

An Analysis of Structural Relationship between Technology Commercialization Competence and New Product Development Performance of SME in Korea

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Abstract: *Based on the survey results, this study reveals that there is a causal relationship between the technology commercialization competence and new product development performance of SMEs. A survey was conducted on 205 people in charge of R & D in small and medium venture firms in Korea, and the results were interpreted through a structural equation model. As a result, the product competence, production competence, and marketing competency belonging to the technology commercialization competence of SMEs were found to affect the technical performance among the new product development performances, but there was no clear evidence that it affected the product development performance. In order to overcome the structural limitations of SMEs, it is necessary to introduce an outsourcing strategy. After analyzing the impact of outsourcing strategy on new product development performance, it is found that it affects not only technology development performance but also product development performance. This study examines the mediating effect to examine the structural relationship between outsourcing strategy, technology commercialization competence, and new product development performance. Outsourcing strategy plays an intermediary role in the effect of product competence and marketing competence on technology development performance. In the case of new product development performance of SMEs with insufficient financial status or management system, the outsourcing strategy can be interpreted as a result of strengthening the product competence and marketing competence that are insufficient for product development performance.*

Keywords: *Small and medium venture enterprise, technology commercialization competence, outsourcing strategy, new product development performance*

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I. Introduction

The Republic of Korea has enacted the Act on the Promotion of Technology Transfer and Commercialization to Strengthen Global Competitiveness, and is accelerating the creation of an active ecosystem for technology-based venture companies. The government's policy stance is increasing the number of venture firms with innovative technologies. However, qualitative growth is more important than sustained growth in quantitative growth. For the sustainable growth of technology-based venture companies, it is necessary to secure a competitive advantage in the market through superior technology. To secure this technology, companies may invest directly in their own R & D, or acquire technology from outside such as technology imitation, commissioned research, OEM adoption, joint research, strategic outsourcing or partnership. Based on the technology secured, venture companies are making high inroads into the market through technology commercialization. This strategy internalizes and improves technology researched and developed within the enterprise or introduced from outside. In addition, it can be explained by the process of strengthening the product competence, the productive competence, and the marketing competence and performing the technology commercialization through this [1].

In this regard, securing intellectual property rights and patent rights to internalize technologies introduced from inside and outside is very important for securing the competitive advantage and protection of rights for technology-based venture firms to secure competitiveness [2]. In addition to acquiring technology, it is also very important for small and medium venture firms to be able to commercialize and commercialize it. Therefore, this study intends to clarify the close relationship between the technology commercialization competence of SMEs and the development performance of new products. In addition, outsourcing strategies are attracting attention as an effective way to overcome the inadequacies of technology commercialization, the inherent limitations of small and medium venture companies [3].

Therefore, outsourcing Strategy argues that performance increases and new product development, technology commercialization capabilities [4], [5], [6], [1], [7]. This study examines the relationship between technology commercialization competence and new product development performance in technology-based SMEs, and empirically examines the structural causality of how outsourcing strategies affect technology commercialization capabilities. In Chapter 2, the theoretical background is examined. In Chapter 3, the research model is set up and data are collected. In Chapter 4, the analysis results are introduced. In Chapter 5, conclusions and future research topics are presented.

II. Literature Review

2.1 Technical Commercialization Competence

Technology commercialization is the pursuit of profits by selling products or services created by introducing new technology into production or process as a whole activity and process to create added value through transfer, trade, application and spread of developed technology [3]. The technology commercialization of this concept can be referred to as "the process of making prototypes, establishing a mass production system, and starting sales" [4].

Small- and medium-sized venture companies have the competence of technology commercialization in order to secure a competitive advantage in the recent environment of rapid technological change. As an indicator of the influencing factors of technology commercialization competence, the Small and Medium Venture Business Department presented technology commercialization competence, technology commercialization competence, new product marketing competence, and technology commercialization management [6]. In addition, in the technology competitiveness evaluation study for technology-innovative SMEs, technology commercialization competence, technology commercialization management, technology commercialization competence, management, market performance, and technical performance prediction were presented as factors related to technology commercialization [8]. Lee and Jung (2010) analyzed the survey on the effect of SME technology innovation capability and technology commercialization competence on management performance [9]. They extracted some important factors for the competences. Therefore, we can further break down those related factors as follows.

