

Exploring the Determinants for Successful Collaboration of SMEs

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Abstract—The goal of this research is discovering the determinants of the success or failure of external cooperation in small and medium enterprises (SMEs). For this, a survey was given to 190 SMEs that experienced external cooperation within the last 3 years. A logistic regression model was used to derive organizational or strategic characteristics that significantly influence whether external collaboration of domestic SMEs is successful or not. Results suggest that research and development (R&D) features in general characteristics (both idea creation and discovering market opportunities) that focused on and emphasized indirected-market stakeholders (such as complementary companies and affiliates) and strategies in innovative strategic characteristics raise the probability of successful external cooperation. This can be used meaningfully to build a policy or strategy for inducing successful external cooperation or to understand the innovation of SMEs.

Keywords—External collaboration, Innovation strategy, Logistic regression, SMEs.

I. INTRODUCTION

SMEs have a great effect on economic growth and job creation. Especially in South Korea, SMEs account for 99% of all enterprises (about 3 million SMEs) and 88% of all employees (13.1 million employees) [1]. Korean SMEs definitely play a pivotal role in the national economy. Recently, SMEs have been important because of their flexibility [2] amid an accelerating market environment [3]. But Korean SMEs face the threat of decreasing international competitiveness by losing market share within the medium-low technology sector to developing countries such as China or India; it also is hard for SMEs to enter the high-technology market. Moreover, led by the Small & Medium Business Administration (SMBA), the Korean SME export ratio has decreased consistently from 43.3% in 2003 to 20.3% in 2011; at the same time, Korea has had a high degree of dependence upon foreign trade—102.2% in 2010 [4]. These trends of SMEs as part of the national economy are very serious and should be solved quickly.

Improving the capabilities of firms to increase their international competitiveness by aggressive external cooperation might be one solution to resolve this problem. And successful innovation of SMEs through external collaboration is logical, because it maximizes the scarce resources of SMEs [5]. Since introducing open innovation as a new paradigm for innovative management [6], many studies about innovation of large enterprises (LE) and SMEs have been conducted.

However, there have been few attempts to study the differences between SMEs that draw successful performance through external cooperation and SMEs that do not. To overcome the Korean SMEs' decrease in international competitiveness, research about the factors that affect successful external collaboration of SMEs is needed.

This study was designed to understand the determinants of success and failure of external cooperation in Korea. The survey was conducted on Korean SMEs, and data from it was used to analyze not only the strategic movements of each enterprise within their general characteristics but also their innovation strategy levels. General characteristics of firms refer to visible indexes, such as firm size, industry sector, R&D intensity, or business models. Innovation strategy levels refer to the characteristics of strategic activities in external cooperation and external partners of the company. These two variables were inserted into logistic models to derive the determinants of external collaboration performance.

II. NEEDS FOR EXPLORING DETERMINANTS OF SME'S SUCCESSFUL EXTERNAL COLLABORATION

There have been a number of studies about external collaboration since Chesbrough introduced the concept of open innovation. In early days, external collaboration mainly was analyzed only in specific fields, such as large, high-tech multinational enterprises, drawing on in-depth interviews and case studies. But there were also various studies about small and medium enterprises after need to study SMEs was raised recently [7].

Through those studies, different characteristics and tendencies can be seen between LEs and SMEs. First, external collaboration of LEs or high-tech companies is regarded as just a new way to extend revenue or develop partnerships [8]. In contrast, collaborative activity of SMEs with external partners is a way to survive in a turbulent market environment [9]. Second, although increasing points of contact by globalization gives every enterprise many opportunities to enter new markets, market failure of SMEs is getting worse because of their chronic limitation—a lack of resources or capabilities [10]. Third, innovation for SMEs through external cooperation is more difficult than for LEs. It is hard for SMEs, with their insufficient internal capabilities, to develop innovative partnerships with external sources [11]. While external cooperation to reinforce SMEs' internal capabilities is urgent to SMEs, it is very difficult to do owing to market failure and a lack of internal resources. Nevertheless, SMEs still are considered an engine for the national economy because of their variety and importance.

