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Innovation Capabilities and Business Performance in the Smart Farm Sector of South Korea

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Abstract: Ever-increasing unpredictability has led to recognition of increasing importance of innovation capabilities of businesses. In spite of recognizing such an important issue of innovation capability, not much research has been conducted on the relationship between innovation capabilities in business planning, R&D, commercialization and innovation performance. The current research, thus, intends to provide an empirical analysis of the effect of smart farm companies' innovation activities on their innovation performance. Classifying innovation capabilities into three categories of planning, R&D and commercialization capability, the current research aims to identify the effect of each category on sales and patent acquired. Moreover, it aims to identify the moderating effect of governmental policy and support for technology on the relationship between innovation activities and performance. It was found that planning, R&D and commercialization capabilities exerted a positive impact on business performance. It was also found that governmental policies and support helped enhance business performance.

Keywords: smart farm; venture companies; innovation capabilities; moderating effect

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1. Introduction

The recent rapid development of information and communication technology has led to the emergence of convergence as a new paradigm of technological innovation among industries [1].

The so-called 4th Industrial Revolution characterized by such key terms as artificial intelligence (AI), big data, block chain and Internet of things (IoT) has enhanced the importance of digital transformation [1]. In an attempt to respond to such changes including technological innovation, businesses can find a variety of new opportunities, and must make strategic decisions on various issues including advancing to foreign markets, mergers and acquisitions (M&A) in related and unrelated areas, direct investment in new businesses, investment in new technology and securing innovation capabilities [2]. Such changes in various forms and areas can result in innovation, which can be defined and classified in many different ways [1,2]. Depending on the target for innovation, it can be classified into technological innovation, management innovation, and quality innovation and all these activities are expected to help provide a base for enhancing competitiveness of organizations [2].

Venture companies can make a great contribution to economic growth and job creation [2].

However, many venture companies would struggle with a set of limitations: scarcity of financial resources and competent manpower, difficulty in advancing into the market, ever-decreasing period of developing new products, and find it extremely difficult to grow to bigger organizations [2,3]. Thus, the importance of technological innovation cannot be overemphasized in order for them to overcome such intrinsic limitations in internal resources and maintain sustainable competitiveness [3].

Previous research on technological innovation has focused on such issues as the relationship between investment of resources in R&D and improvement in innovation, and the overall role and contribution of R&D activities for technological innovation [4]. However, it might be natural to assume that technological innovation capabilities are crucial for success in developing new products or technology and eventual commercialization [4]. The innovation performance should mainly depend on business capabilities for planning, production and marketing as well as technology development and R&D activities [4]. Such previous research on technological innovation has been conducted from theoretical and practical perspectives, but many of them generalized all large and small venture companies, without considering unique characteristics and independent capabilities depending on the size of businesses [2–4]. Moreover, given the increasing number of strategic issues such as customized support for venture companies' competitiveness depending on their phases of development, not much has been analyzed regarding the differences in innovation capabilities and characteristics [2,4]. In particular, past research has been based on the generalized concept of innovation capability to analyze its relationship with business performance [5]. Additionally, most of them have focused on the relationship between performance and such subcategories as planning capability and commercialization capability [5,6]. With the categorization of innovation capabilities into planning, R&D and commercialization, the current research aims to identify the effect of each of these smart farm venture companies' innovation capabilities on their business performance. These companies seek a scientific way of agriculture by automatically remote-controlling so-called green ICT features, observing the growth of crops without any limitation of space and time, and managing farms to stay in an optimal state [7]. The moderating effect of governmental policy and support between smart farm companies' innovation capabilities and business performance has also been identified [8]. Moreover, the non-financial performance of patent registration is taken as a variable for analysis, which would make it possible to analyze overall analysis of smart farm companies' innovation capabilities [8]. The paper focuses on smart farm companies in small and medium industries as smart farming is the one of the innovation sectors in green IT and it is being developed rapidly these days. The purpose of the present research is to evaluate the effect of innovation capabilities (planning innovation, R&D innovation, commercialization innovation) and governmental technology policies and support on companies' innovation performance and it can be summarized as follows.

First, the current research intends to extract research hypotheses on the basis of literature review of past research on innovation activities and business performance of smart farm venture companies.

Second, it conducts an empirical analysis of the impact of these companies' innovation activities and governmental polices supporting technological innovation on their innovation performance.

