DEVELOPMENT OF INNOVATION PLATFORM OF NATIONAL INNOVATION AGENCY (NIA) IN THAILAND: SHAPING-UP OF INNOVATION POLICY FOR STARTUPS AND SMEs

Taeyoung Shin and Chaiyatorn Limapornvanich

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NATIONAL INNOVATION AGENCY
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EXECUTIVE SUMMARY

Thai economy had made a remarkable achievement during 1980s and onwards, though growth stalled for 1998-2000 by Asian financial crisis. In the past, the government took export-oriented growth strategy by attracting foreign direct investment. It is, then, the expansion of the manufacturing sector that shifted Thai economy from lower-middle income country to upper-middle income country.

However, the national economy has been sluggish after the global financial crisis. In order to move back to the long-term growth path, it would be necessary that new growth engines of the manufacturing sector should be developed in consideration of global value chain. Thus, Thai government recently turns its attention to innovation-driven growth strategy, by developing/nurturing startups and SMEs. Sizable investment is being made to establish science parks across the country, and to promote startups. It can be pointed out that the agricultural sector, tourism and internet services—without major innovation—would have only marginal effect on economic growth.

On the other hand, regionally imbalanced development has brought about an economic concentration in Bangkok+ and Eastern areas. It may have a negative influence on potential growth rate of the nation economy, and in addition, an effect to reduce the domestic market. For example, startups are developed and nurtured, most of them would look for the market in Bangkok+ and Eastern areas. If so, the economic impact of development of startups would be limited.

The governance structure in Thailand seems to be highly segmented and fragmented in policy-making and funding/implementing policies/programs. At present, there are many funding instruments regarding to research, technology development and innovation. Such a situation could stand for a while, because the amount of government budget is not large enough to bring a change. However, when innovation policy is placed in the center of the economic policy and increases the fund size significantly, needs for structural adjustment and/or reform of the STI governance will be increased. (Refer to Korean experience in Chapter 5) Thai government targets to increase R&D investment to about 2 percent of GDP by 2021.

As for policies/programs in developing/nurturing startups in Thailand, several points can be made. Both NIA and the science park pay an attention to establish the eco-system of innovation of startups/SMEs. However, from the view point of the demand side for support services, support programs are not developed enough in terms of quantity and quality. Business incubation of the science park provide services only for three years, and other business services are provided on demand without the systematic design of programs. It is

more important for the startup to survive in the market by securing its own market share, not simply to make a business. From the supply side, there seems to be a large room for development of specialty business services focusing on startups/ SMEs, such as business consulting, marketing services, and others. (Refer to Table 5-2). Without various specialty service units being developed, it would be difficult to develop and implement new support programs.

Thai government has taken an initiative for developing and nurturing startups, "Startups Thailand," and an effort is made at the inter-ministerial level. The Ministry of Science and Technology designates NIA as the lead agency for the "Startup Thailand," in implementing support policies/ programs for startups/ SMEs. On the other hand, the government establishes science parks such as Thailand Science Park and three regional science parks. NSTDA and SPA are responsible for developing and managing those science parks.

NIA as the lead agency formulates and implements various support programs, having funding instrument. This implies that NIA has versatility, to greater degree, in its policies/ programs to support startups and SMEs. At the circumstance of the government initiating startup policy through the combined efforts of related ministries, NIA should reshape its policies/programs. Meanwhile, NSTDA and SPA provide support programs and services to startups, based on physical facilities. In the future, it will be critical for them to obtain sustainability in maintaining and managing facilities of the science park, by securing revenue sources.

Finally, recommendations and suggestions are made as follows;

1. ***Expanding the domain of NIA's policy/program in supporting startups/SMEs***: It would be necessary to formulate and implement policies/programs over the entire range of innovation cycle. In so doing, policies/programs can be categorized into the following eight categories. Startups/ SMEs may search a support program in one of the following categories.

    - ***Education/training***: More extensive education and training programs should be developed ranging from K12, college students, potential entrepreneurs, and to retired persons.
    - ***Mentoring/ consulting***: Proactive programs are required to develop business service units. Hence, NIA can better support innovation of startups/SMEs.
    - ***Commercialization***: NIA can implement joint programs for commercialization between universities and startups. By evaluation, currently, NIA provides fund to SMEs for innovation. NIA could take more active actions to facilitate technology transfer and commercialization. That is, NIA staff can formulate and manage a joint action between universities and SMEs, including legal support.

- ***Financial support***: NIA has two major funding schemes. Continuing efforts to develop more funding schemes by investigating what startup's financial issues are. Along the growth stages, the startup need to make financial plan differently.
- ***R&D***: NIA may formulate new policy/ program for " industrial technology development." As industrial technology development will increasingly important, NIA should have a capacity to formulate and implement R&D programs for it. Such effort is related to develop growth engines of the national economy.
- ***Marketing (domestic/ overseas)***: Focusing the market in Bangkok+ and Eastern areas, startups/ SMEs would face a limit to growth. Marketing support has to be reinforced particularly for global market. Startup should target penetration to the global market from the beginning. Specialty marketing services are necessary.
- ***Networking***: So far, various networking programs are installed. However, networking to international knowledge hubs are important, since the knowledge base of Thailand is relatively weak at the moment. For example, Chiang Mai university is now undertaking a joint project, about application of Plasma to the agriculture, with a Korean government research institute. NIA could play a role to facilitate such a cooperation. Need to establish database of foreign knowledge hubs
- ***Facilities/ space***: Facilities/ spaces are provided mostly by science parks run by NSTDA and SPA. Therefore, NIA may play a role as intermediary between entrepreneurs who look for facilities and spaces, and science parks.

2. ***Developing and nurturing specialty business service units***: Not only implementing support policies/ programs, but also providing specialty business services is of vital importance for the innovation eco-system. It seems likely that no agency pay attention to the latter. Thus, NIA might formulate and implement new programs, particularly for developing and nurturing specialty business service units in various areas.

3. ***Industrial technology development: Program for new growth engines development***: R&D program is necessary to develop new growth engines in Thailand. This requires a well- prepared documentation of the plan by undertaking well- structured technology foresight. The program can be implemented through cooperation between industry, universities, and public research organization. For example, high- speed train could be a good case. It is important how quickly Thailand acquires necessary technologies for it; partly by in-house R&D and partly by outsourcing from abroad. Then, NIA (or other agency) might formulate a development program for the part of in-house R&D.

4. ***Creating the integrated portal for support programs/ services***: By creating the integrated portal which connects all support programs/services for startups in Thailand, entrepreneurs can readily get an access to them. To do this, extensive survey has to be undertaken to identify the programs/ services in eight categories above, and regularly updated. Standardization of application and evaluation process are also expected.

5. ***Close cooperation with science parks***: It is necessary to keep in a close touch with science parks, because science parks provide services based on facilities and spaces,

which lacks other services such as financial support and others. In addition, NIA should make an effort to develop business service units in regions where science parks are located.

6. ***Developing an innovation center with new concept***: NIA may attempt to develop an innovation center, in which multinationals participate as a sponsor enterprise. The sponsor enterprise can assist new startups in many ways, such as mentoring, developing new business and market, sourcing necessary technologies, and so forth. (Refer to Korea's Creative Innovation Center). However, heavy investment in establishment of physical facilities is not recommended. To do so, cooperation would be required at the inter-ministerial level. Because incentives to the multinationals will be necessary.

7. ***Creating the department of Planning and Coordination within NIA***: NIA may reform the organizational structure by creating the department of "Planning and Coordination." The mission/function of "planning and Coordination" department is to prepare annual actions with budget allocation at NIA level. This department has to monitor current programs and develop new programs for the next round actions, constantly. In so doing, it undertakes policy studies to identify new issues and develop corresponding programs, as the socio-economic situation is always changing over time. If the capacity of policy studies is not enough, NIA could outsource experts from universities and others. Building such capacity will eventually increase competitiveness of NIA as a funding/implementing agency.

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CHAPTER 1.
INTRODUCTION

In the backgrounds of this study, there was a decision made, in 2016, by both "Ministry of Science, Technology, Information and Communications," (former Ministry of Science, ICT and Future Planning, MSIP), Korea, and National Innovation Agency (NIA), Thailand, to undertake a joint project for NIA's development of innovation platform, when the Korean Minister visited the Agency. In so doing, MSIP send a Korean expert to NIA for the project.

NIA is a non-profit public organization under the Ministry of Science and Technology, whose mission is "to conduct activities that accelerate innovation in industry, business, government and society in systematic and sustainable way." NIA emphasizes to promote and support technological innovation of startups/SMEs, particularly focusing on technology transfer and commercialization. NIA also pursue creating an effective national innovation system in Thailand. To achieve the goal, NIA focuses fostering strategic innovation, promoting cluster development, and offering assistance to both the public and private sectors in developing and managing innovation.

On the other hand, NIA is an important funding instrument and implementing agency for innovation policies/programs. Recently, the government of Thailand recognizes the importance of developing/nurturing startups based on technological innovation, and promotes awareness by "Startup Thailand" campaign. The Ministry of Science and Technology (MOST) takes initiatives, which designates NIA as the lead agency for developing/nurturing startups.

Broadly speaking, there are three agencies for promoting innovation of startups/SMEs under the MOST. They are National Science and Technology Development Agency (NSTDA), Science Park Agency SPA), and NIA. NSTDA and SPA are responsible for managing Thailand Science Park (TSP) and the regional science parks, respectively. Therefore, those two agencies are to implement support policies/programs based on physical facilities.

Meanwhile, NIA formulates and implements various support programs for innovation of startups/SMEs, having funding instruments. As Thai government strongly pursues startup policy, i.e., "Startup Thailand," this is a momentum that NIA has to shape up its policies and programs in supporting startups and programs.

It, thus, will be worthwhile to study about the policies/programs implemented by NIA as a funding instrument. In so doing, suggestions and recommendations could be derived to harness NIA's policy/program, particularly in regard with facilitating innovation of startups.

The purpose of study is to develop innovation platform and assist harnessing innovation policy of NIA, by making an investigation of startup policy/programs in Thailand. In so doing, we will make an assessment of the Thai economy, RTDI (Research, Technology Development and Innovation) landscape, startup policies/programs implemented by NIA and science parks. On the other hand, we also review the startup policy/programs in Korea, for which we will look into startup policy and STI parks, and obtain some lessons and implications.

This study is organized as follows. In Chapter 2, we briefly introduce the theoretical concepts of the national innovation system, STI governance and STI parks. Those concepts would help readers understand this report better. In Chapter 3, we make an assessment of Thai macro-economic situation, and research, technology development and innovation (RTDI) landscape, including STI inputs/outputs and STI governance structure. In Chapter 4, we also make an assessment of startup policy/program in Thailand, including NIA's policy/program and science parks of NSTDA and SPA. They are major implementing agencies for the policy/program. In Chapter 5, we review the Korean exercise in implementation of startup policy/program including Korea's STI parks such as the Creative Innovation Centers, Innopolis (R&D Special Zones) and Techo-Parks. We expect to obtain some lessons and implication form their exercises. In Chapter 6, we will provide policy recommendations and concluding remarks.

CHAPTER 2
THEORETICAL BACKGROUNDS

2.1. NATIONAL INNOVATION SYSTEM

In general, technological innovation is defined as the process through which new and/or improved technologies are developed and brought into practical use. In explaining the process of technological innovation, the theory has shifted from the linear, non-linear models to the complex model. It implies that the technological innovation takes place increasingly in a complex way. The concept of the innovation system since late 1980s has been introduced and enriches the understanding of technological innovation.[1] The approach of the innovation system mostly focuses on flow of knowledge, learning, and interaction of the innovation units; such as firms, universities and research institutions.

The theory of the innovation system places a focus on the interaction of innovation units and flows of knowledge in the given system. Such a theory should be developed as looking into the innovation system of the advanced country. In general, STI (science, technology and innovation) capacity at the level of the innovation unit has been well developed in the advanced country, and thus the main concern should be placed on the dynamism of the innovation system. With greater dynamism of the system, innovation would occur more frequently.

The critical point of such theory lies in that the STI capacity of the innovation unit is already built in at the advanced level. It does not assume that the level of capacity changes over time. Then, it will be more important is to focus on investigation of the system which regulates interaction and the knowledge flow between the innovation units. It could be argued, however, that the theory should look into the process of building STI capacity of the innovation unit. Knowledge or STI resources might be available in advanced countries, while not always in developing countries.

Therefore, it would be worthwhile to consider the innovation system as continuity, particularly when the developing country is concerned. That is, there will be a developed, developing and/or underdeveloped system of innovation. Such a view could expand the domain of innovation policy for, particularly, the government of the developing country.

The STI capacity of universities, research institutes and enterprises would be determined by

[1] For more discussion, e.g., refer to Freeman (1987).

the accumulation of R&D (R&D stocks) of itself, and STI capacity of other units. R&D manpower is also an important factor determining STI capacity. Many developing countries experience brain drain and hence difficulties in securing the R&D manpower, when needed. The manufacturing sector (growth and structure) is one of most important area where technological innovation takes place, and have a significant influence. Therefore, the knowledge system in the developing country should be aligned with the direction of industrialization, since industrialization is influenced nowadays by both conventional factors of production and knowledge. STI environment and others also have an influence on technological innovation, in a way that they regulate the STI activity.[2]

The STI park could be considered as a compressed system of innovation or a part of the innovation system. Usually, the STI park is known that the knowledge-producing institution and firms are located together in a place, including related organizations. The industry in the park could link to other industrial ecosystem—and create its own ecosystem—for a (global) value chain. If the firm in the STI park fails to link to other value chains, the development strategy (of the nation or region) based on the STI park may not be effective, and therefore the industrial performance of the STI park is critical. However, the knowledge institution in the park would determine the technological competitiveness of the enterprise. Modern industry is developed mostly based on technological innovation, not simply on investment in conventional factors of production. If an industry is developed based on cheap labor, the industry would not be sustainable; because it is very difficult to obtain the competing edge continuously over time in a globalized world. This is why the role of knowledge system is important, since it increases the technological competitiveness of the industry eventually.

However, it is not easy to bring the knowledge into application for the business, if the rationale of the knowledge institution is different from that of the enterprise in a system. In most cases, the knowledge sector can hardly foresee economic consequences and/or benefits from the knowledge/technology produced, and thus the primary objective of the knowledge sector is often placed on pursuing the scientific excellence, not creating business. In this line, the STI park draws an attention to facilitate making business of technology.

2.2 STI GOVERNANCE

Unlike the policy approach of the neoclassical economics, when the variables of science, technology and innovation come into the scene of the public policy management, the complexity facing the government sharply increases in process of decision-making. Because most socio-economic problems today are caused and cured by science and technology, an increasing number of stakeholders pay an attention to STI policies of the government.

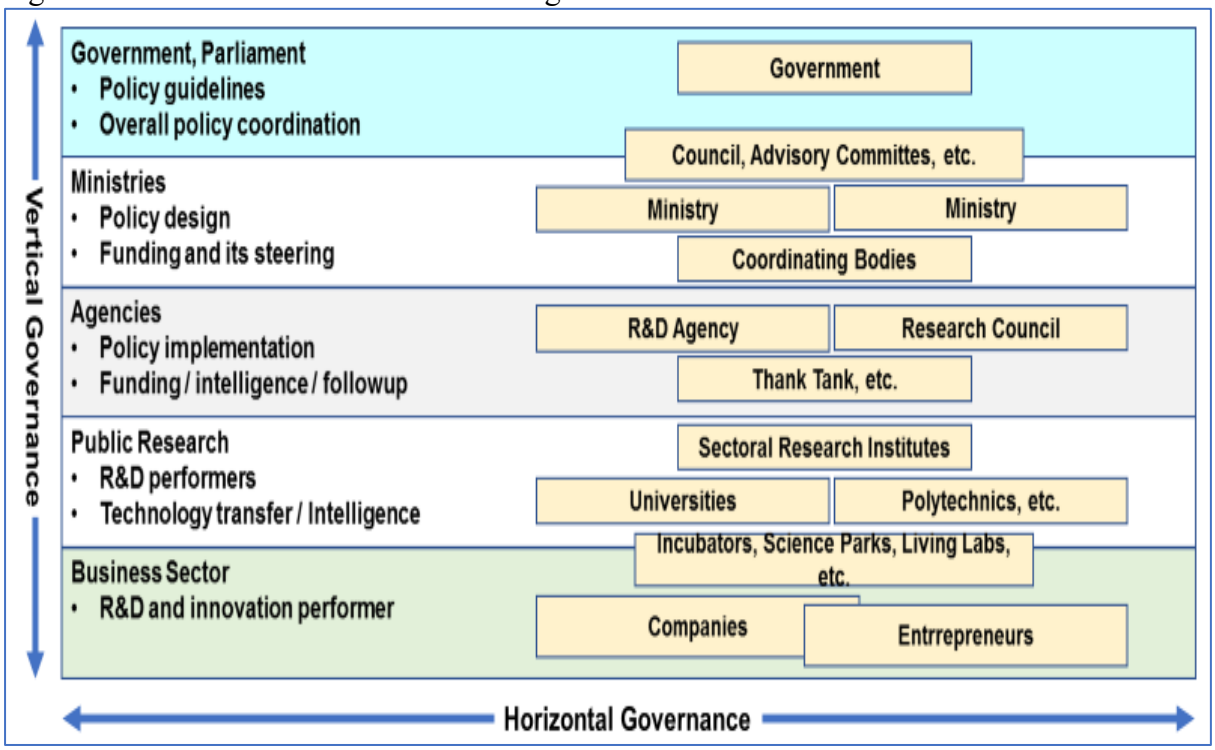
The STI governance system, therefore, draws a good deal of attention. The STI governance is

[2] For more critical discussion about the innovation system, refer to T. Shin et. al. (2012).

defined as "the processes of interaction and decision-making among the actors involved in a collective problem that lead to the creation, reinforcement, or reproduction of social norms and institutions." (OECD 2005, p5). Specifically, Well-structured governance is necessary, because of competing rationales over individual policy domains, short-termism in resource allocation, undermining log-term strategy, different views and understanding of innovation policy, and fragmentation ad segmentation, etc. (OECD 2005, p8)

A schematic presentation is exhibited in the following Figure 2-1. In the decision-making process, there exist several layers. At the top governance, policy coordination and final decision is made by the highest government level. This is necessary because there are many STI-related ministries at the ensuing level of the governance. Each ministry may pursue STI policy for its own purpose. Since each ministry has the different purpose, coordination over the policy domain of the ministry level has to be made to align all resource allocations with the national goal. Then, each ministry would have an agency for implementation of its policy. This agency should have the expertise in STI policy studies and management. Lastly, there will be R&D performers in the public and private sectors. The public sector includes research institutes and universities, while the private sector firms and corporate research institutes. This is about the vertical governance.

Figure 2-1. Schematic Presentation of STI governance



Source: C. Palmberg and T. Lemola, "Governance of Innovation Systems," p.472, in http://siteresources.worldbank.org/INTARD/Resources/335807-1330620492317/8478371-1330712184295/Module6-TN2.pdf. [17November 2016].

In the horizontal governance, there are many actors being engaged in STI activities. At the policy level, an increasing number of ministries make an intervention of STI activities for their own purposes. For example, nowadays, the industry policy is not well distinguished from S&T policy.

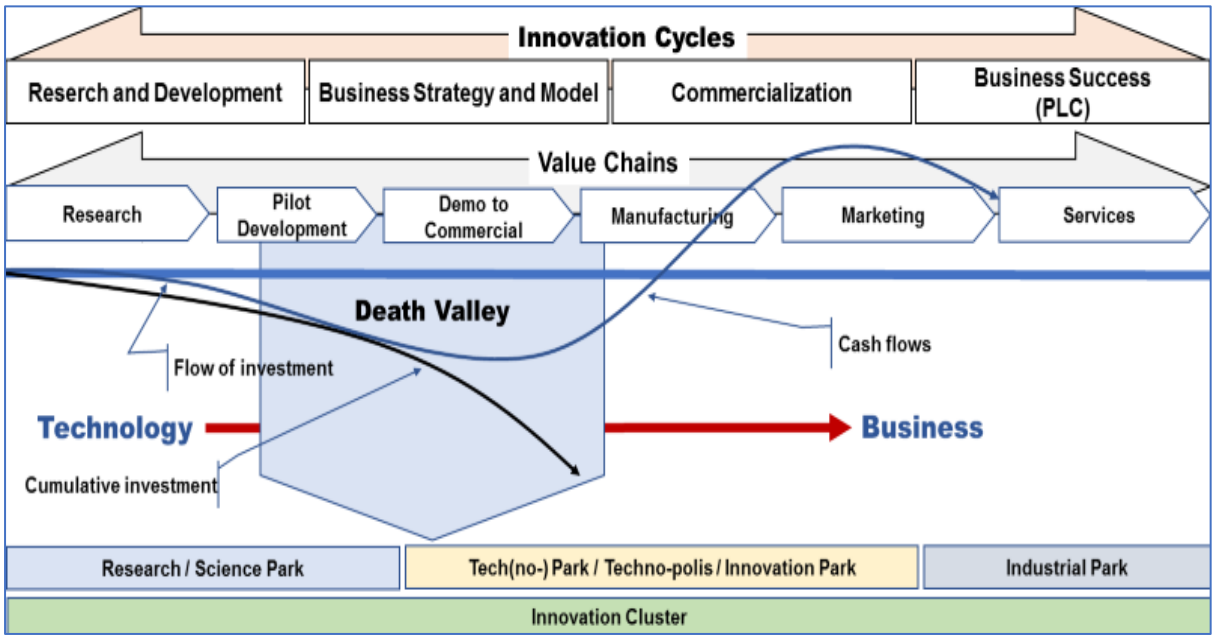
The ministry of health also pays a good deal of attention in STI policy, and so on. As more stakeholders with different objectives intervene STI policy-making, a good exercise of coordination and concerted actions are essential. Because resources are limited. In this line, the government has to undertake regularly strategic planning with creating the national vision and making horizontal approach on the appropriate knowledge bases.

However, the STI governance sometimes is not clear in many cases, and lack of long-term strategy. It is well observed in those countries that the knowledge base for STI policy is relatively lower. When a decision is made, analytical information is necessary to assist the decision-making. If the knowledge base weak,

2.3. STI PARKS

There are many types of Science, Technology and Innovation (STI) parks in the world. They are the science park, research park, tech(no-)park, techno-polis and others. There are also government-led, university-led, and business-led parks. However, it is known that the primary purpose of STI park is to bring innovation in the private sector, to nurture technology startups, to facilitate industrial development, and hence to promote economic development. In the following, we review the theoretical concept of STI park, and success/failure factors derived from the global experiences with development of STI parks.

Figure 2-2. Innovation Cycles and STI Park



In view of the innovation cycle and/or value chain as shown in Figure 2-2, the firm's activity can be described along the value chain, which consists of the stages of *research, pilot development, demo to commercial, manufacturing, marketing, and services*. Up to the point of commercialization, a sizable investment with uncertainty would be made for a long-time period,

which a single enterprise can hardly afford to; particularly the small- and medium-sized enterprise. A firm contemplating an R&D project usually faces uncertainties from within and from without. The effort required to complete the R&D, the magnitude of the invention obtained and its value are all uncertain at inception. Therefore, the firm tends to reduce investment in R&D. However, after the firm successfully makes a commercialization of new product/service and start to make investment for manufacturing/marketing, the firm will be able to earn revenues.

It is known that there exists a Death Valley when technology is brought into the business. In other words, the enterprise cannot afford to make investment over the full cycle of innovation until commercialization is succeeded. The grey area in Figure 2-2 denotes the Death Valley over the process of the innovation cycle. Without government intervention, the private enterprise may not bridge this gap at its own cost.

Bridging over the Death Valley, the government implements various innovation policies. As a strategic tool, recently, so-called STI park is often introduced for such a purpose. Using the illustration of Figure 2-2, the park could be characterized as the science/research park, Technopark/techno-polis/innovation park, and industrial park, moving from the left-hand side to the right. In either case, the park is developed towards the innovation cluster in the long run, embracing the entire innovation cycle, which places innovation units, related institutions and technology-based businesses. If the government places a focus on development of the knowledge system relatively, the science/research park would be developed at the beginning.[3] If industrialization is emphasized more, the industrial park will be developed first; which often happens in the developing country. Today, economic development should be propelled through both development of knowledge system and industry.

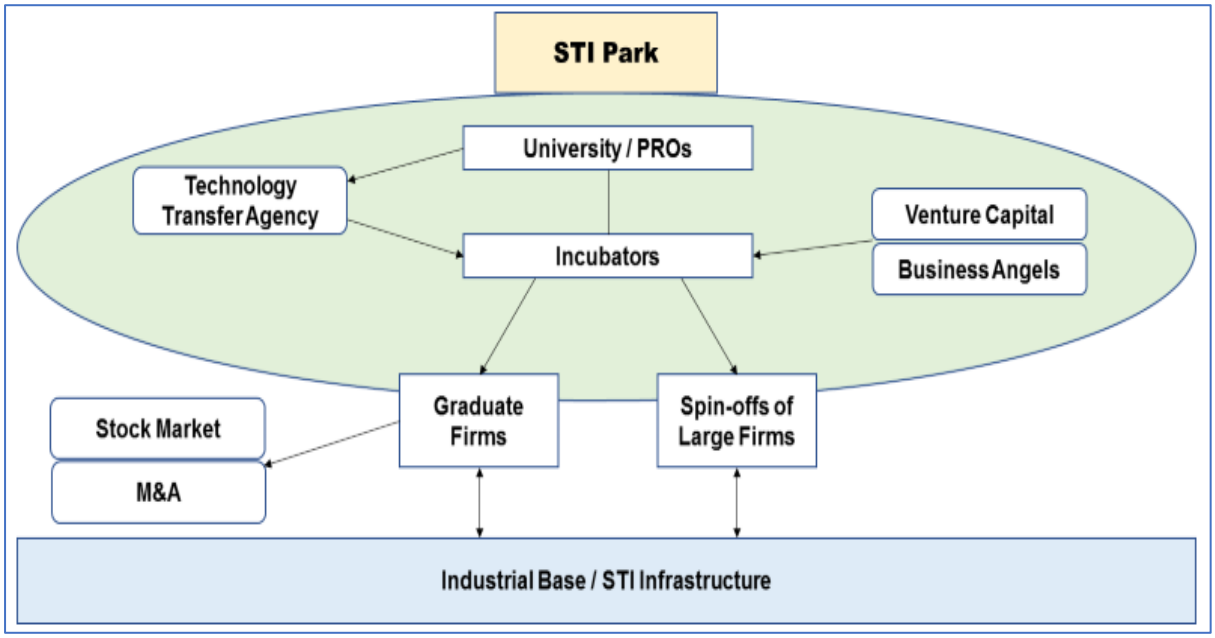
In this line, the STI park could be an effective scheme for regional or nation economic development. However, conditions and environment are important. That is, the knowledge system has to be developed enough to provide technological opportunities, and also the industrial ecosystem for a value chain has to be innovation-friendly. Knowledge could flow from the knowledge hub in the region and/or from international hubs. Creating industrial ecosystem implies whether the domestic firm could secure a share of the market. Otherwise, the economic consequence of the STI park would be limited.

In a system approach, the STI park can be explained within the framework of the regional/national innovation system, in which its primary function is the incubating of the technology startups, as shown in Figure 2-3. In most advanced countries, STI park includes universities, incubator, innovation-related institutions and others in a place. The STI park as an incubating facility plays a critical role in development of the local/regional economy. The entrepreneur

[3] A typical case was shown in Korea, in which the government established a physical complex for various research institutions at the beginning of the industrialization. It had been a driving force to develop the knowledge system of Korea, and now under reshaping to develop an innovation cluster.

with a business idea is incubated in the STI park, based on screening and evaluating his/her business plan. In the STI park, the tenant firm can be assisted by various support programs, such as technological development, business strategy, financing, marketing and others. During incubation, if the tenant firm meet the exit criterion, it will graduate and move into the regional industrial base. Or it could be purchased by the large firm through the M&A market. Successful startups can be listed in the stock market. In such ways, the entrepreneur and/or investors such as business angels and venture capital can earn return on their investment. On the other hand, successful startups may grow up and facilitate economic growth in the region.

Figure 2-3. STI Park and Regional Innovation System



Source: Revised from OECD (1997).

In this line, recently in many developing countries, the STI park is taken account into consideration as a strategic vehicle (or a hub) to stimulate not only industrial innovation, but also development of the knowledge system in the long run. If such a hub is successfully developed, it would facilitate for the regional and/or national economy to move eventually towards a knowledge-based economy, and hence secure economic sustainability. However, it can be said that the performance of STI park would be highly dependent on the STI environment, which regulates technological innovation. There are a number of factors influencing STI environment; such as STI capacity of the innovation unit, framework condition, entrepreneurship, and cultural background, etc.