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There may be remarkable economic growth once SMEs start conducting successful external collaboration. Research suggests that most innovative small firms are involved in extensive and diverse partnerships with a variety of external sources of expertise [12] and that acquiring knowledge and skills through external collaboration has become an effective and efficient way for SMEs to succeed and innovate [13]. Thus, it is necessary to understand the practical determinants of successful external cooperation in order for Korean SMEs to overcome losing international competitiveness.

However, studies about what factors affect successful external collaboration of SMEs are hard to find. There is a paper about innovation and performance of SMEs in subcontracting relationships [14]. But it is limited to the relationship between LEs and subcontracted SMEs. There also is a study about the collaboration of SMEs with public research institutes [15]. But this study is not about the overall external cooperation of SMEs either. Additionally, practical research for barriers to open innovation [16] is not about the determinants of successful external collaboration. Therefore, in this paper, we seek to discover the factors that affect success through external sources based on data describing various types of external cooperation of Korean SMEs.

III. RESEARCH FRAMEWORK

A. Research Process

Fig. 1 represents overall research process of this paper.

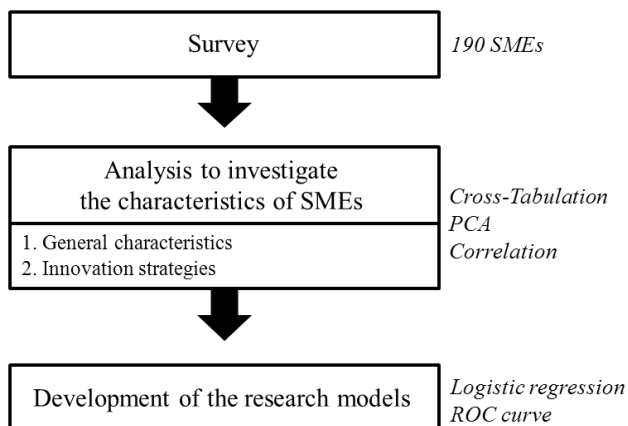


Fig. 1 Overall research process

The survey was carried out from September to October 2011 among 190 SMEs.

Before studying the determinants of successful external collaboration, the characteristics of SMEs should be derived through data from this survey. General characteristics of the firms and characteristics of innovation strategy were used because both factors affect the external cooperation of SMEs.

In this paper, cross tabulation was used for general characteristics, which are categorical variables, and principle component analysis (PCA) and correlation analysis were used for innovation strategic characteristics, which are interval variables. After these analyses, logistic regression models were

constructed using these two types of characteristics as independent variables for search determinants.

B. Development of the Research Models

The objective of this research was to derive the determinants for the success or failure of external cooperation for SMEs. The dependent variables were dichotomous—success was coded to 1 and failure was coded to 0. Logistic regression was used to construct models because the dependent variable and general characteristics as independent variables are categorical and the characteristics of innovation strategy as another independent variable are interval.

IV. RESULT

A. Data

Table I represents basic information about the firms surveyed. The group of respondents comprised three industrial sectors: manufacturing, transportation and professional, and scientific and technical. All of the SMEs had fewer than 300 employees.

TABLE I
BASIC INFORMATION OF 190 SMEs

Characteristics	Classification	No.	%
Size (employees)	Small (<50)	133	70.00
	Medium (<250)	51	26.84
	Large (<300)	6	3.16
Industry sector	Manufacturing	127	66.84
	Transportation	31	16.32
	Professional, scientific and technical activities	32	16.84

There were 44 attributes in the data, including size of the firms and industry sectors, as shown in Table II below. Attributes are composed of general characteristics information, innovation strategy, and performance of external cooperation.

TABLE II
OVERALL DATA INFORMATION

Variable level	Classification	Data type	No.
Results	Performance of conducting external cooperation	categorical	1
General characteristics	General information and R&D strategies of the firm	categorical	7
	Business model		5
Innovation strategic characteristics	Importance of in/out-bound	interval	20
	Importance of the types of external partner		11

B. General Characteristics

The Pearson chi-square test was used to figure out what variables of general characteristics were involved significantly with the performance of external collaboration. Table III shows the result of this test.

