanded to include research institutes, public research institutes, associations, and various organizations.

2.2. Previous Studies

Programs that utilize retired scientists and engineers are also operated in major foreign countries. In the case of the US, these programs operate as science-oriented projects such as Re-SEED (Retirees Enhancing Science Education through Experiments and Demonstration), ReSET (Retired Scientists, Engineers, and Technicians), SSE (Senior Scientists and Engineers), etc. China has an honorary system for scientists and an association of senior scientists and engineers. They are at the center of science and technology policy advisory and education of the government, and they are also responsible for some corporate consulting. Japan has been using these programs in the field of technology commercialization by government agencies, and they include the RSP (Regional Science Promotion) program, Promotion of Technology Transfers at Innovation Plazas, Knowledge Cluster Initiative and patent distribution consultation, etc. (Min et al., 2014).

Nonetheless, studies using the SCOPUS and the RISS database in South Korea revealed that research on retired scientists and engineers' support for SMEs is very scarce. This seems to be due to differences in policy by country and restrictions on data access to government projects. This study focuses on research trends in South Korea.

Research on this in South Korea can be found starting from 2002 academic conference papers. At that time, the topic was systematically approached by a number of researchers looking at the status of retired scientists and engineers and methods to expand utilization (Lee et al., 2002), problems of and methods to improve utilizations (Yang et al., 2002), performance evaluation of utilization projects (Min et al., 2002), etc.

However, there are few subsequent studies. Park et al. (2008) introduced the ReSEAT program as a knowledge service model, Min et al. (2014) is building a utilization model, and Choi et al. (2014) are focusing on a vitalization plan. For research related to performance evaluation, there is an evaluation method (Kim et al., 2002) and an empirical study (Heo & Kim, 2013) on the analysis of technical information operated by the ReSEAT program.

3. Methodology

3.1. Research design

This paper analyzes how SME support activities by retired scientists and engineers are related to SME competitiv eness and technology development capacity. Specifically, this study examines at what stage of technology commerci alization the support activities of retired scientists and engineers are effective. Thus, the research model designed as follows: company competitiveness and technology development capacity are the dependent variables, and the useful ness of knowledge held by retired scientists and engineers at each stage of technology commercialization is set as th e independent variable.

Factors that determine the core competitiveness of companies are rapidly shifting from past capital to technology and knowledge. Knowledge plays a crucial role in sustaining competitive advantage and wealth creation (Cha & Bae, 2002), and many companies are adopting knowledge management and open innovation systems. However, there are not many open innovation cases of SMEs. This is because SMEs have limited ability or skills to access external kno wledge (De Vrande et al., 2009).

To supplement the information asymmetry problem of SMEs, the government and research institutes are carrying out projects such as industry-academic cooperation, technical cooperation between companies, providing customize d information, and support for retired science and technology engineers, etc. (Bea et al., 2017). This is because SME s can utilize external knowledge to solve technological problems of companies (Johnston & Gibbons, 1975), to inno vate technologically (March & Simon, 1985) and innovate companies (Cohen & Levinthal, 1989). Especially becaus e the market environment and customer needs are rapidly changing, the ability to absorb knowledge is very importan t (Van den Bosch et al., 1999). In the case of SMEs, however, their ability to absorb external knowledge is weak. It i s in this circumstances that the role of retired scientists and engineers are emphasized. The importance of their roles is being raised, with the fact that tacit knowledge is often the highest level of knowledge (Teece, 1982). However, th e performance evaluation of these activities is limited to technical literature analysis.

On the other hand, the usefulness of the technical knowledge provided by retired scientists and engineers and the re lationships that they adopt and use in the technology commercialization stages are explained with the technology acc eptance model. Davis (1993), to explain acceptance behavior, explains the relationship between perceived usefulnes s and perceived ease of use from external factors that influence the use of the actual system through use attitudes and behavioral intentions. In other words, only when the technological knowledge provided by the retired scientists and engineers is judged to be useful, it is accepted and applied to the technology commercialization process.

