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Evaluating a Technology Transfer and Commercialization Support Program: A Korean Case Study

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Abstract The study analyzed the effectiveness of a technology transfer and commercialization support program to Korean technology transfer offices and firms. The study created a logic model to design a questionnaire to analyze how the support program, directly and indirectly, affected the technology transfer offices and the firms' performances. The study found that technology transfer offices are focused not only on potential firms' excavation activity to process the technology transfer but also on providing strategic support to provide practical assistance to the firms' needs. Not only has the number of technology transfer cases increased during the two-year program duration, but other activities, such as technical guidance and various strategic consulting for commercialization of the transferred technology, have also appeared to have increased considerably. Support program has helped strengthen the firms' internal capabilities, expand new market capabilities, and increase the firms' indirect performances.

Keywords Commercialization, Technology Transfer, Support Program, Small-Medium Enterprises, Technology Transfer Offices

I. Introduction

The idea of commercialization and its importance was not a new topic, even in the 1990s. Rosenberg et al. (1992) highlighted that the "key factor underpinning the U.S. competitiveness is not the development of technology itself, but the factors that influence the commercialization of the technology." Nelson (1989) summarized that technology has two aspects: 1) the proprietary and the 2) public good. The proprietary aspect focuses on the firm to be profitable by investing in the advancement of the technology, and the public good aspect targets the benefits of the whole community. It is ideal to have the right balance between the two aspects, but the policies since the 1990s have

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focused on emphasizing the technology's proprietary aspects to both companies and universities.

Even before implementing the Bayh-Dole Act in 1980 to help firms retain the ownership of their inventions promoted collaboration between universities and industries, universities have engaged in their effort to collaborate with industries through technology transfer (Sampat and Mowery, 2004). Due to the fast-changing nature of technology and the importance of technology spillover, various policies have been implemented to create an autonomous university-industry collaboration environment.

In the past, the Korean government focused on developing its technical capacity through increased R&D investment (Kim 2001). Through the benchmarking of foreign policies and technology commercialization organizations, Korea has laid the foundation of technology transfer and commercialization activity by the enactment of various policies, such as the "Act of Promoting Technology Transfer and Commercialization," "Technology Transfer and Commercialization Plan (TTCP)," "Special Act of Promoting Venture Companies" (Han, 2018; Lee and Kim, 2013). After the acts, the government has encouraged universities to establish their own technology transfer offices (TTOs) and have shown increased patenting activities since 1997 (OECD, 2009). KIPO (2015) highlighted that the number of patents from universities has increased from 1,019 to 11,149 between 2005 and 2014. Despite these efforts, the performance of the technology transfers in Korea still lagged behind advanced countries, such as the United States

The Korean government has expanded both the policies and the R&D expenditures to build an ecosystem for technology transfer and commercialization. Many financial support programs supported firms and their technology transfer/commercialization process; however, only a handful have been targeted to technology transfer intermediaries. Moreover, the government required the TTOs to collaborate with firms to apply for a support program (Han, 2018).

This study analyzed the effects of the technology transfer and commercialization support program implemented by the Korean government from 2015 to 2016, from the receiving end, the small and medium enterprises (firms). Since the program's data is confidential, we conducted a qualitative analysis through interviews and surveys of both TTOs and firms on transferred technologies' effects. The main finding is that 1) the TTOs believe the intent of the program was excellent. However, there seem to be low to no effect on their sales volume, 2) the firms commented on how the program helped in the areas of market research, business networking, and new business development, but had a low impact on market expansion and in their sales volume, and 3) the TTOs had a slightly higher satisfaction level of the program than the firms. A

significant contribution of the present study lies in examining the effectiveness of a financial support program for TTOs and firms.

The rest of the paper is structured as follows. The next section analyzed past technology transfer and commercialization research to understand what has been studied and what areas of the study have lacked. In section 3, we introduce a finance support program as a case study to examine the program's effect on both the TTOs and firms using a qualitative analysis. We conduct a survey and interview of these participants and illustrate the results. Finally, we end with a conclusion in section IV.

II. Background

1. Technology Transfer and Commercialization

Today, open innovation, co-creation, and many other collaboration activities are common in the hope of nurturing more innovative ideas and knowledge to the world (Simonton, 1988; Inoue and Liu, 2015). Another important activity is the transfer of technology and expertise for technology commercialization. Technology commercialization, especially technology transfer, is a vital factor in today's economy and continues to receive substantial attention from many countries over the world (Morberg and Moon, 2000). Technology commercialization and transfer may seem similar; however, these are two different concepts. Morberg and Moon (2000) define technology transfer and technology commercialization as the "movement of scientific knowledge from one party to another" and "when the transfer involves the making or selling of a product to provide a financial return to the inventor," respectively. In other words, technology commercialization is an innovative activity to create new products or processes by utilizing technologies and knowledge that may or may not be acquired from technology transfer to improve the overall procedure.

Jolly (1997) proposed a "five sub-processes, four bridge" theory that stated that technology commercialization is a series of activities for the innovation stage (imagining the dual market-technology insight, incubating to define the technology's commercial potential, demonstrating the technology contextually in products and processes, promoting the chosen adoption for the technology, and sustaining the commercialization). Each stage plays a role in value creation and helps to increase the market value of the technology. These stages are connected by four sub-processes that help to mobilize the process. Also, the stages and the bridges provide sufficient information on both the technology developed and the market.