2.1.1 Product competence

Productivity is an activity that includes the preparation of products for market introduction in product design. As a source of competitiveness to determine the success of new product development, we presented the marketing competence of resources, technical capabilities of resources, and inter-sectoral integration [10]. And they emphasized the importance of product development by classifying the company's capabilities into product development, marketing, competition response, and product trust group through factor analysis. Therefore, in this study, product competence is defined as product capability through product design and preliminary design of production system, prototype construction, testing and product feasibility review, test and verification, etc. Measure it by reflecting this.

2.1.2 Production competence

An entity's productive capacity refers to its technological competence to adopt and improve production technologies. This management competence factor of the entity refers to the ability to switch to products that meet the needs of the market, design requirements and production requirements and to meet requests related to research and development involving the production department's participation in the early stages of the innovation process. This productive capacity can be described as the ability to convert manufacturing capacity into competitive products for successful market entry [11]. The productive capacity is a combination of a company's special technologies and resources, and an entity that uses its production strategy in advance can gain a position advantage in the market. A company's ability to manufacture a standardized product system into a flexible production platform will affect the release of new products by satisfying the customer's preferences and allowing the end customer to accommodate the diverse needs of the product in the form of its own capabilities, rather than simply staying in production capacity. This can create differentiated value and cost advantages by driving enterprise strategy and culture, determining the design and infrastructure choices of enterprise processes, and leading to strategic choices and practices in the market. In addition, reflecting the diverse product requirements favored by customers, the company has a relationship that affects the performance of the organization by enabling the release of new products in response to market demand. Therefore, based on [11], the productive capacity is defined and measured as the necessary capacity for manufacturing products that meet market requirements.

2.1.3 Marketing competence

The importance of marketing competence is emphasized as a driving force for business growth. It is understood that marketing competency has the greatest influence on the innovative results of technology-based companies, with the emphasis on increasing relationship with customers, leverage in technology and marketing, market penetration in pursuit of innovation, and market-oriented vision and value. In particular, the ability to commercialize continuous innovation and innovation (customer-oriented product creation) is a critical factor for companies in the high-tech market [12].[13]stated that in terms of decision making to enter the market, marketing investment as well as R&D increases sales and market share performance in order to increase new product performance. For successful development of new products, the more experienced a company's marketing resources and capabilities meet its new product development tasks, the more experienced it is in finding and finalizing ideas, market research analysis, and market verification that are in the development process. Therefore, marketing capabilities are supported by the interaction of market-oriented capabilities, which is a key factor that enables companies to achieve a competitive advantage positively [14].Even if products are mass-produced in a form that can be sold to the market through product and production capabilities, the contribution of marketing capabilities to the success of technology commercialization is a critical factor in performance.

2.2 Outsourcing Strategy

Outsourcing is aimed at reducing costs, increasing productivity, and maximizing efficiency and effectiveness by concentrating management personnel on their own core capabilities. Through outsourcing, an entity can quickly respond to external economic changes to secure professional services for its work, expand its information network, and promote the efficiency of the social welfare of its employees.However, the risk factors that accompany outsourcing follow.

Amid fierce competition, companies are increasingly showing the importance of outsourcing. These companies' capabilities are focused on internal core sectors to maximize their competitiveness. In addition, outsourcing may be a factor that facilitates performance that is useful in utilizing an entity's external expertise.

2.3New product Development Performance

New product development can be classified as technical performance of new product and product development performance. The development performance of the new product can be said to be a means for the acquisition of technology by the company to lead to the performance of management In other words, the relationship between the new product strategy and performance was studied by deriving three independent performance dimensions through factor analysis of performance measures representing different characteristics of the entity's performance. [15]refers to three performance dimensions: first, impact on the enterprise as a whole, second, success rate of the new product development project, third, or relative performance against the competition.

In this regard, [16] extracted three independent dimensions of performance: financial performance, opportunity window and market share from ten performance measures: profitability level, investment recovery period, domestic market share, and overseas market share.In addition, the performance in the development process of new products is to measure how efficient and effective the development project for a particular new product has been. It includes variables such as speed to market, new product innovation, quality of new products, and cost of developing new products. And with regard to these new product development processes, these include seven phases: creation of ideas, preliminary evaluation, conceptual design, development, market testing, preliminary shipment and market delivery.

III. Model And Hypothesis

3.1Research Model

To achieve this research objective, the 1st Technology Commercialization Competence and 2 Outsourcing Strategy were selected as performance impact variables and the new product development performance was selected as performance variables.First of all, technical commercialization capabilities were divided into three categories: product and production capabilities, and marketing capabilities. Outsourcing strategies are variables that directly or indirectly affect, and new product development performance was divided into technology performance that is on the supplier's side and product development performance that is on the demand side.Based on the conceptual composition of the preceding prior research, the relationship of the role of outsourcing strategy in the influence of technology commercialization capabilities on the performance of new products was established as shown in Fig. 1.