TABLE III
RESULT OF CHI-SQUARE TEST

Characteristics	value	degree of freedom
Size of firm (employees)	2.690	2
R&D intensity	7.164*	3
Location of firm	0.074	2
Certification	5.013	3
Innovation type	8.013**	3
R&D activation type	11.351**	3
Industry sector	7.257**	2
Target market	5.890	3
Product type	0.895	3
Customer type	1.213	2
Contract type	5.214**	1
Market strategy	4.940*	2

** : $p < 0.05$, * : $p < 0.1$

When the ratio of cells that have an expected frequency lower than 5 is over 20% of the total amount of cells in the cross table, Fisher's exact test was used. There were 6 meaningful variables overall in 12 characteristics at the significant level of 10% ($p < 0.1$), including R&D intensity, innovation type, R&D activation type, industry sector, contract type, and market strategy.

C. Characteristics of Strategic Activities

Inbound open innovation and outbound open innovation were two types of activities in the open innovation context. Inbound open innovation refers to the acquisition of knowledge from external parties. Outbound open innovation refers to establishing relationships with external firms in order to commercially exploit technological opportunities. Based on these inbound and outbound concepts, 20 indexes were used to characterize strategic activities.

To understand those characteristics, PCA was carried out to reduce the dimensions of 20 variables. Table IV displays the result of the analysis. Four principle components (PCs) were selected after a varimax rotated PCA, and the cumulative variance was about 70% (69.7%). These 4 new scored variables can be indicators that inform the preference of strategic activities by each firm. The first component focused on R&D of inbound activity, and second component had high loadings on the idea creation category. Highly scored loadings of the third component were assembled in the *technology development & commercialization* category, except for R&D related characteristics. And the fourth component had high loading values describing the features of outbound open innovation activities.

TABLE IV
PCA RESULT OF STRATEGIC ACTIVITIES

Variables	1	2	3	4
Join of users and customers	0.17	0.59	0.13	0.16
Using external experts	0.57	0.52	0.12	0.14
Idea creation				
Using collective intelligence	0.49	0.56	0.19	0.24
Crowdsourcing or solution contest	0.26	0.62	0.46	0.07
Using unofficial networks	0.13	0.78	0.15	-0.02
Using official networks	0.40	0.71	0.05	0.13
Technology development & Commercialization				
Technology buying	0.09	0.61	0.55	0.24
Mergers & Acquisitions	0.07	0.44	0.70	0.22
Group R&D	0.77	0.31	0.23	0.17
R&D consortium	0.81	0.30	0.22	0.17
Co-marketing and Co-branding	0.38	0.37	0.50	0.27
Coproduction	0.46	0.12	0.69	0.21
Group purchase	0.31	0.06	0.80	0.25
R&D outsourcing	0.69	0.11	0.44	0.21
Outsourcing except R&D	0.59	0.27	0.54	0.17
Funding from outside organizations	0.42	0.30	0.51	0.30
Utilizing internal ideas or technologies to outside				
technology selling	0.09	0.09	0.14	0.78
Foundation of venture business	0.20	0.11	0.12	0.86
Foundation of collaborative venture	0.24	0.00	0.26	0.82
Opening platform	0.09	0.29	0.23	0.74
Varimax rotated				
%	18.3	18.0	17.3	16.0
Cumulative %	18.3	36.4	53.6	69.7

The labeling of each calculated principle component is explained in Table V. R&D focused strategic activity is labeled on PC1, idea creation or discovering market opportunities activity is named on PC2, PC3 includes labels for commercialization-focused strategic activity, and PC4 represents internal technology-focused activity.

TABLE V
LABELING ON STRATEGIC ACTIVITIES

Components	Labeling
PC1	R&D focused
PC2	Idea creation or discovering market opportunities focused
PC3	Commercialization focused
PC4	Using internal technology focused

D. Characteristics of Collaboration Partners

TABLE V
PCA RESULT OF COOPERATION WITH EXTERNAL PARTNERS

Variables	1	2	3	4
Clients and customers	0.12	0.88	0.01	0.24
Suppliers	0.16	0.85	0.20	0.25
Competitors or other enterprises in the same sector	0.25	0.74	0.42	0.03
Affiliates	0.25	0.18	0.83	0.26
Complementary companies	0.19	0.43	0.59	0.46
External partners (S/W, IT system/equipment)	0.37	0.27	0.22	0.75
Business service (accounting, consulting)	0.39	0.29	0.34	0.69
Governmental funded research institutes	0.82	0.11	0.10	0.36
Non-governmental funded research institutes	0.82	0.26	0.23	0.25
Universities	0.85	0.18	0.23	0.14
Non-profit organizations	0.61	0.13	0.59	0.13
Varimax rotated				
%	26.7	23.2	17.1	15.1
Cumulative %	26.7	49.9	67.0	82.1

