

A Study on Appropriability Mechanism of Korean ICT Industry

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Abstract

Background/Objectives: The purpose of this study aimed to understand the appropriability mechanism using companies in South Korea.

Methods/Statistical analysis: This study used the Delphi method among various analysis techniques. Among the Delphi methods, this study analyzed data by using the ranking-type Delphi method. In addition, we will analyze the research trend of Appropriability Mechanism through LDA analysis.

Findings: The analysis results of the derived eight factors are as follows. The lead-time advantage, the patent, and the secrecy were ranked in first, second, and third places, respectively. The importance appeared in the order of the complexity of design, design registered, learning curve effects, complementary sales/service, and complementary manufacturing. In addition, LDA results of priority analysis showed that innovation was the most important factor and most researchers consider patents the most important.

Improvements/Applications: The results of this study can be used as a guideline at the working-level when establishing policies and strategies for appropriability mechanisms in companies. It is expected that the results of this study would be helpful to hands-on staff in the field.

Keywords: Appropriability, Appropriability Mechanism, Patent, Secrecy, LDA

1. Introduction

Owing to the advancement and spread of digital technology, the era of digital transformation, changing the entire digital-based business regardless of industry sectors, has

arrived. In the era of digital transformation, a variety of products and services can be developed using DNA-based technologies and businesses will be developed by using them[1-3]. Companies in the past created new business sectors by developing creative technologies. However, the era of the Fourth Industrial Revolution has been changing the world by creating new businesses through converging with various technologies of adjacent fields, not with a specific technology.

COVID-19, which began in 2020, has changed our daily lives greatly as well. Activities that used to be conducted offline are carried out online, consumption habits have been changed, and working from home has become common. All these changes move to untact. Many industries have been affected. The COVID-19 pandemic has resulted in a global economic slump until now. Of course, certain industries, such as semiconductors, automobiles, and shipbuilding, are booming, but most industries targeting consumers are experiencing a downturn. Companies have developed various products and services to overcome this by applying the latest digital technologies, different from the past.

Moreover, it is necessary to develop technologies that other countries or companies do not have at the national level to survive the competition in the post-COVID-19 era. Additionally, it is needed to break down entry barriers for new technologies along with insight to see the future of technologies. It is imperative to promote an environment for developing convergence technologies. The convergence of technologies has a profound impact on the traditional industrial structure, the traditional production method, business organization, and employment structure. Additionally, in various industry sectors, companies from completely different industries work together and put a lot of effort to lead the competition for convergence innovation across technologies and industries[4].

Companies make a lot of investment in R&D to survive in a fiercely competitive environment. However, R&D succeeds very rarely. For example, in the case of new medicine development, even well-known drugs or treatments often do not pass clinical trials. In particular, more clinical trials are stopped due to the failure in passing the Phase 3 clinical trial. It is known that it generally takes 15 to 20 years from new medicine development to market release, and R&D costs astronomical amounts of money[2].

Most previous studies on the appropriability mechanism indicated patent, secrecy, lead-time, complementary sales/service, and complementary manufacturing were mechanisms. The appropriability mechanism means how to secure profits from a technology developed through investment in R&D. The appropriability mechanism is very important from the standpoint of companies and, and it is also very important at the national level. Recently, the United States, the United Kingdom, Japan, China, and Germany, as well as international companies, have

established various support policies at the national level and strategically supported to secure various new technologies such as digital technology, the 4th Industrial Revolution, and digital transformation[5-7].

However, despite this importance, there are not enough empirical studies on the appropriability mechanism. Particularly, companies are often reluctant to expose information related to the appropriability mechanism because it is closely related to the survival of the company. Therefore, this study aimed to understand the appropriability mechanism using companies in South Korea.

2. Related Work

2.1. Appropriability Mechanism

Appropriability refers to the ability to maintain the added value, the profit generated by a company. It is also a factor that governs an innovator's ability to capture the profit generated by innovation[4]. When a company tries to release a new product, developed by R&D, to the market for the first time, the company generally faces a conflict between the best way to protect innovation and a way to secure and achieve the highest possible return as a result of innovation. Appropriability mechanisms can greatly help companies for securing financial returns through patent, secrecy, lead time, complementary sales/service, complementary manufacturing, and others[7]. However, the priorities of appropriability mechanisms may be different by industry, company, and product. Recently, various appropriability mechanisms are selected and combined to secure returns, instead of using a single appropriability mechanism[8].