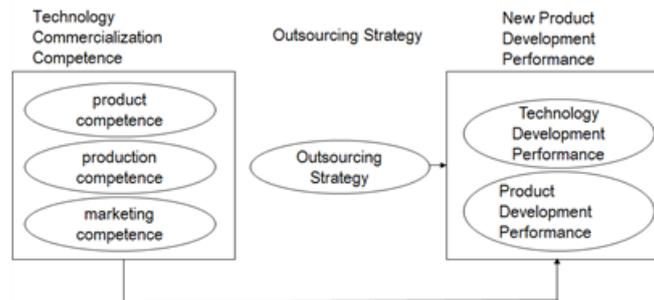


Fig. 1. Research Model

3.2 Hypothesis

The outsourcing strategy of the company affects the development of new products such as improvement of the rate of development of new technologies, reduction of development period, reduction of development cost, and improvement of customer satisfaction of concurrent products through supporting activities for technology development, activities for securing rights of related technologies, and response activities for technology infringement. Based on the previous research, this study is designed to prove whether technology commercialization capabilities and outsourcing strategies affect the performance of new products. Therefore, the following hypotheses were established based on the assumption that the technology commercialization capabilities of technology start-up companies with an influence and correlation will affect the performance of new products in the role of intermediaries in outsourcing strategies.

- Hypothesis 1: Technology commercialization competence will affect new product development performance.
- Hypothesis 2: Outsourcing strategy will affect new product development performance.
- Hypothesis 3: Outsourcing strategy will play a medial role in the impact of technology commercialization capabilities on new product development performance.

3.3 Survey Subject

The survey was conducted on a person in charge of R&D work for small and medium-sized venture companies based in Busan and Gyeongsang province in Korea. The survey period was conducted for 30 days from May 1, 2019 to May 30, 2019, and a structured self-administering questionnaire was used. A total of 220 copies were distributed and the remaining 205 parts were utilized for the final analysis except for 15 missing and non-conformities.

3.4 Questionnaires

To identify the impact of technological commercialization on outsourcing strategies and development performance factors of small and medium-sized venture companies in Korea, a questionnaire was prepared as shown in Table 1 below. The number of questions and questions asked for hypothesis testing is shown in Table 1, and the total number of questions asked in questionnaires is 21. Essentially, independent and dependent variables were organized on a five-point scale and the general status and status of an enterprise were organized on a multi-item scale to allow more detailed questionnaire selection. The data analysis in this questionnaire used the IBM SPSS Statistics 25 and Amos 25 statistical programs, and data processing was handled in the order of frequency of technical statistics, reliability, feasibility analysis, and hypothesis testing.

Table 1 Composition of Questionnaire

Competence Component	Variable (Factor)	Number of Questionnaire	Operational Definition	Measurement Scale
Technology Commercialization Competence	Product Competence	3	Organizational ability to commercialize unique technologies by integrating them into products and processes that meet customer needs for the successful entry of new products into the market	Likert 5-Point Scale
	Production Competence	2	Organizational ability to switch over to products that meet the needs of the market by deploying and operating production facilities based on the developed, introduced and adopted technologies	
	Marketing Competence	4	Organizational ability to plan and practice the distribution and sales of products or services for the satisfaction of customer needs	
Outsourcing Strategy		4	Financial stability, adequate equipment facility assets, quality levels, work-handling rule compliance, health and hygiene levels	
New Product Development Performance	Technology Development Performance	2	Performance of new technology development such as improving the technology development rates, shortening the development period, and reducing the development costs	
	Product Development Performance	2	Performance of new technology development such as product development speed, new product launch rate, quality improvement, and customer satisfaction	
Demographic Factor		4	Number of employees, industry, firm age, sales	Multiple-Item Scale
Total		21		

3.5 Operational Definition of Variables

After considering the preceding prior research, the survey for empirical analysis consisted of each measurement variable using the existing developed questionnaires or by conceptual and operational definitions of variables suitable for research purposes.

3.5.1 Technical commercialization competence

Technology commercialization competence is to be defined as the organizational capacity for developing, producing and selling products or services using new technology. To measure the competence of technological commercialization, the company consisted of product quality, production capacity, and marketing competence based on previous researches. Among them, the ability to commercialize the technology was adopted in studies such as [17]. Production and marketing competence are presented as part of the entity's technical competence and the operational definition of a variable for each activity is as follows in Table 1.