Third, based on the research results, this study is expected to identify on what innovation capabilities smart farm venture companies should concentrate, and where governmental support should go in academic and practical perspectives.

Section 2 is devoted to the literature review of past research on venture companies' innovation capabilities and performance, and governmental policies and support. Section 3 then presents a research model and a set of hypotheses. Section 4 discusses the results of analysis and Section 5 presents concluding remarks and suggestions.

2. Literature Review

2.1. Smart Farms

It might be said that the so-called 4th Industrial Revolution started in January 2016 at the 46th World Economic Forum (WEF). It was announced that we have already reached the turning point of intensifying interdisciplinary developments, especially in the fields of physics, digital sciences and biology [9].

A smart farm refers to a farm in which one can manage and maintain the living environment of crops and livestock by incorporating ICT in operating green houses, cattle sheds, pigsties and orchards. Governmental efforts have focused on creating agricultural new growth engines on the basis of information technology (IT)–biotechnology (BT)–nanotechnology (NT) convergence, and smart farms have drawn much attention as a new area of future industry [7,9].

The convergence of agriculture and ICT can be applied in many aspects including distribution, consumption and rural life as well as production [10]. Thus, some new values can be created through ICT convergence at each point of the value chain of production–distribution–consumption for innovation in products, services and manufacturing processes: refinement of production process, intellectualization of distribution, advancement of management [10].

Technological concepts of the 4th Industrial Revolution that can be applied to horticulture and pomiculture of smart farms can be exemplified by Internet of things, cloud, big data, artificial intelligence, drones, and robots. At present, smart farm features financially supported by policies include sensors, equipment, and programs in IoT and cloud services, and other services such as drone, robot, software (for management diagnosis, technology support) are yet to be developed or undergo empirical experimentation [7–11].

Such convergence can be utilized in various areas including agricultural production based on IoT, online commerce via online mall, and tracing the history of crops based on RFID. Moreover, when diseases occur, K-AHIS (Korea Animal Health Integrated System) can enable us to take preventive measures in an efficient way: for example, control of traffic and appropriate disinfection in vulnerable farms [12].

2.2. Innovation Capabilities and Innovation Performance

Technological innovation should be at the top of the priority list for small- and medium-sized companies due to their relatively insufficient resources and inferior management environment in contrast to large companies. Thus, they invest a great deal of resources in R&D to secure new technology. In this section, we discuss previous research on the relationship between investment and innovation performance [13,14].

Souitaris, in his empirical analysis of manufacturing industries in Greece, found that R&D intensity and manpower are critically important for technological innovation activities [15]. Most research has focused on how R&D investment affects innovation and management outcomes, since the former plays a crucial role in securing manpower and equipment [15].

Griffith et. al., in turn, analyzed the impact of R&D concentration indicating the ratio of R&D investments to sales on technological innovation and labor productivity [16]. They argued on the basis of CIS (community innovation of survey) from four European countries that its higher ratio of R&D concentration was positively correlated with a higher innovation of processes and products, which eventually helped enhance labor productivity [16].

Research on small companies has also emphasized the crucial role of investment in R&D in producing positive outcomes of innovation [16]. Hadjimanolis, for example, claimed that R&D resources and capability of small companies are crucial keys to innovation performance [17]. Freel reported that small companies' investments in R&D expedited launching of new products [18]. Kang & Lee identified various elements affecting innovation activities of venture companies in Korean bio-industry: they found that aggressive investment in R&D also played an important role [19]. Yoo and Noh also argued that one of the crucial factors for technological innovation of small- and mid-sized companies is investment in R&D and qualified R&D manpower [20].

Kim and Chun conducted an empirical analysis of technology-oriented small companies and showed that R&D concentration, which is the ratio of the companies that invested their resources into R&D in total resource, had a positive effect on innovation performance and business performance as well [21]. Most of the previous research on factors for innovation performance focused on the question of how much should be invested and what resources should be invested in order to produce positive outcomes [21]. However, in order for new products or technology to be eventually commercialized, technological innovation capabilities are crucial [21]. In other words, new technology itself does not guarantee its success or positive outcomes, since innovation performance depends on business capabilities such as production and marketing along with R&D [22]. New technology or new ideas can be launched into the market through the process of commercialization and mass production [23].