As an example of STI park, the Silicon Valley in California pioneered it and developed the concept of innovation cluster, beginning in the early 1950s. In Japan, Tsukuba Science City was developed in the late 1960s; in 1970s, Sophia Antipolis in France, and Daedeok Science Town in Korea. In the following, we briefly discuss them.

Silicon Valley was born by the combination of several contributing factors, such as university research, entrepreneurship, venture capital and others. The leadership of Stanford University was especially important in the early development. During the 1940s and 1950s, it is known that Professor Frederick Terman encouraged faculty and graduates to start their own business. He deserves a credit for nurturing the creation of such companies as Hewlett-Packard, Varian Associates, and other high-tech firms, until so-called Silicon Valley grew up around the Stanford campus. Professor Terman is often considered as "the father of Silicon Valley." His insight, dedication and leadership were critical to initiate the Valley as an innovation cluster. In addition, other factors played important role to bring a success of Silicon Valley, such as R&D, entrepreneurship, venture capital/angels, and business-friendly environment.

Tsukuba Science City represents one of the world's largest coordinated attempts to develop the knowledge institutions intensively. The University of Tsukuba and 46 public basic scientific research laboratories began in the 1970s. By 2000, the 60 national research institutes and two universities had been grouped into the zones of higher education and training, construction research, physical science and engineering research, biological and agricultural research, and common (public) facilities. Those zones are surrounded by more than 240 private research organizations. However, it is pointed out that Tsukuba Science City, to some degree, is unsuccessful to foster development of technology-based business, due to the lack of linkage between the research institutes and industry.

Sophia Antipolis is a technology park in France, which was created and built in 1970~1984. The park accommodates primarily business enterprises in the fields of computing, electronics, pharmacology and biotechnology. Several learning institutions are also located in the park area, along with the European headquarters of W3C (World Wide Web Consortium) and the European Telecommunications Standards Institute. To promote interaction between tenants, networking and cross fertilization of ideas, the basic concept was that “bringing together people and making them meet,” which would bring added value and generate innovation. Many professional clubs began to launch, such as the Sophia business angels club, the Sophia Nordic link, Art Sophia, and Telecom Valley, etc. Senator Pierre Laffitte is known as the founder of Sophia Antipolis, whose insight and dedication underpin the park-building. (http://www.sophia-antipolis.org/index.php/sophia-antipolis/le-parc).

Daedeok Science Town is the R&D district in Daejeon, developed by the Korean government since 1973. Daedeok Innopolis grew up out of the R&D district. Major research institutes in the public and private sector make up this science cluster. In the course of Korea’s economic development, it played a critical role to build up R&D capacity and brought major innovations in late 1980s and early 1990s. Further investment is being made to reshape the Daedeok Science Town towards an innovation cluster.

Since 1980s, STI park development is actively made in Asia, Africa, Europe and Latin America, etc. The principal purpose of STI park development is to promote economic development, as

the world moves into the knowledge-based economy. STI park development and achievement are influenced by various factors. We observe that some are successful; some are not.

Main factors for successful development are

- Dedication and leadership of participants from universities, business, and/or government
- Interaction between research organizations and industries in developing new technology-based business
- Sustained government policy creating STI-friendly environment including infrastructure and human resources.
- Developed NIS/RIS: increased STI inputs and outputs, and framework conditions.
- Cultural/social backgrounds nurturing entrepreneurship

Some factors are often pointed out when the development is less successful.

- Strong dependence on government support which is not continued with a consistency
- Lack of innovation culture and resources; particularly entrepreneurship
- Lack of network of innovation units between universities, business and government
- Low STI capacity
- Underdeveloped industrial eco-system

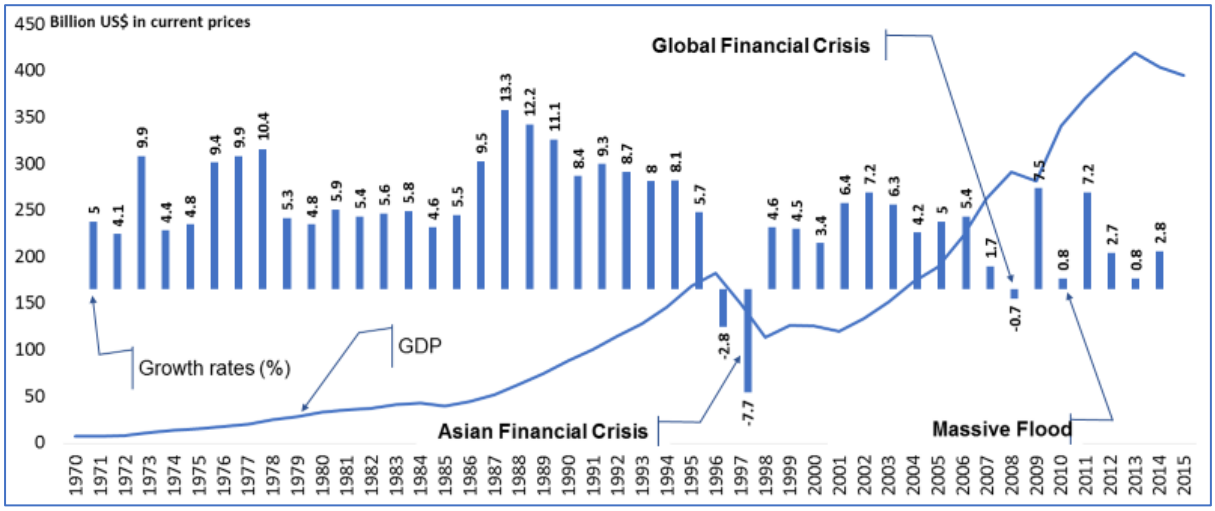
In a sense, a tool of the STI park is a community approach, not an individual approach. It is because various stakeholders are engaged in making a success. In this line, the leadership plays an important role. Fertile soil of entrepreneurship, financial system, science and technology base, among others, are important factors to establish an innovation platform, on which startups/SMEs would be developed and nurtured.

CHAPTER 3
RESEARCH, TECHNOLOGY DEVELOPMENT AND INNOVATION (RTDI) LANDSCAPE OF THAILAND

3.1. ECONOMIC OVERVIEW

Over the last four decades, Thailand has made a remarkable progress in socio-economic development, moving from a lower-middle income country to an upper-middle income country. In the 1970s, Thai government pursued export-oriented development strategy, taking account of foreign direct investment (FDI) as a strategic approach. FDI focused on electronics, automobiles, and resource-based products. During those time periods, lower wages of Thailand was one of main sources attracting FDI; particularly Japanese multinational enterprises. So that Thai economy has been able to participate the global production network. Over the period of 2007-2012, according to ADB (2015), overall labor productivity grew 1.9 percent; 2.5 percent in manufacturing, 1.9 percent in services, and 0.9 percent in agriculture. It implies losing competitiveness in low-wage, low-skilled goods to less developed countries. The major part of the workforce is still employed in low-productivity, small-scale activities in trading and services. (ADB 2015).

Figure 3-1. GDP Growth

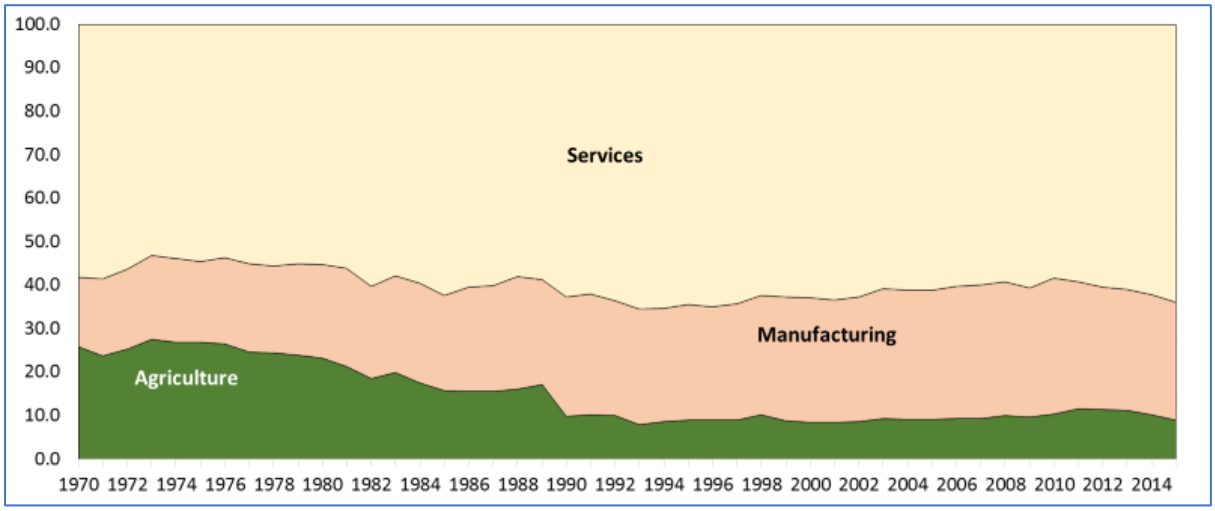


Source: https://unstats.un.org/unsd/snaama/dnlList.asp [28 February 2017]

Thailand's economy grew at an average annual rate of 5.5 percent over the period, 1970-2015. The annual growth rate was 7.5 percent in the boom years of 1971 to 1996 and 4.0 percent following the Asian crisis during 1999-2015. However, GDP grew by less than 2 percent a year

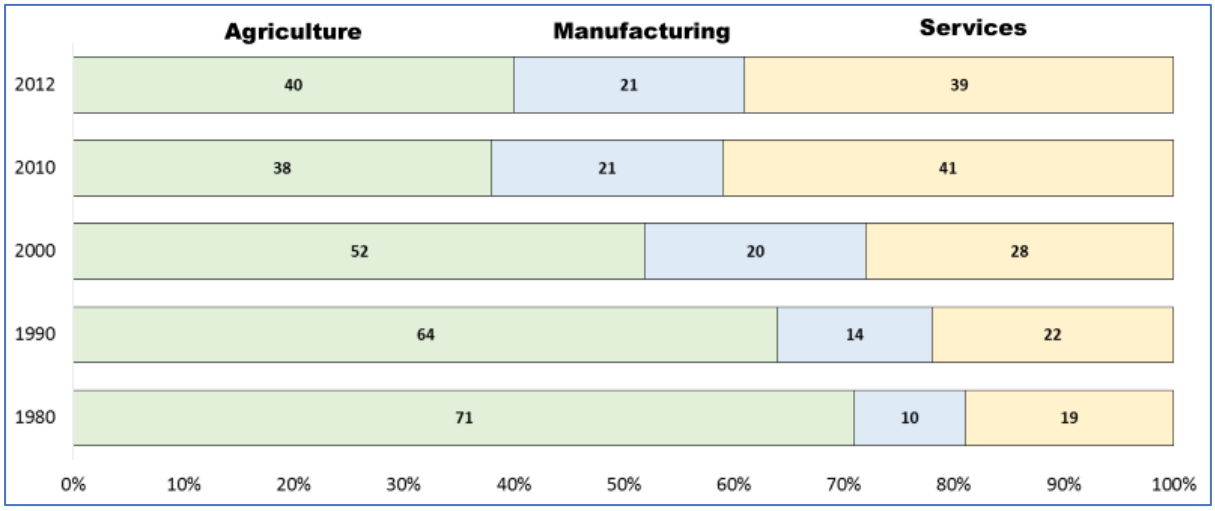
in 2013-2015. Recent sluggish growth was influenced mainly by global financial crisis in 2008, massive flood in 2011, political unrest in 2006 and 2014 as well as structural problems.

Figure 3-2. GDP Share by Industries



Source: https://unstats.un.org/unsd/snaama/dnlList.asp [28 February 2017]

Figure 3-3. Employment Shares by Industries



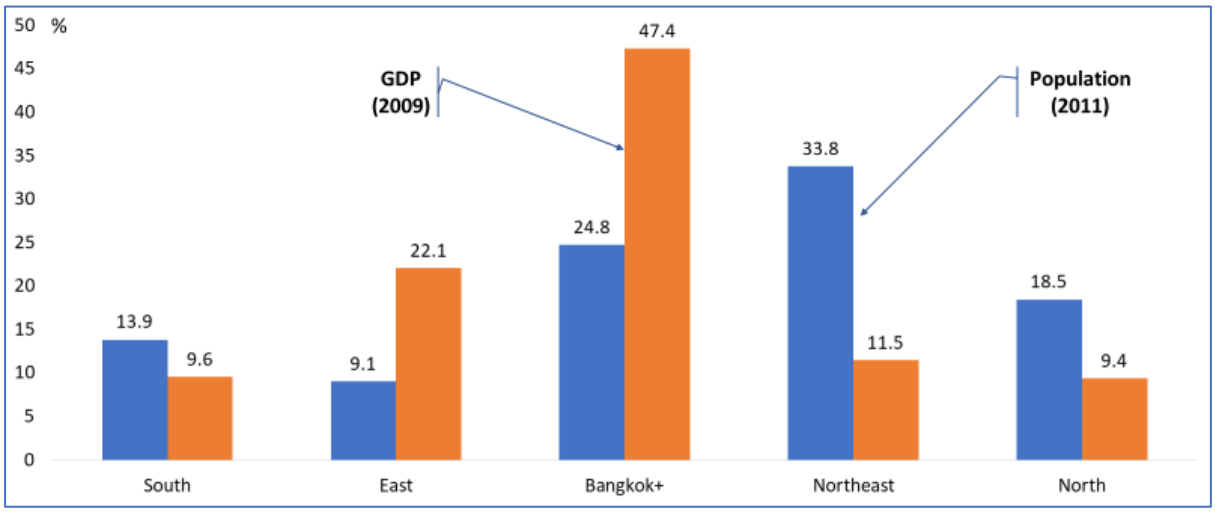
Source: UNCTAD (2015), p.3.

In the economic structure, the composition of service sector and non-service sector is stable over a long period of time, 1970-2015 as shown in Figure 3-2. Only a relative change is made between agriculture and manufacturing sectors. The economic development significantly increased the GDP share of the manufacturing sector (ISIC D) over the time period of 1970-2015; from 15.9 percent in 1970 to 26.9 percent in 2015. The GDP share of the agricultural sector decreased from 25.9 percent in 1970 to 9.6 percent in 2015. However, the agricultural sector accounts for more than 40 percent of total employment, which implies the polarization between sectors becomes worse. As shown in Figure 3-3, the employment share of the agricultural sector was about 71 percent and decreased to less than 50 percent in 2010 and 2012. Meanwhile,

that of the manufacturing sector was about 10 percent in 1980 and increased to 21 percent in 2010 and 2012. The employment share of the service sector increased from 19 percent in 1980 to 39 percent in 2012, reflecting the urbanization over the period.

In addition, the imbalanced economic growth over the regions becomes increasingly serious. The region of Bangkok and vicinity account for about 47.4 percent of GDP in 2009 and 24.8 percent of population (in 2011). The Eastern region accounts for 22.1 percent of GDP and 9.1 percent of population. The Southern region and Northern region accounts for 9.6 percent and 9.4 percent; and the shares of population are also 13.9 percent and 18.5 percent, respectively.

Figure 3-4. Population and GDP by Regions



Source: taken from SPA's fiver-year plan (2013-2017)

Table 3-1. Locations of Establishments by Provinces: Auto Industry

	Up to 1960	1961-75	1976-85	1986-99	2000-14	Total
Bangkok	18	75	102	293	133	333
Vicinity	4	64	72	297	129	566
Central	0	5	4	69	22	100
East	0	16	12	202	99	329
Northeast	1	1	2	17	5	26
South				4		4
Total	23	161	192	885	389	1,650

Source: I. Kurowa and K. Techakanont (2016).

On the other hand, for example, the automobile industry is one of the areas focused by FDI. It is shown that auto industry concentrates in the area of the Bangkok Metropolitan Area and the East. Total number of auto enterprises are 1,650, most of which were established after the mid-1980s. In the areas of Bangkok and the vicinity, the number of enterprises are 899, and in the East, 329. Such concentration probably shows not only that transportation infrastructure is not well developed, but also that the manpower in remote areas is not enough.

Such imbalanced growth pattern by regions, showing economic concentration around the Bangkok region, might be related to the growth potential in the long run. To coper with such issue, recently, the government has made sizable investment in developing science parks in the three regions, Northern, Northeastern and Southern areas, establishing innovation networks with major universities in the region. Main purpose of the science park is developing/nurturing startups through incubation.

Table 3-2. Exports by Commodities

Unit: million dollars, %

SITC	Commodities	1985		2000		2015	
		Values	Shares	Values	Shares	Values	Shares
0	Food and live animals chiefly for food	3,160	44.4	9,642	14.0	26,686	12.7
1	Beverages and tobacco	61	0.9	172	0.3	1,490	0.7
2	Crude materials, inedible, except fuels	740	10.4	2,693	3.9	8,998	4.3
3	Mineral fuels, lubricants and related materials	99	1.4	2,210	3.2	8,294	3.9
4	Animal and vegetable oils, fats and waxes	22	0.3	77	0.1	299	0.1
5	Chemicals and related products, nes	94	1.3	4,061	5.9	20,485	9.7
6	Manufactured goods classified chiefly by materials	1,240	17.4	8,125	11.8	26,558	12.6
7	Machinery and transport equipment	637	9.0	29,984	43.6	94,464	44.8
8	Miscellaneous manufactured articles	983	13.8	9,891	14.4	19,824	9.4
9	Commodities and transactions not classified elsewhere in the SITC	85	1.2	1,964	2.9	3,786	1.8
	All Commodities	7,122	100.0	68,819	100.0	210,883	100.0

Note: Current prices

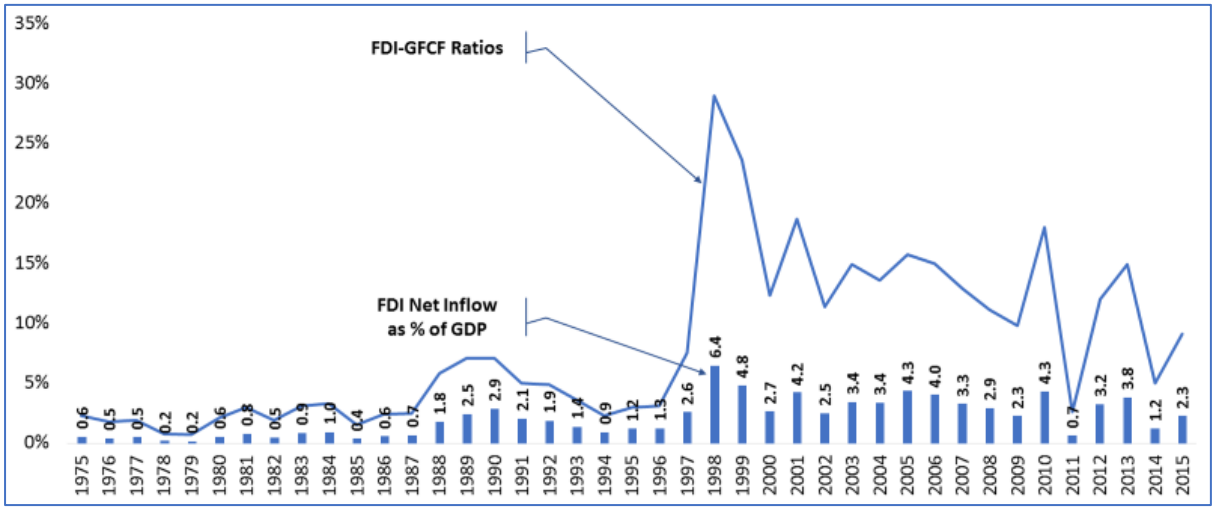
Source: UN Comtrade, https://comtrade.un.org/data/ [15 April 2017].

Due to remarkable performance in manufacturing sector, there has been also a significant change in the export. The total export increased from about 7.1 billion dollars in 1985 to about 210.9 billion dollars in 2015: about 30 times increase in export over last 30 years. In 1985, major exports were agricultural products (SITC 0) and light-industrial products (SITC 6), which reflected the less sophisticated industrial structure. Such export structure changed, as, in 2000 high-tech industrial products (SITC 7) became major export. In 2015, out of total export, the share of those high-tech products, SITC 7, accounted for about 44.8 percent. In the manufacturing, major products are automobile and electronics (hard disks), for which parts and materials depends on the import from abroad. Mostly. The assemblers for those products are multinationals, while the first and second suppliers are local firms. Meanwhile, the export share of agricultural product (SITC 0) reduced to 12.7 percent in 2015 from 44.4 percent in 1985.

Foreign direct investment (FDI) played an important role in the course of economic development. FDI inflow in Thailand averaged annually about 3,916 million dollars from 1975 until

2015, reaching an all-time high of 15,936 million dollars in 2013. On the other hand, as percentage of GDP, the average of FDI inflows is 2.1 percent of GDP and reached a peak of 6.4 percent in 1998, after Asian financial crisis, and it shows a strong trend until 2010: roughly 3.7 percent, and slowed down after 2011. FDI also accounts for a significant portion of the aggregate investment (GFCF). It averaged about 8.0 percent of GFCF over the period of 1975-2015, and peaked at 29.0 percent in 1998, right after Asian financial crisis, and 18.0 percent in 2010. Afterwards, it continued to decrease.

Figure 3-5. FDI Net Inflow as % of GDP



Source: UN Statistical Portal, https://unstats.un.org/unsd/snaama/dnlList.asp and World Bank Database, http://data.worldbank.org/indicator/BX.KLT.DINV.CD.WD?locations=TH [19 April 2017].

3.2. RESEARCH, TECHNOLOGY DEVELOPMENT AND INNOVATION (RTDI) LANDSCAPE

3.2.1. STI ACTIVITY

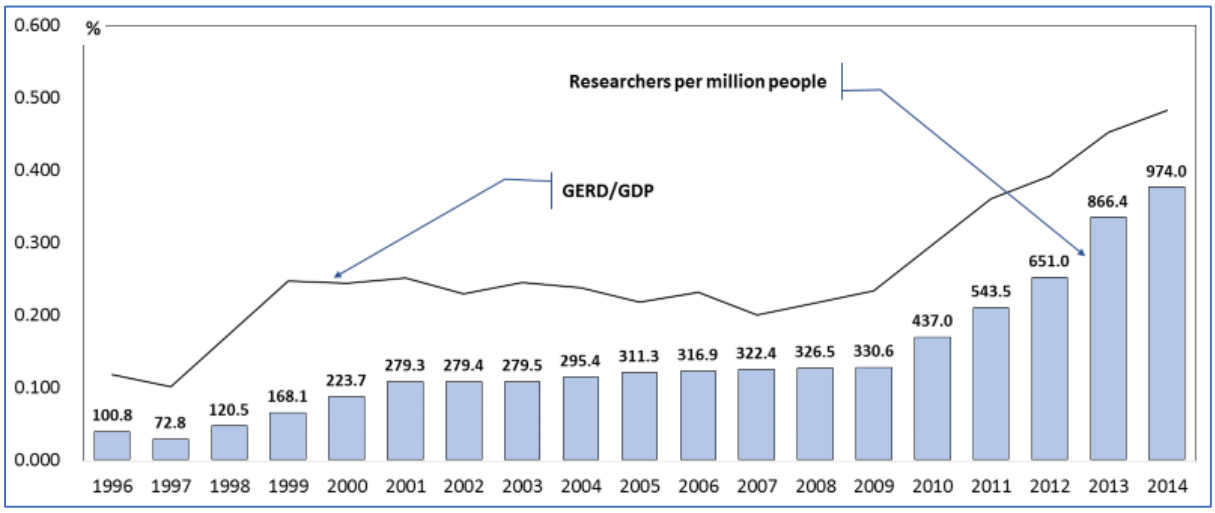
(1) R&D Inputs

R&D investment is a major indicator representing STI inputs. R&D is recognized as core activity creating new knowledge, which brings eventually innovation. In comparison with fast industrialization in Thailand, R&D activity have been sluggish. Until the 2000s, the gross expenditure in R&D (GERD) had been stable: roughly less than 0.25 percent of GDP. Since 2010, GERD increased sharply, and in 2014 the GERD-GDP ratio reaches at 0.48 percent. The GERD-GDP ratios of the industrialized countries in East Asia are by far higher than that of Thailand. The ratios of Korea and Japan are 4.29 and 3.58, respectively, in 2014; and China 2.05 percent. Neighboring Malaysia shows the ratio is 1.26 percent. Considering that industrialization is accompanied by S&T development, R&D investment in Thailand is too little to

push Thailand towards knowledge-based economy. It is probably because the economic development in the past had been led by the multinationals, not by domestic industry.

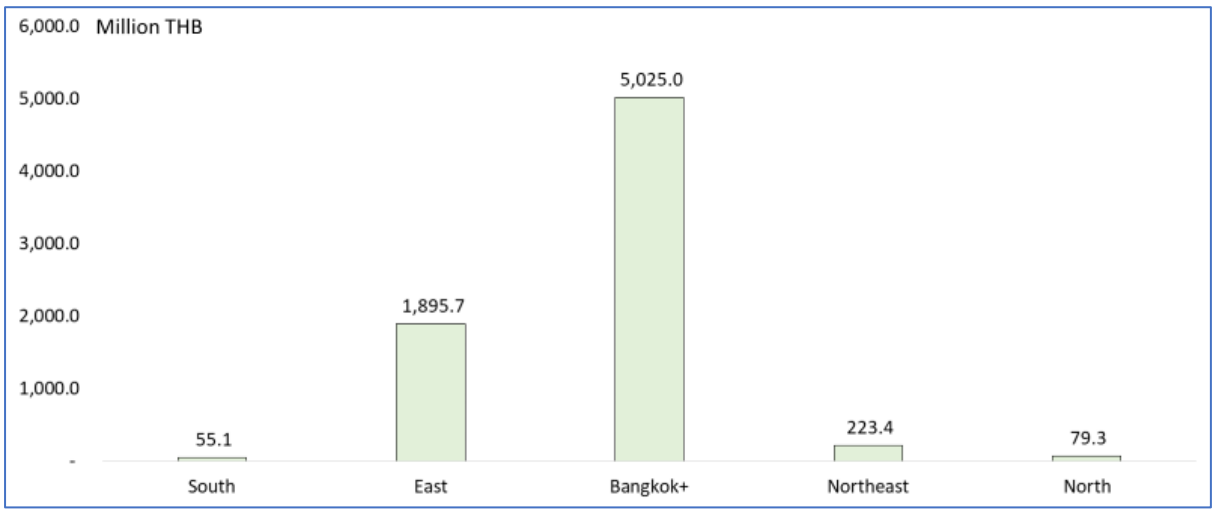
The government share of GERD in Thailand was about 61.2 percent in 2014, while that of the private sector was 38.8 percent. However, it can be seen in Figure 3-11 that major part of GERD is funded by the business sector in most industrialized economies in East Asia. That the government fund is larger relative to the private fund appears for the government to lead R&D of the private sector, but taking account of the size of GERD, the government effort is not enough to promote economic-wide R&D activity.

Figure3-6. R&D Inputs



Source: http://databank.worldbank.org/data/home.aspx [28 February 2017]

Figure 3-7. R&D Investment by Regions: 2008

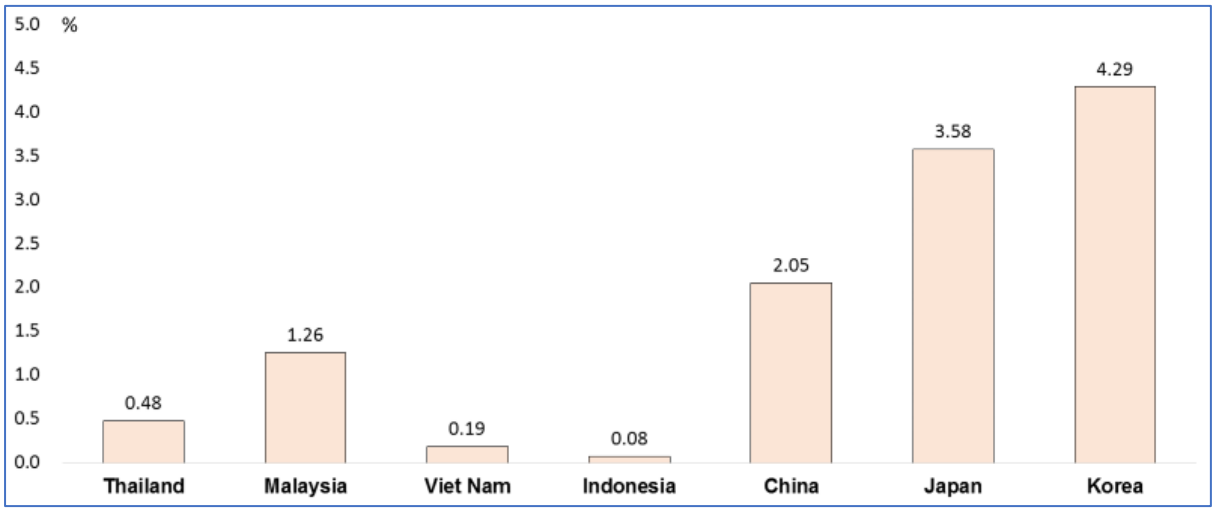


Source: taken from SPA's fiver-year plan (2013-2017)

It is also pointed out that R&D investment is widely varying across regions. The area of Bangkok and vicinity accounts for about 69.0 percent in 2008 and the Eastern region for 26.0 percent.

