



Research on the Growth Strategy of University Technology Holding Companies Based on Public Technology

Jeong-Keun YUN

COMPA, Expert Committee, Technology Commercialization Innovation Plan TF, Korea
E-mail: yunjk007@naver.com

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Abstract

Purpose – Although it has been 10 years since the university technology holding company was launched, it is currently facing operational limitations. The purpose of this study is to study the growth strategy of university technology holding companies by investigating the status and problems of university technology holding companies.

Research design, data, and methodology – In this study, the status of university technology holding companies was analyzed based on the survey data issued by the University Technology Holding Companies Association. Due to the lack of research on university technology holding companies, policy alternatives were suggested by examining problems based on literature research.

Result – In this study, an alternative to strengthening the competitiveness of technology holding companies and supporting policies was suggested. As a result of the research, it was discovered as a policy alternative to enhance the independence of technology-owned subsidiaries, develop outstanding talents, and expand the marketing of support programs to create results based on technology holding companies.

Conclusion – In previous studies, alternatives to technology commercialization policies have been suggested, but studies on the role and status of detailed technology holding companies are insufficient, and the operation system of technology holding companies and discovery of future growth models are insufficient compared to overseas cases. Therefore, in this study, various policy innovation measures are presented as examples.

Keywords: University Technology Holding Company, Technology Holding Company Subsidiary, Growth Model

JEL Classification Code: L10, M10, M30.

1. Introduction

Commercialization of public technology has the expandability of the business as excellent technologies from public research institutes are transferred to companies. In particular, since the aspect of increasing the usability of research results by transferring excellent university technologies to companies contributes to the development of the national economy and job creation, the spread of the achievements of technology holding companies plays a very important role as an axis of public technology commercialization do.

In the 2010s, domestic universities began to establish university technology holding companies in earnest by benchmarking the operating types of technology holding companies of excellent overseas universities. Technology holding companies are playing a big role in fostering and developing university subsidiaries by supporting the full cycle process of technology commercialization, not simply investing in university technology. In 2018, there were 66 domestic technology holding companies, and they are operated in two forms: a single type and an allied type. Commercialization of public technology is not easy to enter into the commercialization process on its own, so the role of the intermediate stage between technology and commercialization is of paramount importance. Technology startups require the role of incubation. In this respect, public technology needs various support capabilities such as discovery and expansion of technology, BM development, commercialization linkage support, and funding.

Technology holding companies need a sophisticated commercialization model in the commercialization stage, and it is of paramount importance to have a technology-based cooperative network through reinforcement of the technical capabilities of the business. Technology holding companies are playing a very important role in discovering growth engines for technology commercialization through support for startups for technology commercialization of public technologies. In particular, technology holding companies are playing an important role as a role of promoting technology commercialization by fostering startups through initial funding by establishing the function of an accelerator.

However, it is a reality that the operation of technology holding companies in recent years faces various limitations due to lack of investment funds and operating personnel. This is because, in the process of commercialization after technology transfer, the commercialization of public technologies is stagnant or difficult due to various issues. In addition, not only is there a practical lack of programs to support companies that have received investment from technology holding companies, but the system for fostering subsidiaries of technology holding companies is currently very insufficient.

The establishment of a technology holding company plays a very important role in the technology commercialization of a university, but the current level of performance creation of technology commercialization is insufficient in terms of actual performance creation, and various policy alternatives to improve the performance of technology holding companies in the future are available. It needs to be presented.

Therefore, this study analyzes the current status of technology holding companies and presents the problem of presenting policy alternatives for technology commercialization growth of technology holding companies. Technology holding companies play an important role in the technology commercialization aspect of public technology, and can be said to be the coordinator of technology commercialization. However, in reality, technology holding companies are experiencing many difficulties due to the limitations of operating funds and manpower, lack of support programs, and a lack of an investment ecosystem for commercialization of public technologies. We believe that it is urgent to prepare a policy to overcome this problem and enable technology holding companies to have competitiveness in commercializing public technology.

Technology holding companies urgently need a plan to settle down as a technology commercialization model that commercializes university technology. Currently, technology holding companies are facing operational limitations such as differences in technology commercialization capabilities between universities, differences in technology levels, shortage of manpower, and dependence on government support projects.

Therefore, this study aims to investigate the current status and problems of public technology holdings, and to prepare policy alternatives for technology holding growth strategies to spread public technology.

2. Literature Research

Lee. et al (2016) studied the successful operation model of a holding company through venture capital cases, and presented the importance of successful model operation for realizing monetization. Do and Um (2013) presents policy implications in three aspects: expanding the foundation for university technology commercialization, improving the legal and institutional support system, expanding the organization's excellent manpower and securing accountability

through research on the operation status and improvement directions of technology holding companies. I did. Lee (2017) presented the justification of an integrated organization in the organizational structure of a technology holding company, and stated that the technology transfer revenue excluding the amount of intellectual property rights and the inventor's compensation is at the level of 24% of the technology commercialization cost.

