How Non-Technological Innovation Reinforces the Effect of Technological Innovation on Firm Performance?: An Empirical Study of Korean Manufacturing Industry

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Abstract. By using empirical data collected from 870 manufacturing firms in Korea, the present study investigates the relationships between technological innovation (i.e., product and process innovations) and non-technological innovations (i.e., organizational and marketing innovations) and its overall innovation success with innovation initiatives. We highlight the business value of non-technological innovations by proposing its moderating effect on innovation success. We then argue that technological innovation exhibits a strong impact on innovation success only when non-technological innovations adequately strain the relationship between them. This study enhances the understanding of innovation in organizations by showing that the effective interaction between technological and non-technological innovations helps firms succeed in innovations and enhance firm performance.

Keywords: Innovation · Technological innovation · Non-technological innovation · Innovation success · Firm performance

1 Introduction

Innovation plays a central role in economic growth. Schumpeter [8] argued that economic development is driven by innovation through a dynamic process in which new technologies replace the old process, which labeled "create destruction." Firm innovation mainly aims to enhance firm performance by reducing costs and improving productivity; thus, it is the core factor for sustaining business. Firms can gain their competitive advantage and improve their performance through innovation activities to develop new products and new processes [10]. These activities of firms generally indicate technological innovations [7].

Despite shifting the value area of firms from technological to non-technological area, most firms still focus on technological innovations. However, only technological innovations are not sufficient to understanding innovation activities of firms because the innovations include technological activities (e.g., introducing and developing new technologies) as well as non-technological activities (e.g., re-establishing business

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strategies, changing in organizational method, and external network and marketing) [1]. Thus, firms should understand the relationship between technological and non-technological innovation when they conduct innovation activities. Therefore, this study aims to analyze the relationship between technological and non-technological innovation from a balanced approach. Our finding shows that the role of non-technological innovation is significant in determining the innovation success and enhancing firm performance.

2 Theoretical Development

Developing new product and new process can enhance productivity and gain competitive advantage of firms [2]. Technological innovation is linked to new product and process innovation, resulting in giving new value and improving existing value to customers. Additionally, firms can also increase customer satisfactions through product differentiation by re-establishing the business strategies and organizational method and by developing new market method. Based on this concept, this study defines the scope of innovation as four types of innovation, namely, product, process, organizational, and marketing innovations, which can encompass a wide range of changes in a firm's innovative activities.

2.1 Technological Innovation

Technological innovation consists of product and process innovations. Product (goods or services) innovation has been identified to be the market introduction of either new or significantly improved goods and services [9]. Product innovation includes new or significantly improved good and services in terms of technological specifications, components and materials, incorporated software, user friendliness, and other functional characteristics. Moreover, process innovation indicates the introduction of new or significant improved methods such as production processes, supporting activities for production process, logistics, delivery and distribution methods for goods or services [9], leading to decrease costs, increase product quality and market share. Thus, firms can gain a competitive advantage that improves customers' satisfactions through process innovation, resulting in achieving innovation success. Production innovation always accompanies with process innovation and they positively influence innovation success. Thus, the hypothesis is the following:

H1-Technological innovation has a positive effect on innovation success.

2.2 Non-technological Innovation

Organizational and marketing innovations are consisted of non-technological innovation. Organizational innovation is a new organizational method in enterprise's business

practices (including knowledge management), workplace organization, or external relations that have not been previously used by an enterprise [9]. Organizational innovation includes organizational structure, learning process, and adaption to changes in technology and the environment [5]. A firm's organizational structure can affect the efficiency of innovation activities, with some structures better suited to particular environments [5]. A greater degree of organizational integration may improve the co-ordination, planning, and implementation of innovation strategies. In addition, the demand of new products may depend not only on product quality and characteristics but also on their social characteristics and image [4]. Marketing theories focus on implementing marketing practices, such as Marketing Mix Model [6]. Marketing innovation is the implementation of a new marketing concept or strategy that differs significantly from enterprise's existing marketing methods [9]. Marketing innovations focus on better addressing customer needs, opening up new markets, or newly positioning a firm's product on the market. Hence, our hypothesis is the following:

H2- Non-technological innovation has a positive effect on innovation success.

Organizational innovation is closely related to process innovation. Creating new development department or sales department, as well as reorganizing workflow and external network to improve the productivity and quality are examples of process innovation. Moreover, marketing innovation is also associated with product innovation. As new products needed to be introduced via a new marketing method, firms are required to accept new marketing methods to increase productivity and product quality. For this reason, technological innovation can positively influence innovation success with non-technological innovation. Thus, we proposed the following hypotheses:

H3-The effect of technological innovation on innovation success will be positively moderated by non-technological innovation.
H4-Innovation success has a positive effect on firm performance.

3 Research Methodology

3.1 Development of Measures

The survey respondents were randomly selected form entire population of manufacturing firms based on the 2008 Korea Innovation Survey (http://kis.stepi.re.kr). To develop the measurement instruments, four items such as product, process, organizational, and marketing innovations were measured on yes–no questions and the other item such as innovation success were on a five-point Likert scale from "extremely low" to "extremely high." A survey item concerning firm performance was measured as factual data using sales growth from 2005 to 2007. In case of yes–no questions, the measurement instrument should be merged to one dummy variable because the nominal scale was difficult to use in this analysis. Finally, we employed 5 constructs and 16 items as measures in this study (a full list of the items is available upon request).