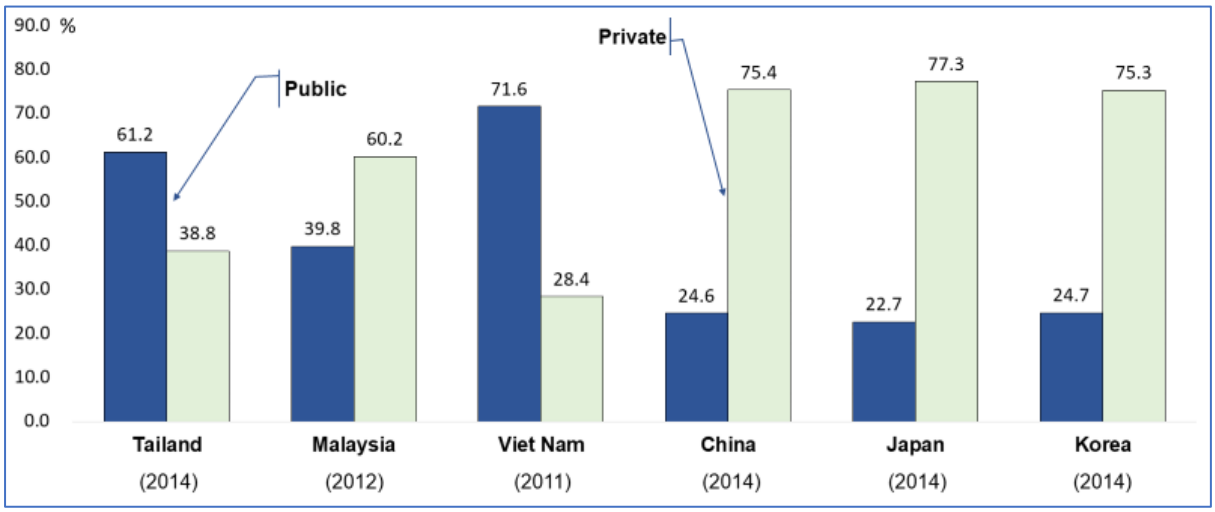
Other areas accounts for about 4.9 percent, combinedly. It implies that the scientific and innovation platform is very weak in those areas of North, Northeast and South, relative to Bangkok and Eastern areas. If the innovation-driven development of the regional area is a right answer, the increase in R&D investment for those areas falling behind is imperative.

Figure 3-8. GERD-GDP Ratios by Countries



Source: http://uis.unesco.org/ [18 April 2017]

Figure 3-9. GERD by Fund Sources



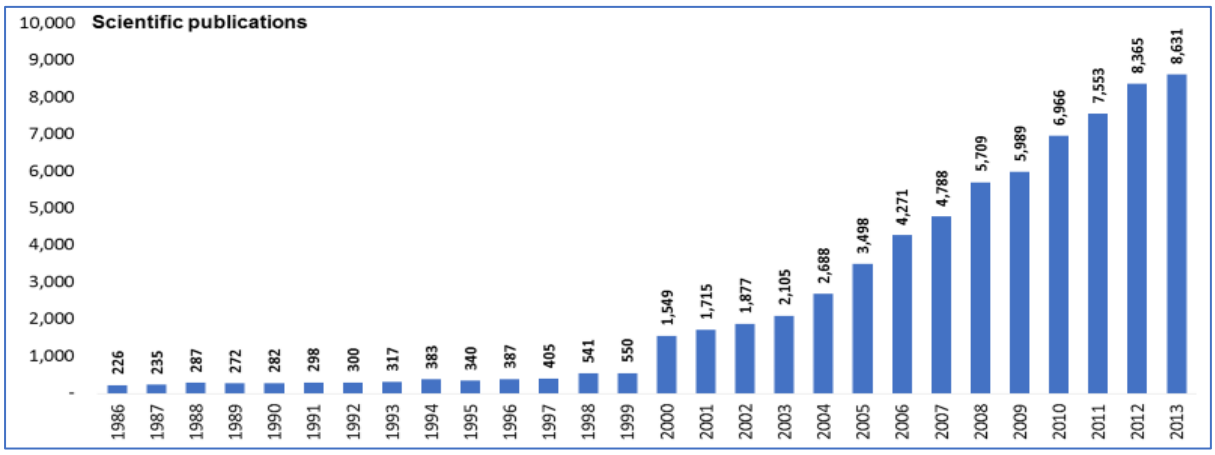
Source: http://uis.unesco.org/ [18 April 2017]

R&D is recognized as an investment, but not merely spending or cost. If so, the accumulation of R&D becomes important, since innovation is determined by the accumulation of R&D, i.e. R&D stocks. It is said that R&D stocks represent the level of knowledge of a country. It means that Thailand has to make much greater efforts to catch up with the gap of R&D stocks in consideration of those of advanced countries. On the other hand, the demand of domestic enterprise is very weak for R&D and hence technology, and the government policy could not

stimulate and induce the private R&D investment enough. In this regard, the current level of R&D investment should be increased more effectively in both public and private sectors.

On the other hand, R&D manpower exhibits a similar trend from Figure 3-6. The number of researchers full-time equivalent (FTE) was 65,965 in 2014, showing about 974 researchers per million people. Furthermore, only about 43.1 percent of researchers are employed in the business sector, while the government and universities employ 15.2 and 40.9 percent, respectively. On the whole, it can be pointed out that R&D inputs are lower, and the public share is relatively larger than the private sector. This implies that the private sector is not active significantly to create needs for technological innovation as much. It may be because the high-tech industry is led by the multinationals, while domestic firms are not innovation-driven. The increase in R&D investment of the private sector will increase the dynamism of the innovation system by increasing interaction of the firm with universities and research institutes. That is, the dynamism of the national innovation system is not increased well enough in this sense. One of targets of the National STI Policy and Plan, 2012-2021 is to increase GERD to 2 percent of GDP, and the share of the private expenditure in R&D to 60 percent.

Figure 3-10. Scientific Publications



Source: http://data.worldbank.org/indicator/IP.JRN.ARTC.SC?locations=TH&view=chart [31 March 2017].

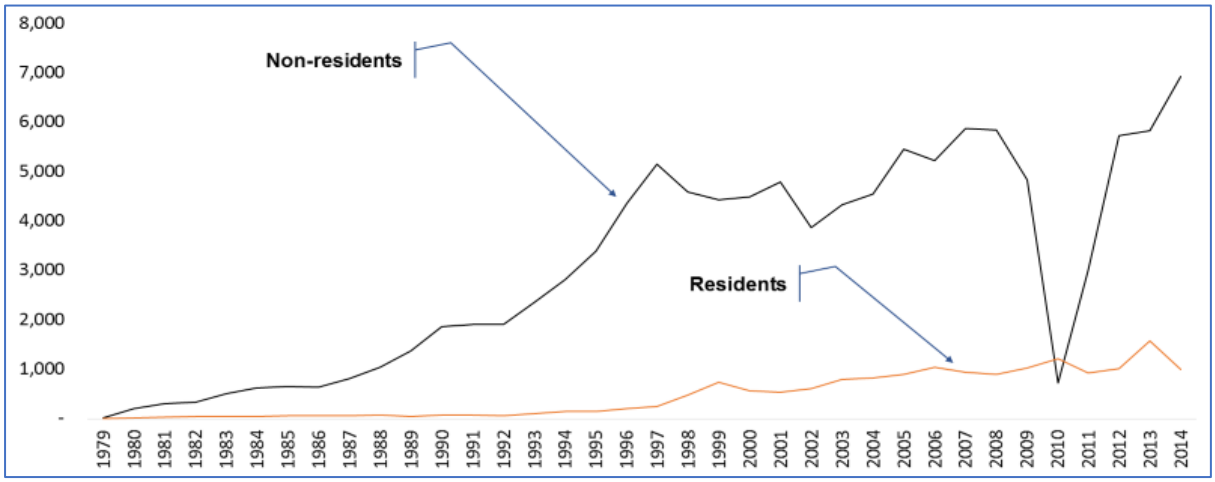
(2) Scientific Publication and Patents

Scientific publications and patents are regarded as outputs of STI activities. According to World Bank, the number of articles published are 226 in 1986 and increased steadily. Since 2000, the number increased sharply; 1,549 in 2000 to 8,631 in 2013. The number of publications may be determined by R&D investment and/or the evaluation system of scientific performance at the individual and organizational levels. It may be influenced by the increase in R&D expenditure. It may imply that human resources in S&T have a good potential.

On the other hand, patent application usually represents results of innovation activity of an organization and hence technological competitiveness of the enterprise. The patent application

exhibits that non-resident application dominates over the resident application, although the resident application made a jump in the end of the 1990s. the number of resident applications was 738 in 1999, and increased to 1,006 in 2014. Meanwhile, the number of non-resident applications was increased sharply from 15 in 1979 to 5,148 in 1997. During the period of 1985-1996, inflow of FDI boomed, which would lead to an increase in the number of non-resident patent applications.

Figure 3-11. Patent Applications



Source: http://databank.worldbank.org/data/home.aspx [28 February 2017]

(3) International Technology Transfer

The sources of international technology transfer are usually FDI, export, OEM, import of capital goods, and others. In Thailand, major source of international technology transfer seems to be FDI. Although Thailand exports shows a significant share of high-tech products, core technologies are owned by multinationals. Meanwhile, R&D for product innovation is undertaken in home country of the multinationals. There would be technology transfer to the local enterprises, i.e. local subsidiaries of the multinationals, to some degree.

It seems, however, that technology transfer is limited from the multinationals to local firms, though regulations are imposed such local contents and others. According to J. Jongwanich and A. Kohaiboon (2011), R&D of the multinationals in Thailand mainly focuses on process innovation rather than product innovation. It implies that the multinationals might undertake R&D for the reduction of production costs in its operation in Thailand. In general, technology transfer is made to its subsidiaries, but not industry-wide. It can be said that the primary contribution of FDI is made, rather, to create job opportunity, capital formation and diversification of production. After Asian financial crisis, FDI inflow increased rapidly, and slowed down after the global financial crisis. Because of increasing labor costs, FDI outflow rises to neighboring ASEAN countries.

If FDI is a major source of technology acquisition, the fluctuation of FDI inflow makes it vulnerable, and hence domestic enterprises would have difficulties to secure (global) technological competitiveness. Therefore, policy mix or combination is required; that is, attracting FDI for job creation, and increasing R&D investment for securing technological competitiveness of domestic industry.

(4) Global Competitiveness

The Global Innovation Index (GII) is a cross-country performance assessment, compiled on an annual basis, by Cornell University, INSEAD and WIPO. According to GII, out of 34 upper middle-income countries, GII of Thailand ranked at 8th in the global innovation index, 7th in innovation output sub-index, and 9th in innovation efficiency ratio. In particular, the rank is below 10th in innovation input sub-index. Innovation output is relatively strong, probably due to export of high-tech products, in comparison with the lower innovation input sub-index.

Table 3-3. Global Innovation Index 2016: Upper-Middle Income Economies (34 in total)

Ranks	Global Innovation Index	Innovation Input Sub-Index	Innovation Output Sub-Index	Innovation Efficiency Ratio
1	China (25)	China (29)	China (15)	China (7)
2	Malaysia (35)	Malaysia (32)	Bulgaria (35)	Turkey (13)
3	Bulgaria (38)	Montenegro (46)	Turkey (37)	Bulgaria (16)
4	Turkey (42)	South Africa (47)	Malaysia (39)	Lebanon (41)
5	Costa Rica (45)	Mauritius (48)	Costa Rica (44)	Romania (46)
6	Romania (48)	Bulgaria (49)	Romania (45)	Mongolia (47)
7	Montenegro (51)	Costa Rica (50)	Thailand (50)	Costa Rica (50)
8	Thailand (52)	Romania (52)	Mongolia (51)	Iran (51)
9	Mauritius (53)	Colombia (53)	Montenegro (52)	Thailand (53)
10	South Africa (54)	Peru (56)	Macedonia (55)	Macedonia (56)

Note: the numbers in the parentheses are score (0-100).
Source: https://www.globalinnovationindex.org/gii-2016-report [1 March 2017], P.29

Table 3-4. GII-Thailand by Indicators groups: 128 Countries

Indicators group	GII	Rank
Institution	54.7	81
Human capital & research	30.7	70
Infrastructure	42.8	68
Market sophistication	51.4	28
Business sophistication	35.3	49
Knowledge & technology outputs	29.0	46
Creative outputs	31.1	57
Global Innovation Index (out of 128)	36.5	52

Source*: op. cit.* p.288

In details, GII by indicators groups exhibits strength and weakness of innovation. Out of 8 indicators groups, the highest scores of GII institution (54.7) and market sophistication (51.4),

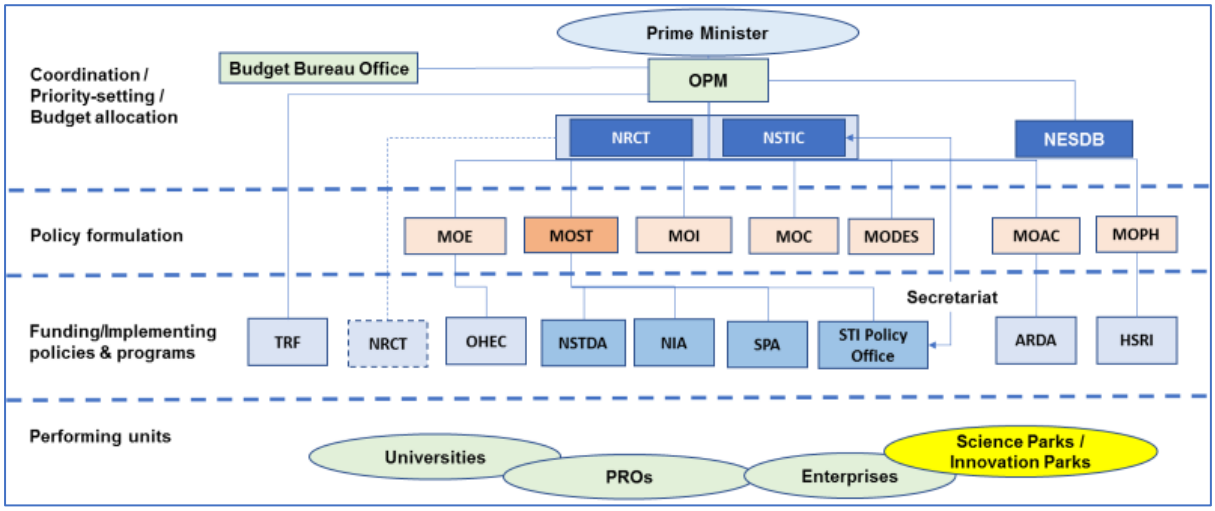
while the lowest scores of GII are knowledge and technology outputs (29.0), human capital and research (30.7), and creative outputs (31.1). In terms of cross-country comparison, out of 128 countries, Thailand ranks at 28th in market sophistication, 46th in knowledge and technology outputs, 49th in business sophistication, and at below 50th in other indicators groups. GII of Thailand ranks at 52nd out of 128 countries.

3.2.2. STI GOVERNANCE

(1) Coordinating and Policy-Making

STI governance is structured vertically and horizontally. The vertical governance shows hierarchy of the decision-making, implementation, and performance for the government STI policy/program. The horizontal governance exhibits the needs for coordination if plural ministries are engaged in STI policy.

Figure 3-12. STI Governance in Thailand



Note: OPM denotes Office of Prime Minister; NRCT national Reseach Cuncil Thailand; NSTIC National STI Policy Committee; NESDB National Ecinomic and Social Development Borad; MOE Ministry of Education; MOST Ministry of Science and Technology; MOI Ministry of Industry; MOC Ministry of Commerce; MODES Ministry of Digiral Economy and Society; MOAC Ministry of Agriculture and Coopertives; MOPH Ministry of Public Health; TRF Thailand Research Fund; OHEC Office of Higher Education Commission; NSTDA National S&T Development Agency; NIA National Innovation Agency; SPA Science Park Promotion gency; ARDA Agricultural Research Deelopment Agency; HSRI Health System Research Institute; PRO Pulbic Research Organization.

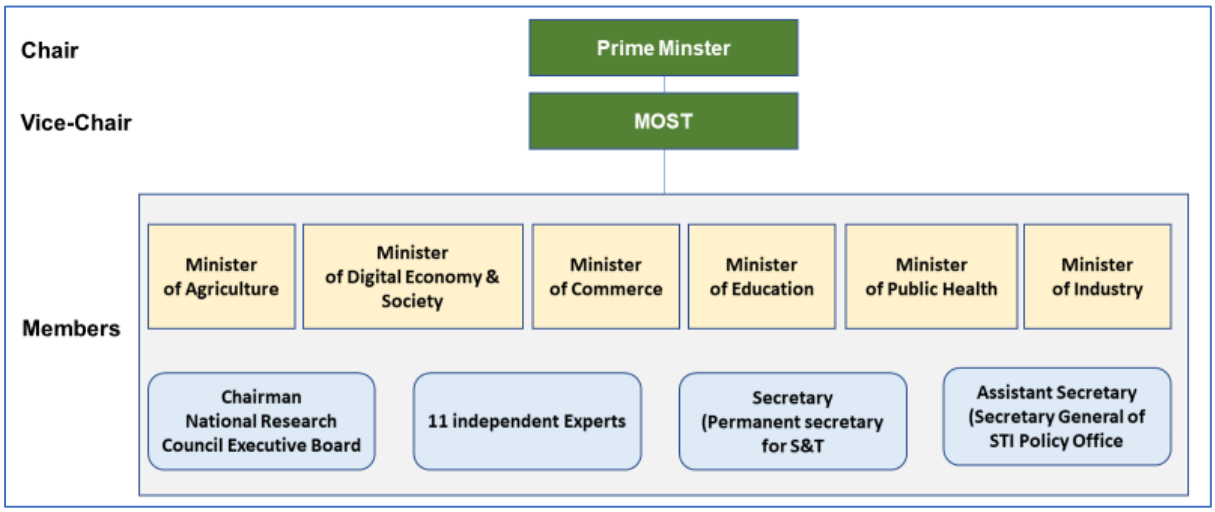
Vertically, the government system can be divided into four, such as (1) coordination/priority-setting and budget allocation, (2) policy formulation, (3) funding/implementing policies and programs, and (4) performing units, as discussed in Chapter 2.

As for coordination bodies in Thailand, under the Prime Minister, there are the Office of Prime Minister (OPM) and three councils, i.e. NRCT, NSTIC and NESDB. At the ministerial level,

STI related ministries are MOST, MOE, MOAC, MOPH, MOICT, MOC, and MOI. Those ministries formulate and implement STI policies for their own purposes. There are funding/implementing agencies under each ministry. It is noted that OPM and NRCT as a coordination body have their own funding instruments, TRF and NRCT, respectively. On the other hand, the STI Policy Office under MOST plays a role as the secretariat to NSTIC. Other ministries have also their own funding/implementing agencies, i.e. ARDA under MOAC, HSRI under MOPH, and OHEC under MOE, etc. Most of funding and implementing agencies are semi-governmental organizations. At the lower governance, there are performing organizations, such as universities, PROs, enterprises, science/innovation parks and others.

In more details, the OPM as the central executive agency is in charge of the coordination and management of the entire executive branches of the government. Most importantly it assists the Prime Minister in the execution, management and formulation of all policies or programs concerned. Therefore, due to urgency and immediacy of political and economic issues, it is likely that OPM may deal with STI policy at lower priority.

Figure 3-13. Structure of NSTIC



Source: UNCTAD (2015), p.27.

Besides, there are three organizations at the upper governance, such as National STI Policy Committee (NSTIC), National Research Council of Thailand (NRCT), and National Economic and Social Development Board (NESDB). They have a function of coordination to some degree. NESDB is responsible for the national socio-economic development strategies and plans. The national strategies/goals are thus set by NESDB at the national level. The NSTIC and NRCT are STI related coordination bodies. The NSTIC, established in 2008, places more emphasis on planning. For example, the NSTIC made the" STI Master Plan 2012-2021" as complementary to the "National Economic and Social Development Plan" of NESDB. NSTIC is chaired by the Prime Minister, and the STI Policy Office, an agency under MOST, plays a role of the secretariat to NSTIC.

Meanwhile, the NRCT, established in 1959, also makes the inter-ministerial plan for research and manages to allocation of research funds in the areas of social science, humanities, basic science, and others.[4] The NRCT was designated as the national body responsible for the implementation of research. The NRCT is also chaired by Prime Minister. Members are recruited from academe in 12 academic disciplines. The main function of the NRCT is to implement research, under the National Research Council Act, and to prepare the annual fiscal budget for NRCT to submit to Bureau of the Budget, and develop human resource in research for the country. **NRCT does not only formulates** and implements policy and national research strategy, but also coordinate and encourage the implementation of projects and research plan. It also coordinates and promotes the networking among researchers, agencies, and researchers, and engages in promoting and supporting the protection of intellectual property rights of research results.[5]

In Thailand, it seems that many ministries are engaged in STI policies, which is an inevitable trend as the global economy moves into the knowledge-based economy. It implies the coordination function is important in formulating and implementing STI policies/programs. NESDB makes socio-economic development plan every five years, while NSTIC made a 10-year plan, "STI Master Plan 2012-2021". The 11th socio-economic development plan of NESDB is finished in 2016, and new plan starts in 2017. Therefore, a coordination between plans might be unavoidable for consistency and alignment of national strategies and goals. Due to decentralized and hence weak coordinating function, it is not clear that the policy/program of each ministry would be aligned with the national strategy. Establishing NSTIC would have strengthened the coordination function across STI related ministries. In effect, however, if the Prime Minister as the chairperson would not attend the meeting, the role of NSTIC could be weakened as the member would also send vice-minister or director-general in his/her stead.

In addition, what it lacks in the Thailand system is the well-structured framework of planning-implementing-monitoring-feedback (PIMEF). The consistency of planning activities of different coordination councils (NSTIC, NRCT and NESDB) should secured to achieve the national goals efficiently and effectively.[6] Then, cross-cutting issues over the STI related ministries will be managed in a rational way, avoiding overlaps in resource allocation. But it is pointed out that some of coordination bodies have their own funding instruments. Under the same ministry, the functions of funding/implementing agencies seem to be also overlapped. Particularly, under

[4] NRCT developed the 8th National Research Policy and Strategy Plan 2012-2016.

[5] To some degree, there seems to exist overlaps in terms of coordination between two committees, NSTIC and NRCT. Recently, the Joint Board of NSTIC and NRCT was established, instead of merging them into one. The final outcomes of both committee should be approved by the joint board. Two committees have functions of coordination, but not effective. It may be because the national budget for R&D activities is relatively small, and because not much conflicts exist across STI related ministries. Furthermore, the policy domains and roles between two committees and the MOST are not clearly distinguished.

[6] Reorganization and/or reform of those committees might be a log-term issue.

MOST, various agencies are engaged in funding/implementing similar programs.

(2) Funding and Implementing

As far as STI program is concerned, there are several funding agencies. Some are under the MOST, and some are not. Under the MOST, there are funding instruments such NSTDA, NIA and SPA. NSTDA manages research organizations such as BIOTEC, MTEC, NECTEC and NANOTEC as well as Thailand Science Park (TSP). NIA is also a funding instrument for supporting SME innovation and nurturing technology startups, and SPA as a funding agency supports development of the regional science parks and business incubators in the universities.

Table 3-5. Government Financing in R&D

Organizations	Main Responsibilities	R&D Budget Shares (Estimates)
National S&T Development Agency	In charge of research institutes operating under MOST, including the four high-tech centers (Nanotec, Biotec, Mtech, Nectec)	20 percent (mostly institutional)
National Innovation Agency	Support policies/programs for startups/SMEs	
Science Park Promotion Agency	Developing regional science parks	
National Research Council of Thailand	Oversees the national R&D policy, reports directly to the Prime Minister	50 percent
Thailand Research Fund	Main body in charge of non-institutional research budget and scholarships, the Talent Mobility Program and the Golden Jubilee PhD Program.	10 percent (mostly contract funding)
Agricultural R&D Institute	Responsible for. Allocates 30 percent of its budget to enhance the research capacity of MOAC	10 percent (institutional and contract funding)
Health System Research Institute	In charge of health research funding and related public research structures	5 percent (institutional and contract funding)
Office of Higher Education Commission	Responsible for research in universities	6 percent (institutional and contract funding)

Source: revised from UNCTAD (2015), p.28.

The NRCT as a coordinating body also have a funding instrument, and OPM also has a coordinating function as well as has a funding instrument, i.e. TRF, whose main missions are to be in charge of non-institutional research budget and scholarships, Talent Mobility Program, and Golden Jubilee PhD Program. The Ministry of Agriculture and Cooperatives has its own funding instrument, ARDI, which is responsible for agriculture research funding and related public research structures. HSRI is a funding instrument under MOPH and in charge of health research funding and related public research structures; and OHEC under MOE responsible for university R&D.

In sum, there are various routes of allocation of government resources in Thailand. If the coordination functions weakly at the upper governance with silo effect existing, overlaps between ministries and funding/implementing agencies would not be unavoidable, causing inefficiency of resource allocation and ineffective achievement of national goals.

(3) MOST and Its Agencies

At the ministerial level, at the center of STI policy, there exists the Ministry of Science and Technology (MOST), established in 1979. Main missions are:

- Recommend integrated policies and strategies on science, technology and innovation for affiliated agencies and related organizations.
- Initiate, advance, drive and manage R&D in building knowledge with socio-economic impact.
- Develop human resource capacity in science, technology and innovation at all levels and raise public awareness and acceptance of science, technology and innovation.
- Develop fundamental infrastructures, supportive systems and mechanisms to facilitate intelligence creation and for value enhancement in the manufacturing and social sectors though knowledge bases in science, technology and innovation.
- Support innovation and technology transfer in the manufacturing and service sectors, including improving productivity and quality of life through science, technology and innovation services.

The National Science Technology and Innovation Policy and Plan 2012-2021 was prepared by the MOST/NSTIC, and approved in 2012. The goal of the Plan is to unify STI commitments among public agencies and to strengthen the collaboration with and among the private sector, academics, and research institutes. The coverage is designed to network knowledge from the community level up to international cooperation. The Plan places emphases on; (1) society and local communities, (2) economy, and (3) energy and environment, with the ultimate goal of having a quality society and a sustainable economy driven by green innovation. The STI Policy Office is the agency responsible for overseeing the implementation of the National STI Master Plan.

On the other hand, there are 17 supporting agencies under the structure of MOST. Those agencies are mostly semi-government. They are

- *National Science and Technology Development Agency (NSTDA)*
- *National Science Technology and Innovation (STI) Policy Office*
- *National Innovation Agency (Public Organization) (NIA)*
- *Science Park Promotion Agency (SPA)*
- Office of the Permanent Secretary (OPS)
- Office of the Minister (OSM)
- Department of Science service (DSS)
- Office of Atoms for Peace (OAP)
- National Institute of Metrology (Thailand)(NIMT)
- Thailand Institute of Scientific and Technological Research (TISTR)
- Geo-Informatics and Space Technology Development Agency (Public Organization)

(GISTDA)
- National Science Museum (NSM)
- Thailand Institute of Nuclear Technology (Public Organization) (TINT)
- Synchrotron Light Research Institute (Public Organization) (SLRI)
- Hydro and Agro Informatics Institute (Public Organization) (HAII)
- National Astronomical Research Institute of Thailand (Public Organization) (NARIT)
- Thailand Center of Excellence for Life Sciences (Public Organization) (TCELS)

The STI Policy Office, among others, was established in 2008. The office is a non-bureaucratic, government-owned juristic person that maneuvers in commission with the policy guidance from the NSTIC, chaired by the Prime Minister. The main functions of STI Policy Office are (1) to produce policies and plans regarding science, technology and innovation at the national level, (2) to provide support and advice to other governmental agencies in formulating their own implementation plans, (3) to monitor and report the implementation results of the national STI plan including the performance of governmental agencies to the NSTIC, (4) to develop standard measurements, indicators, database, and conduct policy research in support of science, technology and innovation, and (5) to facilitate and monitor the development of human resources in science and technology.