1.1 Definition of Technology Transfer and Commercialization

Technology transfer is defined as the "movement of scientific knowledge from one party to another" (Morberg and Moon, 2000) or as the "movement of know-how, skills, technical knowledge or technology from one organizational setting to another" (Roessner 2000). Technology commercialization is defined "when the transfer involves the making or selling a product to provide a financial return to the inventor" (Morberg and Moon, 2000) or as "the process of transferring a technology-based innovation from the developer of the technology to an organization utilizing and applying the technology for marketable products" (Kirchberger and Pohl, 2016).

In Korea, the definition of these two terms is stated in the Technology Transfer and Commercialization Promotion Act (National Law Information Center, 2018; Park and Park, 2017). Therefore, this research will use the following definition of technology, technology transfer, and technology commercialization.

Technology: a) Intellectual Property (Patents, Utility Models, Designs, Semiconductor Integrated Circuit Design, and Software); b) Capital Goods with Intellectual Properties; c) Any information regarding a) or b) and d) Scientific, technological and industrial know-how that can be transferred or commercialized.

Technology Transfer: When the owner of the technology (including those who have the authority to dispose of the technology) either a) transfers, b) grants a license, c) provides technical guidance, d) conducts joint research, e) creates a joint venture or f) goes through an M&A of the technology to another individual, institution, or firm.

Technology Commercialization: Developing, producing, selling a product using technology, or improving the technology in the process.

1.2 Past Researches on Technology Transfer and Commercialization

Technology transfer researches were conducted on various levels. For national-level studies, Schmoch et al. (1997) compared technology transfer systems in two countries; Bozeman (2000) reviewed studies on technology transfer and analyzed technology transfer's strength and weakness through an effectiveness model. King and Nowack (2003) conducted a case study on the relationship between U.S. and International policies on technology transfer and the successive licensing in the aircraft industry.

Most of the studies were on the industry level. Nevens et al. (1990) assessed different technology transfer and commercialization models. Park and Lee (2011) gathered data on 361 Korean firms and found that it is vital to transfer technologies to be implemented in future processes and products, but it is even more important to have your technology asset and capacity. Park and Chang (2016) assessed different government support programs that assist technology

transfers as an exploratory study using 1222 firms. The number of successful technology deployment cases and the number of IPR registration cases positively impacted public technology commercialization's success rate. In contrast, more attempts at technology development, longer lead time in the planning phase were some factors that lowered the success rate of public technology development.

Many studies have been examining the role of TTOs in the university-industry technology transfer process. The TTOs have an advantage over individual scientists searching for potential buyers and reduces uncertainty problems (Hellmann, 2007); Hoppe and Ozdenoren, 2005). Siegel et al. (2004) conducted a study to improve university-industry collaboration effectiveness by identifying factors and barriers to enhance technology transfer. The study found that universities must have organizational and managerial behaviors, improve staff training in TTOs, devote additional resources to technology transfer, encourage informal relationships and networks, and design flexible technology transfer policies to enhance technology transfer activities. Some barriers to effective technology transfer between universities and industries included culture clashes, bureaucratic inflexibility, poorly designed reward systems, and ineffective management of TTOs.

Furthermore, Carlsson and Fridh (2002) surveyed 12 universities in the United States and found that the larger the TTOs, the broader the in-house expertise in technology transfer and commercialization and will be more aggressive in pursuing patents/licenses. Rogers et al. (2000) used correlation analysis and found a positive correlation between faculty age, age of TTO, and the number of TTO staff with a technology transfer performance. Similarly, Thursby and Kemp (2002) found that faculty quality and the number of TTO staff are positively correlated with the number of technology transfer outputs.

Another popular area of the study is determining the success and critical factors in technology transfer and commercialization. Keller and Chinta (1990) stated that important factors are "ambiguous and difficult to measure," especially in the international technology transfer process due to changing market, difficulty estimating price/costs, and external factors political, cultural, and economic conditions. Kumar et al. (2015) classified 24 critical technology transfer factors into five categories using an AHP methodology and found regulatory concerns, international bodies; higher margins of profit; reliability; marketing-related benefits and forces; and managerial and strategic issues to be the top critical factors.

Phan and Siegel (2006) conducted a literature review on the different quantitative and qualitative studies in the U.S. and the U.K. on university technology transfer effectiveness. Forty journal articles were studied; the authors concluded that U.K. universities are hesitant in commercialization due to a lack of funds and endorsements to support technology transfer activities,

and not many universities have succeeded in commercialization. Kim et al. (2014) used cross-nation panel data to estimate the direct and indirect impact of intellectual property rights on R&D development and industry value-added. Logistic regression was conducted on data collected from 2,494 firms and found immaturity of market conditions, lack of competitiveness in the product, and lack of company's commercialization capabilities to cause commercialization failures. A company's technology competencies, technology management personnel, cooperation with technology suppliers, government support, and invested funds (along with more factors) were essential variables to a successful commercialization process. The government support and policies were rated relatively high (more than 80% of the surveyors) due to their contribution in protecting the technology through patents and applying for product certifications.