Thus, in addition to establishing a well-organized portfolio suitable for business strategies and capability to secure new technology, commercialization capability plays a key role in creating innovation performance [23]. In this context, Christensen classified technological innovation capabilities from the perspective of assets: R&D asset, process innovation asset, product innovation asset and design asset [24]. Burgelman et al. stressed the importance of cultural foundation of an organization in order to understand and identify competitors' innovation strategies, relevant market situation, and compatible technologies, and to carry out innovation processes [25].

2.3. Government Policies for Technological Innovation and Companies' Innovation Performance

Some scholars claim that bigger organizations with larger assets are in more favorable position for innovation activities, since big companies are more likely to be able to easily collect data, perform research and make intensive investments [26]. However, others argue that brand new and venture companies can be more creative and diversified in producing and developing ideas [27].

In this respect, government support for small- and medium-sized companies is very important from the perspective of resource dependence theory, which argues that an organization must reduce its dependence on external resources by diversifying its resource acquisition channels. Businesses can lower resource dependence by securing internal, private and government resources. Government support can be viewed from means of policy as well as tools of policy [27]. Salamon has even included government subsidiaries in an active support policy [28]. Government support under discussion can be classified into two categories: financial support including tax support, fund support, banking support, and nonfinancial support, which is the support of research facilities, technology asset and accreditation [28].

Let us discuss some previous research on government support. Czarnitzki, Ebersberger reported that subsidiaries from government exerted a positive impact on innovation activities [29]. In contrast, some scholars such as Wallsten and Lach found negative effects including the crowding-out effect, which is an economic theory arguing that rising public sector spending drives down or even eliminates private sector spending [30,31]. Cerulli, Poti and Hall et al. claimed that the crowing-out effect might exist, but it does not totally offset the whole government support [32,33]. Kim and Sung also reported an empirical analysis showing that government subsidiaries exerted a positive impact on small companies' innovation [34]. Many others showed that government support had a positive influence on innovation performance as well as innovation activities [35–39].

McDonnell and Elmore and Schneider and Ingram presented a similar classification of government policy means: authority, enticement and capability building. As for policy tools, regulations are often criticized as authoritative, since they are often coupled with legal force [40,41]. Many researchers agree that governmental comprehensive regulations imposed for the purpose of control or restructuring might have a negative impact on innovation activities [42–44].

What is important here is that government is also the main agent that should solve such problems as contraction of market and increased costs triggered by government regulations. Thus, we should make every effort to present alternatives as well as acknowledge criticisms, since good government regulations could have a positive effect and eventually lead to improvement in innovation and performance of businesses [45–47].

3. Research Methodology

3.1. Research Model and Hypotheses

Chiesa et al. presented a set of elements for technological innovation capabilities: concept creation, process innovation, product development, technology acquisition, leadership, use of resources, and utilization of system and tools [48]. Adopting their model, Yam et. al. classified technology innovation capabilities into a set of seven subcategories: learning capability, R&D capability, resources allocation capability, manufacturing capability, marketing capability, organization capability and strategic planning capability [49].

Taking the business environment of small- and medium-sized companies in Korea into consideration, the current research simplified such a classification and is based on a set of three capabilities: planning, R&D and commercialization. First, planning capability enables us to understand changes in the market and technology and helps establish the direction of new technology and products. Second, R&D capability, as the name indicates, technologically realizes a new product or technology, develops prototypes and secures cost competitiveness. Finally, commercialization capability is in charge of launching to the market, pioneering the market and conducting customer services. On this basis, the following hypotheses were established in the current research.

Hypothesis 1 (H1). *Innovation capabilities of smart farm venture companies have a positive effect on innovation performance (sales growth).*

Hypothesis 1.1 (H1.1). *Planning innovation capabilities of smart farm venture companies have a positive effect on sales growth.*

Hypothesis 1.2 (H1.2). *R&D innovation capabilities of smart farm venture companies have a positive effect on sales growth.*

Hypothesis 1.3 (H1.3). *Commercialization innovation capabilities of smart farm venture companies have a positive effect on sales growth.*

Hypothesis 2 (H2). *Innovation capabilities of smart farm venture companies have a positive effect on patents acquired.*

Hypothesis 2.1 (H2.1). *Planning innovation capabilities of smart farm venture companies have a positive effect on patents acquired.*

Hypothesis 2.2 (H2.2). *R&D innovation capabilities of smart farm venture companies have a positive effect on patents acquired.*

Hypothesis 2.3 (H2.3). *Commercialization innovation capabilities of smart farm venture companies have a positive effect on patents acquired.*

Research has claimed that innovation overcoming regulations can help a company enhance its productivity and competitiveness [50]. As in Porter's hypothesis, businesses can produce innovation and end up improving its productivity in responding to government's environmental regulations [46]. Environmental regulations would rather produce pressure for innovation, which would lead to reduction of costs and improved products and processes. Vries and Withagen also reported a positive impact of regulations on innovation [47].