Finally, it is necessary to review the technology commercialization process. The technology commercialization pr ocess is divided into the previous stages and the later stages based on the market launch of new products. The previo us stages are somewhat different for each researcher. Jolly (1997) classifies the stages into the imagining, incubating, demonstrating, promoting, and sustaining stages. Cooper (1986) divides them into idea, experiment, realization, me rchandising, and mass production stages. The Korea Institute of Industrial Technology Evaluation and Planning disti nguishes between the basic research stage, the experimental stage, the prototype stage, the manufacturing stage, and the commercialization stage. On the other hand, the later stages are explained using the lifecycle theory of introducti on, growth, maturity, and decay.

Among the various perspectives on the growth process of venture firms, research is also being carried out from th e perspective of knowledge activities. However, most of these studies are about the knowledge and management acti vities required after the product launch. Research in the previous phase is limited to the success rate of technology d evelopment at each stage (Park et al., 2011).

Based on a synthesis of these research results, this study sets the hypotheses as follows.

Hypothesis 1. The usefulness of retired scientists and engineer's support is effective in enhancing corporate competitiveness.

1-1. The usefulness of the basic research stage is effective in strengthening corporate competitiveness.

1-2. The usefulness of product design stage is effective in strengthening corporate competitiveness.

1-3. The usefulness of the prototype manufacturing stage is effective in strengthening the competitiveness of the enterprise.

1-4. The usefulness of the product improvement stage is effective in strengthening the competitiveness of the enterprise.

1-5. The availability of the mass production stage is effective in strengthening the competitiveness of the enterprise.

Hypothesis 2. The usefulness of retired scientists and engineer's support is effective in strengthening technology development capacity.

2-1. The usefulness of the basic research stage is effective in strengthening technology development capacity.

2-2. The usefulness of the product design stage is effective in strengthening technology development capacity.

2-3. The usefulness of the prototype manufacturing stage is effective in strengthening technology development capacity.

2-4. The usefulness of the product improvement stage is effective in strengthening the technology development capacity.

2-5. The usefulness of the mass production stage is effective in enhancing technology development capacity.

3.2. Data and Methodology

The analysis used the results of surveys of companies participating in the SME support program conducted by K a gency from 2007 to 2014. Among the total 567 data, the results were limited to the survey results of 95 companies p articipating in the utilization of retired scientists and engineers from 2009 to 2013.

Table 1 shows the operational definitions of variables. Multiple regression analysis was used for statistical analysi s using SPSS Statistics.

<Table 1> Operational definitions of variables

Classification	Dependent variable	Independent variable
Variable type	Corporate competitiveness, technology development capability	Basic research, product design, prototype production, product improvement, product mass production
Variable definition	Effect of retired scientists and engineers' support	Usefulness of retired scientists and engineers' support
Measuring method	7-point scale (7 points - Very effective)	7-point scale (7 points - Very useful)

4. Result

4.1. Corporate competitiveness

As a result of the correlation coefficient analysis, it was confirmed that 0.05 (p <.05) was significant except competitiveness and basic research, competitiveness and product design.

<Table 2> Corporate Competitiveness Correlation Coefficient

		Corporate Competitiveness	Basic research	Product design	Prototype product	Product improvement	Product mass production
Pearson correlation	Corporate Competitiveness	1	0.059	0.358	0.422	0.602	0.598
	Basic research	0.059	1	0.651	0.662	0.58	0.696
	Product design	0.358	0.651	1	0.826	0.763	0.728
	Prototype product	0.422	0.662	0.826	1	0.786	0.709
	Product improvement	0.602	0.58	0.763	0.786	1	0.873
	Product mass production	0.598	0.696	0.728	0.709	0.873	1
Probability of significan	Corporate Competitiveness	.	0.406	0.066	0.036	0.003	0.003

ce (one side)	Basic research	0.406	.	0.001	0.001	0.005	0.000
	Product design	0.066	0.001	.	0.000	0.000	0.000
	Prototype product	0.036	0.001	0.000	.	0.000	0.000
	Product improvement	0.003	0.005	0.000	0.000	.	0.000
	Product mass production	0.003	0.000	0.000	0.000	0.000	.