Sin and Sang (2014) proposed a method for improving the system of technology holding companies in terms of distribution of performance of technology holding companies. In the review of previous studies, the issue of integrated operation between the technology holding company and the industrial complex has been raised in the operational aspect of the technology holding company, and it is judged that support for the performance management of the technology holding company is necessary in terms of profit distribution. Therefore, in this thesis, we propose a model for the growth strategy of technology holding companies and prepare various policy alternatives for rationalization of the performance of technology holding companies.

Table 1: Related Literature Research

Researcher	Contents
Do & Um (2013)	A Study on the Improvement of Industry-Academia Technology Holding Company
Sin & Sang (2014)	Review to Improvement of Profit Sharing System in Technology Holding Company Based on Industry- Academia-Research Cooperation
Lee, et al (2016)	A Proposal on the Business Model of Technology Holding Company Focused on the Case Study of Venture Capital in Korea
Lee (2017)	Technology commercialization governance of universities - Focused on TLO and technology holding company

2.1. Definition of Technology Holding Company

The Korea Technology Holding Company Association defines two types of technology holding companies. First, in the case of controlling the company by owning the stock of another company for the purpose of commercialization of technology owned by industry-academic cooperation foundations or research institutions, secondly, establishing a new company by investing technology of patents held by universities or research institutions. It is defined as a specialized company that establishes a joint venture corporation and takes over an existing stake to commercialize it. In addition, a technology holding company is defined as the aspect of participating as a shareholder by obtaining a 20% stake by investing in spot or cash to operate a subsidiary.

According to the Ministry of Education (2017), the definition of industry-academic cooperation technology holdings is defined as a specialized organization that establishes subsidiaries by investing technology possessed by universities. Subsidiary refers to a company that controls its business in the technology base of universities and research institutes. It is defined that a technology holding company must obtain a permission for establishment from the Minister of Education, invest technology in kind in excess of 30/100 of the capital, and hold the total number of issued stocks in excess of 50/100.

In the case of a holding company, at least half of the shares must be secured by the university, and in the case of subsidiaries, it is sufficient to secure at least 20% of the shares with voting rights (Cho, 2011). In Korea, Hanyang University Technology Holding Company was first established in 2008, and 48 technology holding companies are operating as of the end of 2016.

2.2. Technology Holding Company Status

In the late 2000s, when the establishment of a technology holding company began in earnest, public technology commercialization performance was weak compared to R&D research results. In the process, technology holding companies of leading overseas universities were very much interested in domestic technology holding companies because they had high profit generation and competitiveness. However, if you evaluate the current technology holding company, the reality is that the results of technology start-up obtained through the establishment of technology holding

company are not higher than expected. Although a program for the establishment of a technology holding company has been introduced, there has been no change in the practical business structure and technology investment method of companies.

As a result, although the system of technology holding companies has been introduced, the actual operational system and the technology commercialization ecosystem of public technologies remain unchanged, and the competitiveness of technology holding companies has declined.

<Table 2> below is a chart showing the establishment status of technology holding companies and subsidiaries by year. As of 2016, 48 technology holding companies were established, and 158 subsidiaries were established. The average number of subsidiaries per technology holding company increased steadily, reaching 8.9 in 2016. The trend of increasing establishment of technology holding companies is to accelerate the spread of public research results by strengthening the technology commercialization capabilities of universities and research institutes, and spreading laboratory startups.

Table 2: Establishment of Technology Holding Companies and Subsidiaries by Year (Unit: Number)

Division	2008	2009	2010	2011	2012	2013	2014	2015	2016
Technology holding	2	6	5	3	7	5	7	1	12
Accumulate	2	8	13	16	23	28	35	36	48
Subsidiary company	2	15	28	31	43	24	58	73	158
Accumulate	2	17	43	74	117	141	197	270	428
Average number of subsidiaries per one technology holding company	1.0	2.1	3.3	4.6	5.1	5.0	5.6	7.5	8.9

Source: Ministry of Education (2017). 2008-2016, Research Report on the Operation Status of Industry-Academia-Research Technology Holding Companies.

Technology holding companies and subsidiaries are on the rise, but in reality, many point out that the establishment of technology holding companies lacks a role as a medium to promote the spread of public technologies and commercialization of superior technologies. Against this background, there is a trend of increasing number of technology holding companies in terms of quantity in terms of revitalization of public technology, but there is a lot of lack of practical performance spread. In particular, there is a need to strengthen the connection in terms of growth through the increase of subsidiaries in terms of technology commercialization.

<Table 3> below is a chart that summarizes the status of revenue generation by technology holding companies by year. In reality, it is necessary to increase the dividend income and technology transfer effects of subsidiaries because the proportion of government-led support for national projects is the highest. The need for government support projects is high, but monetization through equity sale or technology transfer is not high, so a plan for continuous self-sufficiency and capacity enhancement of technology holding companies is essential.