1.3 Overview of Support Program for Technology Transfer in Korea

Lee and Kim (2013) examined support programs for technology transfer and commercialization from three government institutes, MOTIE (Ministry of Trade, Industry, and Energy), MSIP (Ministry of Science and ICT), and KIPO (Korean Intellectual Property Office). The majority of the MOTIE programs were focused on promoting technology transfer and transactions by 1) providing marketing support for commercialization for excellence technologies, 2) differentiating TTOs into independent and cooperation types, 3) promoting IP business, and 4) developing technology transfer and commercialization experts. MOTIE program also included a follow-up R&D program, commercialization - linked technology development project, to provide commercialization support for high potential firms through follow-up technology development, marketing, consulting, and certifications.

MSIP programs focused on building a connection between research institutes (university, government-funded research institutes) and companies, providing training and education to build a pool of experts, but also several commercialization support programs, such as the Upgrade technology transfer projects, which was to discover high potential technologies and support technology commercialization activities (Lee and Kim, 2013). KIPO (2015) focused on discovering high-potential technologies, helping with the commercialization process, and connecting the inventors with patent or IP experts. From 23 support programs, only two programs were follow-up R&D projects for technology transfer and commercialization. Most of the programs supported building infrastructure by providing education and training, consulting, introducing experts, and promoting technology collaboration between academia and industry.

2. Issues Regarding Technology Transfer and Commercialization in Korea

Lee and Kim (2013) stated that even though there has been growth in the number of technology commercialization cases in universities and government-funded research centers, technology incubation activities have been "sluggish," and there is a big gap between top-performing institutions and the lagging groups. Some of the issues regarding technology commercialization include inefficient operations (Han 2018), lack of expertise & business mindset (Lee and Kim, 2013), and lack of the staff of TTOs (OECD 2009).

Han (2018) stated that through the "Leading TTO Cultivation Project," 18 universities in Korea have established their TTOs and saw an increasing number of employees (varying from patent attorneys, technology transfer agents, and certified valuation agents). However, these increases have not had a direct contribution to the growth of the TTO performances.

Furthermore, while the increased investment to government-funded research institutions and universities led to the increased number of technology transferred cases, patents, and technical fees, the "qualitative" efficiency" of the technologies has not changed (Park, 2008). Lee (2013) defined qualitative efficiency in two ways: a) the total technology transfer royalties, or b) the ratio of the transfer royalty to the total investment per technology transfer contract. Park et al. (2011) claimed that public technologies tend to fail during the transfer commercialization process, while civilian technologies tend to fail during the technology transaction process or the early commercialization stage.

Park et al. (2011) added two significant commercialization failure factors: 1) Due to the Market, and 2) Due to the System. Market factors include underinvestment in the early stages of commercialization due to inherent risks and technology development uncertainties. Moreover, while start-up investors may recover their initial investment within 3-4 years, it would take longer for the commercialization process. System factors include overestimating the value of the technology (thus, unable to negotiate in the licensing fee), lack of incentives to the TTO staff, and disclosure of the technologies due to the risk of technology theft. Also, the government-funded research institutes and universities tend to commercialize the "good" technologies themselves directly and thus distributing "less likely to be commercialized" technologies to the market (Park and Lee, 2011).

3. Issues of Financial Support Programs in Korea

Lee and Jo (2018) compared the performance of support program recipients to those who did not receive the support by using the Korean Enterprise Data

from 2010 to 2015. The recipients out-performed the non-recipient group in operations, financing, and capabilities but showed the reverse in trends after two to three years after the support. The authors also stated that despite an increase in R&D grants for firms, there was a lack of improvement in the recipients' value-added, sales, and profit in the number of IP rights registrations.

Furthermore, Park et al. (2016a) analyzed government support programs' performance using a support program in the LED industry as a case study. The result showed that despite support, 65 recipients (firms) did not experience growth in their sales, in the number of exports, nor the firm R&D investments. In his later work, Park et al. (2016b) compared and analyzed the firms participating in a support program for either R&D only, R&D and R&D infrastructure, or R&D Infrastructure only support programs. The studies found that only a handful of firms were actively involved in R&D and R&D infrastructure activities and noted that R&D activities and their performance measurements need to be analyzed by types. The authors highlighted that performance indicators should be set according to the R&D type and the program duration. Depending on R&D type and duration, the performance should be assessed in either scientific, technical, financial, economic, and social aspects.

4. Research Gap

Many studies focused on technology transfer and commercialization in Korea have examined the relationship between the R&D expenditures and various TTO outputs (number of technology transferred cases, number of patents, licensing fee, and even royalty incomes. However, there is a lack of study on evaluating technology transfer commercialization programs' effectiveness due to the lack of understanding of the performance indicators needed to evaluate such R&D supports.

Furthermore, there is a lack of studies to examine the programs' performance in terms of technology development, capacity building, and the firms' rise in sales. The lack of such studies may be due to the lack of follow-up programs and the difficulty of obtaining the data since firms tend to be confidential with their data. The next section introduces a two-year-long finance support program and analyzes the support program's effectiveness to both the TTOs and the firms during the technology transfer and commercialization process.