A patent is a right that legally ensures an inventor to have and enjoy the patent right in the invention for 20 years. It can be legally protected when the invention satisfies three elements (novelty, progressiveness, and industrial applicability), it is applied for examination at the patent office of each country, and it is approved and registered. However, since it follows the territorial principle, it can be used only in the country where the application is registered, which is a disadvantage. Therefore, to use it internationally, a patent is directly applied to the patent offices of each country or an international patent is applied by utilizing the PTC application.

Secrecy or trade secrets can be defined as any confidential information, which contains a commercial value. It means that it is reasonably protected by its legitimate owners (e.g., a company and an inventor) from disclosure[9]. It includes information formulas, processes, and devices used to conduct business, which allows the owner to have a more advantageous position than competitors. A number of previous studies indicated that the secrecy ranked much higher

and received a much higher score than the patent. Of course, the results may vary by industry and product group, but they show that secrecy is more important than the patent. The Coca-Cola manufacturing method is a well-known case, and many other food recipes fall in this category.

The lead time advantage refers to a strategy for a first-mover, who enters the market with a product or service for the first time, to preoccupy the market by leading the standard or brand for technology and establishing a distribution network before others. In other words, it is one of the strategies to leave the fast follower out. If the lead time is lost, one may lose out[10]. The lead time is also used as a way to justify royalties implemented to protect a company's know-how and trade secrets.

Complementary sales/service maintains complementary functions, unlike existing marketing functions[11]. If the level of an innovative product (or service), released through R&D, exceeds customers' expectations, the product (or service) can affect the image, brand, and loyalty of the company. In particular, since upgrading the corporate image can increase sales, brand value, and product value, companies are using Something to supplement existing sales, products, or services in the market through R&D.

Complementary manufacturing is changing the configuration of a product according to the generally known customers' demands. In particular, it can be used in various ways in the production management sector. It can reduce the manufacturing process, and it has been utilized for a complementary role to reduce product cost through using it in various fields such as product quality improvement. In addition, there are various appropriability mechanisms such as learning curve effects/economies of scale and costs of imitation for competitors.

2.2. Previous Studies

Starting with Levin et al.(1987)[12], Wyatt et al. (1985)[13], Cohen et al. (2000)[14], and Park et al. (2020)[15] have evaluated appropriability mechanisms. Each researcher valued appropriability mechanisms differently. Most previous studies examined appropriability mechanisms important for each industry sector empirically. Park et al. (2020) derived several policy implications for knowledge-based management by conducting analysis simulations, based on diverse scenario techniques and proposed countermeasures, on five appropriability mechanisms, selected from previous studies. Table 1 shows the classification of appropriability mechanisms.

Table 1: Study on Appropriability Mechanism

	Wyatt et	Levin et	Hara bi	König/Li cht	Cohen et	Arund el	Sattl er	Park et al.(202	Park & Seo(20
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	al.(1985) [11]	al.(1987) [12]	(1995) [15]	(1995) [16]	al.(2000) [13]	(2001) [17]	(2003) [18]	(2004) [14]	(2011) [4]
Patents	2	-	-	5	5	4	5	1	1
Patents to prevent duplication	-	4	6	-	-	-	-	-	-
Patents to secure royalties	-	5	5	-	-	-	-	-	-
Design registered	-	-	-	6	-	5	6	-	2
Secrecy	4	6	4	4	2	2	4	2	4
Complexity of design	-	-	-	3	-	3	3	-	7
Long-term employment relationship	-	-	-	1	-	-	1	-	-
Lead-time advantages	-	2	2	2	1	1	2	3	3
Learning curve effects/economies of scale	5	3	3	-	-	-	-	-	8
Costs of imitation for competitors	6	-	-	-	-	-	-	-	-
Know-how advantages	1	-	-	-	-	-	-	-	-
Superior sales or service efforts	-	1	1	-	-	-	-	-	-

Brand name recognition	3	-	-	-	-	-	-	-	-
Complementary sales/service	-	-	-	-	4	-	-	4	6
Complementary manufacturing	-	-	-	-	3	-	-	5	5

2.3. Recent Research Trend

2.3.1. Priority Derivation

The results of priority analysis showed that innovation was the most important factor as shown in table 2[19]. It is believed that the result was derived because appropriability mechanisms are the result of innovation.

