

Article

An Open System Understanding of Product Innovation: Attention Allocation, External Information Sources, and Absorptive Capacity

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Abstract: Product innovation is a key achievement by which a firm can not only build up its competitive advantages but also prolong its survival in the open market environment. By understanding the firm as a social system pursuing both efficiency and effectiveness, this study examines three key factors that independently enable product innovation through a theoretical lens of the open system approach: strategic attention, external information sources, and absorptive capacity. While we suggest that a focused set of strategic attentions functions as an internal means to enhance the likelihood of product innovation, we also propose that diverse external partners provide the firm with the relevant knowledge for product innovation. In addition, we argue that the absorptive capacity is a crucial factor that has a positive direct effect on product innovation and mediates the effects of the two variables on the product innovation, based on the organizational learning theory. We empirically examined our hypotheses with the reliable data collected systematically through the “Korean Innovation Survey 2020: Manufacturing Industry” and found support for all of our hypotheses. Finally, we discuss theoretical contributions and practical implications.

Keywords: open system approach; product innovation; attention allocation; strategic attentions; external information sources; absorptive capacity; organizational learning



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1. Introduction

In the contemporary business world, all firms are located in a highly competitive market environment and the firms are intensively required to build up their own unique means by which they can be distinguished from their competitors and prolong their survival in the market environment. Indeed, product innovation is considered as one of the most effective tools to properly respond to the rapidly changing customers' market needs and to look for the opportunities to take a solid market position on behalf of the firms. In a broader sense, a firm's successful innovation in its products is very likely to contribute to the economic and social environment where it belongs, as innovated or improved products that the firm introduces to the market will significantly expand the realm of the external environment [1]. However, more importantly, it is notable that product innovation, once successfully accomplished, is likely to improve the organizational structures and processes of a firm so that it can heighten the level of the fit between its internal characteristics and the external environment where it is located [2,3].

Nonetheless, many firms often experience difficulties in their efforts to achieve product innovation. The existing literature on strategic management and organization theory has pointed out that the failure in product innovation results mostly from the lack of a better understanding about the complex features of product innovation. Product innovation is not a simple project that a firm can accomplish only by paying attention to the technological side of products, but a complex one that requires a more holistic approach

covering both the internal and external sides of the firm, such as the managerial, behavioral, organizational, or environmental aspects [4,5]. To overcome such problems derived from a technology-focused understanding about product innovation, this study aims to provide the policymakers of the firm with a more holistic perspective by which they can look into the managerial aspects involved in product innovation as well as the external environmental aspects. We particularly suggest that an open system approach can be a good solution to the problems that firms confront in their efforts of product innovation. In this study, we attempt to examine the relevance of the open system approach to the research area of product innovation by incorporating the ideas developed in organization theory, therefore suggesting a more holistic viewpoint that can effectively address the fundamental features of product innovation [6]. By adopting the open system approaches to the understanding of product innovation, this study aims to make contributions to the theoretical expansion of the literature on product innovation as well as the practical implications about product innovation.

To do so, we develop our theoretical framework about product innovation, based on organization theory, which has been greatly expanded upon as an academic discipline by inviting an open system approach, over the last seven decades or so [6–8]. As Katz and Kahn [6] suggest, the firm is best understood as an open social system in which various types of input, either internally or externally obtained, are transformed into the output under its managerial discretions along with the continuous transactions between the firm and the economic and social environment. Aligned with such solid research traditions, we further propose that a firm's efforts to enhance its product innovation is the major output and that based on certain features of its subsystems, our main variables that affect the effectiveness of product innovation are introduced: strategic attention, external information sources, and absorptive capacity.

In particular, we begin by proposing that at the center of a firm's managerial subsystems is how the firm allocates its strategic attentions to enable product innovation. Likewise, we also consider the characteristics of external information procurement as an important variable of the firm's supportive subsystems. We finally examine a firm's absorptive capacity as one of the core competencies that can effectively combine the inside resources with the resources located outside in the efforts to foster innovation in products, which is considered as an adaptive subsystem of a firm. In our proposed research hypotheses, we first argue that all of these three variables directly influence the effectiveness of product innovation. Next, we examine that the absorptive capacity, as a main component of a product innovation system, will mediate the effects of the strategic intention and external information sources on the effectiveness of product innovation.

In the following sections, we develop our hypotheses more specifically, based on the literature of organization theories relevant to our attempts to understand the structures and processes of product innovation. We then examine the hypotheses in the research context of Korean manufacturing industries from 2017 to 2019. This study contributes to the product innovation literature by suggesting a more holistic view in which the firm is regarded as an open social system and by promoting a better understanding of the firm's product innovation under such a view. Finally, we discuss some practical implications for the managerial practitioners and the firm decision-makers.