NSTDA is also one of most important agencies under the MOST. Its roles are the promotion of science include research and research funding, technology transfer, human resources development and S&T infrastructure. NSTDA's platform focuses:

- BIOTEC – Genomic Technology & Cell Factory Technology
- MTEC – Design and Simulation for Materials and Manufacturing & Materials Design and Production
- NECTEC – Sensor Technology, Knowledge Engineering Technology, & Information Security Technology
- NANOTEC – Nanocoating, Nanoencapsulation, & Functional Nanostructures
- TMC – Technology transfer and commercialization of discoveries and technologies

The National Innovation Agency (NIA) was established in 2003, and operated as an autonomous agency, under the supervision and policy guidance of the National Innovation Board, but outside the normal framework of the civil service and state enterprise. From September 2, 2009, NIA was restructured and became a Public Organization, while remaining under the umbrella of the Ministry of Science and Technology. It is mainly responsible for funding startups and SME innovation.

Science Park Promotion Agency (SPA) was established in 2011 by Regulation of the Prime Minister, Science Park Promotion Agency (SPA) is a unit under MOST. SPA takes responsibility as secretariat office for Science Park Promotion Committee whose chairman is the minister

of MOST and also performs important roles to initiate, generate, promote and support the mechanisms for driving science parks in Thailand, especially regional science parks.

3.3. SUMMARY

Over last four decades, Thai economy exhibited a remarkable performance and fast industrialization, transforming the economic structure from agriculture-based to high-tech industrial structure. In the process of economic development, it can be said that attraction of FDI played an important role and hence Thai economy was able to participate in the global production network, particularly in the areas of automobile and electronics. FDI may decrease, as labor market supplies no more cheap labor, which would lead the labor-intensive industry to move foreign countries. Thus, transforming industrial structure is critical for the future of Thai economy in the long run. Regaining growth rate will depend on how to quickly overcome factors constraining growth and to expand trade through enhanced integration with the global economy in the short run, but also how to bring in technological innovation efficiently and effectively with industrialization strategy in the long term. Development of human resources in Science and technology (HRST) becomes increasingly important.

However, the outperformance of economic growth concentrates in the regions of Bangkok and vicinity and the East, showing regional imbalanced development. On the other hand, the manufacturing sector expanded rapidly, but it did not provide job opportunities as many; while leaving relative larger share of employment in the agricultural sector. It leads to income polarization between sectors. Regional imbalance and income polarization over sectors would have an effect to reduce the size of domestic market, though the population is more than 67 million, and growth potential in the long run. To increase long-term growth potential and create quality jobs, it is necessary that Thai economy should upgrade and move to high-value segment along the global value chain, and establish an extensive platform of innovation, in consideration of regional development. It places a greater emphasis that Thai economy should turn to the innovation-based development strategy. In so doing, it would be able to move to the knowledge-based economy, and the group of high-income countries.

As Thailand has transformed from an agrarian to industrial economy, the manufacturing and service industries has also moved from the lower end of the global value chain to the higher end. However, transition remains incomplete. Moving further up the global value chain and reaching high-income level requires new growth engines in the manufacturing sector. It is obvious that new growth engine should be identified and developed based on technological innovation. To establish a broader base of innovation in the private sector may increase growth potential. In order to increase global competitiveness in innovation, it is pointed out that Thailand should secure various sources of technology acquisition, or that government initiatives are developed and implemented towards increasing knowledge outputs and business sophistication.

On the other hand, it is important to increase R&D capacity of the innovation units, i.e. enterprise, universities and research institutes. S&T development supporting industrialization will be a greatest challenge in the future. However, R&D investment is still at a lower level and should be increased significantly for Thailand to shift into the knowledge-based economy. In consideration that innovation take place mainly based the accumulation of R&D activities, the government should double its efforts for the S&T development. The government targets to increase R&D investment to 2 percent of GDP by 2021. Nonetheless, Thailand has a good deal of potential in human resources in science and technology.

MOST is the government body responsible for STI policy at the national level. It plays a central role in formulating and implementing STI policies and programs through a coordination body of NSTIC. Though the STI Policy Office is the secretariat to NSTIC, it appears that it does not implement such a PIMEF (Planning-Implementing-Monitoring-Evauating-Feedback) framework across ministries. That is, the policy formulation and implementation seem to be fragmented and segmented, as other STI related ministries undertake their policies on their own.[7] Also, STI-related ministries formulate and implement policies/programs without a PIMEF system. The funding/implementing agencies are not well integrated in consideration of achieving the national goals.

All in all, at both government and ministerial levels, there exist plural organizations for similar purpose. Such institution-building appears to be still underway. It will eventually increase congestion issues in making and implementing STI policy/program. Of course, such trend will continue until the cost incurred by fragmented and segmented structure is increased to the intolerable level. In the long run, it is expected to reform the STI governance with greater efficiency.

[7] It appears in some cases that the lower-governance body has greater power than the upper-governance bodies.

CHAPTER 4
STARTUP DEVELOPMENT AND SCIENCE PARKS IN THAILAND

4.1. OVERVIEW OF STARTUP POLICY

The Thai government has paid a good deal of attention to innovation-driven economic development, as the country has shifted to the upper-middle income level, implying that the wage has no more competing edge. Technological competitiveness of domestic industry is strongly emphasized ever since. Thailand need develop new startups and industries based on technological innovation. In so doing, it is recognized that science and technology plays a critical role in developing a new business/industry. In this line, startups are considered as a strategic tool for economic development. The startups are small and medium-sized enterprises (SMEs) that adopt innovation and technology for the sustainability of their businesses, and technology-based startups will be able to create high value-added products. The Thai government promotes to develop/nurture startups in various fields of business, such as food, tourism, communication, and agriculture.

As shown in Table 4-1, it can be said that the Thai economy is a SME-based economy. Total number of enterprises in 2015 was 2,773,625, Out of which SMEs accounted for 99.72 percent, while the large enterprises did for about 0.26 percent. Out of SMEs, the number of small enterprises accounted for 99.26 percent and that of medium-sized enterprises for 0.47 percent. On the other hand, the GDP share of SMEs in 2015 accounted for about 48.1 percent, while that of the large enterprises did for 45.2 percent, showing a high concentration of industry in terms of the value added.

Table 4-1. Structure of Enterprises by Sizes (2015)

	# of firms	Shares (%)
Small- and medium-sized enterprises	2,765,986	99.72
・ Small enterprises	2,753,058	99.26
・ Medium-sized enterprises	12,928	0.47
Large enterprises	7,156	0.26
Others	483	0.02
Total	2,773,625	100.00

Source: MOST, “Startup Promotion Plan 2016-2021”.

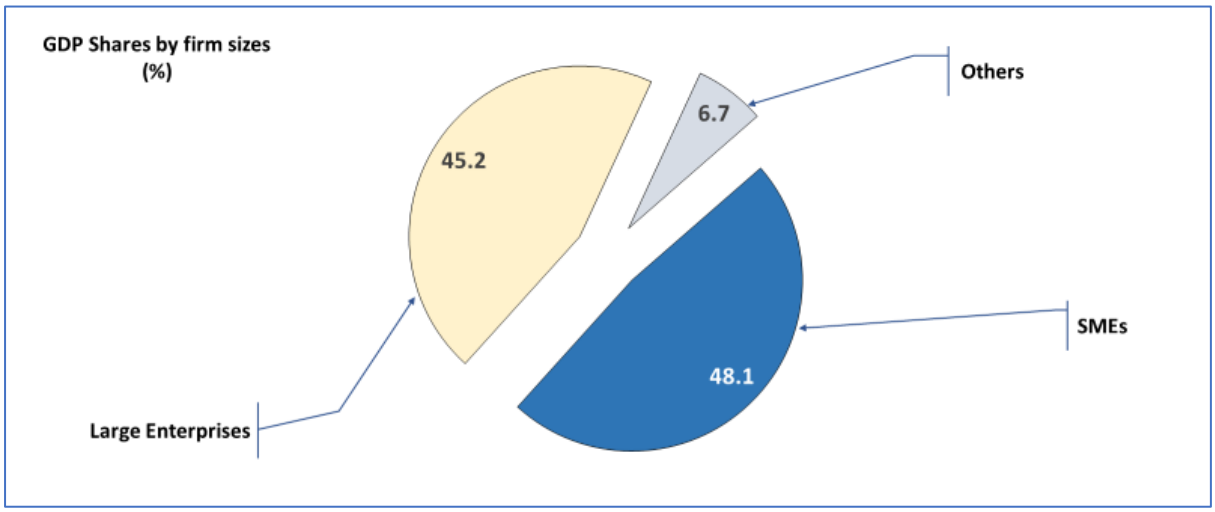
It indicates that small and medium-sized enterprises are the backbone of the economy, and that strengthening competitiveness of SMEs is very important for the development of national economy, particularly focusing on technological innovation. Thus, the course of economic development in the future would depend on developing/nurturing technology-based startups and

SMEs. According to a government source, the number of startups in Thailand was expected to rise from around 1,000-2,500 to 4,000-5,000 in 2016, and the government also estimates an increase to 10,000 by the year 2017.

The government facilitates to communicate and create awareness about its efforts to promote startups across the ministries. The National Startup Committee, chaired by the Permanent Secretary for Finance, has been formed to follow up on the progress of the implementation of the "Startup Thailand Promotion Plan, 2016-2021." With regard to the plan, a priority has been placed on development of the startup ecosystem. To implement the plan, the Ministry of Science and Technology was appointed to be a representative of government and a key host of "Startup Thailand 2016". The plan includes joint efforts of various ministries and others, such as;

- Ministry of Information and Communication Technology,
- Ministry of Commerce,
- Ministry of Finance,
- Ministry of Industry,
- Ministry of Foreign Affairs,
- Ministry of Tourism and Sports,
- Ministry of Education,
- Ministry of Agriculture and Cooperatives,

Figure 4-1. GDP Shares by Firm Sizes (2016)



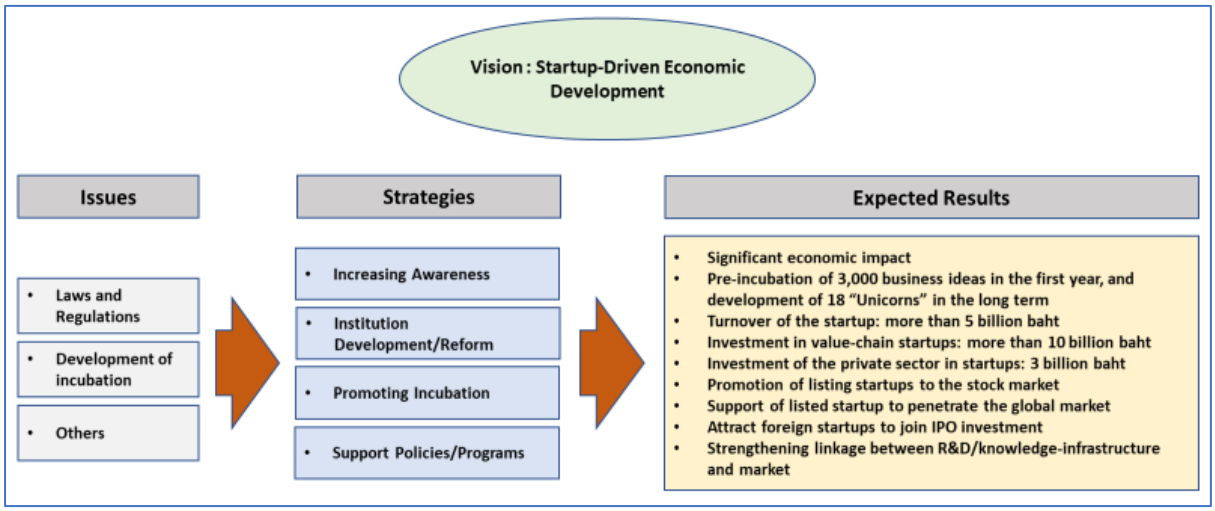
Source: MOST, "Startup Promotion Plan 2016-2021".

The plan aimed to develop over 200 top startups, public and private sectors in Thailand. It is expected that over 10 international startups support agencies to jointly unleash their potential in different types of business, to form a strong network, and to exchange their experiences. Meanwhile, it is recognized importantly to create/stimulate inspiration to new entrepreneurs ranging from college and university students, new office workers, a new generation of farmers

to corporate executives. To promote startups, 8 categories have been identified to be in line with entrepreneurs from different types of business, including:

- Agriculture technology and food technology
- Industry 4.0 and clean technology
- Education technology and government technology
- Property technology
- Lifestyle; personal service, travel and entertainment
- E-Commerce and logistics
- Financial technology and service enhancement
- Healthcare

Figure 4-2. Startup Promotion Plan 2016-2021



To achieve the goal, the government also focuses on new development in education, regulatory reform, and investments to build a favorable startup ecosystem, including:

- Open for new talents:
  - Issuing startup visa
  - Establish ASEAN startup center to boost awareness and entrepreneurship across the region
- Open for new business growth:
  - Reshaping business laws to boost startup growth—employee stock ownership plan (ESOP), vesting convertible debts, and preferred shares
  - Exempting corporate income tax for startups for first 5 years
  - Establishing technology rating and credit guarantee systems
- Open for new investment:
  - Exempting corporate and personal capital gains and dividend taxes for venture capital
  - Boosting investment through equity crowdfunding platforms

    - Launching early stage matching funds for startups
- Open for new ecosystem:
    - Setting up NEW centers to foster ASEAN open innovation
    - Developing county-wide startup districts and private accelerators and incubators

The expected results of the plan are;

- Economic impact;
    - SMEs production: 50 percent of GDP
    - Export growth of SMEs: 5 percent a year
    - New registration of startups and SMEs: 50,000 a year by 2021
- Pre-incubation of 3,000 business ideas in the first year, and development of 18 "Unicorn" startups in the long term
- Turnover of the startup: more than 5 billion baht
- Investment in value-chain startups: more than 10 billion baht
- Investment of the private sector in startups: 3 billion baht
- Promotion of listing startups to the stock market
- Support of listed startup to penetrate the global market
- Attract foreign startups to join IPO investment
- Strengthening linkage between R&D/knowledge-infrastructure and market

In implementing startup promoting policies/programs, NIA is designated as a main driver and undertakes various support programs together with other agencies under the MOST; i.e., NSTDA, SPA, and others. In so doing, NIA focuses on support programs for startups/SMEs, particularly after commercialization, while NSTDA and SPA concentrate the science parks for startup incubation and S&T services.

4.2. NIA'S INNOVATION STRATEGY FOR STARUPS AND SMEs

4.2.1. OVERVIEW

The establishment of NIA was made by merging two funding agencies which have similar functions, i.e. the Innovation Development Fund under the direction of the National Science and Technology Development Agency (NSTDA) and the Revolving Fund of Research and Technology Development under the direction of the Office of the Permanent Secretary of MOST.

NIA's function can be summarized by three; i.e. funding agency, innovation promoter, and platform booster. That is, the NIA's objectives are:

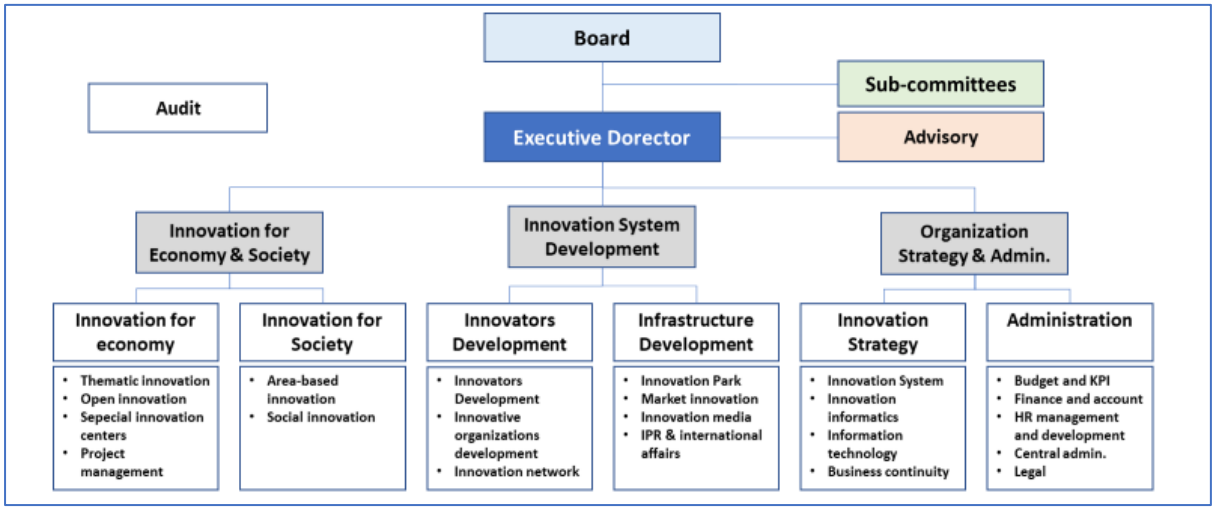
- To accelerate national innovation capacity by providing support for innovation development through funding

- To promote innovation culture and create awareness of innovation at all levels of Thai society
- To develop the effective National Innovation Ecosystem

The NIA focuses mainly on four areas, such as organic agriculture business, bio-based materials, biomedical industry, and clean energy industry

The organization of NIA is shown in Figure 4-3. As a public organization, NIA has a Board as the final-decision-making body. There are three deputy directors for innovation for economy & society, innovation system development and organization strategy & Administration. Each deputy director has two departments. They all are innovation for economy, innovation for society, innovators development, infrastructure development, innovation strategy and administration. Their missions are shown in Figure 4-3.

Figure 4-3. Organization of NIA



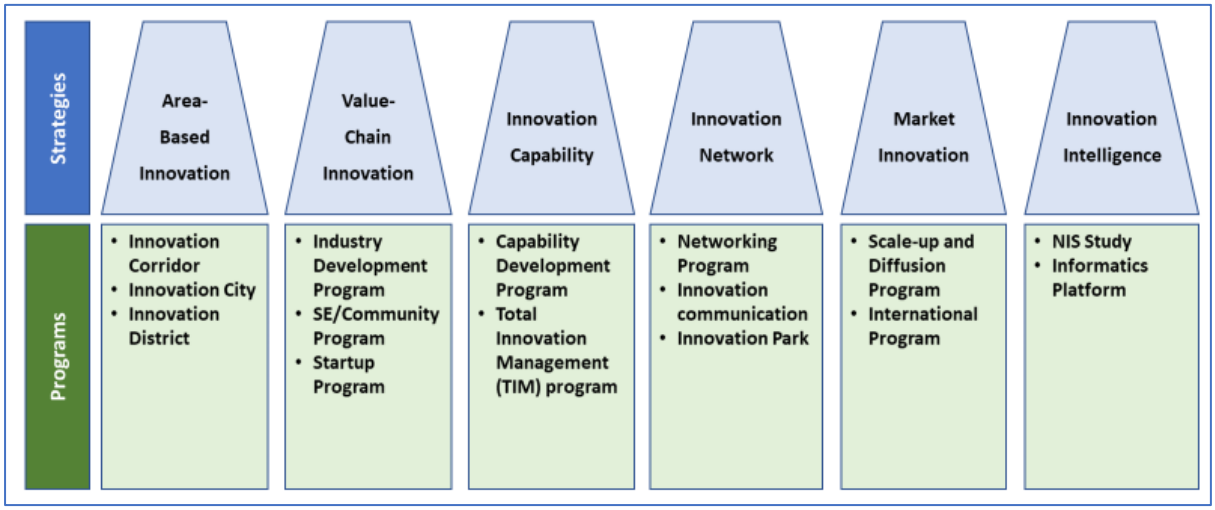
Considering NIA's mission and activities, it could be characterized as an accelerator over the innovation cycle in a narrow sense; and implementing agency for innovation policies/programs in a broad sense. NIA is actively engaged in developing and nurturing startups from development of prototypes for commercial use onwards, at the moment, without regard to basic and applied/development research over the innovation cycle. NIA established in 2014 and manages the Innovation Park to promote startups, while its main focus is on establishing a startup network.

4.2.2. NIA'S STRATEGIES AND PROGRAMS

NIA's strategies are divided into six categories, under which support programs are defined. The strategies are 1) Area-based innovation; 2) Value-chain innovation; 3) Innovation capability; 4) Innovation network; 5) Market innovation; 6) Innovation intelligence.

There are 15 major programs implemented by NIA. The programs under each strategy are shown in Table 4-2. By characteristics, there are 11 projects for direct financial support in 2016; 10 for non-financial assistance; 8 for networking; and 12 for eco-system development. It seems that the innovation programs are narrowly defined if following the criteria. If the innovation policies imply more than those four categories, it will be necessary to identify and develop new programs continuously. Such categories seem to be too broad. In order to develop more programs, it may be necessary to divide the project category into more detailed areas.

Figure 4-4. NIA's Programs by Strategies



Main function of NIA is funding to innovation activities of SMEs, whose annual budget accounts for about 300 million baht. There are two types of funding programs.

The "Seed Funding" program has been implemented for last 10 years, which funding is made to 75 percent of the innovation project of the applicant SME for 3 years; and the remaining 25 percent is financed by itself. The maximum amount paid by NIA is about 5 million Baht. There is the evaluation process in approving the funding. According to NIA regulations, if the funding size is less than 3 million baht, the applicant SME submit the draft plan of innovation, which is reviewed and finalized by NIA staff. Once receiving the application, it is evaluated by the sub-committee, and if the sub-committee makes a positive recommendation of the project, it is approved by the Board, based on which the funding becomes eligible for the SME. If the funding size is greater than 3 million baht, the applicant SME has to make presentation in front of Board members, after the positive recommendation by the sub-committee.

Another scheme of funding is known as "Soft Laon", with zero interest rate. In this case, the applicant SME makes loan from the commercial bank, and NIA pays for the interest of the loan. The approval process is the same as that of the "Seed Funding." This financial support also holds for 3 years. So far, there is no beneficiary SME for the "Soft Loan" program, though.

Table 4-2. Projects Implemented by NIA

Projects	Direct financial support	Non-financial assistance	Networking	Eco-system development	
Funding Mechanism	√				
· Idea development	√				5 million baht
· Technology Capitalization	√				5 million baht
· Cluster Grant	√				5 million baht
· Zero interest loan	√				5 million baht
Program/project					
· Innovation District		√	√	√	Developing innovative area
· Research for Innovation	√		√	√	Funding R&D projects of enterprises
· Innovation Coupon	√				Funding for early-stage startups (1.8 m. baht)
· Innovation Campaign in Northern Food Valley	√			√	Northern Food Valley (1.8 m. baht)
· Total Innovation Management		√			Development of internal innovation management system
· 8 Weeks		√			Training
· Northern Innovation Startup	√	√		√	Improving innovation efficiency Funding 0.6 m. baht for prototype
· SPARK		√	√	√	Global networking
· Startup Thailand			√	√	Eco-system development
· Innovation Park			√	√	Center of networking and innovation
· National Innovation Awards				√	Promoting and public relations
· Market Innovation		√	√	√	Support for market innovation
· Innovation Grand Sales		√		√	Exhibition
Upcoming Projects					
· MIND Credit		√	√		Consulting/services
· Social Innovation Lab		√	√		Access to knowledge base to solve social innovation issues
· City Challenge	√			√	Addressing/identifying innovation issues in an area
· UAV Startup 2017	√	√		√	UAV development for industrial use

Source: NIA.

After an application is received for the fund, the evaluation is made focusing on product/technology, business strategy, market size and growth, and quality of management. After the financial support is made, the monitoring follows. The beneficiary SME through either "Seed Funding" or "Soft Loan" is regulated to spend the secured fund for technical support by experts (100%), standardization/testing (100%), operating/materials (50%), and machinery/equipment (50%).

Table 4-3. NIA Funding in 2016

Unit: THB

Sectors	# of projects	NIA Funding	Total amount of project
Rice industry	8	7,621,395	62,320,000
Cassava industry	2	2,465,330	40,410,000
Rubber industry	3	1,912,500	10,500,000
Sugarcane industry	2	1,500,000	38,153,800
Palm oil industry	3	6,385,500	138,846,000
Vegetable and fruits industry	7	9,222,650	74,596,500
Healthcare products	10	17,358,935	128,933,000
Creative industry	17	30,285,400	465,030,000
・ New products/services design	5	6,660,000	53,840,000
・ Environment-friendly products	3	5,254,600	34,100,000
・ Robot/automation	7	13,953,300	222,030,000
・ Aviation/transportation	2	4,417,500	155,060,000
UAV	2	2,754,950	71,000,000
Tourism industry	3	6,464,500	186,730,000
Telecommunication	4	6,450,000	44,000,000
Foods from Thai to global kitchen	10	12,888,800	842,760,000
Organic Agriculture	5	5,024,600	41,627,100
Bio-materials	3	1,722,000	26,200,000
Bio-medical	10	14,280,000	105,063,000
Clean energy	9	15,511,800	573,373,500
Total	115	141,848,360	2,849,542,900

Source: NIA (2016), *Annual Report 2016*.

In 2016, NIA funded about 142 million baht for 115 projects. Total value of projects is about 2.8 billion baht. Out of them, 35 projects are related to the agricultural industry, such as rice, cassava, rubber, sugarcane, and palm, etc. about 30 million baht for 17 projects were funded in the creative industry; new product/service design, environment-friendly product, robot/automation, and aviation/transportation. In the areas of bio-material and bio-medicine, about 16 million baht were funded for 13 projects. Funding was also made for other areas, tourism, UAV, telecommunication, foods, energy, and others.

In 2016, a new program, "UVA Startup", has been implemented. This program focuses on smart farming, survey, and monitoring using UAV (Unmanned Aerial Vehicle). The fund is allocated about 1.5 million baht for the hardware, and 1.2 million baht for the software and this fund is based on competition. It is also noted that in the Northern area, to promote food industry, the

"Food Valley Innovation Campaign" is underway. Total investment is expected to be about 27.47 million baht, out of which 17.47 million baht is funded by NIA. NIA also implements the program, "National Innovation Awards," since 2015 to increase awareness of and to expand the network of innovation.

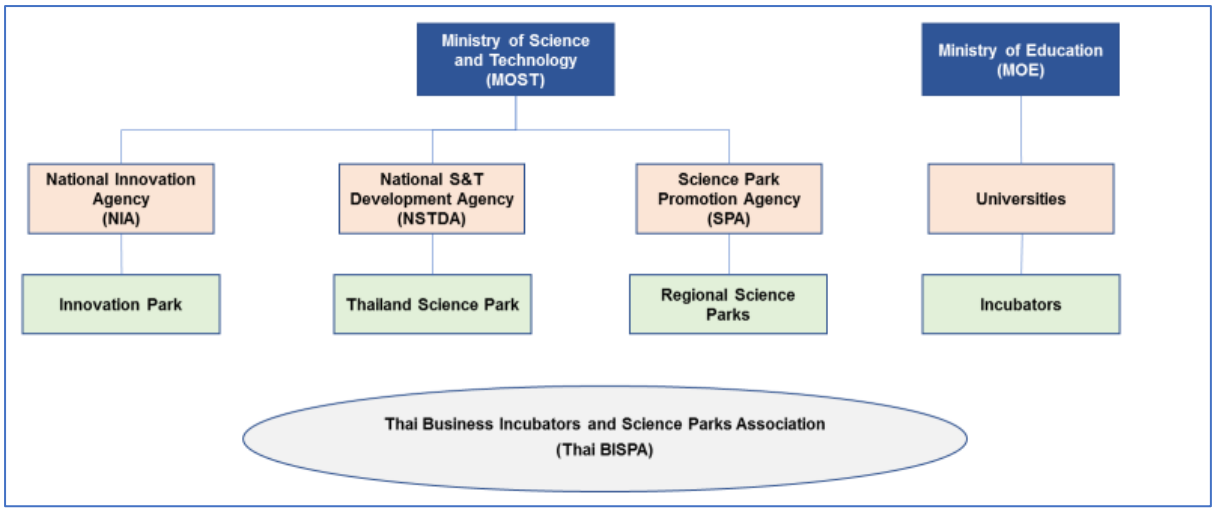
In summary, NIA is an important agency in pursuing support policies for startup/SMEs in Thailand. It is because no other organizations than NIA has a funding instrument for the purpose of promoting startups/SMEs through various programs. Other organization like NSTDA and SPA rather focuses on management of science parks and incubation; that is, they are more likely hardware-oriented in pursuing support policies for startup/SMEs. Meanwhile, NIA's policies/programs are more likely software-oriented. Next, we review the instruments of NSTDA and SPA.