Table 2: Priority Derivation (Appropriability Mechanism)

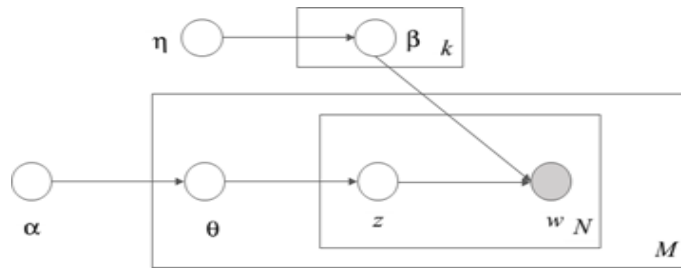
Rank	Rev.	Freq.
1	innovation	292
2	appropriability	268
3	mechanisms	219
4	knowledge	184
5	patents	124
6	protection	93
7	research	91
8	technology	83
9	value	80
10	rights	52

Only patent factor was included among the factors of appropriability mechanisms. Most researchers valued patents the most. It is believed that the result is derived because people tend to apply a patent using the result of R&D. In addition, knowledge, protection, and technology were ranked 4th, 6th, and 8th.

2.3.2. Latent Dirichlet Allocation (LDA)

LDA is a probability model for identifying what kinds of subjects exist in each given

document. In other words, this model analyzes the frequency distribution of words found in a given document based on the known frequency distribution of words for each subject and predicts the subject of the document based on it. In NLP, LDA refers to a probability model for topics



- M : Number of documents
- N : Number of words in the document
- W : word
- Z : Topic number to which the word belongs
- k : Number of topics (Hyper parameter)
- α : Document-topic θ distribution value (Hyper parameter)
- η : Topic-word-by-word β distribution value (Hyper parameter)
- θ : Distribution of topics by document
- β : Word distribution of topics

existing in each document[20,21].

The subject of number 1 and that of number 8 were similar. Key words included appropriability, knowledge, mechanisms, and performance implying that “innovation” was a subject. Verb keywords included such positive keywords as shown in Figure 1.



Figure 1. Result of LDA I

The subject of number 3, that of number 4, and that of number 7 were similar. Key words included innovation, knowledge, information, technology, and protection, indicating that the subject was “appropriability mechanisms” as shown in Figure 2.