2. Theory and Hypotheses

2.1. Attention Allocation

As an open social system, the firm is composed of several different types of subsystems. Among the generic types of subsystems, suggested by Katz and Kahn [6], the managerial subsystem is one that takes the roles and functions of controlling, coordinating, and directing other subsystems in the firm. Usually, the top management is the very component of a firm's organizational structures and processes that develops and carries out the overall strategies about a broad range of organizational activities, given its authority and responsibilities.

According to the attention-based theory view [9,10], the firm is a system of structurally distributed attentions, and the attention of a firm is regarded as a crucial, but limited type of resource mostly due to the characteristics of the bounded rationality to which the firm is exposed [11,12]. Given a limited amount of attention resources, the top management of a firm has to deal with the attention allocating problems that may occur everywhere in the complex and complicated decision-making situations. That is, the main function of the top management is to figure out which issues are to be importantly dealt with in given situations and to select the issues that require the attention. Located in a highly competitive market environment, the firm has to find out which issue is mostly crucial for its prosperity, and even for its survival. However, the problem is that a variety of issues always compete with one another for the management's attentions within the boundaries of a firm [13]. In this regard, Ocasio [9,10] points out that the valuation and legitimization of issues are made by the cultural, social, and economic contexts of the organization and the issues with greater legitimacy, values, and relevance to the organization are likely to obtain more of the management's attention. In this governance procedure of allocation attentions, the top management of the firm, as the crucial decision-makers, should prioritize the issues according to the goals they pursue. That is, the selection of the issues in terms of attention allocation should be carried out by the top management along with their better understanding of the value and legitimacy of the issues.

Product innovation has long been recognized as an 'engine of organizational renewal' by which firms can survive and prosper in a competitive and dynamic market environment [14,15]. However, it is also regarded as a lengthy process that transforms a variety of resources into innovative products [16]. That is, production innovation is one of the most significant goals by which a firm can build long-lasting competencies in the market environment, so it necessarily requires the focal firm's attention to a great extent. However, the top management of the firm usually is situated to pursue diverse organizational goals simultaneously, and product innovation may be considered simply as one of the multiple goals that compete for sufficient attention from the management [10,17]. Therefore, we argue that the more organizational goals the top management attempts to achieve may seriously influence the effectiveness of product innovation.

In a rapidly changing and competitive environment, firms are challenged to accomplish multiple goals simultaneously. However, the literature about the multiple goals in organizations has well documented the problems of the concurrent pursuit of diverse goals (e.g., [18,19]). Aligned with this research line, we argue that the pursuit of diverse and multiple organizational goals not only leads the firm to generate various business strategies without careful managerial discretion, but also distracts the firm from properly choosing which specific strategy has to be given priority in terms of attention allocation [20]. When a firm has too many organizational goals and generates a broad range of business strategies to accomplish the diverse goals, it is unlikely to sustain its focus of attention correctly amongst the goals it attempts to achieve.

In this regard, we argue that pursuing a broader range of business strategies may result in the lack of sufficient managerial attention to product innovation which requires a selective set of managerial attentions comparatively over a lengthy time period in order to be successful. In other words, a firm in which the top management deals with diverse and multiple goals concurrently tends to experience more severely the conflicts in its attention allocation between the product innovation and other organizational goals. Given this, we conjecture that the product innovation may receive less attention when a firm faces such problems of allocating attentions to too many diverse organizational goals. Therefore, we propose that:

Hypothesis 1: *The concurrent pursuit of diverse and multiple business strategies is likely to prohibit a firm from enhancing the effectiveness of its efforts of product innovation.*

2.2. External Information Sources

Interestingly, the open system approach of organization theory emphasizes that a firm reside in a broader open environment in which it interacts with other organizations, in many ways [21]. To overcome the older formulation of system constructs that dealt with the closed system, the system theory suggests that a firm, which used to be considered as a self-contained structure, is more comprehensively understood by conceiving it as the one which is interdependent of external forces [6]. As an open social system, the firm often imports some form of available energy from the external environment and transforms it into other types of output [22,23]. According to the generic typology of subsystems suggested by Katz and Kahn [6], the procurement of the input through the transaction with the environment is a part of the supportive subsystem, and the information residing in the external domain is obtained by this supportive subsystem of the firm [24–26]. Based on this basic logic of the open system approach, we propose that to generate an output called production innovation, a firm needs to reach out to the external environment and obtain some important inputs. More specifically, the inputs are likely to be information and knowledge that may foster the product innovation within the firm's boundaries.

To generate a significant output in innovation-related activities, a firm cannot simply rely on the internal exploitation of its own information and knowledge [24]. As argued earlier in the previous section, product innovation is a project that requires a great number of resources under careful managerial attention [27]. Therefore, it is necessary that a firm reaches out for the information and knowledge that may reside beyond its boundaries to accomplish its goal of product innovation. In this regard, the literature of social networks in the research field of organization theory has consistently emphasized that building relationships with other external organizations may function as a key to innovation-related activities [28–30]. In particular, the exchange relationships with external partners will provide a relevant set of information and knowledge that are relevant specifically to product innovation.