Government support of technology for businesses would help promote innovation activities including technology development, patent acquisition and infrastructure-building [34]. That is, government support of finance, technology and manpower can help businesses establish a base for innovation [25] and, thus, would exert a positive effect on innovation activities [37]. Based on the preceding discussion, the following hypotheses are established for the effect of government support on the relationship between innovation capabilities and innovation performance. On this basis, a research model (Figure 1) was developed.

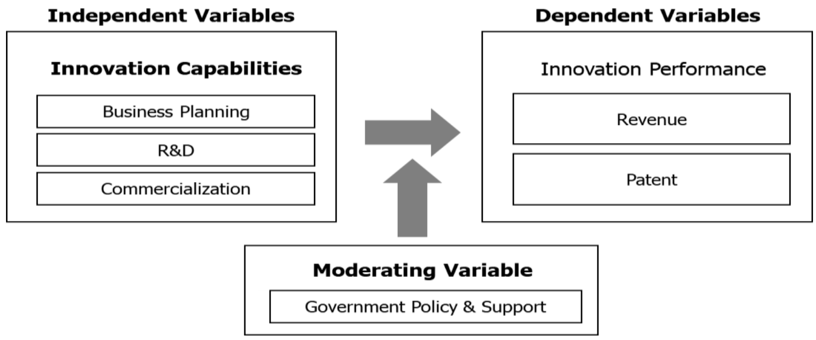

Figure 1. Research model.

Hypothesis 3 (H3). *Governmental technology policies and support have a positive effect on smart farm venture companies' innovation capabilities and sales growth.*

Hypothesis 3.1 (H3.1). *Governmental technology policies and support have a positive effect on smart farm venture companies' planning innovation capability and sales growth.*

Hypothesis 3.2 (H3.2). *Governmental technology policies and support have a positive effect on smart farm venture companies' R&D innovation capability and sales growth.*

Hypothesis 3.3 (H3.3). *Governmental technology policies and support have a positive effect on smart farm venture companies' commercialization innovation capability and sales growth.*

Hypothesis 4 (H4). *Governmental technology policies and support have a positive effect on smart farm venture companies' innovation capabilities and patents acquired.*

Hypothesis 4.1 (H4.1). *Governmental technology policies and support have a positive effect on smart farm venture companies' planning innovation capability and patents acquired.*

Hypothesis 4.2 (H4.2). *Governmental technology policies and support have a positive effect on smart farm venture companies' R&D innovation capability and patents acquired.*

Hypothesis 4.3 (H4.3). *Governmental technology policies and support have a positive effect on smart farm venture companies' commercialization innovation capability and patents acquired.*

3.2. Data Collection

The data under analysis are the figures provided by Smartfarm Korea in 2021. The data came from a group of 160 small- and medium-sized companies that participated in the 3 areas of smart farm project-smart greenhouse, smart orchard and smart cattle shed (pigsty) from 2016 to 2020. The group of the subjects is summarized in Table 1 and variables and data set are summarized in Tables 2 and 3, respectively.

Table 1. Description of companies (venture companies).

Category		Venture	
Observation		160	100%
Type	Smart greenhouses	60	38%
	Smart orchards	46	29%
	Smart cattle sheds	54	34%

Table 2. Variables investigated in the present research.

Variables	Definition
Dependent Variable: Innovation Performance	
Indicator for growth (GRO)	Growth rate of sales
Patent acquired (PAT)	Patent companies acquired for the business
Independent Variable: Innovation Capabilities	
Business planning (BPC)	No. of resources for business planning
R&D (RDC)	No. of resources for R&D
Commercialization (COC)	No. of resource for commercialization
Moderating Variables:	
Government support (GOV)	No. of government support funds and resources
Control Vvariables	
Business type (TYP)	Smart greenhouse, orchard, and cattle shed
Company age (AGE)	Current year (2021) vs. year of establishment

Data set: 2016–2020, source: SmartFarm Korea, Ministry of SMEs and Startups, Ministry of Agriculture, Food and Rural Affairs.