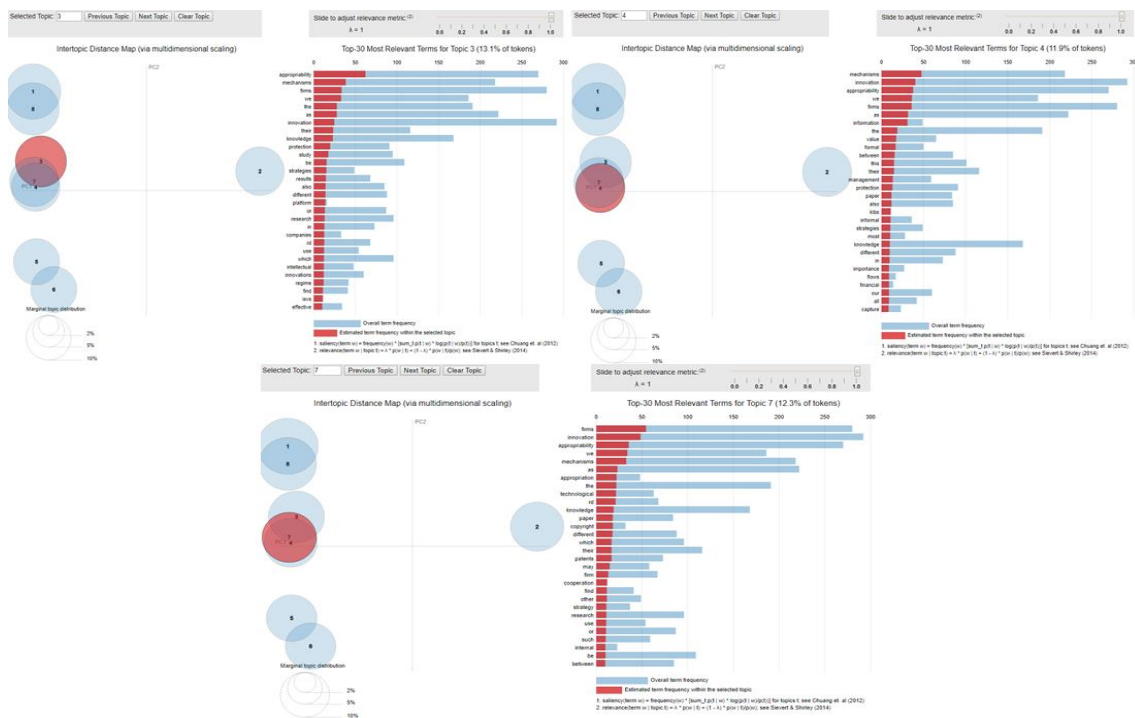


Figure 2. Result of LDA II

3. Materials and Methods

This study examined applicable analysis techniques to identify the factors associated with the appropriability mechanism and to analyze the priority of the derived evaluation factors[22]

3.1. Scoring Model and Rating/Ranking Method

The scoring model is relatively simple and easy to use and can reflect the importance of evaluation criteria in its own way, which are advantages. However, the results may vary depending on the evaluation or quality of experts and it has low reliability and there is no means to test the evaluation results because it is highly likely subjective, which are disadvantages. Rating/ranking is a general methodology for comparing two or more types or elements. It adds evaluation elements after giving weight to them. However, the most difficult thing is to clearly set comparison targets.

3.2. Delphi method

The Delphi method is one of the techniques to predict the future and it can be used for any purpose when used by an expert. However, the Delphi method can be criticized as a unscientific and theoretic method because of its basic limitation that it targets an uncertain situation, which is a disadvantage. Yet, it is meaningful as a prediction method since the ultimate purpose of the Delphi method is to support decision-making in the current situation and the present time.

This study used the Delphi method among various analysis techniques. Among the Delphi

methods, this study analyzed data by using the ranking-type Delphi method. In this study, ranking-type Delphi analysis was conducted in three steps as shown in Figure 3.

The first is brainstorming, which is conducted to extract as many factors as possible. The second step is to reduce the number of factors. The factors derived from the first step are sent to experts, and only the minimum factors that are considered important are derived. The third step is to rank the factors selected in the second step. They are ranked in order according to their importance.

In this study, four experts (two university professors and two valuation experts) participated in the derivation of factors through Delphi. Moreover, this study used Kendall's coefficient of concordance to determine the degree of concordance among experts[23].