Table 3: Technology Holding Company Profit Creation Status by Year (Unit: KRW million)

Year	Subsidiary company Dividend income	Dividend income from investment association	Sale of shares	Technology transfer	service (consulting)	Etc (fees)	National project (Government project cost)
2008				2,091			
2009					14	2	
2010			1,121	664	132	5	2,614

2011	144		2,246	32	57	48	3,140
2012	198		950	1,852	580	35	4,436
2013	104	6	389	43	888	73	2,589
2014	180		1,064	364	1,220	310	3,141
2015	146	201	4,099	1,709	1,140	386	5,901
2016	115	501	5,181	648	1,798	2,000	6,697
Total	888	707	15,050	7,402	5,829	2,859	28,519

Source: Ministry of Education (2017). 2008-2016, Research Report on the Operation Status of Industry-Academia-Research Technology Holding Companies.

According to data from the Ministry of Education (2017), the cumulative average capital of technology holding companies at the end of 2016 was 1.34 billion won in cash and 1.3 billion won in spot, totaling 2.65 billion won. The average established capital of a technology holding company is 500 million won in cash and 740 million won in spot, with a cumulative capital of 64.5 billion won and 66.2 billion won in spot. In particular, the capital of 13 newly established technology holding companies (2015-2016) was 260 million won, which is very insufficient for technology commercialization activities. The size of such capital is difficult to play the original role of a technology holding company, and there are many restrictions in terms of investment activities and discovering excellent technologies.

In particular, even if the founding capital is less than 100 million won, there are three places, so in reality, efforts to increase the capital of technology holding companies are needed above all else. When looking at the mode of operation of technology holding companies, most of them operate technology holding companies in terms of in-kind investment rather than investing in cash. As of the end of 2016, the cumulative sales of technology holding companies amounted to 64.7 billion won, and the return on investment to the subsidiary's investment is increasing to 26%.

According to a survey conducted by the Ministry of Education (2016), out of 426 subsidiaries, the total sales of subsidiaries based on 357 were KRW 163.3 billion, and the average sales was KRW 460 million. In terms of employment performance, a total of 1,648 employees were employed by 357 companies, indicating that the technology holding company had an average of 2.9 employees.

<Table 4> below is a chart showing the use of technology holding company investment associations. Technology holding companies form investment associations and use them to foster subsidiaries and discover superior technologies. However, most technology holding companies have many limitations to have a monetization model, and it is expected that a plan for securing investment funds will be required.

Table 4: Technology Holding Company Investment Association Usage Status (Unit: KRW million)

Division	Company Name	Name of investment association	Investment Price	Total Amount
Invest Combination Formation (LP)	Korea University Technology Holding Company	IDV-U Tech Innovation Investment Association	200	10,000
	Pohang University of Technology Technology Holdings		200	
	Sejong University Technology Holdings		210	
	Hanyang University Technology Holdings		200	
	Gangwon Regional University Union Technology Holding Company		100	
	Yonsei University Technology Holdings		200	
	Korea University Technology Holding Company	KU-DSC Dream 1st Investment Association	500	10,000

	Yonsei University Technology Holdings	Uni One Creative Enterprise Investment Association	300	7,200
Invest Combination operation (GP)	Busan Regional University Alliance Technology Holding Company	Busan Federation No. 1 Private Investment Association	600	5,200
	Yonsei University Technology Holdings	Yonsei University Technology Holdings Company Engineering College Investment Association No. 1	6	106
Total			2,516	32,506

Source: Ministry of Education (2017). 2008-2016, Research Report on the Operation Status of Industry-Academia-Research Technology Holding Companies

2.3. Technology Holding Company Subsidiary Status

Technology holding companies had an average of 9 subsidiaries accumulated in 2016, and the holding company with the largest number of subsidiaries was the Daekyung University Joint Technology Holding Company, which had 42 companies. In particular, out of 426 subsidiaries as of the end of 2016, 194 registered subsidiaries of research institutes were registered at 45.4%. It can be seen that university technology holding companies are actively supporting the establishment of research institutes. In particular, in the case of Daekyung Regional University Joint Technology Holdings, all 42 companies are registered as research institutes, and it can be seen that research institutes are actively using them to support the growth of subsidiaries. According to the survey, in the case of 9 technology holding companies, all subsidiaries were registered as research firms.

<Table 5> below is a chart showing the comparison of management performance between subsidiaries of technology holding companies and venture companies. Compared to venture companies, technology holding companies' sales were 3.6 times higher. However, it can be seen that net profit increased 11.1% for venture companies, while -31.8% for technology holding subsidiaries. As sales increase but net profit decreases, this translates into a decrease in the competitiveness of subsidiaries.