III. Theoretical Framework

1. Contingent Effectiveness Model

Bozeman (2000) presented a "contingent effectiveness model" of technology transfer and highlighted six technology transfer effectiveness criteria and theoretical foundation. They are out-the-door, market impact, economic development, political reward, opportunity costs, scientific and technical human capital. Bozeman stated that many technology transfer studies never clarified technology transfer effectiveness. In his later work, Bozeman (2015) added one more criterion, the public value.

The out-the-door criterion examines whether technology transfer has occurred. This criterion's primary assumption is that the technology transfer agent, whether it is the TTO or a federal laboratory, has succeeded in transferring the technology to another organization. However, this criterion does not examine whether the organization receiving the technology has used the technology or "intend to quash the technology" to limit the competitors (Bozeman 2015).

Market impact criterion looks into the impact of technology transfer and commercialization on the receiving organization's sales and profitability. Bozeman (2015) emphasized that if a transferred technology has not been a commercialization success, it may be due to the receiving organization's lack of development, manufacturing, marketing, or strategy competence. On a similar note, the economic development criterion looks into how technology transfer leads to regional economic development. The political reward criterion examines whether the technology transfer agent or receiving organizations had any political benefits, such as increased funding, in participating in the transfer.

The opportunity cost criterion examines the impact of technology on the alternative use of resources. In other words, what were some other opportunities other than the technology transfer? Bozeman (2015) used the National Science Foundation's Innovation Corps program as an example because it was created to help professors at universities with limited ability to start a start-up and successfully run a firm. The scientific and technical human capital criterion is based on the understanding that the "value of scientific and technical knowledge requires a view of the role of scientific and technical human capital" (Bozeman, 2015). This criterion looks at the human capital and the individual scientist's tacit knowledge, craft-knowledge, and know-how (Bozeman, 2015). Finally, the public value criterion examines whether the technology transfer enhanced the collective good and broad societally shared values.

From these seven criteria, this research will focus on two: the market impact and economic development. As stated above, the market impact criterion assesses the effectiveness of the transferred technology's commercial success, and the

economic development criterion is similar to the market impact but at a regional and national level. Because government programs are rationalized by making results and contributions, technology transfer with low market impact has no value (Bozeman 2000). Therefore, this research will examine whether a) the transferred technologies have any impact on the firms' profitability, and b) whether there has been an increase in economic development, such as an increase in employment.

IV. Research Methodology

1. Case Study

This "Discovery of a Demanding Company to Support Technology Transfers" was a support program managed by the Korea Institute for Advancement of Technology (KIAT) that identified and supported Korean ventures and firms with the willingness and capabilities to pursue commercialization of transferred public technologies. This program was promoted to differentiate the technology transfer and commercialization process. In the past, the technology-push strategy has been dominant in the support programs in Korea. During the technology-push transfer, the technology supplier or the inventor initiates the transfer, and through the help of the support programs and the technology transfer intermediaries, they would be able to find a receiver. Despite the increase in the number of technology transfer cases, there has not been much success in product commercialization. Therefore, a different technology transfer process (the demand-pull) was starting to be implemented and researched.

In 2016, the notion of demand-pull technology transfer had been relatively new, and not many of these researches have been conducted. Jun and Ji (2016) explored the success factors of the demand-pull technology transfer and found that quality of needs-articulation, technology suppliers' openness, and technology capabilities of the receiving end were all critical, and thus implying high technology capabilities result in higher technology transfer outcomes.

This support program closely worked with several public and private TTOs to promote technology commercialization and strengthen firms'/ventures' technology innovation capacity of firms/ventures and competencies. The program excavated firms who had the willingness and capability to receive public technology. Unlike previous technology transfer support programs, this case study adapted the demand-pull strategy by selecting technology transfer intermediaries and assisting them in excavating appropriate firms. A total of 46 TTOs and 1,735 firms were supported through the program.

The program ran for two years, 2015 and 2016, providing up to 1.5 billion Korean Won and 3 billion Korean Won for two years. There were two primary goals for this program: first, identify the companies in demand for technology transfer and commercialization, with the help of industry-academia technology commercialization experts, and second, provide follow-up support to help pursue commercialization by assisting the transfer of their technologies, mediating of technology transactions, supporting product development, and technology linkage.

1.1 Data Collection Stage

Even though a total of 46 TTOs and over a thousand firms participated in the support program, only a handful of firms had a successful technology transfer. Therefore, the questionnaire was conducted from January 18 to March 13 of 2018, to 36 TTOs and about 400 firms. The questionnaire was sent out to both the TTOs and the firms through an online format (email). During the first data collection stage, most TTOs responded; however, only a handful of the firms responded. One of the feedbacks claims that the firms did not truly understand the purpose of the questionnaire.

A revised questionnaire distribution method (distributing the questionnaires through the TTOs) was used to gain these firms' trust. A total of 36 TTOs (100% response rate) and 206 firms (a response rate of 53.1%) were collected. Out of the 36 TTOs, 14% (5) participated only in 2015, 58% (21) participated in 2016, and about 28% participated in both years. Out of the 206 responses, 33 responses were inadequate, and therefore, 173 responses were used to conduct the analysis (a response rate of 44.6%).