Among the many characteristics of the networks that a firm may build beyond its boundaries, the connections to various types of other organizations will function as a conduit through which new knowledge and other relevant information flow into the focal firm. It means that a various set of external partners are likely to help the firm enhance the effectiveness of production innovation as external information sources. The recent literature of knowledge management also highlights the importance of the diverse external information sources in organizations' innovation performances [31–33]. Similarly, the literature points out that by having diverse external partners, not only does this expand the width of knowledge but it also encourages firms to recognize the importance of production innovation. More specifically, the social network literature points out that the external relationships with various types of organizations will provide more diverse information and knowledge than the relationships with the partners in a narrower scope (e.g., [34,35]). It means that other things being equal, establishing relationships with more diverse types of partners will facilitate a firm's capabilities in the activities of product innovation because novel and non-redundant knowledge can be obtained through diverse channels. Taken together, we propose our hypothesis regarding the effects of external information sources as follows:

Hypothesis 2: *A diverse set of external information sources is likely to help a firm enhance the effectiveness of its efforts of product innovation.*

2.3. Absorptive Capacity

As an open social system, the firm is constantly responding to the changing environment for its survival. Rather than simply maintaining the subsystems that concentrate relatively on the inward efficiency, a firm must develop an adaptive subsystem by which it senses the changes in the outward environments and translates the meaning of the changes for its purposes [6]. From a viewpoint of innovation-related activities, firms are required to

constantly pay attention to the development of capabilities of incorporating the external demands and fostering a relevant set of innovation-related information and knowledge. That is, at the center of the adaptive subsystems are new skills and competencies that enable the firm to acquire, assimilate, and exploit new knowledge [36]. The organizational learning literature therefore suggests an internal mechanism to absorb various types of knowledge for the innovation purposes and names its absorptive capacity [37].

Absorptive capacity refers to “the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends [37].” However, from a perspective of organizational learning, absorptive capacity is an innovation-focused capability that tends to be built in a long process of accumulating learning experiences. Such a capability greatly requires the top management’s managerial attentions along with a rich set of pre-existing knowledge that has been obtained through the various types of organizational routines and activities. The learning experiences accumulated within the firm’s boundaries are prerequisite for the absorptive capacity toward innovation outcomes, and such learning experiences tend to reside in every kind of R&D related investments. Prior knowledge obtained from in-house R&D efforts becomes the main feedstock for a firm’s absorptive capacity [38]. That is, the absorptive capacity, starting from the inward learning efforts, expands a firm’s scope towards outward learning beyond the firm’s boundaries.

Product innovation can be effectively facilitated not only by the inward learning processes but also by the external learning efforts that respond to the market demands. It is fundamentally pushed forward by the firm’s efforts to improve the internal innovation-related mechanisms. Furthermore, a successful product innovation is possible when the firm correctly understands the market needs and makes a proper access to the knowledge beyond the boundary. Considering this feature of product innovation, we argue that as a knowledge synthesizing mechanism, absorptive capacity is a crucial part of the function of effective product innovation. To support our arguments, the product innovation literature consistently reports the positive effects of the absorptive capacity on the performance of product innovation by considering it as the core component of successful product innovation (e.g., [39–41]). Therefore, we propose our hypothesis regarding the effect of the absorptive capacity on product innovation as follows:

Hypothesis 3: *Absorptive capacity of a firm is likely to enhance the effectiveness of its efforts of product innovation.*

By paying attention particularly to the roles of absorptive capacity that synthesize the inward learning experiences and the outward learning efforts, we now examine how absorptive capacity mediates the effects of attention allocation and external information sources on the performance of product innovation. We first begin by proposing that absorptive capacity mediates the relationship between the diversity of attention allocation and product innovation. As mentioned earlier, absorptive capacity is a core component of adaptive subsystems of a firm that has been established by incorporating a long managerial effort over a broad range of organizational activities [37,38]. In particular, the literature highlights that the top management’s pursuit of diverse organizational goals tends to be embodied in its absorptive capacity when the goals are innovation focused [37,38,42]. As a main function of absorptive capacity is to interpret and comprehend the firm’s organizational goals regarding innovation-related activities, it is where the diverse organizational goals are collected and cognitively processed into purposeful actions [42,43]. As Todorova and Durisin [43] suggest, a firm’s strategic intentions towards innovation activities are reformulated by its absorptive capacity in terms of the strategic values it pursues. By focusing on the inward learning aspect of the absorptive capacity, therefore we argue that the absorptive capacity shows its mediating functions in linking the top management’s attention allocations to the product innovation outcomes, so proposing our hypothesis as follows:

Hypothesis 4: *Absorptive capacity of a firm mediates the relationship between its attention allocation and the product innovation.*

As argued in the Section 2.2, exploring the diverse external partners provides the firm with new and valuable information and knowledge. However, for the firms, having diverse external information sources is different from interpreting and realizing the real values of the incoming information and knowledge. Unless a firm has built capabilities of assimilating and transforming the knowledge obtained from the external partners, it may be distracted from generating meaningful outcomes in its efforts to enhance the effectiveness of product innovation. Given such conditions, the absorptive capacity will likely function as a mechanism of processing the external information into the purposed innovation outcomes. As the literature on absorptive capacity shows, absorptive capacity takes a crucial mediating role in the process of integrating both internal and external knowledge sources into the creation of valuable outcomes (e.g., [44,45]). Therefore, we argue that the absorptive capacity of a firm will mediate the relationship between the external information sources and the product innovation, so proposing our hypothesis as follows:

Hypothesis 5: *Absorptive capacity of a firm mediates the relationship between the external information sources and product innovation.*

3. Methods

3.1. Data

To test our hypotheses, we use the “Korean Innovation Survey (KIS) 2020: Manufacturing Industry,” which is systematically collected by the Science and Technology Policy Institute (STEPI), a Korean government-operated research institute, every two years. The questionnaire was developed originally according to the Organization for Economic Cooperation and Development’s (OECD) *Oslo Manual*. The manual also serves as a set of guidelines for the development of the European Statistical Office’s (EUROSTAT) “Community Innovation Survey (CIS), therefore the questionnaire design of the KIS is almost equivalent to that of the CIS except for some questions reflecting the Korea-specific context. Like the CIS in the European Union (EU), the KIS is used as a reliable data source by which the Korean government not only monitors firms’ innovation-related actions and capabilities but also develops national policies regarding innovation in its country. Because the data is publicly open, many innovation-related empirical studies have used this data (e.g., [20,27,46–49]). Following the existing studies that have used this data, we also decided to use it in our analysis.

The population of the “Korean Innovation Survey 2020: Manufacturing Industry” is defined by the following two criteria: First, only the manufacturing companies that have more than 10 regular employees and that are registered in the “Korean Statistical Business Register (KSBR)” as of the end of 2019, are included in the population. Second, in order to identify whether the company is classified as a manufacturing industry, only those that fall under the categories 10 to 34 of the Korea Standard Industry Classification (KSIC) (2 digit), are included. Based on these criteria, the size of the population was identified as 50,785. The sample of the survey was drawn from this population through the stratified sampling scheme, and the final sample size was 4000. In our analysis, we used the same sample, so the number of our sample is also 4000.

3.2. Variables

3.2.1. Dependent Variable: Product Innovation

To measure the performance of product innovation, we used the answer to the KIS question, “During the three years 2017 to 2019, has your firm introduced any new or improved products to the market?” As described in the question item, the definition of product innovation in our measurement includes both the introduction of completely

new products to the market and the achievement of significant improvement to existing products. That is, our measure of product innovation considers both the incremental and radical innovation of products. Among the 4000 firms in the sample, 951 firms were identified as having introduced new or improved products to the market (approximately 24%). Based on the answer, we constructed the production innovation variable as a binary variable.

3.2.2. Independent Variable: Attention Allocation

To measure the extent to which a firm focuses upon diverse business strategies, we used the KIS question, “During the three years 2017 to 2019, how important were the following strategies to the economic performance of your enterprise?” To answer this question, 10 different types of business strategies were provided: (1) focus on improving your existing goods or services, (2) focus on introducing new goods or services, (3) focus on low-price (price leadership), (4) focus on high-quality (quality leadership), (5) focus on a broad range of goods or services, (6) focus on one or a small number of key goods or services, (7) focus on satisfying established customer groups, (8) focus on reaching out to new customer groups, (9) focus on standardized goods or services, and (10) focus on customer-specific solutions. [50] To each business strategy, the respondents were asked to answer the question using a scale from “never (=0)” to “very important (=5).” Based on the answers, we constructed the variable as Blau’s heterogeneity index, as follows [51]:

$$\text{Diversity of business strategies} = 1 - \sum_i^{10} p_i^2, \quad (1)$$

where i refers to each category of the business strategies, and p refers to the proportion of a weighted importance of a business strategy to those of all business strategies [50].