Table 5: Comparison of management performance between subsidiaries of technology holding companies and venture companies (Unit: KRW million)

Division		Venture business		Technology holding company subsidiary	
		2014	2015	2014	2015
take	Total amount	198,822,456	215,908,755	92,818	121,082
	Increase rate (%)	8.6		30.5	
net profit	Total amount	6,255,042	6,950,418	-11,270	-7,683
	Increase rate (%)	11.1		-31.8	

Source: Ministry of Education (2017). 2008-2016, Research Report on the Operation Status of Industry-Academia-Research Technology Holding Companies.

<Table 6> below is a chart showing the number of employees of technology holding companies. Looking at the table, the number of dedicated personnel increased to 197% in 2016 compared to the 2010s due to accumulation. However, it can be seen that the average number of dedicated employees for technology holding companies is 2.9, which is not significantly different from year to year. As such, it is a reality that 2.9 employees in charge of technology holding companies have no choice but to perform limited work areas.

Table 6: Number of Technology Holding Company Employees (Unit: Person)

Division	2010	2011	2012	2013	2014	2015	2016
Number of dedicated personnel	47	55	56	77	84	103	140
Cumulative number of technology holding companies established	13	16	23	28	35	36	48
Average number of employees in charge of technology holding companies	3.6	3.4	2.4	2.8	2.4	2.9	2.9

Source: Ministry of Education (2017). 2008-2016, Research Report on the Operation Status of Industry-Academia-Research Technology Holding Companies.

<Table 7> is a chart that summarizes the number of years of service for technology holding companies and technology holding companies. Employees with less than 3 years of service account for 68%, which is very short.

Table 7: Number of Years of Service for Technology Holding Company Employees (Unit: Persons, %)

Years of service	Less than 3 years	3 years or more Less than 6 years	7 years or more Less than 9 years	Over 9 years
Based on 48 responding technology holding companies	96	34	2	8
ratio	68.57%	24.29%	1.43%	5.71%

Source: Ministry of Education (2017). 2008-2016, Research Report on the Operation Status of Industry-Academia-Research Technology Holding Companies.

<Table 8> below is a chart showing the average workforce of technology holding companies. Although the establishment of new technology holding companies is increasing, the number of professional manpower is gradually decreasing, and this aspect can be seen as an obstacle to technology commercialization. The lack of professional manpower of technology holding companies is considered to be a very difficult situation to carry out additional work while the technology holding company is currently in position.

Table 8: Technology Holding Company's Dedicated Manpower Status

Division	Year 2015	Year 2016	Year 2017
Number of dedicated personnel	103	139	148
Cumulative number of technology holding companies established	36	48	58
Average number of dedicated personnel	2.9	2.9	2.6

Source: NRF (2018). Industry-University Cooperation Technology Holdings Operation Status Report.

<Table 9> below is a chart showing the amount of investments to subsidiaries and the amount of investments recovered from subsidiaries. The cumulative investment recovery rate of technology holding companies is 15.9 billion won, and 5.2 billion won was recovered as of 2016. In 2016, the technology holding company's cash contribution amounted to 4.3 billion won, and it is a reality that the share of cash contributions cannot increase. However, in the case of 2015 and 2016, the recovery rate increased significantly and remained at 50% level.

Table 9: 2008-2016 Technology Holding Company Investments and Subsidiary Investments to Subsidiaries
(Unit: KRW million)

Year	Technology Holding Company → Subsidiary Investment			Subsidiary Investment Recovery Amount			Recovery Rate (%) (B/A)
	Cash Investment	Cash Investment	Sum (A)	Allocation Revenue	Share For Sale	Sum (B)	
2009	3,298	2,133	5,431	-	-	-	0%
2010	1,377	3,509	4,886	-	1,121	1,121	22.9%
2011	2,345	8,587	10,932	144	2,246	2,390	21.9%
2012	3,600	3,227	6,827	198	950	1,148	16.8%
2013	2,010	2,277	4,287	104	389	493	11.5%
2014	1,830	8,998	10,827	180	1,064	1,244	11.5%
2015	2,613	4,894	7,507	146	4,099	4,245	56.5%
2016	6,312	4,301	10,613	115	5,181	5,295	49.9%
Sum	23,384	37,926	61,310	888	15,050	15,937	26.0%

Source: Ministry of Education (2017). 2008-2016, Research Report on the Operation Status of Industry-Academia-Research Technology Holding Companies.

<Table 10> below is a chart that summarizes the current status of subsidiaries attracting external investment. Of the total 426 subsidiaries in 2016, 69 companies attracted investment, accounting for 16%. This level of investment is much higher than that of a general venture company, and it can be viewed as a stage of expanding investment.