1.2 Descriptive Statistics of the Program

Figure 1 shows the breakdown of the different TTOs that participated in the program. Out of the various TTOs, the public TTOs were the highest in number, with 23 offices, followed by private TTOs (11). Despite the importance of university TTOs, only eight offices participated in this program, as described in the literature review. Furthermore, there was a significant increase in the number of public and university TTOs participating in 2016, compared to that in 2015. Table 1 shows the average number of firms excavated by the TTOs.

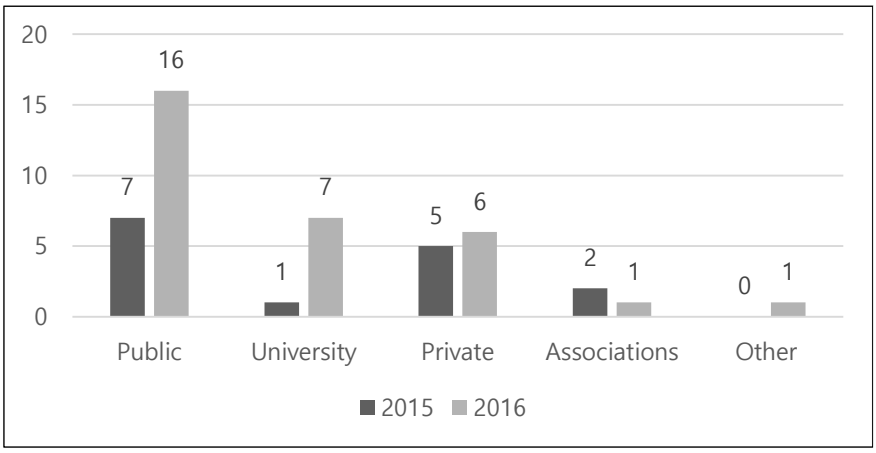

Figure 1 Breakdown of the Type of TTOs Participating in the Program

Table 1 Breakdown of the Participants of the Support Program

Type	Counts	Total Number of Firms Excavated	Average Number of Firms Excavated Per TTO
Public	23	946	41.1
University	8	411	51.4
Private	11	292	26.5
Associations	3	66	22
Others	1	20	20
Total	46	1735	37.7

2. Describing a Logic Model and its Usage

A logic model tool has been widely used in evaluating government support programs, as it helps to specify program goals, objectives, activities, outputs, and outcomes. Using a graphical representation of the program objectives and goals helps systematize the program's planning and designing, implement and manage the program, and evaluate the outcome. Therefore, this study aims to evaluate the technology transfer support program using a logic model, but intends to implement 1) the 38 performance indicators, selected by the Korean firms and Startup Agency (KOSME), for technology commercialization program for Korean firms, and 2) the success factors for technology commercialization in Korean firms as presented by Yang et al. (2015).

There are several kinds of logic models, but this study plans to use a performance measurement logic model that uses ambient conditions and surroundings to evaluate the program. There are four major components: the inputs, the activities, the outputs, and outcomes are separated into short-term, mid-term, and long-term outcomes. Input is an indicator aimed to assess whether the necessary resources (funding, technical knowledge, facilities, equipment) and personnel have been implemented as planned. Activity is a series of actions that need to be taken to achieve the technical development and used as a mid-term inspection indicator for program promotion. The output is an indicator of whether the final outputs have been produced in proportion to the input (budget and human resources). Finally, the outcome is an indicator to measure the effect of the program. There may be cases where the output and outcomes are the same. Unlike the output, outcomes are direct results or benefits by implementing the program, divided into short-term (within three years after the termination of the program), mid-term (within 3~6 years after), and long-term (after six years).

2.1 Setting the Performance Indicators for the Logic Model

Logic models help examine the program in various aspects and set appropriate performance goals and indicators. Performance Indicators are measurable characteristics that represent the achievement of the overall purpose of the program. KOSME developed a simple logic diagram using the three-level R&D development process and Jolly's 5 Sub-processes-4 Bridges Theory.

Furthermore, Yang et al. (2015) examined various technology transfer and commercialization support programs in Korea and in other countries to extract the performance indicators used to evaluate the programs. Table 2 shows the government institutes and the number of technology transfer/commercialization programs, and the different performance indicators used for that program.

Table 2 Number of Performance Indicators by Government Institution Support Programs

Institution	Number of Programs	Number of Performance Indicators	Institution	Number of Programs	Number of Performance Indicators
MAFRA	4	9	ME	7	30
MOLIT	3	15	MOF	7	28
RDA	4	15	MFDS	1	4
MSIT	32	91	DAPA	2	7
MOE	11	30	NEMA	1	5
MOIS	1	3	KFS	2	5
MCST	1	2	MSS	1	4
MOTIE	22	83	KMA	6	16
MOHW	4	14			

Source: Yang et al.