3.2.3. Independent Variable: External Information Sources

To measure the diversity of the external information sources a firm relies upon in its efforts for product innovation, we used the KIS 2020 question, “During the three years 2017 to 2019, how often did your firm cooperate with the following types of external partners as an external information source?” To answer this question, eight different types of partners were listed: (1) sister companies within your enterprise group, (2) other private companies, (3) other public companies, (4) universities or other higher education institutions, (5) private research institutes, (6) public research institutes, (7) governmental agencies, and (8) non-profit organizations. The respondents were asked to answer the question according to an interval scale from “never (=0)” to “very often (=5).” Using the answers to the question, we constructed the measure of the variable as Blau’s heterogeneity index, as follows [51]:

$$\text{Diversity of external information sources} = 1 - \sum_i^8 p_i^2, \quad (2)$$

where i refers to each category of the information sources, and p refers to the proportion of a weighted importance of an external information source to those of all information external sources.

3.2.4. Independent and Mediating Variable: Absorptive Capacities

To measure the absorptive capacity, we adopted an integrative approach suggested by the existing literature [52,53]. In particular, we constructed an indicator of the absorptive capacity as the principal components of the following variables: (1) the enterprise’s internal R&D expenditure, (2) the number of employees specializing in R&D, (3) a dummy indicating whether the enterprise establishes and operates a fully staffed R&D department, (4) a dummy indicating whether the firm engages in in-house R&D activities, (5) a dummy indicating whether the firm collaborates with others for their R&D purposes, (6) a dummy

indicating whether the firm contracts out their R&D activities, and (7) the number of funding methods for R&D purposes. This composite proxy measure is considered to include the key features for the conceptualization and measurement for the absorptive capacity because it is based mainly on the R&D features of the enterprise and R&D is accepted as a reliable proxy for the enterprise's capabilities that compose its absorptive capacity [37].

3.2.5. Control Variables

We controlled for other factors that may affect the performance of product innovation, in our analysis. First, we included the industry dummies by considering the fact that the extent to which a firm achieves product innovation may vary in different industrial contexts. According to the Korean Standard Industry Code (KSIC), we included 24 industry dummy variables, based on the 2 digit KSIC categories (KSIC 11 to 34). Second, we controlled for the firm's age. The firm's age is measured as the number of years from its foundation year to 2019 by following the existing studies [20,27,30,50]. Third, we included a dummy variable indicating whether the firm was classified as a small-and-medium-sized enterprise (SME), according to the Korean legal system. In the Korean legal system, the Small and Medium Enterprises Promotion Act is currently enforced, and the standards specifying the SMEs are based on the total assets and the average sales over the last three years. To be officially registered as a SME in Korea, the total assets must not exceed KRW 500 billion and the standards of the three-year average sales vary from KRW 80 billion to 150 billion, according to the industry category. In our sample, about 79 % of the firms were identified as SMEs. Finally, we also controlled for the firm's size by the number of employees as of 2019, by following the existing studies [20,27,28,30,50].

4. Results

In Table 1, we report the descriptive statistics of the variables included in the analysis. As mentioned earlier, out of 4000 firms in our sample, 951 firms (24%) introduced new or improved products to the market where they belong during the observation period from 2017 to 2019. Table 2 shows the pairwise correlations between the variables included in the analysis. While 24 industry code dummy variables are included in the analysis, the results of the pairwise correlation analysis are not reported in Table 2, due to space limitation.

Table 1. Descriptive Statistics.

Variables	Mean	S.D.	Min.	Max
Product innovation (<i>binary variable</i>)	0.24	0.43	0	1
Small and medium sized company (<i>dummy</i>)	0.79	0.41	0	1
Firm age (<i>in Year</i>)	22.75	13.12	5	95
Firm size (<i>number of employees</i>)	227.69	1270.93	10	66,468
Diversity of strategic attentions	0.75	0.21	0	0.90
Diversity of external information sources	0.15	0.29	0	0.88
Absorptive capacity	0.00	1.63	−1.73	27.31

Notes: $N = 4000$; industry dummies are not reported due to the space limitations.

As our dependent variable is constructed as a binary variable, the hypotheses proposing the independent direct effects of each independent variable are all tested using the logistic regression analysis. Table 3 shows the results of these logistic regression analyses in which all of the proposed effects on the product innovation are carefully examined. Due to the space limitations and minor research interests, all of the coefficients of each of the industry dummies, which we include in the analyses as the control variables, are not reported in Table 3. Model 1 includes all of the control variables as the baseline model.

Table 2. Pairwise correlations.

Variables	1	2	3	4	5	6
1. Product innovation						
2. Small and medium sized company (<i>dummy</i>)	−0.24 **					
3. Firm age (<i>in year</i>)	0.15 **	−0.37 **				
4. Firm size (<i>number of employees</i>)	0.11 **	−0.25 **	0.14 **			
5. Diversity of strategic attentions	−0.09 **	−0.13 **	0.11 **	0.07 **		
6. Diversity of external information sources	0.27 **	−0.31 **	0.22 **	0.15 **	0.21 **	
7. Absorptive capacity	0.46 **	−0.41 **	0.28 **	0.40 **	0.19 **	0.58 **

Notes: $N = 4000$; ** $p < 0.01$; industry dummies are not reported due to the space limitations.