4.3. SCIENCE PARKS IN THAILAD

In Thailand, there are several types of the science park, i.e. Thailand Science Park (TSP), Regional Science Parks, and Innovation Park under the umbrella of Ministry of Science and Technology (MOST), and incubators in universities under the umbrella of Ministry of Education (MOE). Those parks have different roles focusing on different areas, but have the same purpose of bringing innovation by nurturing startups. In terms of physical facilities, TSP and regional science parks are better developed.

There are three agencies under the MOST, each of which manages science or innovation parks. NSTDA manages Thailand Science Park and research organizations such as MTEC, BIOTEC, NECTEC and NANOTEC. This is the biggest science park in Rang Sit, established in 2002. The main areas of specialization of TSP are bio-technology, IT, materials, and nano-technology. TSP has attempted to attract private businesses and also establishes facilities for incubation of technology startups, having an advantage of R&D capacity of the public research organizations.

Figure 4-5. Science/Innovation Parks in Thailand



The Science Park Promotion Agency (SPA) is engaged in the Regional Science Parks, established in 2012, which are located in the Northeastern, Northern and Southern Regions. Each park has its own focus area, according to the economic specificity of the region. (Table 4-4). Main goals of the Regional Science Parks are to promote regional economic development through technological innovation.

National Innovation Agency, whose primary function is funding in support of innovation for SMEs, manages the Innovation Park (NIA-IP). The NIA-IP was established 2015, primarily focusing on acceleration of startups. However, as the physical size of the Innovation Park is small and provide only the office space, it rather focuses on establishing an innovation network.

Table 4-4. Science/Innovation Parks in Thailand

	Location	Start Year	Main Areas of Specialization
Thailand Science Park	Rang Sit	2002	・ Bio-technology, IT, materials, and nano-technology
Regional Science Parks ・ Northeastern Science Park	Khon Kaen	2012	・ Agriculture and Food Processing ・ Hard Disk Drive, Enterprise Software, Embedded Software ・ Mining Industry and Alternative Energy
・ Northern Science Park	Chiang Mai	2012	・ Agriculture and Food Processing ・ IT Software and Digital Contents ・ Medical/Health Science/Biotechnology
・ Southern Science Park	Songkhla	2012	・ Food/Agriculture ・ Proactive Medicine, Herb, and Cosmetics
Innovation Park	Bangkok	2015	・ Bio-business ・ Eco-industry: Clean industry/products platforms ・ Design and Solutions

Universities also run incubation facilities to develop/nurture startups independently, and it is funded by OHEC under the Ministry of Education. In some case, the Songkhla University of Southern Science Park had been running the incubation a long time ago by itself. After the program of the regional science parks implemented by the government, it is included into the network of the Southern Science Park as the hub. Still, there are many incubations run independently by universities.

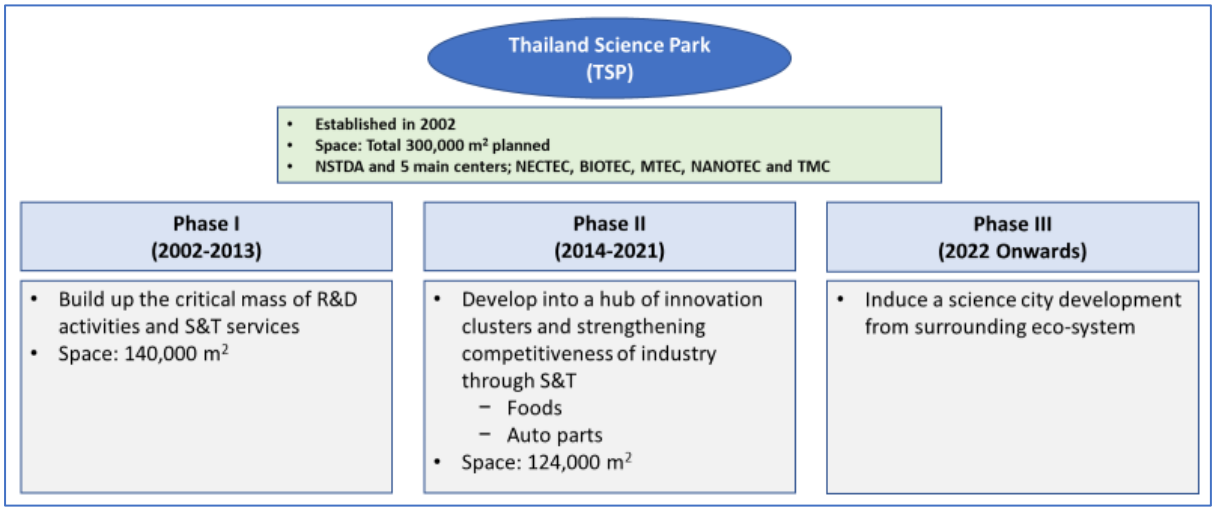
4.3.1. THAILAND SCIENCE PARK (TSP): NSTDA

The Thailand Science Park (TSP) was set up in 2002 as an integrated R&D hub for science and technology. It is managed by the Technology Management Center (TMC) of the National Science and Technology Development Agency (NSTDA) under the MOST. TSP is an important strategic vehicle to strengthen national capabilities in research and technological innovation. TSP is under development by three phases, 2002-2022.

At Phase I, the TSP has established built-up space over 140,000 m^2, in which four national research centers and tenant companies are located. At Phase 2, the TSP, designated INC 2, comprises of additional space over 127,000 m^2. It is possible to share advanced laboratories and equipment at the four national research centers, to access to over 600 full-time scientists and researchers (with more than 360 PhDs), and to link with leading universities and government agencies, etc.

TSP makes a good deal of effort to attract domestic/foreign enterprises.[8] To attract them, TSP offers following services; R&D support facilities; technology & technical services; financial services; human resource services; business support services; and industrial technology assistance program (ITAP).

Figure 4-6. Development of TSP by Phases

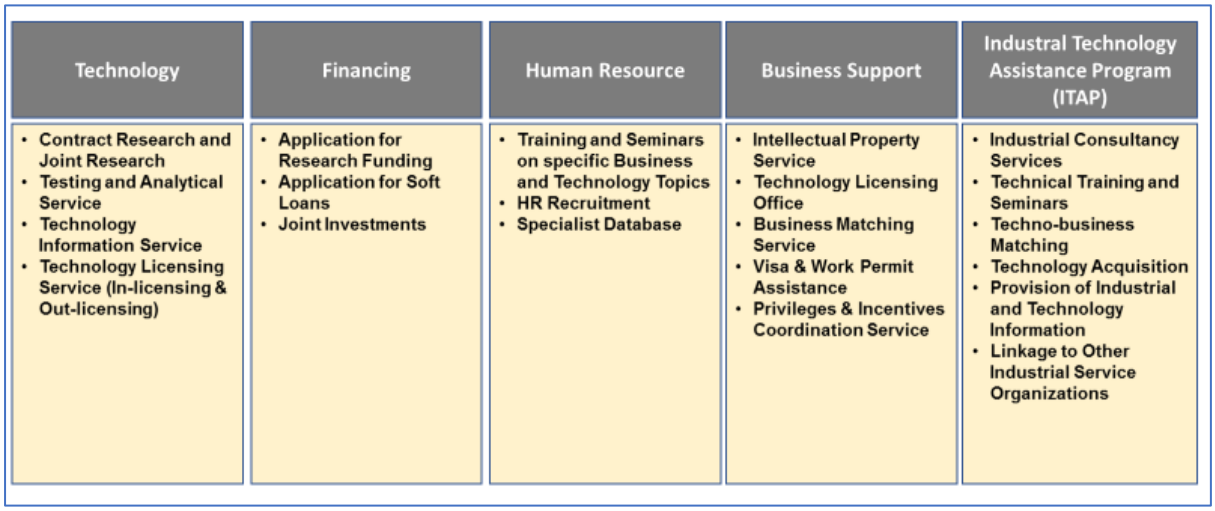


Furthermore, there are various incentives to the tenant enterprise. Thailand Board of Investment (BOI) provides science park developers with tax exemption according to BOI-Zone III policy; and tenants of science parks with import tax exemption for machineries, corporate income tax exemption for 8 years, 50 percent of corporate income tax reduction for 5 more years after tax exemption period ends. In addition, to promote "Talent Mobility," incentives are provided for matching fund to improve employee skills, work-integrated learning to earn industrial Ph.D. and/or Ms., employee exchange between private and public sectors, employment of high-qualified foreign workers (work permit and visa facilitation for foreign specialists and researchers), and so forth. The Revenue Department also provides incentives such as accelerated depreciation rate for R&D machineries and equipment, and 200 percent tax deduction for R&D expenses.

[8] The space rental process usually takes less than two months. After receiving application of customer firms, evaluation takes about 45 days and make a contract. The evaluation process includes seven steps. So far, the vacant area is significant, due to the transportation problem. After transportation infrastructure being improved, the vacant space could be rented out.

TSP's financial support services for R&D, Company Directed Technology Development Program (CD), is provided in the form of "low-interest loans" to industrial operators who want to undertake R&D in order to develop new products, improve manufacturing processes, set up a laboratory, conduct reverse engineering and commercialize R&D outcomes. This program is focused on providing support to projects in areas such as genetic engineering and biotechnology, metals and materials, electronics and computers as well as projects that will lead to scientific and technological advancements. The CD plays a role in encouraging Thai industrial operators to realize the importance of technology investment and research and development.

Figure 4-7. TSP's Support Services and Incentives



On the other hand, the NSTDA Investment Center (NIC) is responsible for promoting investment in science and technology for achieving national goal. The NIC will commercialize technologies developed by Thais and/or the NSTDA by co-investing in a joint venture or a spin-off company. The NIC is also in charge of educating technology business operators that are looking for technology investment opportunities and managing the NSTDA's investments with transparency. The NIC has so far formed 9 joint ventures as follows:

- Shrimp Culture Research & Development Co., Ltd. (SCRD)
- Innova Biotechnology Co., Ltd. (INNOVA)
- Thai Dairy Research and Development Co., Ltd. (ET)
- Micro Innovate Co., Ltd. (MICRO)
- Internet Thailand Plc (INET)
- Trade Siam Co., Ltd. (TS)
- T-NET Co., Ltd. (T-NET)
- Internet Innovation Research Center Co., Ltd. (IIRC)
- AT Ceramics Co., Ltd. (ATCL)

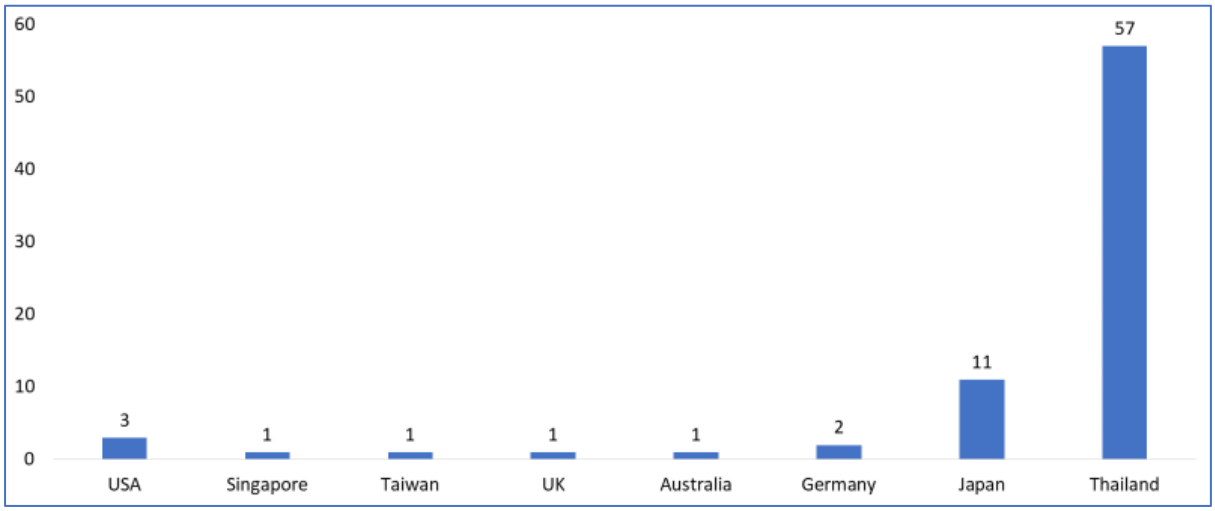
Technology Licensing Office (TLO) provides IP services, and is in charge of managing intellectual property assets for NSTDA and promoting transfer and commercialization of patented

technologies owned by NSTDA. TLO's responsibilities include promoting R&D for creating intellectual property, protecting researchers' right to their works.

As of November 2016, TSP attracted 77 enterprises into the campus. Out of them, 20 enterprises are overseas companies. Most enterprises attracted by TSP are to undertake R&D, since TSP maintains R&D facilities (four public research organizations) and secures manpower in research (more than 400 R&D personnel).

For Phase I, an estimation shows that about 3,000 jobs created; R&D investment of about 3,500 million baht was made; and about 300 collaborative projects were undertaken. For Phase II, various programs supporting for tenant firms was carried out, such as technical training (2 seminars for 200 audiences and 60 companies), cluster visit (3 times; 103 visitors from 71 companies), business matching (about 35 projects; 20 for foods and 15 for auto parts), and business brotherhood matching (large enterprises + startups + small enterprises; 2 large enterprises).

Figure 4-8. Tenants by Countries (as of November 2016)



Source: http://www.sciencepark.or.th/index.php/en/access-to-rad-network/technology-companies-in-tsp [23 May 2017]

Besides S&T services, TSP also runs incubation facilities. However, it seems that main objective of TSP focuses on attracting domestic/foreign companies and creating an innovation cluster in the area, combining with the public research organizations.

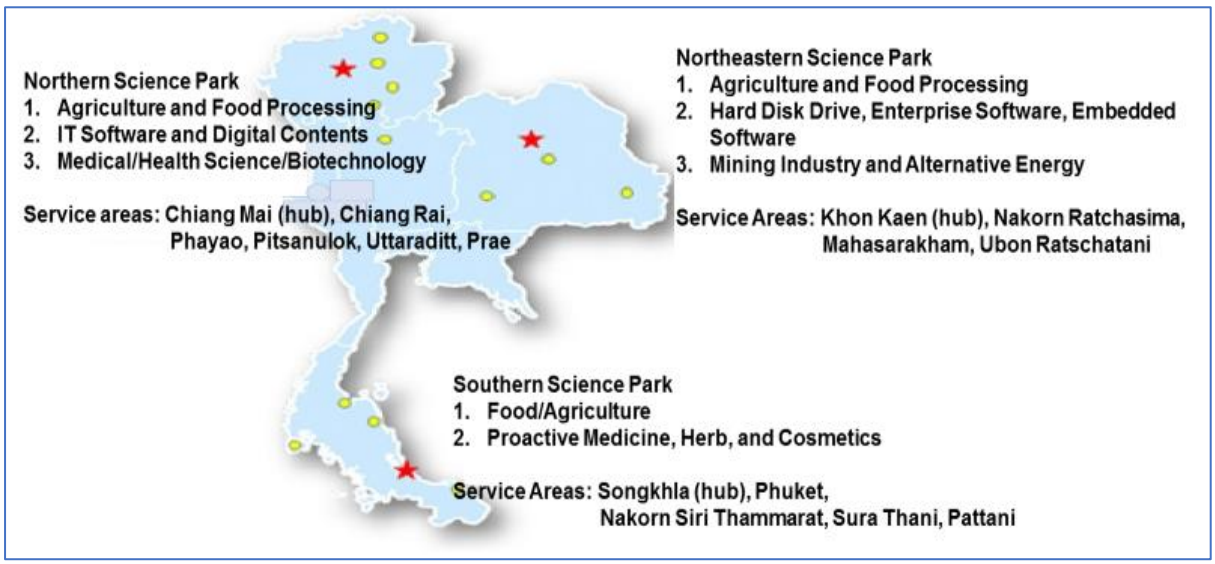
4.3.2. REGIONAL SCIENCE PARKS: SPA

The regional science parks in Thailand is supported by Science Park Agency (SPA) under the Ministry of Science and Technology. The regional science parks are located in the northern, northeastern, and southern regions of the country. Their mission is to promote commercialization of scientific and technological research outputs through five strategic measures: (1) Technology business incubation; (2) Science park services development; (3) Industrial research and

technology capacity development for businesses in the regions; (4) Collaborative research with businesses; and (5) Scientific and technological infrastructure development. Currently, the regional science parks make temporary use of regional universities' space, resources, and personnel to execute their mandates as provided for in "Thailand's National Strategic Plan for Science Park Development (2013-2016)."

The primary purpose of the operation of regional science parks is to develop regional economies, since economic inequalities becomes increasingly serious between Bangkok and the rest of the country. Theses economic inequalities is well indicated by significant differences between urban and rural areas in terms of per capita income level, economic growth, and employment rate. Business opportunities and high-wage jobs are concentrated in Bangkok and the vicinity, while the rest of Thailand remains underdeveloped and largely dependent on agricultural production. Therefore, it is necessary not only to promote regional economic development but also to shift Thailand to one of the "high-income countries."

Figure 4-9. Regional Science Parks in Thailand



The regional science parks have been developed under the 5-year plan of the Science Park Promotion Agency (SPA). The SPA as a government body was established in 2011 and responsible for policy-making in regard to development of regional science parks. SPA started to establish the regional science parks since 2012, based on the five-year plan (2012-2017). At the beginning, 13 universities in the three regions were included.[9] The regional science parks consist of Northern Science Park (NSP, hub in Chiang Mai University), Northeastern Science Park (NESP, hub in Khon Kaen University) and Southern Science Park (SSP, hub in Songkhla University). Each park determines its own focus areas, for example, NSP focuses on the areas of agriculture/food, IT software/digital contents and medical/bio-technology, while NESP on agriculture/food, hard disk drive/software and mining. SSP focuses on food/agriculture and herb/cosmetics.

[9] KMUTT, located in Bangkok, is to participate in 2017

For development of the regional science parks, Thai government supported 8.6 million dollars for RSP activities in 2013, and it is increased to more than 10 million dollars in 2014 including a construction of Northern Science Park Campus in Chiang Mai; Northeastern and Southern Science Park Campuses in 2015. Besides the government funding, each science park also makes an effort to raise fund for its operation.

According to the five-year plan, SPA planned originally to make investment about 8,000 million Baht for 7 parks, but ended up with the actual investment of less than a half of the planned for 3 parks. However, main campuses of three regional science parks are under construction, and they will be completed by 2018. Main campuses will have labs, manufacturing facilities, and office space, etc. Those main campuses will play a role as the hubs of the region, bringing innovation. In the long-run, SPA envisages that each RSP would be completely managed by the private sector after securing sustainability. It is planned that investment is made by both public and private sectors. The investment of the public sector is made for building infrastructure of lab and technical spaces for business and technology incubation. The government budget is allocated according to the development stages. That is, the government will allocate the budget for the science park 100 percent for 0-5 years, and reduce the government budget for 6-10 years as science park's revenues increase. After 10 years, the government will make a budgetary support at the minimum level. Meanwhile, the private sector makes investment for supporting activities such as incubation, consulting, special loan, and others.

SPA's role includes (1) Creating concepts, frameworks and plans of science parks development in Thailand; (2) Proposing criteria to promote and support science parks; (3) Promoting incentives for science parks; (4) Advising about establishment and operation of science park; (5) Monitoring and evaluating performance of science parks; and (6) Networking and collaboration. Particularly, for monitoring and evaluating, SPA implement KPI (Key Performance Indicators) system, by which the performance of each science park and university is evaluated. The evaluation result might be related to the allocation of next-year budget.

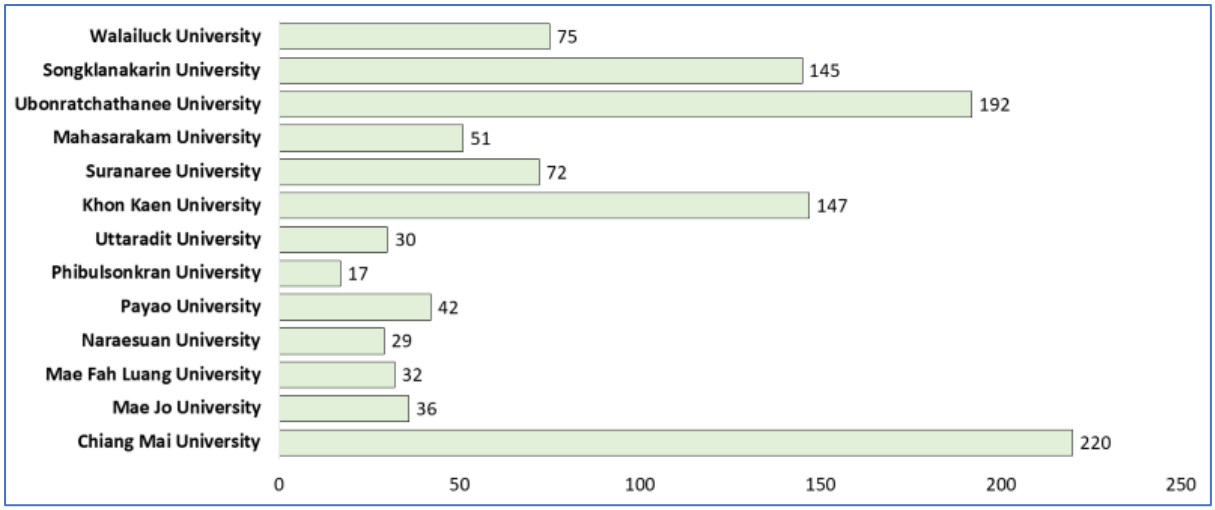
By SPA's policy, the regional science park is engaged in (1) Services; (2) Industrial R&D and technology capacity development program; (3) STI-business development including incubation, acceleration and research to market (R2M); (4) Collaborative R&D; and (5) Infrastructure development for three science parks, Northern, Northeastern and Southern Parks

The service provided by the science park includes provision of office, lab spaces and testing, Innovation Design Center, intellectual property management for industry, S&T infrastructure databank (STDB), and Office of Industrial Liaison (OIL). Before the construction of main campus, labs are available from the university. For the efficient services, the Science Park also establish the STDB for labs, researchers/scientists, research equipment and tools, and research activities. The management office of Science Park arranges other services requested by the startup, by connecting experts in the specific area.

Each regional science park is now located in three major regional universities around the country-Chiang Mai University in the North, Khon Kaen University in the Northeast, and Songkhla University in the South. Regional science parks at these major universities have been set up as autonomous units within each university's administrative structure. As autonomous units, the regional science parks can establish their own rules and regulations on revenue generation and financial matters, making inter-organizational management flexible and efficient. In contrast, the regional science parks at smaller universities have not been given the same level of organizational and regulatory flexibility.

Overall, the regional science parks across Thailand have 1,088 researchers and 244 supporting staff. The Northeast Reginal Science Park has the largest number of researchers. At the university level, Chiang Mai University has the largest number of researchers and supporting staff. Thailand also faces shortages of human resources in science and technology. Presently, worker with advanced scientific and technological skills account for 8.9 percent of the country's labor force. In Thailand, moreover, R&D expenditures have fallen below international standards for many years, with only 0.48 percent, and the public R&D expenditures made up 46 percent, while the private R&D expenditures did 54 percent. As pointed out earlier, the private sector's figure stands in sharp contrast with those in the developed and newly industrialized countries where private R&D investments are approximately 70 percent of the gross expenditure in R&D (GERD). (See Table 4-6).

Figure 4-10. Number of Researchers by Universities (persons)



Source: SPA (2016), p.79

Since 2013, the national government has allocated 498.42 million baht for the regional science parks. In this amount, 180.51 million baht were earmarked for science park services development, 172.72 million baht for technology business incubation, 99.09 million baht for industrial research and technology capacity development, and 46.10 million baht for collaborative research projects. These funds were transferred to the regional science parks as general-purpose grants, which gave each regional science park the authority to determine its spending priorities. Since the regional science parks started their operations in 2013, only the Northern Regional

Science Park has allocated fund evenly to all four strategic measures. Meanwhile, the Northeastern Regional Science Park and the Southern Science Park have invested more in programs and activities related to science park services development and industrial research and technology capacity development.

The regional science parks identify 6,965 organizations related to their activities; the Northern Science Park 2,701; Northeastern Science Park 3,118; and Southern Science Park 1,146. Local government organizations account for 947; central government organizations 487; private companies 905; public corporation 82; SMEs 2,323; NGOs 100; communities 1,875; and research institutes 246. Combinedly with the number of researchers, the regional science park seems to have plenty of resources. It is implied, however, that management capacity of each science park is very important for dealing with those stakeholders. Because the success of the science park depends on the community approach as a whole, but not an individual approach.

Table 4-5. Revenues by Sources

Unit: 1,000 baht

	Revenues from Design Center			Revenues from lab/testing		
	2015	2016	total	2015	2016	total
Northern Science Park	659.9	1,050.5	1,710.4	2,377.8	2,682.7	5,060.5
・ Chiang Mai University	350.0	645.0	995.0	1,526.0	1,800.5	3,326.5
・ Mae Jo University	86.1	86.2	172.3	547.2	574.6	1,121.8
・ Mae Fah Luang University	63.8	64.6	128.4	124.0	118.0	242.0
・ Naraesuan University	15.0	45.0	60.0	80.1	81.8	161.9
・ Payao University	120.0	142.2	262.2	100.5	107.8	208.3
・ Phibulsonkran University	15.0	45.0	60.0	-	-	-
・ Uttaradit University	10.0	22.5	32.5	-	-	-
North Eastern Science Park	323.0	524.5	847.5	1,458.8	1,669.8	3,128.6
・ Khon Kaen University	154.0	206.5	360.5	803.8	674.8	1,478.6
・ Suranaree University	100.0	250.0	350.0	430.0	670.0	1,100.0
・ Mahasarakam University	69.0	68.0	137.0	225.0	325.0	550.0
・ Ubonratchathanee University	-	-	-	-	-	-
Southern Science Park	278.0	592.5	870.5	1,415.3	1,554.5	2,969.8
・ Songkhlanakarin University	278.0	592.5	870.5	1,200.5	1,448.8	2,649.3
・ Walailuck University	-	-	-	214.8	105.7	320.5
Total	4,536.8	6,350.9	6,856.7	12,518.9	13,830.0	22,317.9

Source: *op. cit*. p.92.

Such a large number of related organizations is also a base for establishing an innovation network. In that sense, the Northern Regional Science Park has the most robust and sustainable network, compared to the Northeastern and Southern Regional Science Parks. Social network analysis confirmed that the Northern Regional Science Park is central and influential in the network of science and technology agencies in Thailand's northern region. Its frequent contact with businesses, service quality, and economic impact were rated high by researchers and business owners with prior work experience with the regional science parks.

All regional science parks have been able to generate 14.59 million baht in gross revenue from various services, including brand design services and laboratory space and equipment rental.

The Northern Regional Science Park and Chiang Mai University were able to generate the highest amount of revenue. Revenues of the entire regional science park from lab/testing services account for 13.8 million baht, while those from design center for about 6.9 million baht. Revenues of the Northern Science Park are highest among the Parks. It is because it has better facilities than others and the market in the Northern area is relatively big. If market demand for those services is high enough, the sustainability of the science park would depend by and large on those types of facilities, so that hardware-oriented development and maintenance will be important.

Over the past four years, the regional science parks have also provided assistance and information about science and technology to 6,696 businesses. The majority of these businesses were those contacted and assisted by the Northeastern Regional Science Park and Khon Kaen University. On the other hand, cases of collaboration between science parks and entrepreneurs account for 424 during 2013-2016. The cases of the Northern Science Park account 229 which is more than a half; the Northeastern Science Park 33 and the Southern Science Park 11.