<Table 3> Corporate Competitiveness Multiple Regression Analysis Results

Classification		Non-standardization factor		Standardization factor	t	Probability of significance	Durbin-Watson	R^2
		B	Standard error	beta				
Model 1	(Constant)	5.205	1.732		3.006	0.01		.734
	Basic research	-1.015	0.355	-0.738	-2.861	0.013		
	Product design	-0.188	0.337	-0.179	-0.559	0.586		
	Prototype product	0.373	0.403	0.315	0.926	0.371		
	Product improvement	0.15	0.485	0.127	0.31	0.762		
	Product mass production	0.822	0.355	0.908	2.318	0.037		
Model 2	(Constant)	5.461	1.472		3.709	0.002		.709
	Basic research	-1.048	0.327	-0.763	-3.21	0.006		
	Product design	-0.173	0.323	-0.164	-0.538	0.599		
	Prototype product	0.423	0.358	0.357	1.183	0.256		
	Product mass production	0.901	0.237	0.995	3.798	0.002		
Model 3	(Constant)	5.505	1.435		3.837	0.002		.692
	Basic research	-1.068	0.317	-0.777	-3.371	0.004		
	Prototype product	0.307	0.278	0.259	1.103	0.287		
	Product mass production	0.865	0.222	0.955	3.898	0.001		
Model 4	(Constant)	5.928	1.392		4.259	0.001	2.195	.697
	Basic research	-0.951	0.301	-0.692	-3.164	0.006		

	Product mass production	0.978	0.198	1.079	4.936	0.000

For regression analysis, the method of inputting variables must be selected. The variables are divided into input method, step selection, elimination, backward, and forward according to whether the variable contributes significantly to the regression equation. In this study, the backward analysis method was selected to remove the least statistically significant variables from all independent variables. The statistical baseline of the variables removed was based on a 95% significance level. The variables that are statistically insignificant were removed and the remaining variables were adopted as important variables.

The results of multiple regression analysis by backward analysis showed that based on Model 1, Model 2, Model 3, Model 4, the significant independent variables at the $p < 0.05$ levels are basic research and mass production. This means that retired scientists and engineers' support activities at the significance level of 95% as a result of the backward analysis, have a significant effect on the competitiveness of enterprises.

4.2. Technology development capability

As a result of the correlation analysis of technology development capacity, it was found that the correlation coefficient between technology development capacity and basic research was significant at the level of 0.01 ($p < .01$).

<Table 4> Technology development capacity correlation coefficient

		Technology development capacity	Basic research	Product design	Prototype product	Product improvement	Product mass production
Pearson correlation	Technology development capacity	1	0.341	0.658	0.604	0.604	0.577
	Basic research	0.341	1	0.651	0.662	0.58	0.696
	Product design	0.658	0.651	1	0.826	0.763	0.728
	Prototype product	0.604	0.662	0.826	1	0.786	0.709
	Product improvement	0.604	0.58	0.763	0.786	1	0.873
	Product mass production	0.577	0.696	0.728	0.709	0.873	1
Probability of significance (one side)	Technology development capacity	.	0.077	0.001	0.003	0.003	0.005
	Basic research	0.077	.	0.001	0.001	0.005	0.000
	Product design	0.001	0.001	.	0.000	0.000	0.000
	Prototype product	0.003	0.001	0.000	.	0.000	0.000
	Product improvement	0.003	0.005	0.000	0.000	.	0.000
	Product mass production	0.005	0.000	0.000	0.000	0.000	.

As a result of multiple regression analysis by backward analysis, product design is a significant independent variable at $p < 0.05$ based on Model 5. This means that at the level of significance of 95% as a result of the backward analysis, retired scientists and engineers' support activities have a significant effect on technological competitiveness.