Table 3. Results of the logistic regression.

Variables	Model 1	Model 2	Model 3	Model 4
(<i>constant</i>)	−0.93 ** (0.20)	0.54 ** (0.25)	−1.07 ** (0.20)	−1.09 ** (0.21)
Small and medium sized company (<i>dummy</i>)	−0.94 ** (0.10)	−1.03 ** (0.11)	−0.77 ** (0.11)	−0.30 ** (0.11)
Firm age (<i>in year</i>)	0.01 ** (0.00)	0.02 ** (0.00)	0.01 ** (0.00)	0.00 ** (0.00)
Firm size (<i>number of employees</i>)	0.00 ** (0.00)	0.00 ** (0.00)	0.00 ** (0.00)	−0.00 ** (0.00)
Diversity of strategic attentions		−1.83 ** (0.19)		
Diversity of external information sources			1.45 ** (0.14)	
Absorptive capacity				0.87 ** (0.04)
<i>Log Likelihood</i>	−1985.85	−1940.59	−1931.58	−1658.65

Notes: $N = 4000$; ** $p < 0.01$; standard errors are in parentheses; industry dummies are not reported due to the space limitations.

In Model 2, we add the diversity of strategic attentions to the baseline model (Model 1). The findings show that the variable has a negative and significant effect on the product innovation. Because a larger magnitude of the diversity of strategic attentions implies the firm implements of a broader range of business strategies to the economic performances, the negative sign of the coefficient indicates that the firm may be hampered to generate its product innovation when it uses an unfocused set of business strategies. That is, Model 2 supports Hypothesis 1.

To test Hypothesis 2, Model 3 adds the variable of the diversity of external information sources to the baseline model (Model 1). The result shows that the coefficient of the variable turns out to be positive and significant. It indicates that the more diverse a firm interacts with external information sources, the more likely it will accomplish the product innovation. Thus, our hypothesis regarding the positive effect of the external information sources is supported.

Model 4 adds the variable of the absorptive capacity to the baseline model (Model 1). Model 4 tests Hypothesis 3, regarding the positive effect of the absorptive capacity on the product innovation. The coefficient of the absorptive capacity is positive and significant, and it confirms that a firm with a sufficient level of absorptive capacity is more likely to facilitate the product innovation. Therefore, Hypothesis 3 is also supported by the analysis.

Table 4 presents the results of the test of the mediating effects of the absorptive capacity on the relationship between the diversity of the strategic attentions and the product

innovation. To analyze the mediating effect, we adopt the three-step analysis suggested by the existing literature [54–56]. The first step is to examine whether the diversity of the strategic attentions affects the product innovation, which is supported in Model 2, as reported both in Tables 3 and 4. The second step is to demonstrate that the diversity of the strategic attentions influences the absorptive capacity and the mediating variable. This step is supported in Model 5, in which the absorptive capacity is regressed on the diversity of strategic attentions along with the control variables. The diversity of strategic attentions has a positive and significant relationship with the absorptive capacity ($\beta = 0.78$, $p < 0.01$). In the last step, which is reported in Model 6, the findings show that the absorptive capacity affects the product innovation at a significant level ($\beta = 1.00$, $p < 0.01$), after controlling for the diversity of strategic attentions. Because the absorptive capacity and the diversity of strategic attentions are both significant in their effects on product innovation, a partial mediation effect is confirmed. Thus, Hypothesis 4 is supported in our mediation analysis.

Table 4. Mediation of the absorptive capacity between the strategic attentions and product innovation.

Variables	Dependent Variable		
	Product Innovation (Logistic)	Absorptive Capacity (OLS)	Product Innovation (Logistic)
	Model 2	Model 5	Model 6
(constant)	0.54 ** (0.25)	−0.66 ** (0.14)	1.52 ** (0.28)
Small and medium sized company (dummy)	−1.03 ** (0.11)	−1.00 ** (0.06)	−0.37 ** (0.12)
Firm age (in year)	0.02 ** (0.00)	0.02 ** (0.00)	0.01 (0.00)
Firm size (number of employees)	0.00 ** (0.00)	0.00 ** (0.00)	−0.00 (0.00)
Diversity of strategic attentions	−1.83 ** (0.19)	0.78 ** (0.11)	−3.27 ** (0.23)
Absorptive capacity			1.00 ** (0.04)
R-square		0.36	
Log Likelihood	−1940.59		−1554.86

Notes: $N = 4000$; ** $p < 0.01$; standard errors are in parentheses; industry dummies are not reported due to the space limitations.