3.5.2 Outsourcing strategy

The outsourcing strategy factors were modified to suit the questionnaires by referring to the preceding study of [18], and the definition of the manipulator of the variables is as shown in Table 1.

3.5.3 New product development performance

Through outsourcing strategies, the technology development performance on the supplier's side focused on the development of new technologies and new technologies in developing products, and product development performance as a means to solve customer problems. The operational definition of a variable for each activity is as follows in Table 1.

3.6 Analyzing Survey and Empirical Results

In the study, the effect of technological commercialization capabilities of technology start-up companies on new product development performance and the causal relationship leading to new product development performance by outsourcing strategies were carried out, and the measurement items used through existing literature were used. Frequency analysis was performed on secured measurement items using SPSS 25. The single dimensionality of the concept was then determined by conducting a Confirmation Factor Analysis for each concept. Then, the proposed structural equation model was estimated to verify the relationship of the derived constitutive concepts, and the hypothesis was verified. Structural Equation Model Analysis estimated the study model established using Amos 25 and validated the hypothesis.

IV. Result Of Analysis

4.1 General Characteristics of Respondents

As shown in Table 2, the number of employees per company was 48.3% of the surveyed companies, with less than 20 employees, and 31.2% among 21-30 employees. According to grouping the employment of survey respondents, manufacturing industry accounted for 36.6% with 75 employees, information and communication industry with 36.6% with 75 people, bio-medical industry with 54, 26.3%, and electrical and electronics related businesses with 0.5%. The firm age was classified by 48.3% for 99 people over 11 years and

less than 20 years, 46.3% for 95 people for 6-10 years, 3.9% for 8 people for 4-5 years, and 1.5% for 3 people over 21 years. And information on sales figures is shown in Table 2.

4.2 Reliability of Questionnaire

Reliability analysis results for each questionnaire are shown in Table 3. As a lower factor of the technology commercialization competence, the Cronbach α value of production competence, production competence, and marketing competence was over 0.8, indicating satisfactory reliability. The Cronbach α value of the questionnaire for the sub-factors of the outsourcing strategy and the new product development result also showed more than 0.8, so the reliability of the questionnaire was evaluated to be satisfactory and analyzed.

Table 3 Reliability of Questionnaire

Classification		Number of question	Cronbach's α
Technology Commercialization Competence	Product Competence	3	0.823
	Production Competence	2	0.844
	Marketing Competence	4	0.921
Outsourcing Strategy		4	0.895
New Product Development Performance	Technology Development Performance	2	0.842
	Product Development Performance	2	0.885

4.3 Result of Factor Analysis

Fig. 2 is a conceptual diagram for factor analysis and shows the result of concentration validity of each variable through confirmatory factor analysis as shown in Table 4.

Table 4 Analytical Result of Factor Analysis

Classification		β	S.E.	C.R.	Construct reliability	AVE
Product	A1	0.87	-	-	0.91	0.77
	A2	0.80	0.06	15.11		
	A3	0.71	0.04	12.47		
Production	B1	0.95	-	-	0.90	0.81
	B2	0.77	0.06	15.42		
Marketing	m1	0.93	-	-	0.96	0.85
	m2	0.82	0.03	17.40		
	m3	0.90	0.04	21.67		
	m4	0.87	0.05	20.16		
Outsourcing	O1	0.73	-	-	0.96	0.87
	O2	0.71	0.09	10.30		
	O3	0.90	0.09	13.27		
	O4	0.90	0.09	13.26		
T	T1	0.87	-	-	0.91	0.83
	T2	0.84	0.07	15.81		
P	P1	0.89	0.06	20.06	0.96	0.92
	P2	0.90	-	-		