Table 10: Status of External Investment Attraction of Subsidiaries (Unit: Case, KRW million)

Year	Angel investor Investment attraction		Investment and loan institutions Investment attraction		Attracting investment from public (bank) institutions		Private Institution (CVC) Investment attraction		Sum	
	Number of cases	Price	Number of cases	Price	Number of cases	Price	Number of cases	Price	Number of cases	Price
2008	0	0	0	0	1	800	1	1,000	2	1,800
2009	2	30	0	0	0	0	0	0	2	30
2010	5	155	2	600	0	0	3	2,950	10	3,705
2011	1	100	2	1,000	1	200	0	0	4	1,300
2012	5	145	12	8,046	1	2,998	4	1,920	22	13,109
2013	11	703	7	2,555	0	0	6	3,719	24	6,977
2014	11	1,532	8	4,660	2	370	4	1,095	25	7,657
2015	14	4,283	8	1,900	1	500	7	1,407	30	8,090
2016	22	1,609	17	18,351	7	1,590	16	9,708	62	31,258
Total	71	8,557	56	37,112	13	6,458	41	21,799	181	73,927

Source: Ministry of Education (2017). 2008-2016, Research Report on the Operation Status of Industry-Academia-Research Technology Holding Companies.

3. Problems of Operating Technology Holding Companies

Currently, the capital size of university technology holding companies remains at a small level. In order to establish a technology holding company, it is established through a spot or cash investment method, but most are operated by a spot investment method of technology. However, since securing cash is of paramount importance in order to operate normally, it is realistically necessary to cover operating expenses after the establishment of a technology holding company. Accordingly, the investment of cash by a technology holding company will improve the operating conditions of the technology holding subsidiary and lay the foundation for growth.

However, in a situation where cash capital is insufficient, technology holding companies are faced with a difficult situation in reality in a structure that is established without corporate participation. The biggest obstacle for technology holding companies is that there is a lack of personnel to systematically support the development of subsidiaries, and it is not easy to secure excellent technical resources because the investment funds are not out of reach. As technology holding companies focus on establishment first, they own a stake in a subsidiary, but are not able to attract follow-up investment, which is a limitation in growth.

3.1. Lack of Operating Funds for Technology Holding Companies

Most technology holding companies are operated with in-kind capital. Due to the lack of cash capital, there are many very difficult parts in terms of supporting investment and profit activities.

<Table 11> below shows the average capital stock of technology holding companies by year. In cash, the survey was estimated at 260 million won from 2015 to 2016, but the reality is that it is difficult to say that it is a level that can be invested in cash by technology holding companies. At present, it is inevitable that it will come to a limit to play the role of a university technology holding company at a poor level of capital.

Table 11: Average Capital Stock of Technology Holding Companies by Year (Unit: KRW 100 million)

Division		2008~2009	2010~2012	2013~2014	2015~2016
Number of Technology Holding Companies		8	15	12	13
Average Capital	Cash	12.2	5.0	2.8	2.6
	Non-cash items	19.6	7.8	4.8	1.9
	Sum	31.8	12.8	7.6	4.5

Source: Ministry of Education (2017). 2008-2016, Research Report on the Operation Status of Industry-Academia-Research Technology Holding Companies.

In particular, the capital stock of technology holding companies is becoming a serious problem in terms of decreasing gradually. On average, the lowering of the establishment capital is because the operation of an unstable organization that does not adequately provide the personnel expenses of employees exposes many limitations in operation.

The technology holding company's capital stock must be systematically stabilized so that the management personnel of the technology holding company can conduct management activities through stable investment activities. In reality, there is a difficulty in securing subsidiaries as it is not able to come up with a way to generate profits in terms of not securing the capital of technology holding companies.

3.2. Technical Holding Company Operation Problems

Most of the technology holding companies are operated with 100% stake in the industrial complex. Accordingly, there are many cases where the operating personnel of the industrial complex exist in the form of overlapping between the technical holding personnel and the head of the operating industrial complex is operated in the form of concurrently serving as the representative of the holding company. This aspect reflects the reality that it is difficult to operate independently of the rationality of management and the operating structure.

In Korea, university-centered technology holding companies are mostly operated under the Industrial Promotion Act, but there are operational limitations because the scale of capital is very small. Accordingly, the role of public

technology holding companies is being strengthened, and technology holding companies in the form of new technology start-up companies have a high level of capital and are capable of independent investment activities.

Having a management form of a technology holding company is very important in terms of technology commercialization, and differentiating each technology commercialization among various types has become the core of commercialization.

Competitiveness of entrepreneurship is a very important factor in expanding the growth path of start-up companies (Yoon & Lee, 2017).

<Table 12> is a chart that summarizes the current status of public technology holding companies. Public technology holding companies have three holding companies in Korea, and it can be seen that the scale of capital is higher than that of general university technology holding companies. In reality, university technology holdings have limitations in the aspect of fostering investment by discovering companies with excellent technology because their capital is small in reality.

Therefore, in the case of public technology holding companies, the role of public technology commercialization is being emphasized because the scale of capital is far higher than that of university technology holding companies. The competitiveness of university technology holding companies requires the role of an accelerator to foster and discover excellent companies along with capital that can be invested. Public technology holding companies have many opportunities to discover excellent technologies through a strategic approach, so they have the advantage of maximizing the capabilities of excellent technology commercialization if funding and manpower management are supported.