As a robust check, we also conduct an additional mediation analysis based on a bias-corrected bootstrapping approach [57]. It is known that the bootstrapping approach effectively overcomes the limitations of Baron and Kenny’s three step methods as well as the over-reliance on the normality assumption of the Sobel test [58]. In the bootstrapping test, the exclusion of zero in confidence interval (CI) is accepted to confirm the mediation effect [59]. Using 300 bootstrap samples and 95% CIs, we found a significant indirect effect of the diversity of the strategic attentions on the product innovation through the mediation of the absorptive capacity. The estimation of the indirect effect is 0.12 (CI = [0.09, 0.5], $p < 0.001$), which also supports Hypothesis 4.

Similar to Tables 4 and 5 reports the mediation test of the absorptive capacity on the relationship between the diversity of the external information sources and the product innovation based on Baron and Kenny’s mediation test. As the first step, Model 3 shows that the diversity of the external information sources directly influences the product innovation. The second step is reported in Model 7, in which the absorptive capacity is regressed on the diversity of the external information sources along with the control variables. The findings show that the diversity of the external information sources has a pos-

itive and significant relationship with the absorptive capacity and the mediating variable (beta = 2.56, $p < 0.01$). Model 8, which reports the last step, presents that the absorptive capacity positively affects the product innovation at a significant level (beta = 0.92, $p < 0.01$), with the independent variable controlled. As both the mediating variable and the independent variable have significant effects in Model 8, the partial mediation effect of the absorptive capacity is confirmed.

Table 5. Mediation of the absorptive capacity between the external information sources and product innovation.

Variables	Dependent Variable		
	Product Innovation (Logistic)	Absorptive Capacity (OLS)	Product Innovation (Logistic)
	Model 3	Model 7	Model 8
(constant)	−1.07 ** (0.20)	−0.32 ** (0.09)	−1.07 ** (0.21)
Small and medium sized company (dummy)	−0.77 ** (0.11)	−0.64 ** (0.05)	−0.32 ** (0.11)
Firm age (in year)	0.01 ** (0.00)	0.01 ** (0.00)	0.00 (0.00)
Firm size (number of employees)	0.00 ** (0.00)	0.00 ** (0.00)	−0.00 (0.00)
Diversity of external information sources	1.45 ** (0.14)	2.56 ** (0.07)	−0.46 ** (0.17)
Absorptive capacity			0.92 ** (0.05)
R-square		0.51	
Log Likelihood	−1931.58		−1654.93

Notes: $N = 4000$; ** $p < 0.01$; standard errors are in parentheses; industry dummies are not reported due to the space limitations.

In a separate mediation test, using the bootstrapping approach, it is found that the absorptive capacity also has a significant indirect effect on the relationship between the external information sources and the product innovation, by using a 300-bootstrapping sample. The estimation of the indirect effect is 0.39 (CI = [0.35,0.43] $p < 0.001$). Therefore, Hypothesis 5 is also supported.

Figure 1 depicts the findings of our analysis, in which the diversity of the strategic attentions, the diversity of the external information sources, and the absorptive capacity, all influence directly product innovation; and the absorptive capacity mediates both the relationship between the diversity of the strategic attentions and product innovation and the relationship between the diversity of the external information sources and product innovation.

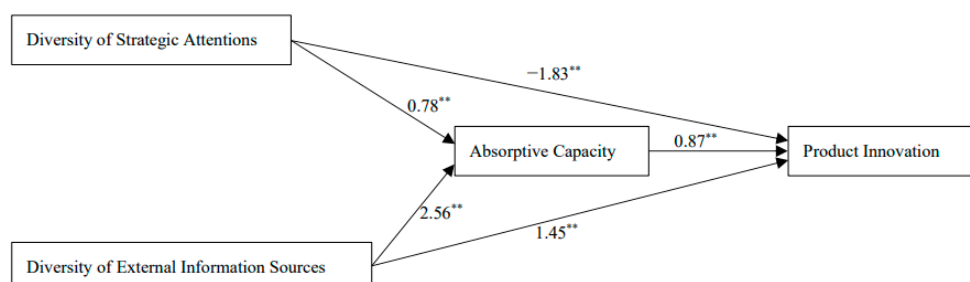


Figure 1. The diagram of the findings. ** $p < 0.01$.

5. Discussion

Building upon the open system approach to organization studies [6–8], this paper proposes that a firm's efforts to enhance its product innovation is best understood when the firm is considered as an open social system in which the managerial subsystem of the attention allocation, the supportive subsystem of procuring external information sources, and the adaptive subsystem of building the absorptive capacity function collaboratively to accomplish the product innovation outcomes. We therefore suggest that the product innovation is a complex and complicated task that requires more holistic arrangements of subsystems encompassing both internal and external aspects of an organization than simple improvements of technological competencies. By using the data set of the "Korean Innovation Survey 2020: Manufacturing Industry", we empirically examined all of our hypotheses we developed, based on the open system approach, and our empirical findings support all five hypotheses.