Table 3. Data set summary for smart farm companies.

Characteristic	GRO	PAT	BPC	RDC	COC	GOV	TYP	AGE
Min. value	12.25	0.323	0.132	0.732	0.243	0.130	0.000	1.000
Max. value	34.22	3.241	3.634	3.793	4.245	4.000	1.000	12.000
Average	18.71	1.232	1.237	1.389	2.567	1.447	0.658	5.32
Standard deviation	0.876	0.034	0.624	0.778	0.534	0.229	0.134	3.721
Skewness	0.354	−0.298	−0.276	−0.137	0.324	0.991	0.110	0.908
Kurtosis	2.183	1.889	2.760	3.169	5.435	4.328	3.545	2.341
Observation	160	160	160	160	160	160	160	160
Characteristic	GRO	PAT	BPC	RDC	COC	GOV	TYP	AGE
GRO	1							
PAT	0.221 **	1						
BPC	0.354 *	0.301 **	1					
RDC	0.462 *	0.298 ***	0.256 **	1				
COC	0.232 *	0.221 **	0.092 **	0.410 *	1			
GOV	0.123 **	0.098 *	0.309 *	0.247	0.301 **	1		
TYP	0.320 *	0.214 **	0.222 **	0.151 *	0.201 **	0.410 *	1	
AGE	0.290 *	0.378 **	0.364 **	0.294 **	0.101 *	0.389 *	0.05	1

Note: GRO: indicator for sales growth; PAT: indicator for patent; BPC: business planning capability; RDC: R&D capability; COC: commercialization capability; GOV: government support; TYP: type of companies; AGE: company age. ***, **, * represent the significance at the level of 1%, 5%, 10%, respectively.

4. Results and Findings

4.1. Regression Analysis Result

The statistical program SPSS 18 was utilized to test the hypotheses under investigation: regression analysis and moderating effect analysis. To conduct a moderated regression analysis using the program, an interacting variable connected with 'independent variable-moderating variable' was calculated first, and a hierarchical regression was performed in the order of independent variables, moderating variables and interacting variables.

Table 4 illustrates the results of testing Hypotheses 1 and 2. First, As for the hypothesis testing a fixed effect model, the model was found significant, since the null hypothesis was rejected by the regression formula (R2: 37.6%, p-value < 0.005). Their innovation capabilities had a positive relationship with total sales: business planning (ß = 0.223, p-value < 0.05,), R&D (ß = 0.374, p-value < 0.01) and commercialization (ß = 0.216, p-value < 0.01), respectively. In other words, a greater level of planning, R&D and commercialization capabilities would produce a greater level of sales. Second, after conducting a regression analysis testing Hypothesis 2, it was found that the null hypothesis was rejected to find the model significant. There existed a positive relationship between innovation capabilities and patent acquired: planning (ß = 0.331, *p*-value < 0.01), R&D (ß = 0.299, *p*-value < 0.01) and commercialization (ß = 0.363, *p*-value < 0.05), respectively. What it means is that their innovation capabilities also had a positive effect on their patent acquired.

Table 4. Panel regression results for sales growth (model 1) and patent (model 2).

Characteristic		**Model 1 (GRO)**	**Model 2 (PAT)**
Business planning capability	BPC	0.223 ** (0.053)	0.331 *** (0.027)
R&D capability	RDC	0.374 *** (0.048)	0.299 *** (00.039)
Commercialization capability	COC	0.223 *** (0.051)	0.363 ** (0.039)
Government policy and support	GOV	0.216 ** (0.257)	0.268 ** (0.195)
Type	TYP	0.212 * (0.237)	0.345 ** (0.189)
Company age	AGE	0.211 ** (0.022)	0.246 ** (0.118)
_con		8.231 ***	2.432 ***
R2 (within)		0.376	0.443
N		160	160

Note: standard errors are reported in brackets. GRO = growth in sales; PAT = patent acquired. ***, **, * represent the significance at the level of 1%, 5%, 10%, respectively.

4.2. Results of Moderating Effect Analysis

The current study also verified the hypothesis that government policy and support would play a moderating effect. Its moderating effect was tested by performing a regression analysis based on their innovation capabilities (planning, R&D and commercialization), the level of government technology support, interactive term (innovation capabilities x government support) and innovation performance. Tables 5–7 illustrate the results of testing Hypotheses 3 and 4. First, it was found in the analysis of the moderating effect that the interacting variable between innovation capabilities and government support had a statistically significant influence on sales (ß = 0.497, *p*-value < 0.01), and patent acquired (ß = 0.725, *p*-value < 0.01). Thus, it can be predicted that a greater planning capability with a high level of government support would help achieve a greater level of innovation performance (sales and patent). Thus, Hypothesis 3.1 and 4.1 were accepted.