The number of research projects undertaken by the science parks are 126 during 2013-2016. Out of them, about 42.1 percent was undertaken by the Northeastern Science Park; 29.3 percent by the Northern Science Park and by the Southern Science Park, respectively, showing that the Northeastern Science Park, particularly Khon Kaen University, carries out research activities to the greatest extent among science parks.

Table 4-6. Collaboration Cases and Number of Research Projects: 2013-16

	Collaboration Cases	Research Projects
Northern Science Park	229	407
· Chiang Mai University	91	150
· Mae Jo University	39	70
· Mae Fah Luang University	20	37
· Naraesuan University	19	36
· Payao University	22	41
· Phibulsonkran University	19	36
· Uttaradit University	19	37
North Eastern Science Park	136	243
· Khon Kaen University	55	96
· Suranaree University	30	54
· Mahasarakam University	29	54
· Ubonratchathanee University	22	39
Southern Science Park	59	104
· Songkhlanakarin University	39	71
· Walailuck University	20	33
Total	424	754

Source: *op. cit*. p.97&103

Table 4-7. Number of Organizations by Science Parks

	Local Government Org.	Central Government Org.	Private Companies	Public Corporations	SMEs	NGOs	Communities	Research Institutes in Universities	Total
Northern Science Park	175	219	223	9	978	46	959	92	2,701
· Chiang Mai University	120	80	62	4	360	8	344	22	1,000
· Mae Jo University		16	54	3	85	-	25	3	186
· Mae Fah Luang University	12	5	29	-	100	5	34	12	197
· Naraesuan University	8	10	33	1	60	-	153	34	299
· Payao University	14	76	-	-	290	24	60	8	472
· Phibulsonkran University	6	11	10	1	60	1	300	5	394
· Uttaradit University	15	21	35	-	23	8	43	8	153
North Eastern Science Park	750	223	529	31	763	24	691	107	3,118
· Khon Kaen University	600	47	55	6	250	6	370	35	1,369
· Suranaree University	64	107	276	24	170	14	35	31	721
· Mahasarakam University	48	48	153	-	153	-	156	15	573
· Ubonratchathanee University	38	21	45	1	190	4	130	26	455
Southern Science Park	22	45	153	42	582	30	225	47	1,146
· Songkhlanakarin University	20	34	110	30	537	20	191	42	984
· Walailuck University	2	11	43	12	45	10	34	5	162
Total	947	487	905	82	2,323	100	1,875	246	6,965

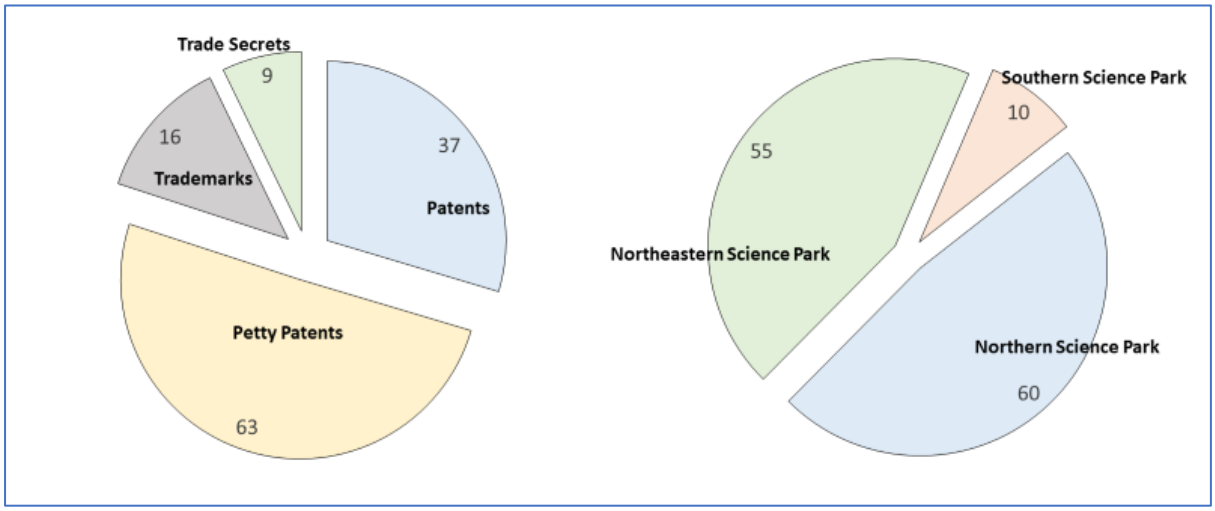
Source: *op. cit*. p.95.

Table 4-8. Number of Beneficiary Entrepreneurs by Services

	Tech-business incubation	IRTC	Collaborative Research	Total
Northern Science Park	87	229	19	335
・ Chiang Mai University	21	91	7	119
・ Mae Jo University	10	39	8	57
・ Mae Fah Luang University	11	20		31
・ Naraesuan University	13	19	1	33
・ Payao University	11	22		33
・ Phibulsonkran University	13	19	1	33
・ Uttaradit University	8	19	2	29
North Eastern Science Park	92	142	22	256
・ Khon Kaen University	25	55	8	88
・ Suranaree University	21	30	4	55
・ Mahasarakam University	23	29	6	58
・ Ubonratchathanee University	23	28	4	55
Southern Science Park	64	60	11	135
・ Songkhlanakarin University	50	39	10	99
・ Walailuck University	14	21	1	36
Total	243	431	52	726

Note: IRTC denotes “industrial research and technology capacity.”
Source: *op. cit*. p.105.

Figure 4-11. IPs by Types and Science Parks: 2013-2016



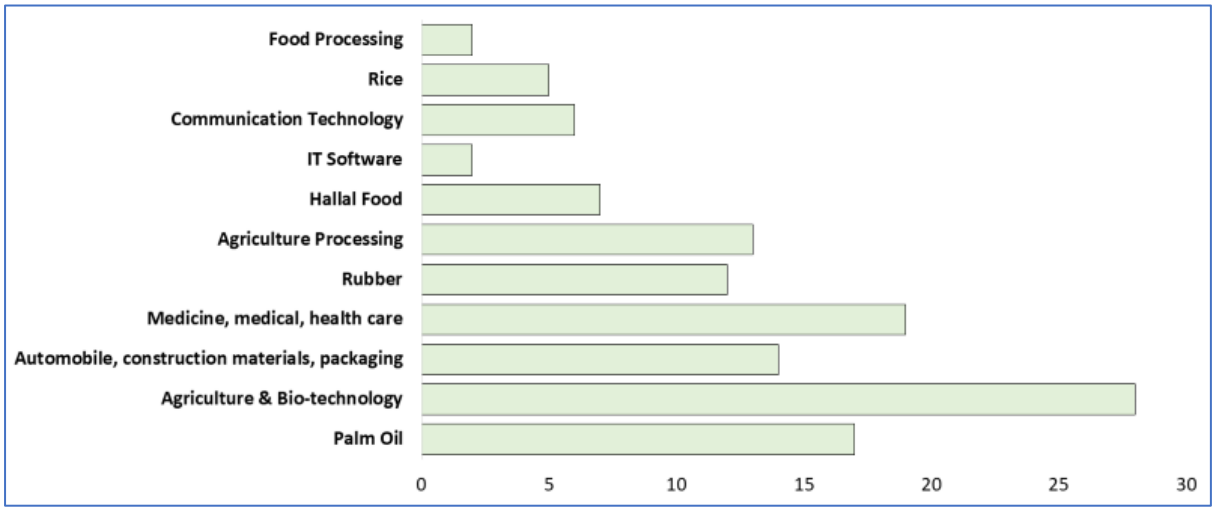
Source: *op. cit*. p.107-108.

Major services except hardware services provided by the science parks are technology-business incubation, industrial research and technology capacity (IRTC), and collaborative research. The number of beneficiary entrepreneurs is available in Table 4-8. Total number of beneficiary entrepreneurs accounts 726 during 2013-2016. Out of them, 46.1 percent were provided by the Northern area, particularly by Chiang Mai University; 35.3 percent by the Northeastern Science Park and 18.6 percent by the Southern Science Park. By types of services, IRTC services are 431; technology-business incubation 243, and collaborative research 52. The number of collaborative research is smaller than that of research projects undertaken by the science parks in

Table 4-7. The technology business incubation provided by the Northeastern shows greatest number among the science parks. The number of IRTC provided by the Northern Science Park is highest among others.

Since their founding, the regional science parks in Thailand produced 125 commercialized research outputs, which purportedly enabled businesses to reduce costs or increase their revenues. Most of these research works belonged to the Northeastern Regional Science Park and Khon Kaen University. Also, of all recipients of the regional science parks' services, 726 of them were able to start their own businesses, improve their technological and research capabilities, and completed their collaborative research projects with the regional science parks. Most of these successful business owners were recipients of the Northern Regional Science Park's assistance. Importantly, the regional science parks' research works were patented, with the total economic value of 99.89 million baht. The largest number of these patented research outputs belonged to the Northern Regional Science Parks and Chiang Mai University.

Figure 4-12. IPs by Industries: 2013-2016



Source: *op. cit*. pp.107-108.

Overall, Thailand's regional science parks demonstrated a decreasing pattern of unit costs from 2013-2016, indicating their efficient management and service delivery. Also, 77 percent of business owners who had been involved in the regional science parks' activities expressed their satisfaction with the services. Among the regional science parks in Thailand, the Northern Regional Science Park was the most efficient due to its decreasing unit costs over the past four years and the business owners' satisfaction.

Each of the three main regional science parks has its own industrial strength, officially referred to as "Flagship Project." When the regional science parks were about to launch in 2013, they were required to select specific products (or produce in case of farm-produced crops and goods) that they wanted to promote. The Northern Regional Science Park has rice as its flagship product, and the Northeastern Regional Science Park chose chicken. Rubber is the Southern Regional Science Park's flagship project. Overall, the regional science parks produced 27 research outputs between 2013 and 2016. The flagship outputs generated 72.63 million baht in total

economic impact. Most of these flagship products were related to rice, thereby belonging to the Northern Regional Science Park. However, none of the regional science parks succeeded in completing the agricultural value chain.

Table 4-9. Flagship Projects by Universities

	Flagships	Year	Value Chains
Northern Science Park: "Thai rice value added project to global market"			
· Chiang Mai University	· Payao Red Rice product development skin care & UV protection	2013	Processing
	· Drying Rice by heating pump technology system development	2014	Processing
	· Anthocyanin Extract from soak rice water (Luem Pua Breed)	2015	Processing
	· RF Technology Pilot Plant for eliminate insect & eggs	2015	Processing
	· Anti-aging & whitening product development from Payao Rice	2015	Processing
	· Paddy Drying System (High Quality)	2016	Processing
· Payao University	· Skin care lotion with Germ extract	2016	Processing
· Phibulsonkran University	· Retorted Pad Thai Development for commercialization	2013	Processing
	· Healthy cookies from Low Sugar-High Fiber Rice flour product development	2013	Processing
	· Healthy boiled rice water beverage	2014	Processing
	· Rice & Millet snack Product development	2014	Processing
	· Chocolate Rice Berry Rice Product development	2014	Processing
· Uttaradit University	· Organic Rice Product transforming	2016	Imported factor
	· Noodle Value added project	2014	Processing
	· Silica Extract from Rice Mill ash husk processing	2014	Processing
	· Instant congee product development for sliced noodle product development	2015	Processing
North Eastern Science Park: "Thai Broiler chicken value added project"			
· Khon Kaen University	· Broiler chicken breed development for industry	2013	Imported factor
	· Enrich chicken Health by using Thai herb with New Tri-genomic technique	2014	Agricultural
	· Khon Kaen Chicken Breed development serving for industry	2014	Imported factor
	· Enrich mixing broiler chicken & house chicken breed by using Thai herb with New Tri-genomic technique	2015	Agricultural
	· Improving healthy food with New Tri-genomic technique through Black bone chicken antioxidant gene experiment	2015	Imported factor
· Suranaree University	· Smart chicken farm automatic counting system & weighing development using RFID	2015	Agricultural
Southern Science Park: "Rubber value added project"			
· Songklanakarin University	· High quality rubber cover gloves	2014	Processing
	· Rubber pillow & prayer ritual	2014	Processing
	· Rubber cleansing spray & material coating	2015	Processing
	· Engineering system design & machine production	2015	Processing
	· Heathy shoe pad	2015	Processing

Source: *op. cit*. pp.122-123.

The regional science parks altogether generated economic impact of 635.89 million baht, measured by increase in revenues of enterprises through joining projects of science parks. The Northern Regional Science Park made the most substantial contribution to this total economic impact. For last 5 years, outcomes of the Science Parks were estimated; 215 techno-preneurs; 1,500 lab customers; 2,000 service customers; 220 industrial R&D and technology capacity development projects; 30 collaborative researchers; and 73,000 data on STDB. SPA targets, among others that value added and private R&D investment would be increased to 250 million dollars and 15 million dollars in 2018, respectively.

Table 4-10. Economic Impact

Unit: 1,000 baht

	2013	2014	2015	2016	Total
Northern Science Park	41,885	44,870	52,890	108,358	248,003
· Chiang Mai University	35,000	38,000	42,300	75,900	191,200
· Mae Jo University	2,500	3,800	5,100	26,780	38,180
· Mae Fah Luang University	1,400	980	1,700	2,090	6,170
· Naraesuan University	880	640	1,200	950	3,670
· Payao University	725	520	890	430	2,565
· Phibulsonkran University	530	350	650	208	1,738
· Uttaradit University	850	580	1,050	2,000	4,480
North Eastern Science Park	33,000	46,500	59,300	93,400	232,200
· Khon Kaen University	25,000	35,000	41,300	65,600	166,900
· Suranaree University	3,500	5,000	9,500	15,600	33,600
· Mahasarakam University	2,500	3,000	4,500	6,400	16,400
· Ubonratchathanee University	2,000	3,500	4,000	5,800	15,300
Southern Science Park	40,950	33,090	26,200	55,450	155,690
· Songklanakarin University	40,500	32,450	25,000	54,500	152,450
· Walailuck University	450	640	1,200	950	3,240
Total	115,835	124,460	138,390	257,208	635,893

Source: *op. cit*. p.151.

It is Chiang Mai university of the Northern Science Park that leads activities of science parks, in terms of services and revenues, moving ahead in establishing physical facilities. Meanwhile, Kon Kaen University of the Northeastern Science Park has greater manpower and activities in R&D. The Southern Science Park has only two universities in the innovation network, and major activities—probably more than 2/3—are undertaken by the Songkhla University. Such a result might be influenced partly by management capacity and partly by industrial strength of the region and community factors. Economic impact of science parks seems to be overestimated, and, maybe, it would be too early to expect a performance to large extent, in consideration of the

success rate of incubation in other exercises.[10] Taking account of the flagship projects of science parks, most universities concentrates on innovation in the agricultural sector.

(1) Northern Science Park

As a practice of the science park, we briefly review the management of the Northern Science Park (NSP). The NSP is established as a strategic vehicle for economic development of the Northern Region. The NSP is funded and supported by the SPA/NIA, MOST. The purpose of NSP establishment is to develop and strengthen an innovation platform to increase dynamism between the private, university and government sectors. It thus promotes technological commercialization through R&D, technology transfer, collaboration, and others, primarily focusing on incubation of the technology startups.

The NSP includes 7 universities in the Northern Region; Chiang Mai university (hub) Maejo University, Mae Fah Luang University, University of Phayao, Naresuan University, Uttaradit Rajabhat University, and Pibulsongkram Rajabaht University. The Science and Technology Park in Chiang Mai University (STeP) is a leading park and focuses on the arears of agriculture/foods, bio-technology/medical, IT software/digital contents, and renewable energy industries. Meanwhile Maejo university focuses mainly on organic food/fisheries technology; Mae Fah Luang University on tea/fungi; University of Phayao on food technology; Narensuan University on cosmetic/bio-materials; Uttaradit Rajabhat University on agricultural technology; and Pibulsongkram Rajabhat University on food/ceramic. That is, those universities seems to have different strategies for the different focus areas.

Figure 4-13. Areas of Specialization by Universities

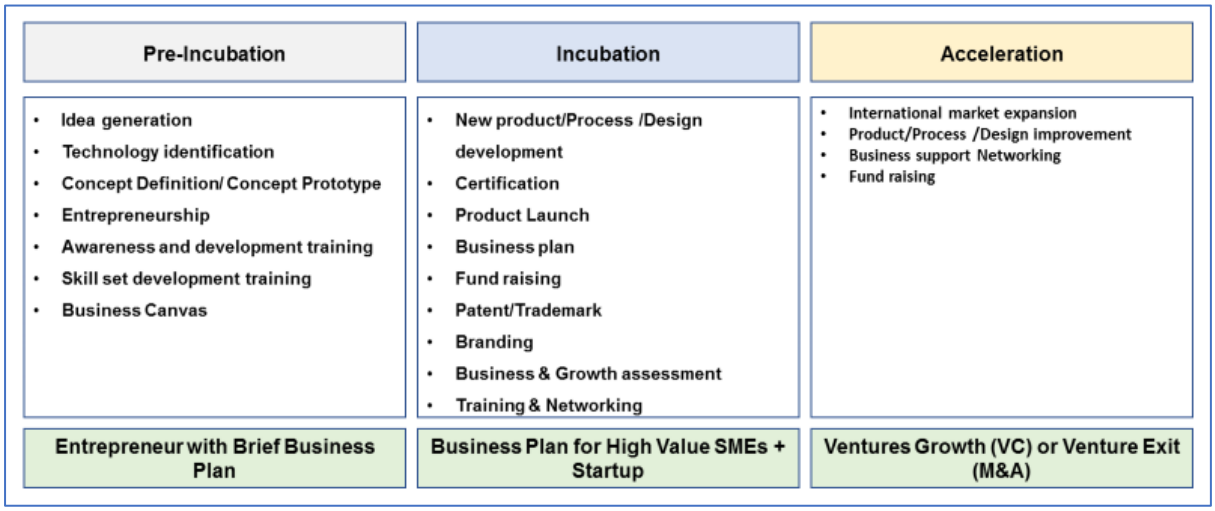
Chiang Mai University	Maejo University	Mae Fah Luang University	University of Phayao	Naresuan University	Uttaradit Rajabhat University	Pibulsongkram Rajabhat University
• Agriculture • Food Products • Food Safety • Biodegradable Polymer • Bio-Plastic • Bio-Packaging • Cosmetic • IT Software and Digital Content • Renewable Energy • Material Innovation • Medical Device • Design and Creative	• Organic Certified Material for Agricultural Products • Crop Production Technology and Plant Breeding • Fisheries Technology and Aquatic Resources • Animal Science and Technology • Agricultural Produce Management • Precision Agriculture • Food Safety, Security and Sustainability • Value Creation for Organic Food • High Value-Added Product and Service • Molecular Gastronomy • Renewable Energy	• Tea Institute • Fungal Research Excellent Center • R&D in Cosmetic Science • Natural Products Excellent Center	• Food Technology and Food Safety • Natural Products • Cosmetic • Renewable Energy • Environmental Technology	• Cosmetic • Biomaterials • Food Technology • Natural Products • Environmental Technology	• Agricultural Technology Machines • Renewable Energy • Organic Food and Farming • Lab on ISO/IEC17025	• Food Safety • Food Product Development • Ceramic Technology • Information Technology

The funding is made by various sources. Major part of the fund is made by SPA. For example,

[10] In case of Korea, the success rate is known to be less than 7 percent.

the fund of STeP in 2016 was about 172 million Baht, of which 65 million was funded by SPA and 57 million Baht by other source; and the remaining 50 million Baht (funded by SPA) is transferred to other university science parks. Normally, the director and management team are responsible to raise the remaining part of the fund. Also, SPA funded 5-10 million Baht each to the other universities in NSP. Total staff of NSP accounts for about 144, and STeP staff is about 65, including 5 managements.

Figure 4-14. STeP Incubation Process



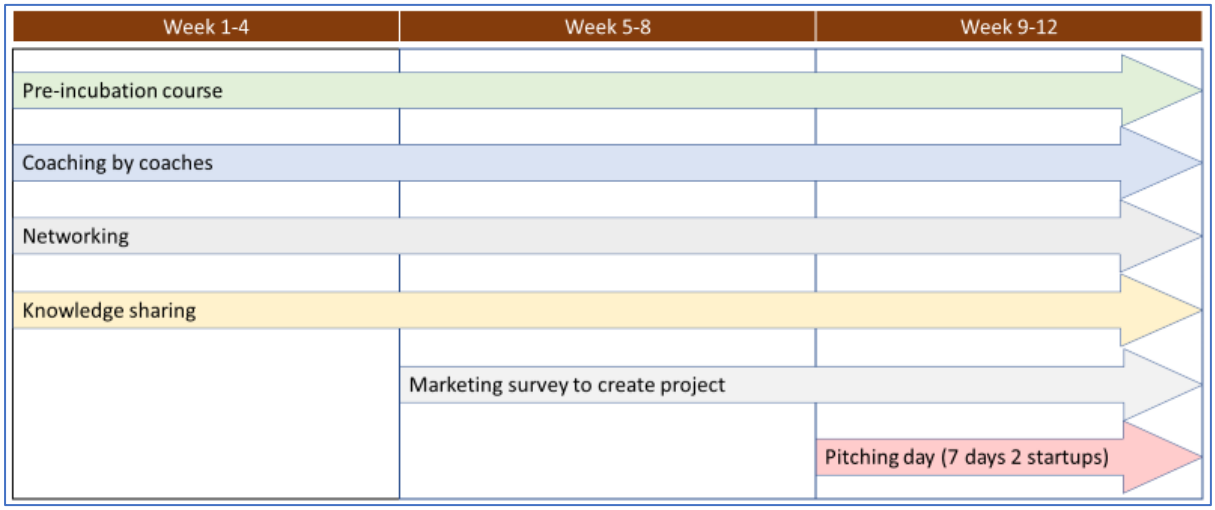
The STeP has the support programs, mainly focusing on incubating startups. They are

- STI services
  - Industry-oriented lab service
  - Innovation design
  - Intellectual property management
  - Database on available S&T infrastructure
  - Office of industrial liaison, etc.
- Incubation:
  - Startups and spin-offs
- Collaborative research with companies
  - Collaborative R&D
  - Technology transfer
  - Space rental
  - Pilot plant, prototype ready for commercialization
- Industrial Research & Technology Capacity Development
  - Utilization of STI resources, researchers and consultants
  - STI awareness
- STI infrastructure

The STeP includes three steps in incubating startups, such as pre-incubation, incubation and acceleration. The STeP seems to more concentrate on the pre-incubation and incubation programs, relative to the acceleration. Most services of the programs are provided at the expenses of STeP, when the startup requests.

For the present, NSP has 82 startups being incubated, and the incubation period is three years; after the incubation period, the incubating startup has to move out of the facilities of STeP. When the startup is approved to participate in the pre-incubation program, in which various services are, for three months, provided for idea generation, technology identification, concept prototype, entrepreneurship, development training, business model/plan, and others. There is a course for the pre-incubation, that is, general course, coaching, networking, knowledge sharing, marketing survey, and others. The startup completes the business model/plan and product development plan. Afterwards, the startup moves into the incubation facility. During the incubation period, the startup is provided with the services such as business/technology/IP consulting, design/branding, and others. Those services are available on demand. However, during the incubation period, the startup does not have to pay for the space and services. For example, if the startup need to use research facilities, then STeP makes an arrangement with university professor, and pays for it if it incurs costs. Due to such advantage, the competition is high. Usually, twice as many of incubation capacity make applications for the incubation program.

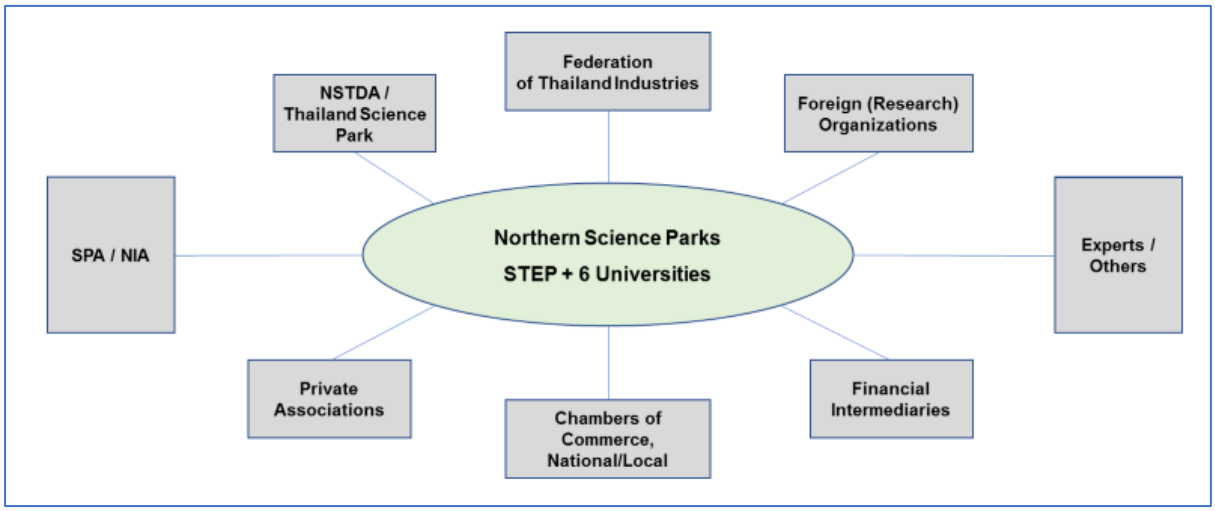
Figure 4-15. Pre-Incubation Courses



The incubation of the startup is made mainly for the areas of agriculture and food, IT software and digital contents, medical and bio-technology, and energy technology and materials. Major source of technology is the Chiang Mai University, which has large-scale engineering school. However, technologies are acquired from both domestic and foreign sources. As an example, STeP undertakes collaboration with Sungkyunkwan University (3D printing), Nuclear Fusion Research Institute in Korea (Plasma technology), Mitsubishi Electric in Japan (smart agriculture), Kyoto Prefecture in Japan (smart City), and others.

The NSP establishes a network across the nation, as shown in Figure 4-16. It is being developed by the policy of SPA/NIA and other agencies of MOST, as an important government initiative for the regional economic development. Therefore, the future course of development will be greatly influenced and determined according to the sustained government policy. On the other hand, NSP cooperates with many private organization, at the domestic/foreign and national/local levels. Since current the level of investment in university R&D is not high enough to establish of the platform for the supply of technologies, although Chiang Mai university like others has a good R&D potential. In this sense, pursuing cooperation with foreign organizations seems to be desirable. In addition, the participation of large-scale enterprises in incubation of technology startups would also have a significant influence on the performance of STeP.

Figure 4-16. STeP Eco-System



Some outperforming cases for the last five years can be indicated as follows. For example, PATTA, Little Onion Factory Co. Ltd., has been incubated since 2015, and its major products are organic herbal soaps and amenities for all skin types, by applying organic herbal to soap and amenity production. This company employs 5 workers and its annual revenue was 1.5 million Baht in 2016. It also takes an advantage of the partnership with large enterprise, MITR PHOL. Siam Novas has been also incubated since 2015, and its major products are Gender biased frozen semen for artificial insemination on dairy and beef cattle to increase number of female calves, by developing technology to increase the likelihood of producing a female calf by approximately 70%. Employees and revenues in 2016 are 5 and 1 million Baht, respectively. BeNeat, incubated since 2015, makes a business with the online platform for connecting Be-Neat professionals and clients for space cleaning based on Airbnb standard; 3 employees and 150 thousand Baht of revenues in 2016.