However, since the financial situation of the university is not good, there are many limitations in continuously expanding capital increase. Accordingly, the university is approaching the aspect of establishing a technology holding subsidiary through a partnership with a technology transfer company.

Table 12: Status of Public Technology Holding Companies

Division	Founding capital	Date of establishment	Shareholder	Purpose of establishment
Korea Science and Technology Holdings	KRW 52.4 billion	2013.11	17 appearances (annual)	Investment in establishing a subsidiary to commercialize technology based on donated (annual) public technology
Future Science and Technology Holdings	12 billion won	2014.03	4 specialized universities	Investment in establishing a subsidiary using 4 technology and technology
Etri Holdings	20 billion won	2010.05	Electronics and Telecommunications Research Institute	Technology commercialization of Korea Electronics and Telecommunications Research Institute

Source: Created by the author through the homepage.

3.3. Lack of Support Projects from University Technology Holding Companies

Currently, among the government-sponsored projects of university technology holding companies, the TMC (Technology Management Center) business exists as a business related to startups. The TMC business can be seen as a virtual organization that establishes a linkage system between university TLO and technology holding companies. In the case of universities, it is difficult to establish a cooperative system to carry out technology commercialization because the capabilities of technology commercialization are distributed among industrial complexes and technology holdings.

Currently, universities are operating an organization that operates technology commercialization by establishing a system that separates industrial complexes from technology holdings. TMC operates in the form of a technology transfer organization, technology investment, and technology holdings, and is establishing a commercialization process in connection with the technology transfer system. Most technology holding companies register with research

institute companies to secure R&D funds. Fostering research firms has the advantage of being able to receive R&D funding when university technology holding companies, public research institutes, or new technology startup companies that have a 20% stake in them apply for research firms.

Most of the subsidiaries of technology holding companies are receiving growth support by applying to research institutes. However, even if a research institute company is registered, it is a reality that the accelerator function at the level that can actually support the growth of the company is insufficient. University technology holding companies actually do not have any other support system other than research institute companies, so when they graduate from research institute companies, there are many limitations due to difficulties in funding and lack of support projects.

Securing R&D expenses is also important, but in reality there is a lack of various start-up design programs such as investment support and IR support for subsidiaries of university technology holding companies. Research institute companies are supported for R&D, so even though the founder wants to receive a support system for commercialization, there are many limitations in the structure that competes with the private ecosystem.

Accordingly, although private programs are actively used, the level of commercialization of the technology is still low, so it is bound to act as a limitation to increase the effect of actual profit generation.

In order to build competitiveness, it is necessary to develop various platform strategies, and in reality, a competitive model for technology holding companies must be developed.

4. Technology Holding Company Policy Development

4.1. Accelerator and Cooperation Model Development

Most of the domestic technology holding companies are owned by the industry-academic cooperation group and are participating as the main body of operation. The industry-academic cooperation group usually operates in three forms: a technology transfer organization (TLO), an incubation center, and a technology holding company. Technology holding companies are affiliated with the operating organization of the Industry-Academic Cooperation Foundation, and are operated by owning a stake by investing in spot when transferring technology to a company to foster subsidiaries.

Entrepreneurship in the distribution and service sectors linked to technology commercialization acts as a competitive edge because it helps a lot in marketing activities (Suh & Yoon, 2017).

Technology holding companies should be nurtured into specialized organizations with expandability in management focusing on implementing the functions of accelerators and supporting the growth of subsidiaries, but in reality, there are many cases that do not have any distinction from the work performed by technology transfer organizations.

Understanding the industrial structure and technology is very important, and it acts as an important factor in the growth of a company from a commercialization perspective (Han, S. S., 2016).

Although it is necessary to establish a cooperative relationship between the technology holding company and the technology transfer organization, in reality, they are performing the same or similar technology transfer work. Accordingly, technology holding companies that consider integrated operation between university TLO organizations and technology holding companies are increasing in order to strengthen their organizational power. Although technology holding companies establish subsidiaries through technology transfer, there are many limitations in promoting effective public technology commercialization because universities are in charge of the same area. Public technology holding companies need to present various differentiated business models, and in order to expand the current public technology to the base, it is essential to develop a differentiated business model.

Cooperation between universities and companies is helpful to start-up companies and acts as a reinforcing factor in the competitiveness of technology commercialization (Han & Yim, 2018).

The current technology holding company's commercialization model is concentrated on research institute companies. Currently, technology holding companies have more than 40% of research firms, and they often receive investment from technology holding companies aiming at research firms. However, research institute companies are a process of technology commercialization, and a variety of technology commercialization growth promotion models are needed to achieve results. Most accelerators are expanding advance technology transactions through cooperation with researchers to secure initial technology. As technology holding companies lack a system to foster subsidiaries on the basis of accelerators, maintaining a cooperative relationship with the accelerator would be one way for technology holding companies.