Table 5. Panel regression results for sales growth (model 1) and patent (model 2).

Characteristic.		**Model 1 (GRO)**	**Model 2 (PAT)**
Business planning capability	BPC	0.261 *** (0.066)	0.495 *** (0.145)
Government support	GOV	0.474 *** (0.516)	0.785 *** (0.257)
Business planning x government support	BPCxGOV	0.497 *** (0.132)	0.725 *** (0.151)
Type	TYP	0.165 ** (0.021)	0.275 * (0.018)
Company age	AGE	0.022 ** (0.010)	0.041 ** (0.019)
_con		11.66 ***	1.686 **
R2 (within)		0.540	0.570
N		160	160

Note: standard errors are reported in brackets. GRO = growth in sales; PAT = patent acquired. ***, **, * represent the significance at the level of 1%, 5%, 10%, respectively.

Table 6. Panel regression results for sales growth (model 1) and patent (model 2).

Characteristic		Model 1 (GRO)	Model 2 (PAT)
R&D capability	RDC	0.261 *** (0.066)	0.495 *** (0.145)
Government support	GOV	0.474 *** (0.516)	0.785 *** (0.257)
R&D x government support	RDCxGOV	0.497 *** (0.132)	0.725 *** (0.151)
Type	TYP	0.165 ** (0.021)	0.275 * (0.018)
Company age	AGE	0.022 ** (0.010)	0.041 ** (0.019)
_con		11.66 ***	1.686 **
R2 (within)		0.540	0.570
N		160	160

Note: standard errors are reported in brackets. GRO = growth in sales; PAT = patent acquired. ***, **, * represent the significance at the level of 1%, 5%, 10%, respectively.

Table 7. Panel regression results for sales growth (model 1) and patent (model 2).

Characteristic		Model 1 (GRO)	Model 2 (PAT)
Commercialization capability	COC	0.261 *** (0.066)	0.495 *** (0.145)
Government support	GOV	0.474 *** (0.516)	0.785 *** (0.257)
Commercialization x government support	COCxGOV	0.497 *** (0.132)	0.725 *** (0.151)
Type	TYP	0.165 ** (0.021)	0.275 * (0.018)
Company age	AGE	0.022 ** (0.010)	0.041 ** (0.019)
_con		11.66 ***	1.686 **
R2 (within)		0.540	0.570
N		160	160

Note: standard errors are reported in brackets. GRO = growth in sales; PAT = patent acquired. ***, **, * represent the significance at the level of 1%, 5%, 10%, respectively.

Second, as for the moderating effect of government support, it was also found that interacting variables between smart farm venture companies' R&D innovation capability and government support had a positive effect on their business performance: sales (ß = 0.269, p-value < 0.05) and patent acquired (ß = 0.288, p-value < 0.01). That is, a greater level of R&D with a high level of government support would produce a greater level of business performance. Thus, Hypotheses 3.2 and 4.2 were also accepted.

Third, in the analysis of the moderating effect of government support on the relationship between commercialization innovation capability and business performance, it was also found that interacting variables between commercialization innovation capability and government support had a positive effect on their business performance: sales (ß = 0.173, p-value < 0.05) and patent acquired (ß = 0.173, p-value < 0.05). What it indicates is that a greater level of commercialization capability with a high level of government support would lead to a greater level of business performance. Thus, Hypotheses 3.3 and 4.3 were also accepted.

5. Discussion: Business Capabilities and Open Innovation

This study examines the interaction effect of innovation capabilities and government support on a firm's business performance for smart farm industries. However, it should be elaborated that the effect of technological innovation on firm value through interaction with governmental support may differ depending on types of innovation capabilities. Among these, innovation capabilities, especially business planning innovation and R&D innovation, have a significant effect on firm performance through interaction with governmental support because of the nature of its activities. Business planning innovation is an activity to prepare a firm's strategic plan to tackle various problems in a competitive environment to obtain advantages over other companies. To enhance business planning innovation, the company should establish solid processes internally with various resources and finance. Government support is beneficial to enhancing the interaction between companies' internal innovation capabilities and business performance. Thus, companies can significantly enhance the firm's value by increasing governmental support and their internal innovation capabilities.