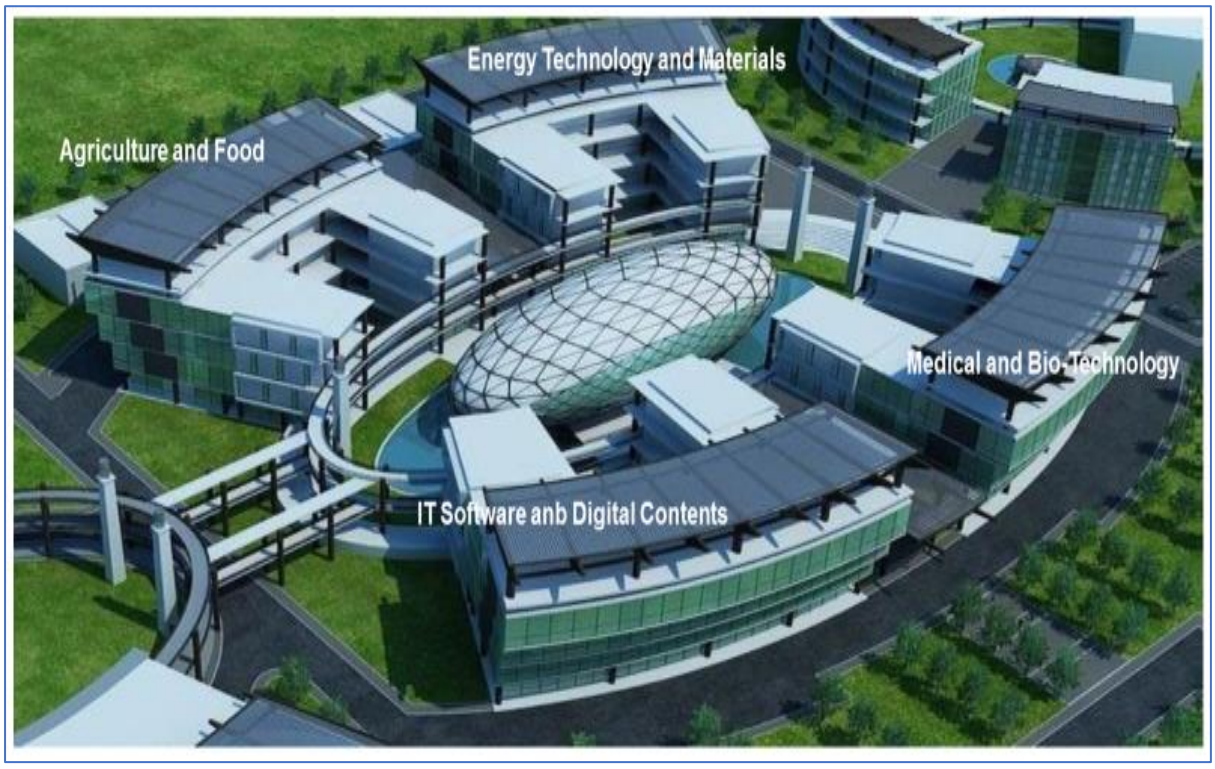
According to STeP, the impact of NSP during 2013-2016 exhibits the increase of 123.9 million Baht in revenues of the private sector; the increase of 313.4 million Baht in production of the private sector. And also, it does, for job creation, 607 for workers and 33 for researchers; 208.8

million Baht of R&D investments by the private sector; and 78.5 million Baht of investment in collaborative projects, etc.

The SPA made an investment to construct new NSP main campus. It is expected to open new campus in February 2018. The plan is shown in Figure 4-17. This new campus will promote to incubate more startups, and play a central role in the science parks in the Northern Region.

In summary, STeP well establishes a network of universities in the region, and other related organizations for STI activities; particularly it runs well-prepared courses of pre-incubation. However, the number of startups being incubated is too small, considering the rate of success in major countries, and it is expected to increase the number when new campus is open next year.

Figure 4-17. Plan of NSP Main Campus in CMU



It might be pointed out that the STI platform is too weak mainly due to small investment in university R&D. In addition, it seems that the support programs for the startup need to be more developed, particularly support for business financing should be reinforced as most startup finances itself from family funds, etc. the financial plan for the startup is one of most important factors to be successful, and therefore a support program has to be made from the pre-incubation, according to the growth stages of the startup.

On the other hand, greater effort has to be made for joint R&D between startup and university. Technology/technical services are provided at the STeP expenses, when the startup requires. But

at the pre-incubation, if the business/product plan is completed, STeP may be engaged in promoting joint R&D for the product development between concerned startup and university professor; pro-actively rather than reactively. Lastly, it can be pointed out that STeP should make a plan for the follow-up after the startup graduates. Since only three years is allowed for the incubation, some might-be-promising startup loses its chance for the success. There is rough idea for the acceleration, which needs to be more developed.

4.4. SUMMARY

The Ministry of Science and Technology has taken initiatives for the startup policy in Thailand. There are three major agencies under the umbrella of the MOST, that is, NSTDA, SPA and NIA. Those are the implementing agencies for startup policies/programs.

NIA as a funding instrument implements various policies/programs. It supports to bring innovation of SMEs, by funding schemes, and support programs. There are 15 support programs for startup/SME innovation. However, NIA policy seems to focus a narrow range of innovation activities, i.e., focusing supports after commercialization. Thus, reorientation of NIA policy seems to be necessary to cover the entire range of the innovation cycle, from R&D, development of new product/process, technology transfer/commercialization, marketing and services, etc. Because it is NIA that has the versatility in implementing policies/programs in supporting innovation of startups/SMEs. Basically, it can be said that NIA's policy/program is software-oriented, not based on physical facilities.

NSTDA is responsible for management of Thailand Science Park, in which public research organization and private enterprises are accommodated. Main functions of Thailand Science Park are to manage the business spaces for the tenant companies, and to provide S&T services to them. It also manages incubation facilities in part. On the other hand, SPA is responsible for the development of regional science parks. There are three regional science parks, all of which manage the technology/business incubation, focusing mainly agricultural sector. In a word, it could be said that the policies/programs of both NSTDA and SPA are hardware-oriented; i.e., their programs are based on the physical facilities. The regional science parks are now located in the university campuses, and under construction of its own campuses. After completion of the regional science park building, the regional science parks would be separated from the university administrative structures. For a while, cooperation between SPA and universities, who are in the network of science parks, is important. The future of the regional science parks depends on how, for sustainability, they secure other revenue-generating channels, such as testing services for water quality, microbiological testing services, and training programs on technology business innovation and modern entrepreneurial skills.

An exercise of management of the science parks was available from case of the Northern Science Park.[11] Science parks seem to have difficulties due to the weakness of the innovation

[11] A couple of opportunities were available to have talks with the managements of STSP and Ubon Ratchathani University of NESP.

platform. It can be pointed out that the science park for developing/nurturing startups is not an individual approach, but the community approach.

Putting it differently, it is important for the science park to establish a virtuous circle, that is, the community → entrepreneurs → startups → incubation/support programs on STI platform → successful graduation (criteria) → impact of regional economy (employment, production, etc.). For example, the community in consideration is the ground of STI activities, where entrepreneurs are continuously produced out. Thus, the science park as a promotor should fertilizes the soil of entrepreneurship. Various policies and programs will be developed and implemented for nurturing startups, which will eventually bring about the impact on the regional/national economy. In this line, NIA could find a room for cooperation with regional science parks, as a funding instrument.

CHAPTER 5
KOREA'S STI SYSTEM AND STARTUP POLICY

5.1. EVOLUTION OF STI GOVERNANCE

5.1.1. OVERVIEW OF INDUSTRIALIZATION

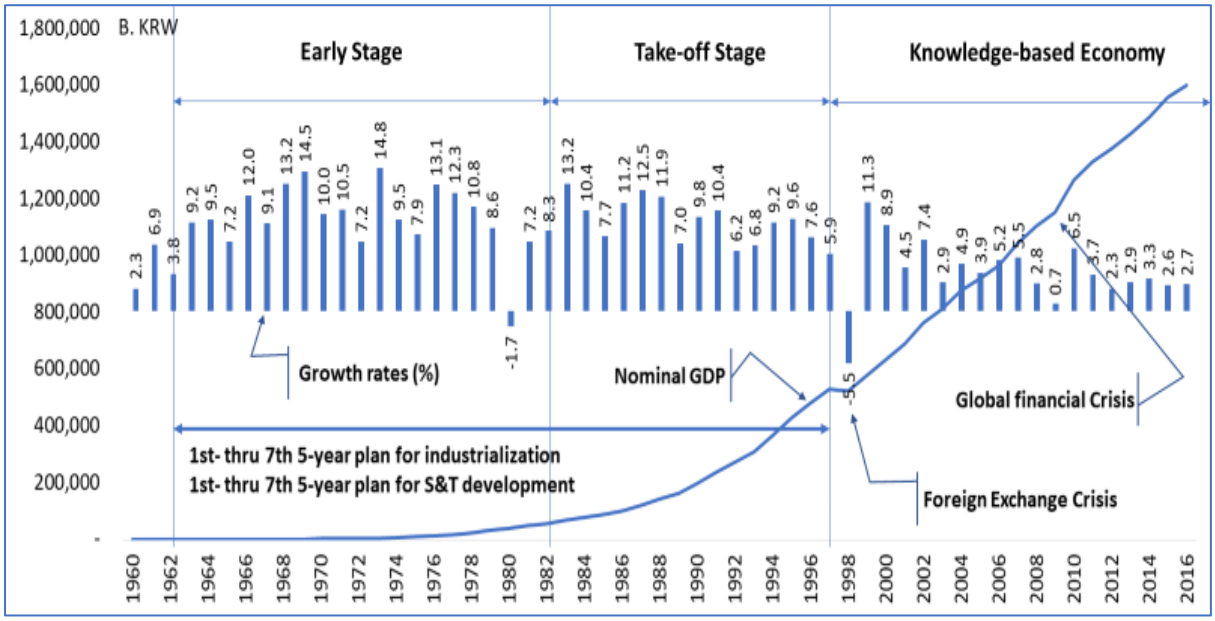
The Korean economy has grown from the resource-based economy in 1960s to the industrialized economy, and to the knowledge-based economy. The industrialization process could be divided into three stages, i.e., the early stage (1962-81), take-off stage (1982-97), and afterwards knowledge-based economy. During the period of the early stage, Korea started to pursue actively economic development, focusing on export-oriented light industry. While the industrial structure become technology-intensive due to development of heavy-chemical industry, by which the Korean economy made a jump. Since the end of 1990s, Korean economy moved into the knowledge-based economy, taking advantage of ICT revolution in the 1990s.

Korean government had implemented seven times the "Five-Year Plan" for both industrialization and S&T development during the period of 1962-97. Korea's strategy for industrialization emphasized the development of import substitution industry and promotion of export. From the beginning, thus, competition is one of important factors for the domestic firms. The remarkable performance in 1960s-70s led to a sizable investment in heavy-chemical industry in the late 1970s and early 1980s. However, acquisition of technology was an important issue for the development of heavy-chemical industry. During those days, Korea's knowledge system has only teaching capacity at the university, and the engineering schools were rare. Thus, the government implemented a number of initiatives for the development of science and technology. Among others, a focus was made on building GRI system, engineering schools and polytechnic schools. They were the important technological platform in the process of developing heavy-chemical industry.

For the heavy-chemical industry, such as Samsung, Hyundai, LG, POSCO and others, brought innovation from imitation through OEM manufacturing and reverse engineering at the beginning. As S&T investment had been accumulated, those enterprises had been able to bring innovation based on domestic sources of science and technology. In this line, the GRI system played an important role, and in time those large enterprises built up their own innovation capacity. Due to gaining competitiveness in heavy-chemical industry in the world market, Korean economy was able to take off to an industrialized economy in 1990s. Some of domestic enterprises became global enterprises, establishing its own global value chain.

After the foreign exchange crisis in 1997, Korean economy experienced a serious structural adjustment with massive unemployment. The unemployed resources released into the market, which became a ground for active spring-out of technology-based venture companies in ICT area, among others. The venture business is continuously developing, as a growth engine of the economy.

Figure 5-1. Stages of Korea's Industrialization



Source: Bank of Korea, http://ecos.bok.or.kr/EIndex_en.jsp [20 March 2017].

On other hand, since the beginning of the industrialization, the Korean government started to develop R&D capacity of both public and private sectors by creating the Government Research Institutes (GRI) system. Over three decades, the GRI system played a critical role to lead the development of government R&D capacity, bringing major innovations. In the late 1990s, R&D capacity of the university increased to a large extent by the government support.

After 2000, the Korean innovation system exhibits well-balanced capacity and greater dynamism between the innovation units, moving towards a firm-centered innovation system. In the course of Korea's industrialization, it would be said that the underpinning principle lies in competition and learning.

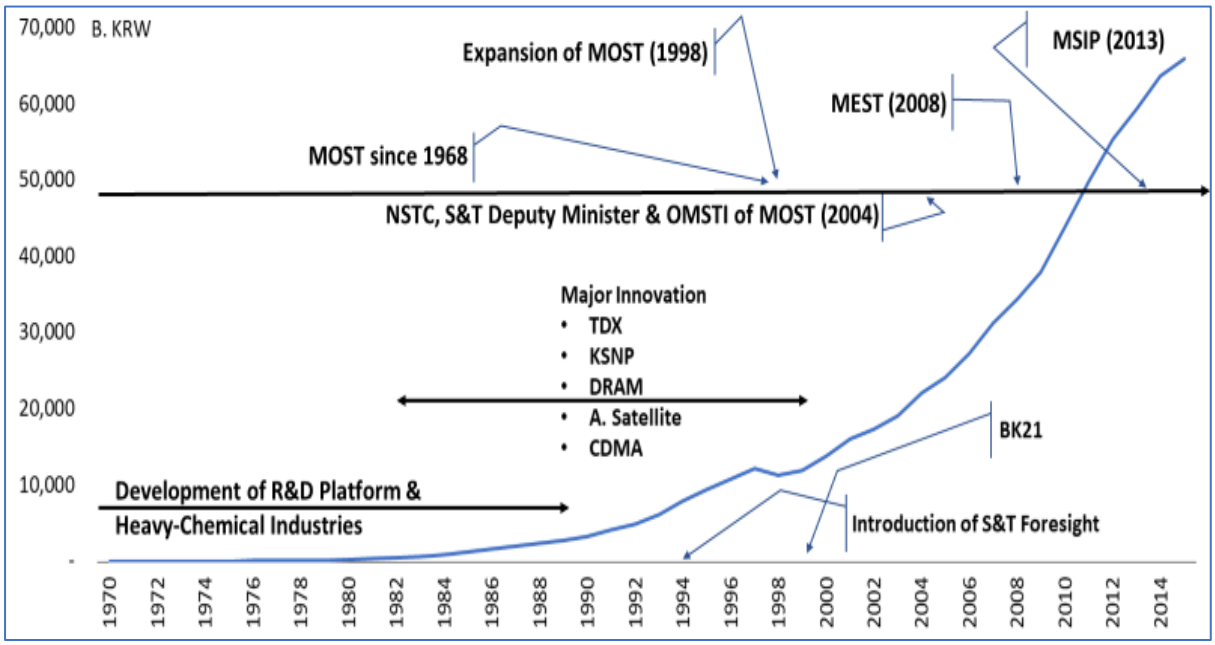
5.1.2. EVOLUTION OF STI GOVERNANCE

The evolution of Korea's STI governance has been made in accordance with the size of STI activities. The Korean government firstly established the ministry of science and technology in 1967, right after the establishment of a modern research institute, KIST (Korea Institute of Science and Technology), in 1966. Since then, MOST had been responsible for S&T policy, with firstly making a long-term plan for S&T development.

The Korean government drove the policy for development of heavy-chemical industry, focusing on steel, electronics, petrochemicals, machinery, ship building, and non-ferrous metals. Such industrial development required a good deal of skills and technologies, and furthermore technological capability managing these industries was in demand. In so doing, the government expanded the GRI system by establishing more specialty research institutes in various areas of science and technology. Those institutes played a critical role at the beginning of industrialization in import and assimilation of foreign technologies.

Mostly, the policy target of the MOST was placed on development and nurturing of GRIs. In 1960-70s, it seemed that S&T policy was not complicated. Securing budget and distributing over the GRIs were main policy of MOST. The system for planning, monitoring and evaluating was not well developed. Maybe, such a system was too much in comparison with the size of R&D expenditures of the government. In 1980s, the government kept expanding the GRI system.[12] A considerable expansion of the GRI system was made, and the policy domain also expanded increasingly with more public R&D expenses.

Figure 5-2. R&D Investment and Evolution of STI Governance in Korea



Source: MSIP, *Survey of Research and Development in Korea,* various issues.

On the other hand, the government established the Korea Science Foundation (KOSEF) in 1977, as a funding instrument.[13] The KOSEF was an implementation and management agency for

[12] In the private sector, the large enterprises began to establish the corporate research institutes for their own purpose

[13] The KOSEF became National Research Foundation (NRF) in 2009, being merged with Korea Research Foundation (KRF) established in 1981.

the R&D investment of the government. The objective of establishment of KOSEF was to increase R&D capacity and promote science education to cope with industrialization.[14] On the other hand, in 1982, the government started to implement the strategic government R&D program, and various support policies, including tax incentives, for business R&D.

In 1980s, several major strategic R&D projects were undertaken with the GRIs leadership. They are;

- TDX (Digital Electronic Switching System; 1982-1991)
- KSNP (Korea Standard Nuclear Power Plant; 1983-1996)
- High-speed integrated DRAM (1986-1993)
- Wooribeol I (Artificial Satellite; 1989-1992)
- CDMA (Code Division Multiple Access; 1989-1996)

Those major innovations brought by the GRIs became a S&T platform for Korea's moving towards knowledge-based economy since the end of 1990s. during the period of 1982-1996, a series of successful development of TDX, DRAM and CDMA, among others, led to Korea's ICT industry today. Throughout the development process, Korea was able to build up S&T platform, on which a number of technology startups has made successful businesses. The "Venture Dream" in particular after Korean foreign exchange crisis stimulated a number of young entrepreneurs.

In 1992, MOST formulated the G7 Project at the inter-ministerial level. It was the first attempt to launch a strategic government R&D program based on the coordination between S&T related ministries. The G7 Project included 12 projects for products and processes, and targeted to achieve at least one of results at the G7 level. In the process of the formulation of R&D program, a number of experts and stakeholders participated, and drew a consensus. Soon after this, a large scale of technology foresight was undertaken in 1994, and attracted a good deal of attention from the Korean society. Then, the size of R&D investment and project was increased considerably. As shown in Figure 5-2, the size of the government budget for public R&D had been increased sharply from the mid-1990s, mainly due to introduction of S&T foresight which increased rationality and transparency in managing government R&D. In 1999, the government implemented BK21 (Brain Korea, 21st Century) program to increase R&D capacity of the university.

Korea's STI governance kept changing over time due to changes in domestic STI environment. The Ministry of Science and Technology (MOST) was expanded in 1998. However, the major change in STI governance was made in 2004, introducing the coordination mechanism. The S&T minister was promoted to a deputy prime minister under whom the Office of Minister for

[14] http://www.archives.go.kr/next/search/listSubjectDescription.do?id=000073 [6 January 2017].

STI (OMSTI) was created in the MOST. On the other hand, the National Science and Technology Council (NSTC) was established for the overall coordination of STI policy across the ministries. NSTC was chaired by the President and its members are S&T related ministers and civilian experts. It was the body for the final decision-making in STI policy. The OMSTI played a role as the secretariat to NSTC, and also made budget allocation according to the decision of NSTC.[15] The MOST merged into the Ministry of Education in 1998, which became the Ministry of Education, Science and Technology (MEST). The NSTC also changed to a standing committee at the ministerial level. The additional change was made by new government in 2013, and the S&T part of MEST was separated and merger together with the Ministry of Information and Communication, which became the Ministry of Science, ICT and Future Planning (MSIP). The NSTC also changed. More details are discussed in the following.

5.1.3. PROCESS OF POLICY-MAKING AND PROGRAM-FORMULATING

(1) Structure of STI Governance

Unlike the policy approach of the neoclassical economics, when the variables of science, technology and innovation come into the scene of the public policy management, the complexity facing the government sharply increases in process of decision-making. Because most socio-economic problems today are caused and cured by science and technology, an increasing number of stakeholders pay an attention to STI policies of the government.

The STI governance is defined as "the processes of interaction and decision-making among the actors involved in a collective problem that lead to the creation, reinforcement, or reproduction of social norms and institutions." Well-structured governance is necessary, because of (1) competing rationales over individual policy domains, (2) short-termism in resource allocation, undermining log-term strategy, (3) different views and understanding of innovation policy, (4) fragmentation ad segmentation, etc. (OECD 2005, p5).

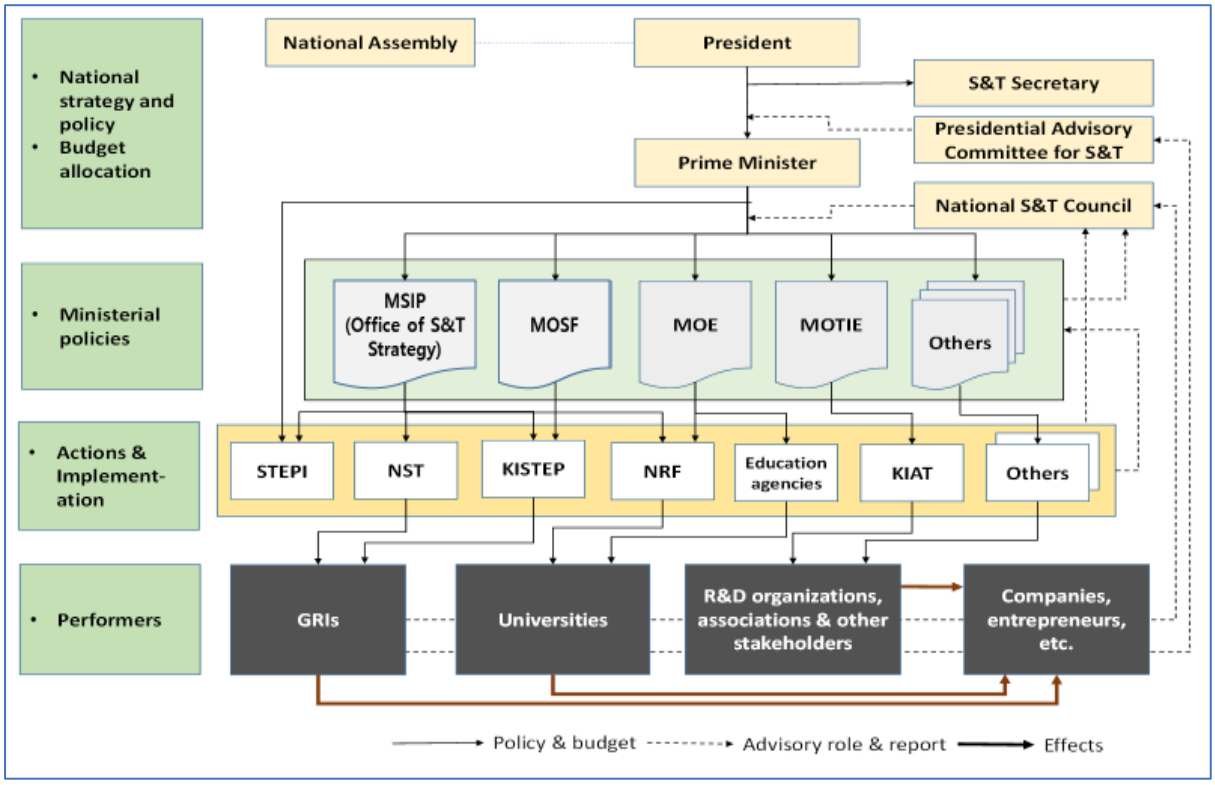
In the decision-making process, there exist several layers. At the top governance, policy coordination and final decision is made by the highest government level. This is necessary because there are many STI-related ministries at the ensuing level of the governance. Then, each ministry would have an agency for implementation of its policy. This agency should have the expertise in STI policy studies and management. At the lower governance, there will be R&D performers in the public and private sectors. The public sector includes research institutes and universities, while the private sector firms and corporate research institutes. This is about the vertical governance.

[15] This caused conflict between the budget authority and MOST to some degree.

In the horizontal governance, there are many actors being engaged in STI activities. At the policy level, an increasing number of ministries make an intervention of STI activities for their own purposes. Since they have the different purposes, coordination over the policy domain of the ministry level has to be made to align resource allocations with the national goal, more efficiently. In other words, as more stakeholders with different objectives intervene STI policy-making, a good exercise of coordination and concerted actions are essential. In this line, the government has to undertake regularly strategic planning with creating the national vision and making horizontal approach on the appropriate knowledge bases.

Korea's STI governance includes the vertical governance and horizontal governance. The horizontal governance draws increasingly attention since more ministries are involved in STI policy on their own. This increases necessity for coordination function in the government. The vertical governance consists of four levels; showing the hierarchy of decision-making processes.

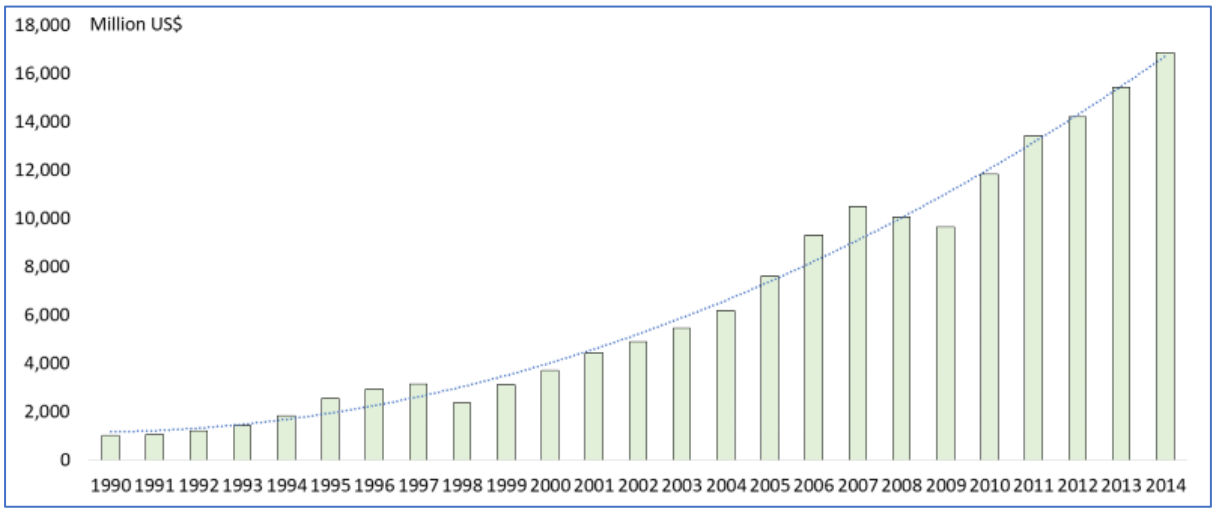
Figure 5-3. Korea's STI governance



The upper governance makes the final decision about national strategy/policy and budget allocation, which includes the President, the Prime Minister, NSTC on the one hand, and the National Assembly on the other. Each ministry formulates for the sake of its own purpose. To avoid duplication of policies/programs, the coordination is made by NSTC. After the coordination, the final decision is sent to the budget authority. At the level of the upper governance,

the mechanism of PIMEF (Planning-Implementing-Monitoring-Evaluating-Feedback) functions in regard to budget allocation. Such PIMEF is well structured and managed by the OSTS within the MSIP and the Office, which plays a role as a secretariat to NSTC.

Figure 5-4. Total Government Budget Appropriations or Outlays for R&D



Source: MSIP, *Survey of Research and Development in Korea*, various issues.

Table 5-1. R&D Budget by Ministries and Administrations (2016)

Unit: Billion KRW

Ministries and Administrations	2015
Ministry of Science, ICT and Future Planning	6,557
Ministry of Trade, Industry and Energy	3,407
Defense Acquisition Program Administration	2,557
Ministry of Education	1,740
Small and Medium Business Administration	956
Rural Development Administration	631
Ministry of Oceans and Fisheries	572
Ministry of Health and Welfare	532
Office for Government Policy Coordination & Prime Minister's Secretariat	466
Ministry of Land, Infrastructure and Transportation	446
Korea Meteorological Administration	164
Korea Forest Service	104
Others	962
Total	19,094

Source: http://www.kistep.re.kr/getFileDown.jsp?fileIdx=6324&contentIdx=10111&tbIdx=BRD_BOARD [2 March 2017]

Under the umbrella of each ministry (or the office of Prime Minister), there exist various specialty agencies. Some of those agencies play a role as an advisory organization, which also

undertakes research works in various fields of the society. Others are implementing agencies with allocated funds. Usually those agencies are responsible at their levels for planning, selecting, monitoring, evaluating and reporting for implementation of R&D programs/projects. In addition, they are also to develop the indicators for monitoring and evaluating. The specialty agencies are very important because they produce references/materials and collect data about the control process and effects of the exercises of implementation in close touch with R&D performers, and also prepare agenda for related ministry. All information collected and analyses of implementation are reported to the upper governance. They are synthesized in the Office of S&T Strategy, i.e., the secretariat to NSTC, which also prepares the agenda for NTSC meeting.

The Office of S&T Strategy in MSIP has two bureaus, i.e., Science and Technology Policy Bureau and R&D Investment Coordination Bureau. The S&T Policy Bureau has six divisions, while the R&D Investment Coordination Bureau four divisions.