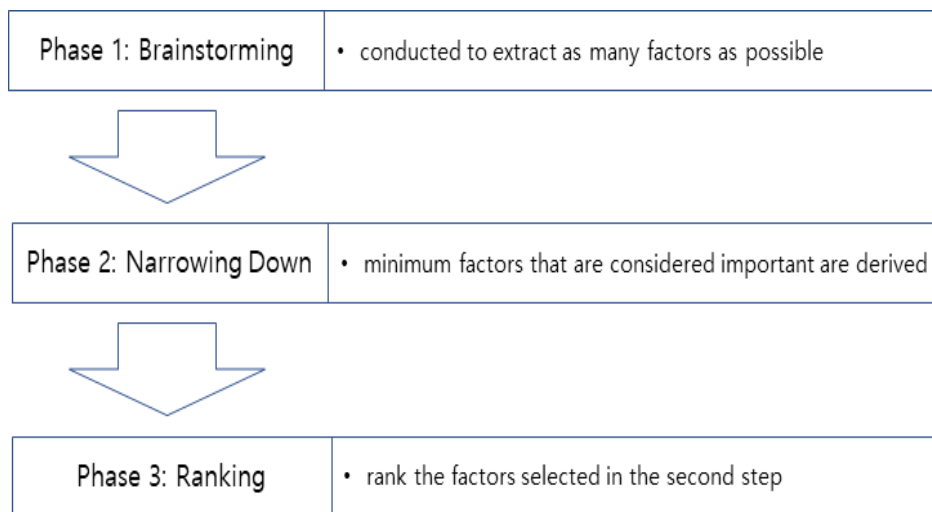


Figure 3. Description of Delphi Survey Process Used in this Study

4. Results

4.1. Characteristics of Samples

The survey was conducted from Feb 15 to 27, 2021, and the questionnaire was prepared and distributed online. Among the retrieved questionnaires, 26 copies after excluding untrustworthy responses were used for the final analysis. Since the characteristics of experts are more important than the number of respondents in the Delphi method, a small sample size, smaller than the sample size required for common statistical analyses, does not cause any issues in analysis.

Table 3: Characteristics of Samples

		Frequency	%
Education	Graduate	17	65.38
	Master	9	34.62
Career	~5 year	3	11.54

	5~10 year	4	15.38
	10~15 year	12	46.15
	15 year ~	7	26.92
Position	~ Section Chief	13	50.00
	Director	6	23.08
	Executive ~	7	26.92

The characteristics of the samples are as shown in table 3. The highest level of education of 17 subjects was bachelor's degree and that of twelve subjects was master's degree. In terms of working experience, three subjects had less than 5 years, four subjects had between 5 and 10 years, twelve subjects had between 10 and 15 years, and seven subjects had at least 15 years, indicating that they had more than one year of experience in related fields. In terms of position, thirteen subjects were managers or lower ranks, six subjects were department heads, and seven subjects were executives, indicating that the ratio between hands-on workers and managers was similar.

4.2. Analysis Results

The analysis results are as shown in table 4. The lead-time advantage was the top. The ICT industry generally has a fast trend owing to the rapid development of technology, compared to other industries. Consequently, these companies prefer to enter the market with products or services, the results of R&D, ahead of their competitors. For example, since Apple first launched the iPhone, it still has the upper hand over other competitors in the smartphone market.

Table 4: Appropriability Mechanism Analysis Results

	Average	VAR.	STDEV.	Rank
Patents	2.778	3.79	1.95	2
Design registered	3.111	5.08	2.25	5
Secrecy	2.778	6.18	2.49	3
Complexity of design	3.037	3.61	1.9	4
Lead-time advantages	2.704	2.92	1.71	1
Learning curve effects (economies of scale)	3.185	4.63	2.15	6
Complementary sales/service	3.259	3.13	1.77	7
Complementary manufacturing	3.296	3.2	1.79	8

The lead-time advantage was the top. The ICT industry generally has a fast trend owing to the rapid development of technology, compared to other industries. Consequently, these companies prefer to enter the market with products or services, the results of R&D, ahead of their competitors. For example, since Apple first launched the iPhone, it still has the upper hand over other competitors in the smartphone market.

The patent was in second place. Companies generally prefer patents[24]. Since patents can be legally protected for 20 years, most R&D results are applied for patents. Patent disputes are still occurring in many industries, and most of them are regarding who infringed the patent to what extent.

Secrecy was in third place. In some aspects, it is hard to apply for a patent. In this case, a company wisely selects the scope to apply for a patent and protects the rest as business secrets. In the case of smartphones, most of the hardware is protected by patents, but most software is protected as business secrets.