Using the above pool of performance indicators, Yang et al. (2015) created the performance indicators for each logic model variable. The Input, Activity, and the Output variables are potential performance indicators within the first year of the program, while the outcome and impact variables are potential performance indicators between one to three years after the program's termination. Similar to other support programs, the input variable is the funds; activity variable is the satisfaction of the technology commercialization planning; output variables are the acquisition of various certifications per 100 million won, the number of prototypes produced compared to the number of facilities and equipment used, and new product launch rate compared to the number of prototypes produced. The outcome variables are growth rate and the number of certifications and the contribution to sales, profit, and the number of export, shorten time to market for new products, and import-substituting effect of the new products. Finally, the impact variables are the net growth rate of job creation; and the total amount of new investments compared to the number of new investments. Using these performance indicators and showing the relationship/flow, a revised logic model can be constructed.

2.2 Using the Logic Model to Evaluate the Program

This study created a logic model by referencing the KOSME logic model. These performance indicators listed in the KOSME logic model had to be re-evaluated because it focused only on the firms' performance. The logic model was modified to reflect the characteristics of technology transfer offices (inputs and activities) and the firms' performance (outcomes).

Figure 2 shows the logic model used in this study. The input, activity, and output variables depict the program's input and actions, while the outcome (short-term, mid-term, long-term) variables represent the firms' potential performance indicators. With the identified evaluation/performance indicators, a questionnaire was created to examine the program's effectiveness and the firms' performance.

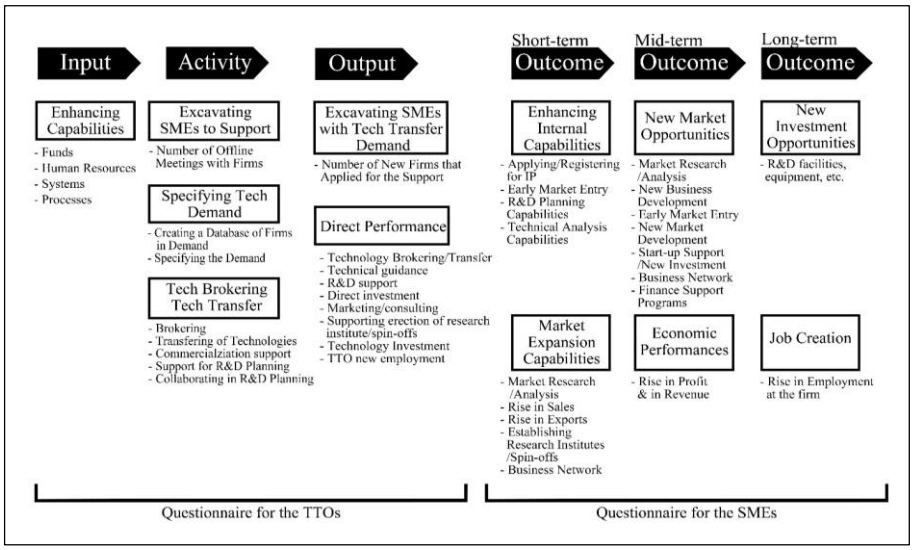

Figure 2 Logic Model Used for the Study

With the modified logic model, the study evaluated the program's effectiveness through a qualitative analysis of the performance of the TTOs and the SME. With help from KIAT, the program operator, the study conducted two types of analysis: qualitative analysis on the performance survey data submitted by the TTOs at the end of the program and quantitative analysis (a questionnaire) to the firms that participated in the program. The questionnaires focused on examining the following variables for each actor by using a five-point Likert scale (where one is low to no effect, and five being high effect):

TTOs: strengthening the firm selection capabilities, demand consolidation, technology brokering/transfer, direct performance of the TTOs

Firms: Strengthening the firm's internal capabilities, market expansion, new market opportunities, and indirect performance.

V. Research Outcomes

1. Evaluating the Technology Transfer Offices

Three indicators were used to evaluate the program: 1) the excavation activity of finding the appropriate firms to support, 2) the total number of excavated firms by the TTOs, and 3) the direct performance of the program in terms of the number of technology transfer/transaction and the number of technical support.

For the first indicator, 72% of the respondents participated through a direct consultation from a TTO, while only a few joined through KIAT's support program notification/conference. The result clearly shows that this support program was not a public recruitment type of project, but instead, field-oriented activities, such that the meetings held by the TTOs were the main reasons for joining the support program.

The second indicator of the logic model was selecting the appropriate firms to support. The study examined the number of offline meetings by the TTOs devoted to select firms. Although the average number of offline meetings in 2016 increased by around 1.6 times compared to that of 2015, it appears that the funds and resources devoted to the excavation of firms did not increase in proportion to the budget increase (2 times). Also, the total number of firms participating through the TTOs have increased more than double in 2016, compared to 2015. Figure 3 shows the breakdown of the average number of firms excavated by the different types of TTOs. The public and the university TTOs were far superior over the other three TTOs.