There were 11 types of organizations that were cooperation partners of SMEs. Table VI shows the result of the PCA classified into 4 components with a cumulative variance of 82% after the varimax rotation. The first component had highly scored loadings on R&D-related organizations. Thus, if a firm had a high value at this component, it might have emphasized R&D partners.

Clients & customers, suppliers, and competitors were highlighted organizations of the second component. They were stakeholders acting in the same market segment of a certain company. This made it easy to label a strategy of emphasizing market-directed stakeholders on the second component.

In contrast, affiliates and complementary companies had a high loading score at the third component. These partners maintained a close association with a certain firm, but they didn't involve themselves directly in the same market segment. This can be a reason to label an emphasis on market-indirected stakeholders on PC3. IT (Information Technology) business and business service partners can raise the managerial capabilities for a certain firm. Therefore, we labeled like emphases on solution partners on PC4.

TABLE VI
LABELING ON COOPERATION OF EXTERNAL PARTNERS

Components	Labeling
PC1	Emphasis on R&D organizations
PC2	Emphasis on market-directed stakeholders
PC3	Emphasis on market-indirected stakeholders
PC4	Emphasis on solution partners

Table VII displays the 4 labeled tags on each principle component of external partners' collaboration.

E. Causal Model Construction

In this section, models are constructed by using variables from the results of PCA that were conducted before. To explore the determinants of successful external cooperation, models were designed like the model shown in Table VIII. Strategic activities and external partners were inserted separately as independent variables, because of the correlation between those two characteristics. Meanwhile, variables of general characteristics were used as control variables. This is because we can see correctly the effect of strategic movements when a firm's uniquely general characteristics are controlled

TABLE VII
MODEL DESIGN

Variables	Model 1	Model 2
General characteristics	●	●
Innovation strategies	●	○
Strategic activities	○	●
External partners	○	●

●: used, ○: disused

Model 1 and model 2 consisted of binary dependent variables divided into the success or failure of control variables from general characteristics and of independent variables of innovation strategies.

After building models, an ROC curve analysis was used to decide the cut-off value of the logistic regression. Logistic probability was chosen when the Euclidean distance between the logistic probability plot and the coordinate point (sensitivity, specificity) = (1, 1) had minimum value. The total accuracy rate of each model was about 70%—69.5% for model 1 and 70.5% for model 2. Table IX represents the result of the logistic regression. The significant characteristics of innovation strategies were idea creation or discovering market opportunities activity at model 1 and emphasis on market-indirected stakeholders at model 2. Conclusions can be drawn based on the results from all the analyses. First, physical limitation, such as size or location of a firm, doesn't affect whether external collaboration of SMEs is successful or not, but the system of innovation or R&D (e.g., R&D intensity, innovation type, and R&D activation type) and essential natures of each firm (like industry sector and contract type) affect the general characteristics. Second, successful performance of external cooperation seems to occur when SMEs focus on idea creation or discovering market opportunities, because SME flexibility may easily leverage the ideas or opportunities. When expanding the significance level to 0.2, using internal technology focused activity as an outbound open innovation concept had an exp(B) value of 1.283. This suggests that the chance for external collaboration to succeed increases when the degree of using internal technology goes up. This seems to be because SMEs achieve

success more easily by external cooperation if the firm's internal technology capabilities are enough to transfer outward.

According to model 2, emphasizing market-indirected stakeholders correlates to successful external collaboration. Affiliates may make up for financial problems or a lack of expertise, and complementary companies can help improve outcomes by improving SME competitiveness in the market.

Consequently, for successful external cooperation, firms should establish strategic activities that strengthen the advantages of SMEs or select the partners who can make up for shortcomings.