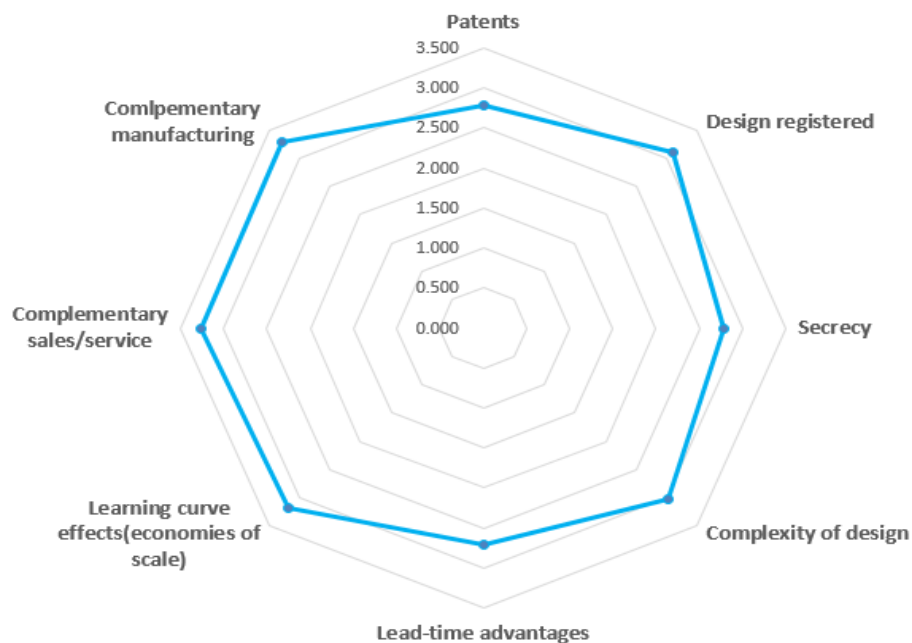


Figure 4. Appropriability Mechanism Radial Chart

The complexity of design was identified as the fourth factor. It is a strategy that makes a complex design to prevent followers from copying the design. Design registered was ranked in fifth place. It is to protect design rights by registering them or prevent others from copying the design by making it very complex. As design has become more important in recent years, the importance of design rights has been increasing. Moreover, disputes over design rights are increasing in various industry sectors.

The learning curve effect, a very important factor for determining the corporate cost advantage, ranked in sixth place. Experience has been accumulated through the results of R&D. Owing to this, it is possible to improve processes or reduce production costs by redesigning products.

Complementary sales/service ranked seventh. It has been utilized to supplement existing sales or services through the results of R&D. Complementary manufacturing was the eighth factor. It is playing a complementary role to reduce product cost by utilizing the results of R&D in various fields such as the improvement of the manufacturing process and product quality. Fig. 4 shows the results of appropriability mechanisms by using a radial chart.

Kendall's coefficient of concordance was calculated by using the following equation. Kendall's coefficient of concordance was 0.41, indicating a slight agreement.

$$\sum (R_i - \bar{R}_i)^2 / k^2 (n^3 - n)$$

$W = \text{actual } R_i \text{ change} / \text{maximum } R_i \text{ change}$

$= \text{Sum of } R_i \text{ deviations squared} / \text{Sum of } R_i \text{ when rank among } k \text{ variables is completely consistent}$

5. Conclusion

The rapid development of ICT technology has induced many changes in our daily lives. Particularly, the advent of the untact era due to the COVID-19 pandemic has shifted the daily life of consumers. In addition, companies have made various efforts to survive in an uncertain environment that is ceaselessly changing. R&D is the key driving force to increase and boost productivity and economic growth. As a result, companies engage in R&D activities. In other words, innovation is the driving force boosting national economic growth and corporate growth, and companies generate revenues owing to the results of various R&D activities.

This study derived eight factors as the factors of appropriability mechanisms by conducting a ranking-type Delphi survey by using the factors suggested by previous studies on appropriability mechanisms based on the opinions of company experts. The analysis results of the derived eight factors are as follows. The lead-time advantage, the patent, and the secrecy were ranked in first, second, and third places, respectively. The importance appeared in the order of the complexity of design, design registered, learning curve effects, complementary sales/service, and complementary manufacturing.

The implications of this study are as follows. First, this study attempted an academic

approach to appropriability mechanisms that are widely used in the actual corporate setting. Most previous studies simply used a 5-point scale to rank them, and researchers analyzed data using different factors. However, this study has implications at the academic level in terms of carrying out a Delphi survey targeting experts using the factors suggested by previous studies and analyzing the finally derived eight factors.

Moreover, the results of this study can be used as a guideline at the working-level when establishing policies and strategies for appropriability mechanisms in companies. Since most of the respondents were hands-on staff, it is expected that the results of this study would be helpful to hands-on staff in the field.

However, despite these implications, the results of this study cannot represent all industry sectors because the sample size of this study was insufficient. Future studies need to expand the number of samples, and it will be necessary to utilize AHP and simulation techniques as analysis methods.

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