Establishing a startup strategy for a young company can have very important consequences for a company to grow (Kwang et al., 2014).

A platform strategy is needed to realize joint investment through a cooperative network between technology holding companies and accelerators, or jointly foster subsidiaries of technology holding companies. In order to form the basis for such joint investment, a problem arises about the establishment of research and development companies along with structural negotiations on the ownership ratio. Therefore, various methods of cooperative agreement are required for R&D projects.

Since the TIPS program is used for R&D projects based on accelerators, it is expected that various R&D projects will be additionally needed on the basis of technology holdings. The strategy of fostering subsidiaries by sharing functions between technology holding companies and accelerators is very important. This is because it can be nurtured as a competitive company only by continuously leading the growth support of its subsidiaries. Although there are many limitations on the operating manpower of technology holding companies, it seems necessary to develop a commercialization model that prepares a nurturing strategy through cooperative investment between accelerators through spot investment in technology transfer.

In the process of launching new products, companies may experience failures, but they are an important innovation process because they present new growth to companies (Moreau et al., 2001). Since technology holding companies play a very important role in the aspect of commercialization of technology, a large portion of policy support should be provided to support startup design of early companies.

4.2. Build a Platform Business Model in Connection with Support Organizations

It is difficult for a technology holding company to discover superior technologies and systematically establish support for the growth of its subsidiaries through investment. In particular, for the ability to discover superior technologies, there are many cases where investment target companies cannot easily enter due to lack of human resources and lack of investment capital. Therefore, it is realistically necessary to establish a cooperation system with technology holding companies through the technology platform established by the Science and Technology Job Promotion Agency.

Currently, the Institute of Science and Technology Jobs is a support organization that supports public research results and is promoting public technology commercialization through technical consulting to discover various excellent technologies. Therefore, the Institute of Science and Technology Jobs should discover excellent technologies early and establish a turning point that is linked to technology investment, and become a public technology commercialization that contributes to job creation.

As the capacity gap in technology commercialization between universities is deepening, customized technology commercialization support is needed. Currently, COMPA operates various cooperation programs to build the competitiveness of university technology holdings. As a university management promotion project, it operates a startup support platform and operates various commercialization promotion programs.

It is to establish a public technology commercialization process in which the Science and Technology Job Promotion Agency is in charge of the discovery of public technology to technology transfer, and the technology holding company operates the subsequent technology investment and growth support stages. In order to create the results of public technology commercialization, competency must be gathered from the perspective of commercialization of superior technology through technology discovery and technology marketing. With the establishment of a government-led support agency platform, technology holding companies need a process that allows them to transfer superior technologies and connect them to startups.

Therefore, in this study, the role of the support organization is considered very important. Supporting institutions have an overall pool of public technologies and maintain a cooperative relationship by meeting excellent researchers directly, so they have the advantage of promoting excellent technologies or introducing them to demanding companies through the platform. It is expected that the capabilities of technology holding companies will improve if the support organization's platform system for superior technology is considered and the part that can provide support to demanding companies or entrepreneurs is considered.

Useful information that customers seek lowers uncertainty, so the likelihood of using the information to make a good purchase increases (Steffes & Burgee, 2009). Information becomes a tool for commercialization with excellent capabilities for purchasing customers. Therefore, the use of a platform of technology information for technology commercialization will be an opportunity to enhance the capabilities of technology startups.

4.3. Support for fund operation exclusively for technology holding companies

As technology holding companies lack investments in establishment, there is a constant need for a dedicated fund to revitalize the holding company. Since technology holding companies are established in the form of spot investment

of technology, investment in terms of the operating capital of the company must be activated. From this point of view, it is necessary to establish a university start-up fund to spread start-up companies and establish a monetization model. In terms of commercializing public technology, the role of establishing an initial company is very important, and initial funding investment is required to support the establishment and growth in this side.

The establishment of a dedicated fund for a technology holding company not only becomes a support tool that can support growth for early companies in terms of public technology commercialization, but it can also build competitiveness in terms of fund recovery.

<Table 13> below is a chart showing the status of revenue generation for technology holding companies. As shown below, technology holding companies are generating profits through business as the proportion of government projects increases. Since operating as a government-sponsored project has obvious limitations, the holding company must grow with a structure that generates funds or other investment returns. This dependence of the holding company on the government is an important part to be improved because it represents a very difficult operational structure in the process of commercialization.

Table 13: Technology Holding Company Revenue Generation Status

Year	Division	Dividend income from subsidiaries	Investment association Dividend income	Sale of shares	Technology transfer	Services and other fees	National project (Government project cost)	Sum
2015	cash	146.3	200.5	4,098	1,708	385.7	5,901	12,441
	ratio	1.2%	1.6%	32.9%	13.7%	3.1%	47.4%	100%
2016	cash	115.4	500.5	5,180	647	1,999	6,697	15,141
	ratio	0.8%	3.3%	34.2%	4.3%	13.2%	44.2%	100%
2017	cash	228	167	4,362	771	1,876	10,116	17,522
	ratio	0.3%	0.3%	9.0%	4.8%	21.5%	64.1%	100%

Source: NRF(2018). Industry-University Cooperation Technology Holdings Operation Status Report.