<Table 5> Technology development capability multiple regression analysis results

Model		Non-standardization factor		Standardization factor	t	Probability of significance	Durbin-Watson	R^2
		B	Standard error	beta				
	(Constant)	3.609	1.633		2.21	0.046		
	Basic research	-0.349	0.334	-0.319	-1.045	0.315		
	Product design	0.393	0.318	0.467	1.235	0.239		
1	Prototype product	0.203	0.38	0.214	0.534	0.603		0.503
	Product improvement	-0.013	0.458	-0.013	-0.027	0.979		
	Product mass production	0.23	0.334	0.318	0.687	0.504		
	(Constant)	3.588	1.383		2.593	0.021		
	Basic research	-0.347	0.307	-0.316	-1.13	0.278		
2	Product design	0.391	0.303	0.465	1.291	0.218		0.503
	Prototype product	0.199	0.336	0.21	0.591	0.564		
	Product mass production	0.223	0.223	0.309	1.001	0.334		
	(Constant)	3.79	1.311		2.89	0.011		
	Basic research	-0.311	0.294	-0.283	-1.056	0.308		
3	Product design	0.5	0.237	0.594	2.11	0.052		0.491
	Product mass production	0.247	0.215	0.342	1.15	0.268		
	(Constant)	2.812	0.932		3.017	0.008		
4	Basic research	0.426	0.227	0.506	1.876	0.079		0.453
	Product mass production	0.15	0.195	0.208	0.772	0.451		
5	(Constant)	2.982	0.894		3.334	0.004	1.544	0.433
	Product design	0.554	0.154	0.658	3.6	0.002		

5. Discussion and Conclusion

5.1. Discussion

The purpose of this study is to analyze the effectiveness of support by retired scientists and engineers for SMEs. This is used to enhance technological innovation and corporate competitiveness by using the tacit knowledge of retired scientists and engineers for SMEs whose accessibility of external knowledge is limited. Nevertheless, the related research is very poor. This study analyzed whether retired support by scientists and engineers is effective on corporate competitiveness and technology development capacity of SMEs. Specifically, stages of technology commercialization were divided and the effectiveness of this support was analyzed at each stage.

As a result of the analysis, it was confirmed that support by retired scientists and engineers have about a 95% significance level in the basic research stage and the mass production stage. However, the basic research stage was analyzed as negative (-) effect, and it was confirmed that support by retired scientists and engineers had a negative effect. On the other hand, in the case of mass production, which is the final stage before the product launch, and connected to the company's profits, there was a positive (+) effect on corporate competitiveness. Thus, Hypothesis 1-1 and Hypothesis 1-5 were adopted.

Also, it was confirmed support by retired scientists and engineers has a significant effect of 95% on the product design stage with respect to the technology development capacity. Investment in new product development until the design stage of the product is only a level of laboratory research, but after that, the cost of investment increases because molds are produced for prototype production. In other words, it is presumed that product design is important for technological development ability when considering investment cost in technology commercialization stage, and there is a positive (+) effect. Thus, Hypothesis 2-2 was adopted.

These results suggest that SMEs can solve their technical problems by using external knowledge (Johnston & Gibbons, 1975), technology innovation (March & Simon, 1985) or corporate innovation (Cohen & Levinthal, 1989, p570), consistent with previous studies. However, if the technology commercialization is divided into stages, it is important to note that the effects of external knowledge appear differently and can produce a negative effect.

5.2. Conclusion

The implications of this study are as follows. First, the effect of support by retired scientists and engineers for SMEs were analyzed for the first time. Although the existing research is limited to the technical literature analysis results, this study is meaningful in that it analyzes the effect of support for SMEs. Second, the study can contribute to government-related policies. By presenting the demand objectives of support by retired scientists and engineers and the effects for each stage of technology commercialization, it can be used as a customized support method of SMEs for corporate competitiveness or technology development capability. Third, it is necessary to train retired scientists and engineers to transfer technical knowledge. A negative (-) effect was analyzed in the basic research stage for enhancing corporate competitiveness, which means that it will confuse the technology commercialization of SMEs. Therefore, it is necessary to train them to transfer knowledge in the future by integrating the company situation, product technology, and market knowledge.

There are also limitations of this study. First, the analysis of characteristics of retired scientists and engineers and companies is insufficient. The study is insufficient in detail as it does not include the knowledge characteristics of scientists and engineers, the performance of the respondent company, employees, capital, growth stage, etc. Also, the number of samples used in this study is small. Therefore, there is a limit to generalizing the results of this study.

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