T=Technology Development Performance,
P=Product Development Performance

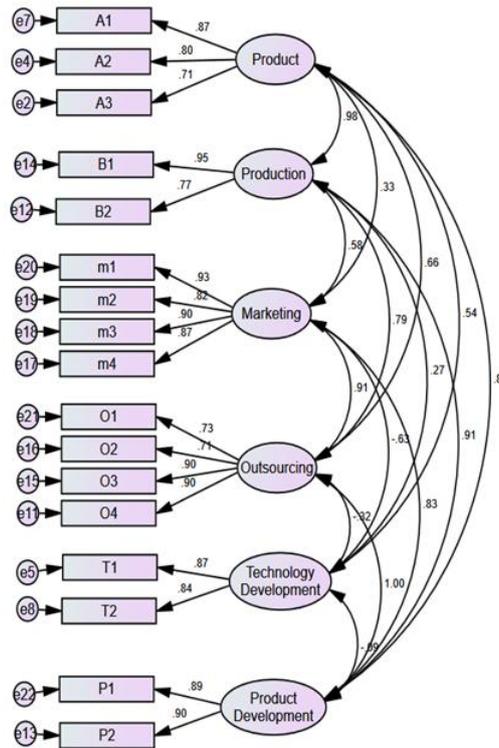


Fig.2. Conceptual Diagram for Factor Analysis

For the validity of the conclusions drawn from the questionnaire to be valid, the standardized factor load of 0.5, C.R of 1.965 or higher, AVE of 0.5 or higher, and conceptual reliability of 0.7 or higher are considered to be valid. In this study, all three methods were used to verify the concentration validity. As a result of the concentration validity analysis of the variables, all the variables satisfied the criterion of validity and were used for analysis without modification.

4.4 Path Model and Path Coefficient

The model fit index of the study model was calculated as Chi-square = 1805.474, Degrees of freedom = 108, GFI = 0.920, RMR = 0.035, CFI = 0.906. Since GFI, CFI 0.9 and above, and RMR below 0.05 can be considered suitable (Hong, Se-hee, 2000), the model of this structural equation is considered to be appropriate. In order to calculate the path coefficient, which is the actual influence that occurs between paths, and to investigate the relationship in this study model, the path model as shown in Fig. 3 was constructed and the path coefficient value was extracted as shown in Table 5. The technology commercialization competence, which is a factor, was significant in relation to the performance of new product development, and the outsourcing strategy was found to affect the performance of new product development.

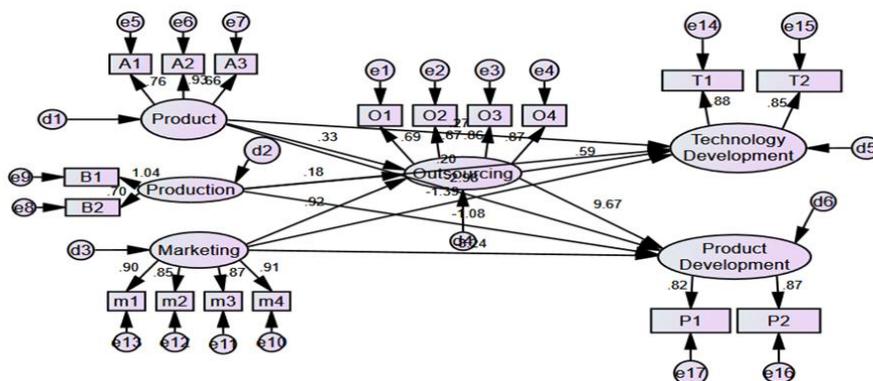


Fig.3. Path Model

Table 5 Path Factor Verification Results

	Path			B	β	S. E.	C. R.	P	Adopt or reject
H1-1	Product	→	Technology Development	0.276	0.266	0.063	3.347	***	Adopt
H1-2	Product	→	Product Development	-2.044	-2.983	2.876	-0.711	0.477	reject
H1-3	Production	→	Technology Development	0.227	0.202	0.057	3.978	***	Adopt
H1-4	Production	→	Product Development	-0.603	-1.082	1.634	-0.492	0.623	reject
H1-5	Marketing	→	Technology Development	-1.077	-1.391	0.151	-7.123	***	Adopt
H1-6	Marketing	→	Product Development	-4.214	-8.243	5.91	-0.713	0.476	reject
H2-1	Outsourcing	→	Technology Development	1.04	0.589	0.358	2.904	0.004	Adopt
H2-2	Outsourcing	→	Product Development	0.441	0.493	0.326	3.134	0.002	Adopt