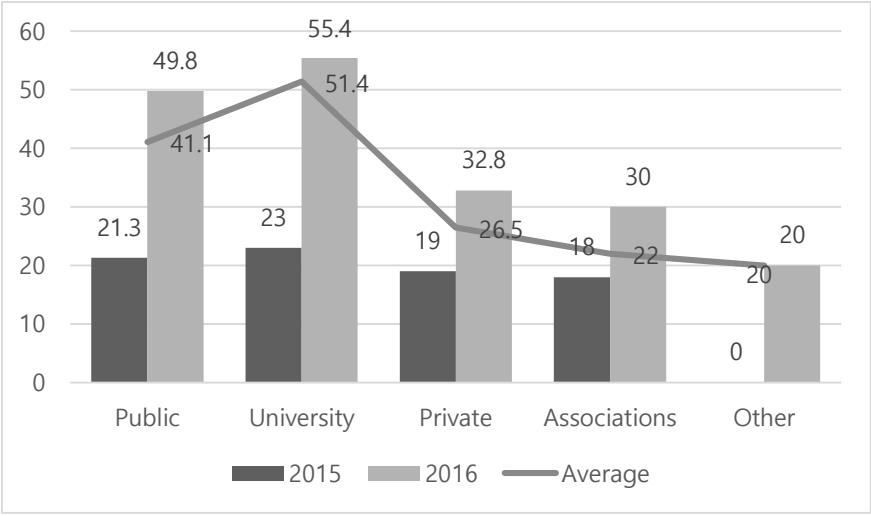

Figure 3 Average Number of Firms Excavated by the TTOs

The third indicator was examining the direct performance of the TTOs. Figure 4 shows the direct performance of the TTOs. The average number of technical guidance, R&D support, the number of technology transfer, the number of investment attraction, and consulting cases increased in 2016, compared to 2015. Moreover, the public and the university TTOs tend to focus on technical

guidance and R&D support, while the private TTOs concentrated more on technology brokering and consulting activities. It was interesting how the establishment of spin-offs and the number of technology or direct investment were low in both years.

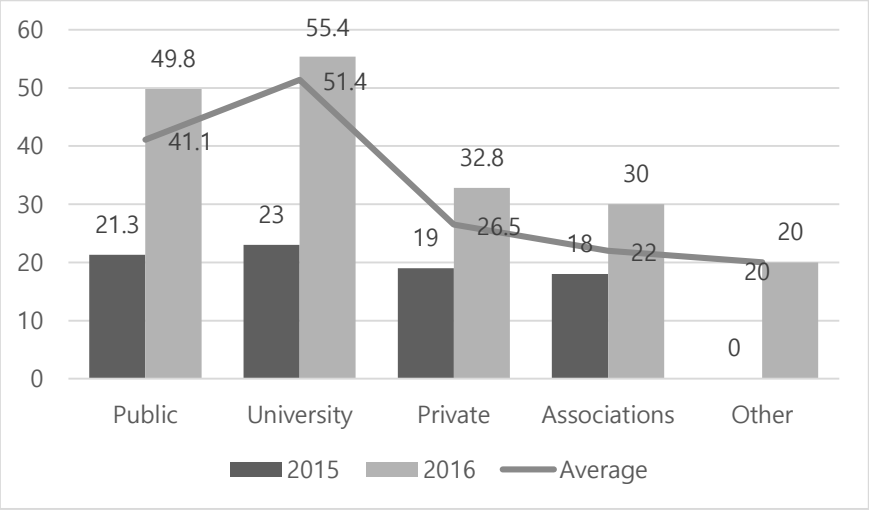

Figure 4 Breakdown of the Performance of the TTOs

2. Evaluating the Performance of the Participating Firms

As shown in the logic model, a short-term outcome for the firms was examining whether the program has helped increase the firm's internal capabilities. The survey results show that the firms were satisfied with the program's support in technical analysis and R&D planning (Figure 5). Most of the firms were developing the public technology they received through the program; however, their early market entry performance was not evaluated as high. Overall, the questionnaire results confirmed that 1) the support program contributed to the increase in the internal capabilities of firms, but not in the rise of the employment or in sales, and 2) the participants in 2016 had relatively higher performance compared to 2015.

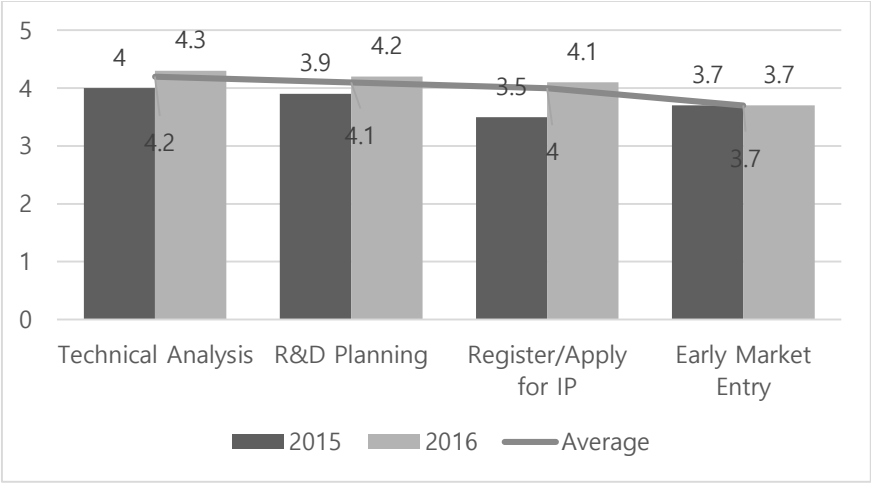

Figure 5 Internal Capabilities for the Participating Firms

On the other hand, the contribution of increasing the firms' existing market presence through the technology transfer program was found to be reasonably low (Table 3). It had a weak contribution to the increase in establishing spin-offs, the rise in sales, and the rise in exports. However, the program helped the firms expand their business network and conduct market research and analysis.