3.2 Sample and Data Collection

For our empirical analysis, the 2008 Korea Innovation Survey was used. The survey only focused on manufacturing firms. Hence, respondents who had implemented at least one innovation in the reference period 2005 to 2007 were asked to respond to the whole questionnaire. The questionnaires were distributed to 3081 firms and 1432 responses were finally received. The complete case approach applied was the missing data imputation method. Finally, 870 responses were found useful for this study with a usable response rate of 28.24 %. The respondent characteristics in terms of number of employees, total sales revenue, and R&D budget are summarized in Table 1.

Table 1. Characteristics of the sample

Employee (#)	Freq. (%)	Revenue ($)	Freq. (%)	R&D budget (%)	Freq. (%)
<100	368(42.3)	< 50 mil.	186(21.4)	<1.0	226(30.6)
100 ~ 500	307(35.3)	50 ~ 100 mil.	86(9.9)	1.1 ~ 5.0	385(44.3)
500 ~ 1,000	117(13.4)	100 ~ 500 mil.	223(25.6)	5.1 ~ 10.0	129(14.8)
1,000 ~ 3,000	56(6.4)	500 ~ 1,000 mil.	94(10.8)	10.1 ~ 15.0	34(3.9)
3,000<	22(2.4)	1,000 mil. <	281(32.3)	15.1<	56(6.5)
Total	870(100)	Total	870(100)	Total	870(100)

4 Analysis and Results

4.1 Measurement Model

Convergent validity was assessed by looking at the composite reliability (CR) and average variance extracted (AVE) from the measures. Table 2 shows that the obtained CR values ranged from 0.75 to 0.87, which exceeded the threshold value of 0.7. The AVE ranged from 0.37 to 0.86 [3], which was above the acceptable value of 0.5 A score of 0.5 indicates an acceptable level for the average variance extracted by a measure [3]. Results showed that the average variances extracted by measures ranged from 0.37 to 0.86, which were above the acceptable value. All measures except ORI are significant on their path loading as the level of 0.01. Table 3 shows that the square root of the average variance extracted for each construct was greater than the correlations between it and all other constructs (detailed results of measurement model test are available upon request). These results explain that measurement models were strongly supported by the data gathered, thus requiring further analysis.

4.2 Structural Model

With adequate measurement models, the proposed hypotheses are tested with PLS. Figure 1 shows the results of PLS structural model including the path loadings, t-values of the paths, and R-square. Among the four hypotheses, three are significant.

Table 2. Results of PLS measurement model

Construct	Item	CR	AVE	Loading	t-value
Tech. innovation (TI)	PDI	0.75	0.52	0.9529	3.7355
	PRI			0.5687	2.5717
Non-Tech. innovation (NTI)	ORI	0.87	0.86	0.0122	0.5324
	MKI			1.3143	49.2481
Tech.Innov. * Non-Tech. Innov. (TI*NTI)	PDIORI	0.87	0.63	0.7960	58.6032
	PDIMKI			0.7845	43.4375
	PRIORI			0.7387	34.2293
	PRIMKI			0.8417	71.0944
Innovation success (INS)	INS1	0.80	0.67	0.5874	21.2143
	INS 2			0.5882	19.6908
	INS 3			0.2015	3.9321
	INS 4			0.2373	4.8457
	INS 5			0.6874	31.6320
	INS 6			0.6942	31.4541
	INS 7			0.7544	36.6935
	INS 8			0.8441	40.1499
Performance (FP)	FP	1.0	1.0	1.0000	0.0000

Table 3. Correlations between constructs

Construct	TI	NTI	TI*NTI	INS	FP
TI	***0.787***	–	–	–	–
NTI	−0.031	***0.927***	–	–	–
TI*NTI	−0.090	−0.417	***0.794***	–	–
INS	−0.039	−0.336	0.714	***0.698***	–
FP	−0.057	−0.026	0.056	0.072	***1.000***

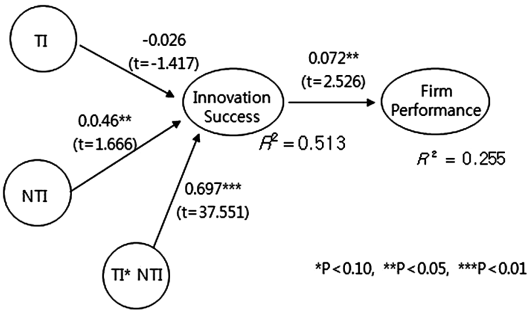

Fig. 1. Result of PLS structural model

Technological innovation exhibited no significant effect on innovation success. However, non-technological innovation was significantly related to innovation success. Non-technological innovations can positively influence innovation success with technological innovation. It means that the effect of both technological and non-technological innovations is more synergistic than that of each innovation.

5 Discussions and Implications

A negative relationship between technological innovation and innovation success is observed in this study although technological innovation has been considered as an important factor for innovation activities. It means that technological innovation does not guarantee innovation success. Therefore, a firm should strategically conduct technological innovation and focus on establishing the positive relationship between them. Furthermore, our result implies that the non-technological innovation is a critical factor for superior innovation success. Firm should consider non-technological innovations, especially marketing innovation, to achieve innovation success and it may function as a significant differentiator of firm performance. This study increases our understanding that the leveraging effect of non-technological innovation (organizational and marketing innovation) in facilitating the relationship between technological innovation (product and process innovation) and innovation success. The technological innovation with non-technological innovation results in high innovation success, leading to superior firm performance. Hence, establishing an accompanying model between technological and non-technological innovations would help manufacturing firms to succeed in innovation and enhance their firm performance. Future research should be expected to determine the relationship between sub-innovations (i.e., product-organization, product-marketing, process-organization, and process-marketing innovations). Additionally, we limited this study to only manufacturing firms. Therefore, future research should extend the scope of service firms to explore more relevant effect of innovation.

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