- Hypothesis 1-1 (Product competence will affect technology development performance), there is a significant effect because the path factor is 0.266, C.R 3.347, and the calculated P-Value is less than 0.01.
- Hypothesis 1-2 (Product competence will affect product development performance), there is not a significant effect because the path factor is -2.983, C.R -0.711, and the calculated P-Value is 0.477 (>0.05).
- Hypothesis 1-3 (Production competence will affect technology development performance), there is a significant effect because the path factor is 0.202, C.R 3.978, and the calculated P-Value is less than 0.01.
- Hypothesis 1-4 (Production competence will affect product development performance), there is not a significant effect because the path factor is -1.082, C.R -0.492, and the calculated P-Value is 0.623 (>0.05).
- Hypothesis 1-5 (Marketing competence will affect technology development performance), there is a significant effect because the path factor is -1.391, C.R -7.123, and the calculated P-Value is less than 0.01.
- Hypothesis 1-6 (Marketing competence will affect product development performance), there is not a significant effect because the path factor is -8.243, C.R -0.713, and the calculated P-Value is 0.476 (>0.05).
- Hypothesis 2-1 (Outsourcing strategy will affect technology development performance), there is a significant effect because the path factor is 0.589, C.R 2.904, and the calculated P-Value is 0.004(<0.05).
- Hypothesis 2-2 (Outsourcing strategy will affect product development performance), there is not a significant effect because the path factor is 0.493, C.R 3.134, and the calculated P-Value is 0.002(<0.05).

4.5 Mediating Effect Analysis

Under the hypothesis that the outsourcing strategy will have a mediating effect on the impact of technology commercialization capabilities on new product development performance, the Bootstrapping method was used and 500 iterations were applied, and a significance level of 5% was applied. The results are shown in Table 6.

Table 6 Total, Direct, Indirect Effects

Path			Total Effect	Direct Effect	p	Indirect Effect	p	Adopt or reject
Product	→	T	0.46	0.27	***	0.19	0.35	reject
	→	p	0.21	-2.98	0.48	3.19	0.04	Adopt
Production	→	T	0.31	0.20	***	0.10	0.35	reject
	→	p	0.62	-1.08	0.62	1.70	0.05	reject
Marketing	→	T	-0.85	-1.39	***	0.54	0.31	reject
	→	p	0.67	-8.24	0.48	8.91	0.00	Adopt

T=Technology Development Performance,
P=Product Development Performance

- Hypothesis 3-1 (outsourcing strategy will play a mediating role in the effect of production competence on technology development performance), there is no mediating effect because the indirect effect is 0.19 and the calculated P-value is 0.35 (> 0.05).
- For Hypothesis 3-2 (outsourcing strategy will play a mediating role in the impact of production competence on product development performance), the indirect effect is 3.19 and the calculated P-value is 0.04 (< 0.05).
- For Hypothesis 3-3 (outsourcing strategy will play a mediating role in the effect of production competence on technology development outcomes), the indirect effect is 0.1 and the calculated P-value is 0.35 (> 0.05).
- For Hypothesis 3-4 (outsourcing strategy will play a mediating role in the impact of production competence on product development performance), the indirect effect is 0.7 and the calculated P-value is 0.051 (> 0.05).
- For Hypothesis 3-5 (outsourcing strategy will play a mediating role in the effect of marketing competence on technology development outcomes), there is no mediating effect, with an indirect effect of 0.54 and a calculated P-value of 0.31 (> 0.05).
- For Hypothesis 3-6 (outsourcing strategy will play a mediating role in the effect of marketing competence on product development performance), the indirect effect is 8.91 and the calculated P-value is 0.0001 (< 0.05).

V. Concluding Remarks

In order to investigate the relationship between technology commercialization competence and new product development performance of small and medium venture firms, a questionnaire was conducted for those in charge of R & D work. As a result, it was confirmed that the technology commercialization competence of SMEs had a significant influence on the performance of new product development.

In detail, the product competence, production competence, and marketing competence of the technology commercialization capabilities all had a direct effect on the technology development performance, which is one of the new product development performance, but there was no clear evidence that it had an effect on the product development performance. This is interpreted as a phenomenon caused by difficulties that small and medium-sized venture companies cannot afford due to other factors such as funding, commercial design, and intellectual property management required during the development of actual products. Therefore, in order to overcome the structural limitations of SMEs, it is necessary to introduce outsourcing strategy. After analyzing the impact of outsourcing strategy on new product development performance, it affects not only technology development performance but also product development performance.

In this study, the mediating effect was examined to find out the structural relationship between the outsourcing strategy, technology commercialization competence, and new product development performance. This suggests that the outsourcing strategy will lead to more production and marketing capabilities that are insufficient for product development performance in terms of new product development performance of SMEs with insufficient financial status or management system.

Future research needs to examine the impact of outsourcing strategies on sustained growth potentiality, and to identify outsourcing detailed strategies that have the greatest impact on sustainability.

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