Table 3 Existing Market Expansion for the Firms

Performance	2015	2016	Average
Market Research & Analysis	4	4.1	4.1
Business Network	4	4.2	514.24
Spin-off Establishment	3.2	3.5	3.4
Rise in Sales	3.3	3.4	3.4
Rise in Exports	3	3.1	3.1

The study also examined two mid-term outcomes, 1) whether the program has helped the firms find new market opportunities, and 2) their feedback and satisfaction level of the support program. Table 4 shows the firms' mid-term outcomes from the perspective of new market development capacity. The firms stated that the program has helped to participate in the new business

development, conduct market research and analysis, create a more extensive business network, and join new support programs. However, the firms stated a low contribution in receiving support for start-ups and attracting new investments.

Table 4 Mid-term Outcomes – New Market Development Capacity for the Firms

Performance	2015	2016	Average
Market Research & Analysis	4	4.1	4.1
New Business Development	4.1	4.1	4.1
Government Support Programs	4.1	4.2	4.2
Business Networking	3.8	4.2	4.1
New Customers	3.7	3.7	3.7
Early Market Entry Opportunities	3.6	3.7	3.7
Investment Attractions	3.4	3.4	3.4
Start-up Support	3	3.4	3.3

3. Discussion

The overall results show that the TTOs are focused not only on potential firms' excavation activity to process the technology transfer but also on providing strategic support to provide practical assistance to the firms' needs. However, the public and university TTOs did not centralize the program's fundamental purpose to shift the technology transfer and commercialization process into more a demand-pull approach. It appeared that these TTOs were focused on the transfer and the commercialization of their technologies (technology-push method). In terms of the program's outcome, the firms expanded their internal capabilities and gained new market opportunities but rated reasonably low on contributing to increased employment and sales.

Furthermore, the program was effective in assisting the TTOs and the firms in developing their internal capabilities. In the case of the TTOs, the program helped develop their business in the order of 1) technology demand excavation activities, 2) technology brokering/transfer activities, and 3) indirect performance of firms. The program appeared that the program helped them

expand their business in the order of 1) strengthening the firms' internal capabilities, 2) new market expansion capabilities, and 3) firms' indirect performances. However, it is difficult to state that the support program has been effective. One main reason is that the program has not helped raise the number of employees and sales in the firms. Therefore, the study results show that the program has helped enhance the indirect performance of the participating firms, but shows limitations on the relationship between the technology transfer activity and the enhancement of the R&D performance.

The number of technology transfer cases have increased during the program's two-year period, and more firms were participating in the second year compared to the first year of the program. However, this result does not show the overall case of the technology transfer in Korea as there were more funds available in the second year compared to the first year of the program. It is important to note that Korean firms participate in technology transfer support programs, whether due to the funds or their real desire to transfer in public technology. Another important note is that despite the technology transfer activity in Korean firms, there have been low commercialization results. Therefore, further studies on 1) the motive of Korean firms in participating in the support programs for technology transfer and commercialization and 2) why commercialization activity is low in Korean firms are needed.

VI. Conclusion

The study analyzed the effectiveness of a technology transfer and commercialization support program to Korean technology transfer offices and firms. The study created a logic model to design a questionnaire to analyze how the support program, directly and indirectly, affected the technology transfer offices and the firms' performances.

The study contains the following limitations. First, the analysis was conducted only through a questionnaire, which may not depict the program's actual performance. Not only this, measuring the performance of the technology transfer and commercialization activity of the TTOs and firms through the support program alone is difficult. There are many possibilities of improving a firm's performance, such as self-investment and other support programs; therefore, examining a firm's innovation performance may show limitations. Second, the study was conducted based on the KOSME logic model and its performance indicators; therefore, the study acknowledges that there may be limitations in using this methodology. Third, the data used in evaluating the performance is relatively old since the support program ran from 2015 to 2016. Despite these limitations, the study was significant in examining the technology

transfer and commercialization performance through the eyes of the TTOs and the firms' indirect performances.

This study and the results recommend strengthening and linking follow-up support programs to increase the firms' economic factor in job creation and sales. It would be necessary to provide follow-up programs for the firms participating in this program, such as prototype production support and commercialization linkage support, to develop the mid-term and long-term outcomes (increased sales and employment). Furthermore, policy development in creating a more technology-pull ecosystem is needed to enable participating firms to develop and commercialize the transferred technology into new products and innovation. Also, efforts should be made to raise awareness of this program to other potential firms with difficulties in materializing and commercializing technology demand. Therefore, follow-up research in this manner is needed to provide a more holistic view of the technology transfer and commercialization performance in Korea.

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