Our findings contribute to the product innovation literature by providing a more holistic and comprehensive explanation on how to successfully overcome myopic strategies that hasten for immediate visible outcomes of product innovation. While the existing studies about product innovation tend to focus mostly on the technological side of products, our findings highlight the importance of long-term managerial considerations, which incorporate a more focused distribution of attentions to the goal of product innovation [1–3]. Unless the top management carefully pours more focused attention into the firm's efforts of product innovation, it is unlikely that the firm will achieve the goal of product innovation. Additionally, the findings show that the firm must expand the range of external information sources diversely in order to obtain the relevant information and knowledge for its efforts of product innovation. More importantly, this study found that building up the absorptive capacity is a crucial step to synthetically combine the internal strategic attentions with the external information and knowledge for its purposes of product innovation. In sum, we believe that our findings guide the firm pursuing the product innovation to a more holistic viewpoint based on the open system approach.

Our study also contributes to the system theory by expanding its theoretical perspectives to the realm of organization studies. Since the system theory was first introduced, the expansion of the theory has been attempted in many other disciplines, and the research area of organization studies is one of those disciplines. By understanding the organizations through the lens of the open system theory [6–8], we suggested in this study that the efforts to enhance the product innovation is better understood as an organic combination of various subsystems residing in the organizational structures and processes. Rather, a simple sum of independent subsystems within the organizational boundaries, the organizational goals can be accomplished more effectively when the firm is considered as a total sum of interactively communicating subsystems that encompass both internal and external aspects of the whole system. All three subsystems included in our hypotheses do not separately function, but closely interact with one another to generate the purposed outcomes. Thus, the empirical findings of this study not only confirm the theoretical relevance of the open system theory to the understanding of the firm's actions of achieving its goals but also expands the scope of the theory.

6. Conclusions

This study provides some important practical implications, especially to the firms that attempt to generate considerable outcomes in product innovation. First, it highlights the importance of the proper allocation of managerial attentions. While a firm faces diverse goals concurrently, it must build up managerial competencies to overcome the potential distraction derived from diverse and multiple goals. Based on the attention-based view of the organizations, we argued that the pursuit of multiple goals may result in the dispersion of limited attention resources, which can be detrimental to the relatively complex and complicated goals that require prioritized attentions, such as product innovation, in our case [9,10,20]. As our findings show, the failure of prioritizing the attention resources is

very likely to hamper the firm in the accomplishment of its important strategic tasks. To build the competencies of choosing which goals need more attention resources, the top management of the firm must pay attention especially to the features of the given tasks in terms of the values of various goals, and prioritizing groups of the goals.

Second, based on the findings of this study, we emphasize the importance of reaching out to for information and knowledge through the external networks of various types of external organizations. As product innovation is a task that requires a broad range of information and knowledge, the firms pursuing this goal are likely to obtain the knowledge resources that may not grow within the firm boundaries. The knowledge for product innovation is not limited to the technological kinds, but may include institutional or legal kinds. Establishing good relationships with various types of external partners will therefore function as the reliable inflowing channel of the knowledge that resides in the external environments [34,35]. Thus, it is very important that the policymakers should find ways to establish reliable relationships with other organizations.

Lastly, our findings guide the policymakers to build the absorptive capacity within their firms in order to enhance the effectiveness of product innovation. As argued earlier, the absorptive capacity is a crucial component of the innovation-related activities, especially because it connects the external knowledge with the internal competencies. From a viewpoint of organizational design, it is known that the absorptive capacity is structurally positioned in an independent department specializing in research and development. Likewise, maintaining the professional workforce with research skills and knowledge also functions as a crucial part of the firm's absorptive capacity. The top management of a firm must consistently invest in establishing knowledge-intensive routines and mechanisms within the boundary, and such efforts will consequently lay a solid ground for building the firm's absorptive capacity.

Despite some critical contributions and practical implications, this study has some limitations that deserve future study, in terms of the data. As the dataset used in this study is constructed by a survey method, one may raise a question particularly about the data. It is often addressed that a survey method may be subject to some issues about the reliability of responses, which may lead to response biases such as the self-enhancement bias. While the Korean Innovation Survey has been conducted by an authoritative, government-funded research institute, following the global standard, and thus considered as a reliable data source by prior studies (e.g., [20,27,46,47]), future studies would benefit from a more objective measure to rule out such restrictions. Another limitation may be pointed out in terms of generalizability of our findings. Our research context of Korean manufacturing industries may have some institutional, cultural, and economic features. Therefore our findings need to be validated in other contexts, for example, by using the Community Innovation Survey (CIS) that encompasses the member nations of the European Union. We believe that these limitations will be effectively addressed by future research.

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