The current research performed an empirical analysis to identify the effect of smar farm venture companies' innovation capabilities on their innovation performance and the moderating effect of government support. Based on some previous research, we categorized the capabilities into three areas: planning, R&D and commercialization. The importance of commercialization has recently been emphasized. In sum, all the three categories of innovation capabilities had a positive effect on innovation performance (sales) and patent acquired.

Theoretically, it is true that internal R&D capability is important for the development of a new product or service, but it should also be noted that planning before R&D and commercialization after R&D are very important as well. A regression analysis of the moderating effect of government support also found that it strengthened the effect of innovation capabilities on both sales and patent acquired. Innovation capabilities include introduction and operation of new technology and systems inside an organization [51].

Therefore, businesses should strengthen and enhance the level of internal innovation capabilities, actively approach government policy and support, and use these to enhance competitiveness and business performance including financial outcomes as practical implications. Moreover, small- and medium-sized companies should pay careful attention to the process of developing and acquiring patents. In making decisions in relation to innovation capabilities, businesses must consider the level of government policy and support for technology [52].

The results of the present study are in line with previous research: internal innovation capabilities and external support from government produce a synergy effect in enhancing innovation performance and business performance as well. In particular, the smart farm industry's heavy dependence on new technology, in comparison to other industries, has been very rapidly developing [53]. Companies in this industry are always in need of enhanced innovation capabilities and support/funding from outside. In order to overcome the difficulty of insufficient R&D resources and manpower, they should secure competitiveness by creating innovation capabilities and obtaining government support. In sum, their innovation capabilities and government support are found to be the two main keys to the success and growth of smart farm venture companies. On this basis, results for hypothesis of this research are illustrated in Table 8.

Table 8. Results for hypothesis testing.

Hypothesis	
H1. Innovation capabilities of smart farm venture companies have a positive effect on sales growth.	Accepted
H2. Innovation capabilities of smart farm venture companies have a positive effect on patents acquired.	Accepted
H3. Governmental technology policies and support have a positive Effect on smart farm venture companies' innovation capabilities and sales growth	Accepted
H4. Governmental technology policies and support have a positiveeffect on smart farm venture companies' innovation capabilities and patents acquired.	Accepted

6. Conclusions

Using the data from a group of 160 smart farm venture companies between 2016 and 2020, the present research conducted a regression analysis in order to identify the effect of their innovation capabilities on business performance and the moderating effect of government policy and support. The results can be summarized as in the following findings.

First, it was found that planning, R&D and commercialization capabilities exerted a positive influence on their sales, which might well signify their growth. Thus, in order to innovate technologically, smart farm venture companies must have internal innovation capabilities and external resources such as government technology policy and support. The three types of innovation capabilities—planning, R&D and commercialization—all had a positive impact on patent creation. Thus, it might be concluded that innovation capabilities contribute quantitative growth including productivity and sales, and qualitive growth such as patent creation as well. From a different angle, we safely conclude that innovation capabilities would lead to the growth of sales and acquisition of patents, and eventually play a crucial role in enhancing the value of businesses.

Second, it was found that the level of government policy and support had a moderating effect on business performance. Thus, such a finding should be used as meaningful base data in establishing business strategies. One significant meaning of the current study would be that it dealt with smart farm venture companies crucially based on new technology and conducted a regression and moderating analysis. In particular, how it departs from other previous studies is that the current research took smart farms such as smart greenhouses, smart orchards and smart cattle sheds, and discussed the relationship and correlation among their innovation capabilities, innovation performance and government support.

It should be noted, however, that the present research did not intend to prepare or suggest detailed strategies for their future growth, which might mean that further case studies are in order for that purpose. One additional remark we should make is that one could ask an interesting question of whether innovation capabilities play a different level of role depending on the size of companies. In other words, future studies might address the question of whether large companies differ from small- or medium-sized ones in any aspect of innovation capabilities.

Though we admit certain limitations in some respects, the current study might be meaningful in that it has shed light on the relationship between companies' innovation capabilities (planning, R&D, commercialization) and business performance, and the moderating effect of government policies and support. The current analysis can be used as base data for further studies in the future. Moreover, the results of this research are expected to make a contribution to helping smart farm venture companies perform their innovation activities.

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