The aspect of spreading the use of public research results is becoming an important factor in raising the results from the viewpoint of practical use of technology (Bak & Jeong, 2015).

The technology holding company is operated as a subsidiary that owns shares in the form of in-kind investment, with a very low proportion of average cash capital, and needs initial cash funding.

The establishment of a dedicated fund to secure the operating competitiveness of domestic university technology holding companies will be an opportunity to increase the capital of university technology holding companies and to commercialize superior technologies early. The most difficult thing early start-ups experience is that they miss the opportunity for commercialization due to lack of initial funding, and the initial support for the self-sustaining commercialization of universities is urgent.

4.4. Discovery of Support Projects for Fostering Technology Holding Subsidiaries

In 2018, the number of subsidiaries of technology holding companies is estimated to be about 600, and the number of subsidiaries of technology holding companies is on an increasing trend. However, as subsidiaries of technology holdings are often established for the purpose of technology transfer during the establishment process, there is a lack of ways to derive competitiveness after establishment.

It can be said that the process of actively exchanging opinions and consensus among consumers helps consumers overcome the qualitative limit of the empirical dimension that they could directly evaluate after purchasing and using a product or service (Han, 2018)

Technology holding companies have invested in subsidiaries, but have not established a substantial subsidiary fostering program. Since the growth support system for subsidiaries has not been systematically established, activities such as investment attraction, marketing, and support are inevitably weak. Accordingly, government support projects from the side of subsidiaries of technology holding companies are needed. There is a realistic need for a government-supported project that can establish a R&D project and a growth support system, and investment cooperation of the holding company should be achieved through the connection to these projects.

In reality, the current technology holding companies play a very important role from the viewpoint of discovering the support business of subsidiaries. The business of fostering technology holding companies is approached from the aspect that subsidiaries can solve the difficulties caused by insufficient funding, and it is necessary to expand the non-R&D field to enhance the competitiveness of the business in the support business that focuses on R&D.

5. Conclusion

In order to commercialize technology in universities, it is necessary to develop strategies for the spread of technology transfer channels and start-ups through various channels using public technology and support companies to participate. Since there are many aspects of university technology holdings that cannot be self-reliant, various policy support will inevitably be needed to create synergy between universities or to leap into a specialized institution for commercialization of technology within universities.

The commercialization of university technology has been geared to the aspect of supporting establishment by utilizing only foreign cases, but it is more important than anything else to build competitiveness to build self-sustainability through profits.

In this research paper, by examining the problems of university technology holdings, various alternatives were suggested in terms of the most needed by university technology holdings in promoting technology commercialization. Universities pursuing the role of facilitator of technology commercialization have various stakeholders, and innovative ideas for technology commercialization must be created in a variety of markets. In the technology market, there must be a market that can create self-sustaining ideas and usable products that can be competitive.

Public technology is often approached in markets where the market is unexplored or unavailable. In such a market, even if a product is released early, if it does not have the innovativeness of investment and technology commercialization, in reality, commercialization will be limited.

The level of technology commercialization of technology holding companies varies from university to university. These differences in technology commercialization capabilities need to be supported by a differentiated support policy of government support projects, and a program to strengthen the university's own capabilities is required. The limitation of this study is that each university needs to establish a differentiated technology holding company growth model, and it is most important to establish a commercialization strategy according to the level and capability of possessed technologies. The limitations of this study are that the characteristics of each university, the maturity of technology, and willingness to commercialize are different, so the consistency of policy seems to be insufficient and there is a limitation in grasping the systematic level.

For the growth of a technology holding company, rather than looking at overseas cases and discovering the same strategic model, it is more important than anything else to clearly understand the implications, current status of domestic universities, and obstacles to technology commercialization, and to increase the university's own technology commercialization capabilities. something to do. In particular, differentiated policies should be introduced by distinguishing groups that produce excellent results by presenting various policies such as government support projects, fund operation, and growth support, and groups that desperately need support.

The academic implication of this paper is that there are few research topics on public technology holding companies, and through this study, we believe that analysis and research on the performance factors of technology holding companies can be actively developed in the future. As policy implications, it is expected that institutional supplementation tailored to the areas needed in the commercialization support of university technology holdings will be established, and various implications are presented in the government support system and operation policies that have not been studied before.

In this respect, it is very important to propose alternatives for innovative growth of university technology holdings, and it should be supported to establish a systematic model for technological commercialization and to increase the capabilities of technical commercialization technologies.

Improving the innovative results of technology commercialization and establishing a commercialization model is expected to be a competitive edge that can overcome the crisis facing universities.

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