TABLE VIII
RESULTS OF LOGISTIC REGRESSION

Model 1***		Model 2***	
p-value			
R&D intensity	0.334	R&D intensity	0.289
Innovation type	0.131	Innovation type	0.113
R&D activation type	0.099	R&D activation type	0.089
Industry sector	0.169	Industry sector	0.136
Contract type	0.119	Contract type	0.083
Market strategy	0.397	Market strategy	0.347
EXP(B)			
R&D focused activity	0.889	Emphasis on R&D organizations	0.93
Idea creation or discovering market opportunities focused activity	1.411**	Emphasis on market-directed stakeholders	1.141
Commercialization focused activity	0.976	Emphasis on market-indirected stakeholders	1.401**
Using internal technology focused activity	1.283*	Emphasis on solution partners	1.104
cut-off value	0.352	cut-off value	0.317

*** : $p < 0.05$, ** : $p < 0.1$, * : $p < 0.2$

V. CONCLUSION

This study explored the determinants of successful external cooperation of SMEs. The results of the analyses, we can suggest the following guideline: "SMEs should strengthen advantages through strategic activity and overcome weakness by using external partners."

Despite this meaningful contribution, this paper has some limitations. First, there is a generalization problem because respondents of the survey were restricted to Korean SMEs. Second, National Innovation System (NIS) was not considered in this research. Third, we were able to shed light on what the

determinants are, but we did not research how the determinants are conducted.

Thus, additional research is needed to study more deeply the characteristics of determinants and to provide case studies that test the results of this paper through detailed interviews.

REFERENCES

- [1] Report of the census on establishment 2009(2010), Statistics Korea
- [2] M. Legi, P. Powell, "SME flexibility and the role of information systems," *Small Business Economics*, vol. 11, 1998, pp.183–196.
- [3] J. Tidd, J. Bessant, K. Panitt, *Managing Innovation: integrating technology, market and organizational change*, Moscow: John Wiley & sons, 2005, pp.124–126.
- [4] OECDE annual report, *OECD*, 2010
- [5] W. Vanhaverbeke, Open innovation in SMEs: How can small companies and start-ups benefit from open innovation strategies?, Vlerick Leuven Gent Management School, March 2012.
- [6] H. Chesbrough, *open innovation: the new imperative for creating and profiting from technology*, Boston: Harvard Business School Press, 2003.
- [7] V. Van de Vrande, J. P.J. De Jong, W. Vanhaverbeke, "Open innovation in SMEs:Trends, motives and management challenges," *Technovation*, vol. 29, 2009, pp.223–237.
- [8] L. Mortara, T. Minshall, "How do large multinational companies implement open innovation?," *Technovation*, vol. 31, 2011, pp.586–597.
- [9] H. Lee, D. Kelly, J. Lee, S. Lee, "SME survival:The impact of internationalization, Technology Resources, and Alliances," *Journal of Small Business Management*, vol. 50, 2012, pp.1–19.
- [10] J.W. Lu, P.W. Beamish, "The internationalization and performance of SMEs," *Strategic Management Journal*, vol. 22, 2001, pp.565–586.
- [11] A. Hadjimanolis, "Barriers to innovation for SMEs in a small less developed country(Cyprus)," *Technovation*, vol. 19, 1999, pp.561–570.
- [12] M. Freel, "External linkages and product innovation in small manufacturing firms," *International Small Business Journal*, vol.12, 2000, pp.245–266.
- [13] P.C. Kaminski, A.C. de Oliveria, T.M. Lopes, "Knowledge transfer in product development processes: a case study in small and medium enterprises (SMEs) of the metal-mechanic sector from Sao Paulo, Brazil," *Technovation*, vol. 28, 2008, pp.29–36.
- [14] R. Sudhir Kumar, M.H. Bala Subrahmanya, "Influence of subcontracting on innovation and economic performance of SMEs in Indian automobile industry," *Technovation*, vol. 30, 2010, pp.558–569.
- [15] R. Fontana, A. Geuna, M. Matt, "Factors affecting university-industry R&D projects: the importance of searching, screening and signaling," *Research Policy*, vol. 35, 2006, pp.309–323.
- [16] I. Savitskaya, P. Salmi, M. Torkkari, "Barriers to open innovation: case china," *Journal of Technology Management and Innovation*, vol. 5, 2010, pp.10–21.