Finally, at the lower governance, there exist R&D performers, such as universities, GRIs, enterprises and others. Sometimes, they are competing for the R&D funds, and sometimes they form a consortium for undertaking a R&D projects. Their behaviors are well induced by the government policy and/or programs.

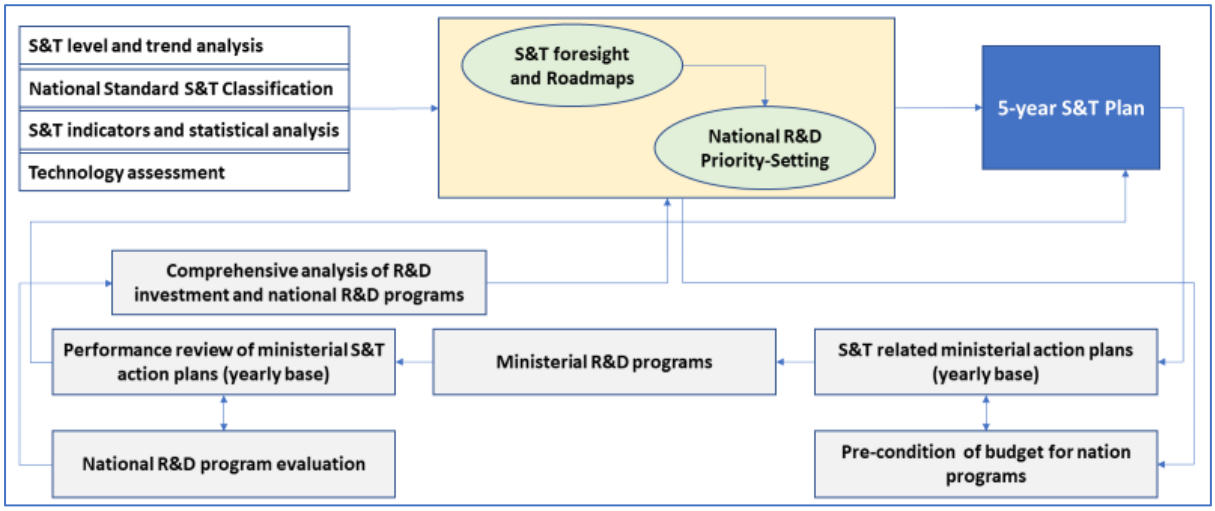
(2) PIMEF Framework

PIMEF (Planning-Implementing-Monitoring-Evaluating-Feedback) is the cycle of STI policy action. Such PIMEF activity takes place at various levels of the STI governance. For example, Figure 5-5 exhibits the Korean exercise at the upper level of STI governance. PIMEF framework play an important role to make efficient resource allocation, by which individual policy can be aligned with the national goal.

In general, before the planning, studies on socio-economic analyses are under taken in various areas of social science approaches, and in turn various socio-economic issues can be developed and identified. Such studies are usually extensively undertaken by the experts of various organizations including universities, research institutes and others. Those studies might be related to the specific planning, directly or indirectly. Such studies make the policy-maker better understand the real world. Usually, when any organization prepares a planning, it makes a survey over related studies, and synthesizes them to draw relevant issues.

Taking account of implications from those socio-economic studies, the government, MSIP, undertakes technology foresight and national technology roadmaps (NTRM) with priority setting, every five years. The foresight activity is time-consuming and costly, because it invites a number of stakeholders from various communities, including universities, research institute and industry. In fact, Korea has a tradition of technology foresight since the mid-1990s, by which policy/program formulation is possible at the inter-ministerial level.

Figure 5-5. PIMEF Framework in Korea



Such technology foresight underpins the "Five-Year S&T Plan" of the government, which is the blueprint of the government S&T policy in the medium and long term. According to the "Five-Year S&T Plan" approved by the NSTC becomes a guideline for the S&T policy and R&D programs of the individual ministry. That is, the individual ministry makes a yearly action plan for its own R&D programs based on the "Five-Year S&T Plan." At the end of the year, performance of the individual ministry is reviewed and evaluated. The evaluation results and other information are collected by the secretariat of NSTC, the Office of S&T Strategy, and reported to the NSTC. The yearly performance of the individual ministry will have an influence eventually on the resource allocation in the next year. PIMEF framework has a significant influence on policy/program formulation of the individual ministry, because it is related to the resource allocation.

(3) Management of Government R&D

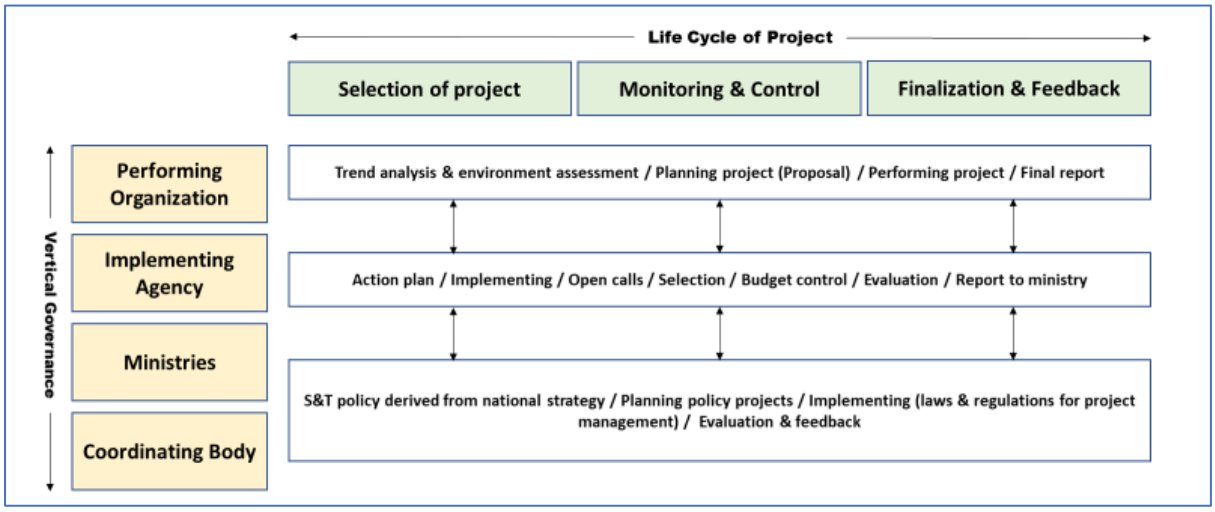
Basic ideas for the R&D management can be presented, summarizing how the policy/program management can be structured, although the management of government R&D must be defined and regulated by the laws basic

At the ministry level, a medium- and long-term STI plan should be made, which includes the clear direction of the national development and detailed agenda. According to such national strategy and plan, R&D planning can be made at each level of governance, from the principal investigator (research organization) to the funding/implementing agency, and to the ministries. At the ministerial level, the government policy and hence R&D programs (five-year plan) will be formulated by MSIP, which is derived from the national development strategy, if any.

R&D planning will be based on preliminary survey for technology needs and pre-planning.

Based on R&D programs, the agency will open calls for the R&D project. The principal investigator will make its own R&D plan and proposal for the research. This will be reviewed and evaluated, for which the agency has to prepare the manual of evaluation including evaluating parameters. Various criteria can be employed, but it is important for the proposal to be in accordance with the national strategy and ministerial policy. Based on evaluation, selection is made, and followed by budget control/management. After completion of the R&D project, the agency undertakes evaluation of R&D results. The feedback will be made to the next round call and selection. All those processes will be overlooked and directed by the ministry. (See Figure 5-6).

Figure 5-6. Governance and Project Management



5.2. STARTUP POLICY AND STI PARKS

In this part, we will review the startup policy and STI parks in Korea. The startup policy used to be pursued by Ministry of Science, ICT and Future Planning (MSIP), and Small and Medium Business Administration. In 2017, as new government moves in, SMBA is promoted to the "Ministry of SMEs and Startups," being responsible for the startup policy.[16] On the other hand, there are three types of parks; creative innovation centers, Innopolis, and techno-park. They are taken account of as strategic vehicles for innovation-based economic growth. We also review the management of Chungnam Techno Park (CTP) as a best practice.

5.2.1. GOVERNMENT POLICY FOR STARTUPS

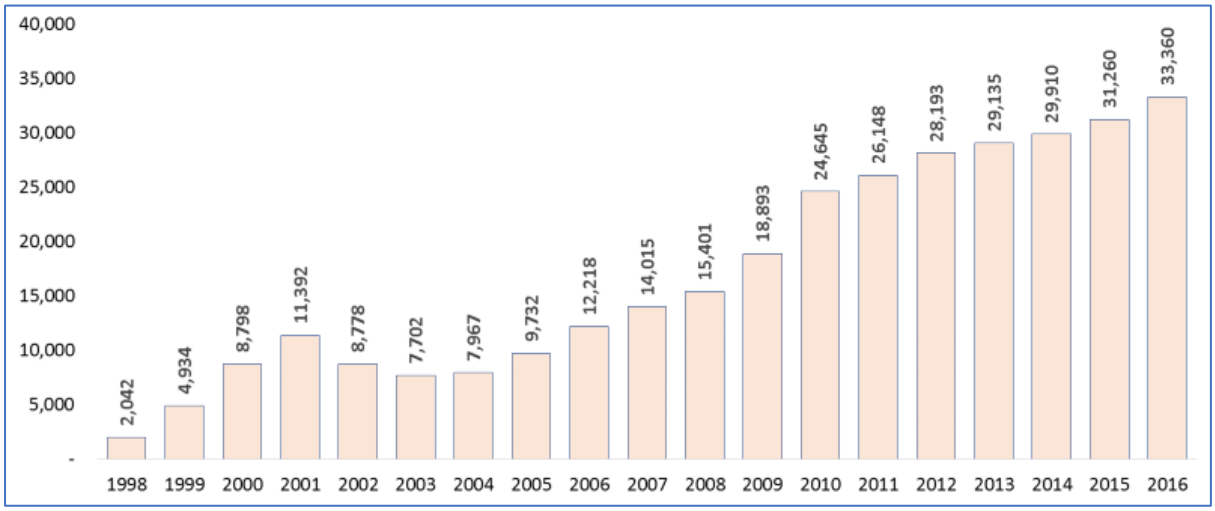
In general, the word of startup (or technology startup) means a small firm who prepares to enter and/or just entered the market, making business based technological innovation, in a narrow

[16] As new government changed MSIP to Ministry of Science, Technology, Information and Communications, new ministry will focus on policies of S&T, information/communications, and also coping with the fourth industrial revolution.

sense. Meanwhile, in Korea, SMEs based on technological innovation is often called venture business, and therefore, venture business includes the startup. Both are the SMEs under the focus of the government intervention.

The government policy and economic environment have an important influence on development of the eco-system for venture business/startups. Korea experienced massive unemployment, and the economic condition has not been well improved as a whole, after the Asia financial crisis in 1997. The economic structure dominated by Chaebeol is no more to work effectively to create job opportunities. Even though export is increased and profits of Chaebeol enterprises are increased, trickle-down effect has been hardly perceived. Thus, the government turned the attention to development of new business focusing on venture business/technology startups.

Figure 5-7. Number of Venture Companies



Source: http://www.venture.or.kr/#/home/bizNotice/h0203/2

In Korea, the term of venture business is legally determined, which usually indicates new technology-based firm, risk business, high-tech business, and so forth. The legal definition is necessary for the government to make an intervention into developing and nurturing venture firms. By the laws and regulations, the venture business includes the firm invested by Venture Capital corporations, 'R&D investment firm' in which R&D investment is greater than 5 percent of its total sales of the previous year, new technology firm which makes business based commercialization of patents, and 'technology evaluation firm' whose technological capacity is evaluated to be excellent by the venture business evaluation organization. Those venture businesses are certified by and registered in the Small and Medium Business Administration (SMBA)—now "Ministry of SMEs and Startups." Thereby, those venture business companies are entitled to receive benefits from the government support policy.

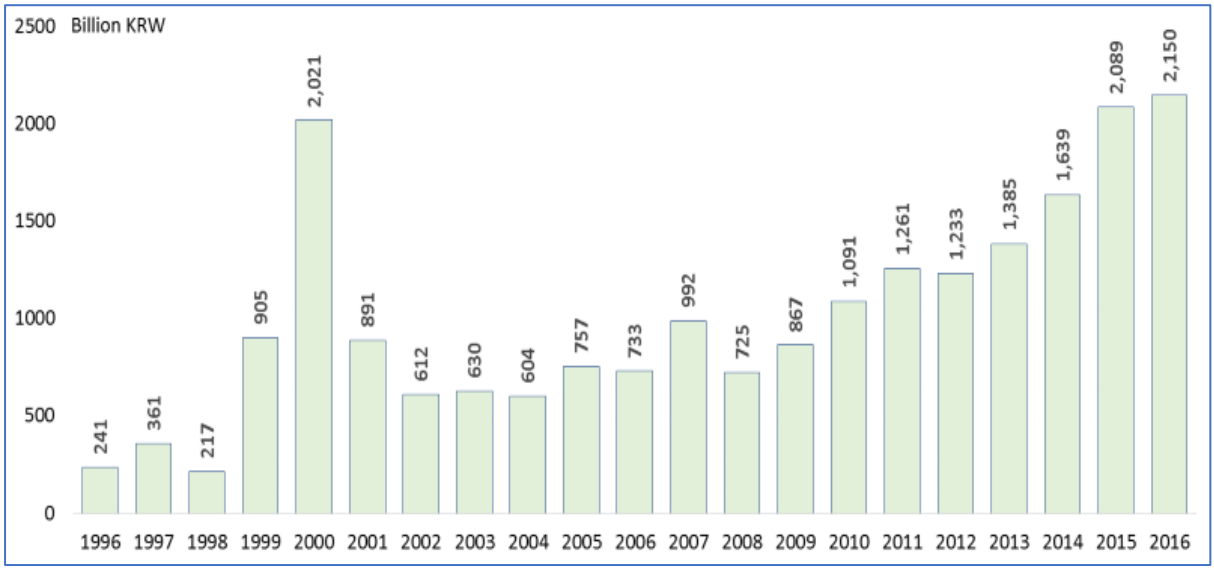
Thus, the concept of venture business is defined inclusively from startups to technology-based SMEs. When it comes to startup in Korea, the startup could be venture business at very early

stage of its business, either certified or not. Some of them prepares to enter the market, with developing new products, and some make businesses already in the market. The support programs are implemented for the startup and/or innovation-based SMEs usually less than three years after making business; up to seven years.

The technological innovation platform, by accumulation of R&D activities since the beginning of the economic development strategy being implemented in the early 1960s, has been well under establishment, on which (young) entrepreneurs makes challenge for creating venture businesses. Over last decades, the eco-system has been developed for the venture business/startups, reinforced by the factors of entrepreneurship, technological/financial environment, related industries/organizations and so forth. In 1996, the KOSDAQ (Korea Securities Dealers Automated Quotation), as a stock market for the high-tech venture companies analogous to NASDAQ in US, was established to promote venture business, through which venture business can find an opportunity for the direct finance and a window of exit strategy.

In 1998, new government started to actively pursue policies and implement programs for developing/nurturing venture business. On the other hand, some of large (Chaebeol) enterprises went bankrupt, and thereby a good deal of resources was released in the market. Those combinedly triggered startups for new business and led to the first 'Venture Boom." There were success and failure. Some of successful cases became large (global) enterprises, which impressed a legend into minds of young entrepreneurs. Those successful entrepreneurs are called as the 'first generation of venture business' in Korea. Over time, the challenge by young entrepreneurs has been increased, and hence increases the number of venture business.

Figure 5-8. New Investment by Venture Capital



Source: http://www.kvca.or.kr/Program/board/list.html?a_gb=board&a_cd=15&a_item=0&sm=4_1 [11 April 2017]

Table 5-2. Government Plan for Support Programs and Budget (2017)

Programs	Beneficiaries	Performing Organization	Budget (M. KRW)	Related Ministries
Education/Training			**30,210**	
1. Bizchool for youth	K-12 students	K-12 schools	7,660	SMBA
2. Startup Academy	Students, entrepreneurs (< 3 years)	Universities, RIs, etc.	2,080	SMBA
3. Startup Grad. School	Graduate students	Graduate schools	720	SMBA
4. Customized startup training for the disabled	Preliminary disabled entrepreneurs/ startups	DEBC	970	
5. Startup support for senior citizens	Senior citizens (> 40 years old)	University, local government	4,740	SMBA
6. Smart Startup Factory	Entrepreneurs (< 3 years)	Universities	9,840	SMBA
7. Education system for college education of startups	Students & professors of universities, etc.	NRF, university, etc.	1,550	MOE
8. Startup support for sports industry	Preliminary entrepreneurs, entrepreneurs (< 3 years) in sports industry	Universities, RIs, startup accelerators	2,650	MCST
Startup Facilities/Spaces			**29,950**	
9. Support for K-Global big data startup	College students, entrepreneurs	Universities, RIs	840	MSIP
10. Promoting for K-global smart contents hub	SMEs in smart contents, service, marketing, etc.	NIPA	800	MSIP
11. Support for creative factory	Entrepreneurs (< 7 years)	Creative Factory	8,000	SMBA
12. Establishment of startup incubation center	Startup incubation center	Local SMBA, KOBIA	3,000	SMBA
13. Strengthening incubating capacity	Startup incubation center	KOBIA	7,200	SMBA
14. Business center for one-person startup	One-person startups	Public/private org.	6,600	SMBA
15. Business incubation for the disabled	Disabled entrepreneurs/startups (< 3 years)	DEBC	650	SMBA
16. Support for the disabled startup	Disabled entrepreneurs	DEBC	2,860	SMBA
Mentoring/Consulting			**34,690**	
17. Training for K-global entrepreneurship and incubating internship	CEOs of SMEs, startups	NIPA	700	MSIP

Programs	Beneficiaries	Performing Organization	Budget (M. KRW)	Related Ministries
18. Mentoring program by first generation (pioneers) of venture business	ICT-based startup, venture clubs in universities	KOEF	2,990	MSIP
19. 6-month challenge Platform	Preliminary entrepreneurs, startups (< 1 year)	INNOPOLIS Foundation	11,250	MSIP
20. Support for accelerator programs	Startup certified by creative innovation centers, graduate startup from 6-month challenge platform	INNOPOLIS Foundation	9,100	MSIP
21. STAR-Exploration (startups for space industry)	Space-technology-based startups/entrepreneurs	KARI	250	MSIP
22. Support for costs of agriculture/food crowding funds consulting	Agriculture/food SMEs (< 7 years)	APFS	120	MAFRA
23. Startup incubation in rural area	Agriculture/food SMEs (< 7 years)	FACT	480	MAFRA
24. IP platform program	Preliminary entrepreneurs		2,600	KIPO
25. IP utilization program	Technology-based startups	IPR centers	7,200	KIPO
Commercialization			**276,970**	
26. K-Global Re-Startup	Startups (< 7 years)	Private org.	5,000	MSIP
27. Contest of K-Global Startup	Preliminary entrepreneurs & startup in ICT area	NIPA	1,000	MSIP
28. K-Global Accelerator	Preliminary entrepreneurs, startups, re-startups, venture companies in ICT & S/W	Accelerators	1,800	MSIP
29. K-Global Startup for Smart devices	Students, preliminary entrepreneurs, startups, venture companies, SMEs	Public org.	1,400	MSIP
30. K-Global Smart media	One-person startups, SME developers in new smart media service	SME/Venture developers	700	MSIP
31. K-Global DB-Stars	Individual developers, startup (less than 500 million KRW of sales)	KDATA	450	MSIP
32. K-Global Cloud-based S/W	Preliminary entrepreneurs, startups	NIPA	400	MSIP
33. K-Global security startup	Preliminary entrepreneurs	KISA	100	MSIP
34. K-Global startup for new IoT product/service development	Preliminary entrepreneurs, startups, venture companies, SMEs	Preliminary entrepreneurs, SMEs	360	MSIP
35. K-Global startup for multi-nationalization	Startups who want to employ foreign ICT experts, or to make global business	NIPA	2,000	MSIP
36. Support for package-type re-startup	Preliminary entrepreneurs, re-startups (< 3 years)	KISED	12,500	MSIP/SMBA
37. Startup jump package	Startups (3-7 years)	KISED	50,000	

Programs	Beneficiaries	Performing Organization	Budget (M. KRW)	Related Ministries
38. Technology startup derived from leader venture business	Preliminary entrepreneurs, startups (< 3 years)	KISED	7,000	SMBA
39. Startup internship	Students of college & graduate school, high school graduates unemployed for less than 7 years	KISED	5,000	SMBA
40. Support for TIPS startup team	Financial support for starting business (TIPS startups < 3 years), financial support for overseas marketing (TIPS startups < 7 years)	KISED	15,000	SMBA
41. School for smart venture/startups	Preliminary entrepreneurs (< 39 years old), startup (< 3 years)	Universities	12,150	SMBA
42. Developing leader university for startups	Preliminary entrepreneurs, startups (< 3 years)	Leader university for startups	92,200	SMBA
43. Success package for startups	Preliminary entrepreneurs (< 39 years old), startup (< 3 years)	SBC	50,000	SMBA
44. Program caring women venture startup	Preliminary (venture startup) woman entrepreneurs	KOVWA	500	SMBA
45. Support for product design, prototype manufacturing of enterprises of the disabled	Disabled entrepreneurs, enterprises of the disabled	DEBC	470	SMBA/MOEL
46. Nurturing social entrepreneurs	Preliminary entrepreneurs, startups (< 1 years)	KoSEA	15,000	MCST
47. Support for startup power-plant	Preliminary entrepreneurs, startups (< 3 years)	KOCCA	1,500	MCST
48. Support for tourism venture business	Preliminary entrepreneurs, startups (< 7 years) in tourism area	KTO	2,200	MCST
49. Support for technology value evaluation	Startups with IP in agriculture/foods	FACT	240	MAFRA
Policy Finance			**23,662,000**	
50. Policy fund for general startups	SMEs (< 7 years)	SMBA	1,530,000	
51. Policy fund for youth startups	SMEs (< 3 years & < 39 years old)	SMBA	120,000	SMBA
52. Policy fund for re-startup	Preliminary re-startup entrepreneurs, CEOs of re-startup (< 7 years)	SBC	100,000	SMBA
53. Guarantee for startups	Startups (< 5 years)	KODIT	13,100,000	SMBA/FSC
54. Support for technology startup guarantee	Startups (< 6 years)	KIBO	8,800,000	
55. Fund for startup ideas	Young farmers, startups in agriculture/foods (< 3 years)	APFS	12,000	MAFRA
R&D			215,400	
56. K-Global ICT development (ICT startup/re-startup)	Preliminary entrepreneurs, startups (< 1 year), re-startup of re-challenging entrepreneur	SMEs	3,000	MSIP
57. R&D support for firm growth linked with investment	Law of support of SME startups	TIPA	12,000	MSIP

Programs	Beneficiaries	Performing Organization	Budget (M. KRW)	Related Ministries
58. K-Global SW specialty startup-planner	Preliminary entrepreneurs, startups, re-startups, venture companies in ICT & S/W	Accelerators	1,500	MSIP
59. Technology development for startup growth linked with investment	SMEs (< 7 years)	SMEs	130,600	SMBA
60. Technology development for startup growth	SMEs (< 8 years)	SMEs	64,500	SMBA
61. Technology development of creative innovation oriented re-challenge	Preliminary re-startup entrepreneurs, re-startup (< 7 years)	TIPA	3,800	SMBA
Marketing, domestic/global			**15,140**	
62. K-Global penetrating overseas markets	Preliminary startup entrepreneurs, startup (< 7 years) in ICT convergence	Private org.	5,180	MSIP
63. K-Global data	Startups, SMEs in data	KDATA	360	MSIP
64. Developing/nurturing global startups	Startups (< 5 years), foreigner's startup (< 3 years)	KISED	5,300	SMBA
65. Marketing support for one-person startups	One-person startups/entrepreneurs	Private enterprises	4,000	SMBA
66. Marketing channel support for agricultural enterprises	Products of startups (< 7 years) in agriculture/foods	FACT	300	MAFRA
Networking, conferences/exhibitions			**3,440**	
67. Grand Exhibition of Venture/Startups	Venture, startups, youth startups	KISED	230	SMBA
68. Korea Startup League	Preliminary entrepreneurs, startups (< 3 years)	Local SMBA	1,400	SMBA
69. Contest of startup items by the disabled	Preliminary disabled entrepreneurs/startups (< 2 years)	DEBC	50	SMBA
70. Contest of Woman startups	Preliminary woman entrepreneurs/startups (< 2 years)	KOVWA	90	SMBA
71. Startup Contest of Agriculture/Foods, 2017	Preliminary entrepreneurs/startups (< 3 years)	FACT	400	MAFRA
72. Korea Grand Contest of Intellectual Property	Citizens	KIPA	1,270	KIPO
Total			**24,267,800**	

Note: APFS denotes Agriculture Policy Insurance & Finance Service; DEBC Disabled Enterprise Business Center; FACT Foundation of Agricultural Technology Commercialization and Transfer; FSC Financial Services Commission; KARI Korea Aerospace Research Institute; KDATA Korea Data Agency; KIBO Korea Technology Finance Corporation; KIPA Korea Invention Promotion Association; KIPO Korea Intellectual Property Office; KISA Korea Internet & Security Agency; KISED Korea Institute of Startup and Entrepreneurship Development; KOBIA Korea Business Incubation Association; KOCCA Korea Creative Content Agency; KODIT Korea Credit Guarantee Fund; KOEF Korea Entrepreneurship Foundation; KoSEA Korea Social Enterprise Promotion Agency; KOVWA Korea Venture Business Woman's Association; KTO Korea Tourism Organization; MAFRA Ministry of Agriculture, Food and Rural Affairs; MCST Ministry of Culture, Sports and Tourism; MOE Ministry of Education; MOEL Ministry of Employment and Labor; MSIP Ministry of Science, ICT and Planning; NIPA National IT Promotion Agency; RDA Rural Development Administration; SBC Small & Medium Business Corporation; SMBA Small and Medium Business Administration; TIPA Korea Technology and Information Promotion Agency for SMEs; TIPS Technology Incubator program for Startup Korea.

Source: MSIP, www.MSIP.go.kr [14 April 2017].

After the Asian financial crisis, as shown in Figure 5-7, the number of venture companies is increased rapidly, due to active government intervention. The number of venture companies was 2.042 in 1998 and increased to 33,360 in 2016. Most venture companies find their market abroad. The export by venture companies in 2016 amounted to 18.1 billion dollars, showing about 3.7 percent of total exports

On the other hand, the investment of Venture Capitals (VCs) was about 217 billion KRW in 1998. After the government strengthened the venture policy in 1999, it increased sharply to 2,021 billion KRW; afterwards exhibited slowdown in investment in the 2000s but recovered in mid-2010s. In 2016, the VC investment reached about 2,150 billion KRW. Besides VC, there are also increasing investment by Angels.

As the government policy has drawn a good deal of attention, many ministries started to implement support programs for startups on their own policy domains. In 2015, 99 support programs were implemented by 9 ministries of the central government, and the government budget accounted for 602 billion KRW (21,172 billion KRW, if including the support of financing and guarantees). Each program had requested the applicant in a different way, i.e. document forms, and prerequisites. Confusion was caused to large extent by the applicant of startups. Such fragmentation and segmentation of the support programs increased the necessity to make programs more user-friendly.

The government thus launched “K-Startup” as an integrated brand, which plays a role as an integrated portal for the services, and also reduced the number of programs from 99 to 72; to increase the efficiency by eliminating overlaps of the programs. As shown Table 5-2, total number of the support programs in 8 groups is 72, out of which 32 are implemented by SMBA and 16 by MSIP. In terms of budget size, the support of financing and credit guarantees amounts to 23,662 billion KRW; and commercialization and R&D are 277.0 and 215.4 billion KRW, respectively.

After establishing K-Startup (Net), easy access to the startup services is possible through the portal, to which all services provided by implementing agencies are connected, such as education/training, startup facilities/space, mentoring/consulting, commercialization, financial support, R&D, domestic/overseas marketing, and networking. Each of those services includes various explicit programs. As shown partly in Figure 5-2, in Korea, there are numerous business service units to support various services to startups/SMEs. Such resources are an important part of the innovation platform.

5.2.2. STI PARKS

(1) Creative Innovation Center

The creative innovation center was established in 2014 by the former government. The center

mainly focuses on support for the startup; not on incubation. The center is funded by both the government and large enterprise. The creative innovation centers are established in 18 provinces with region-specific focus areas.[17]

Figure 5-9. Creative Innovation Centers

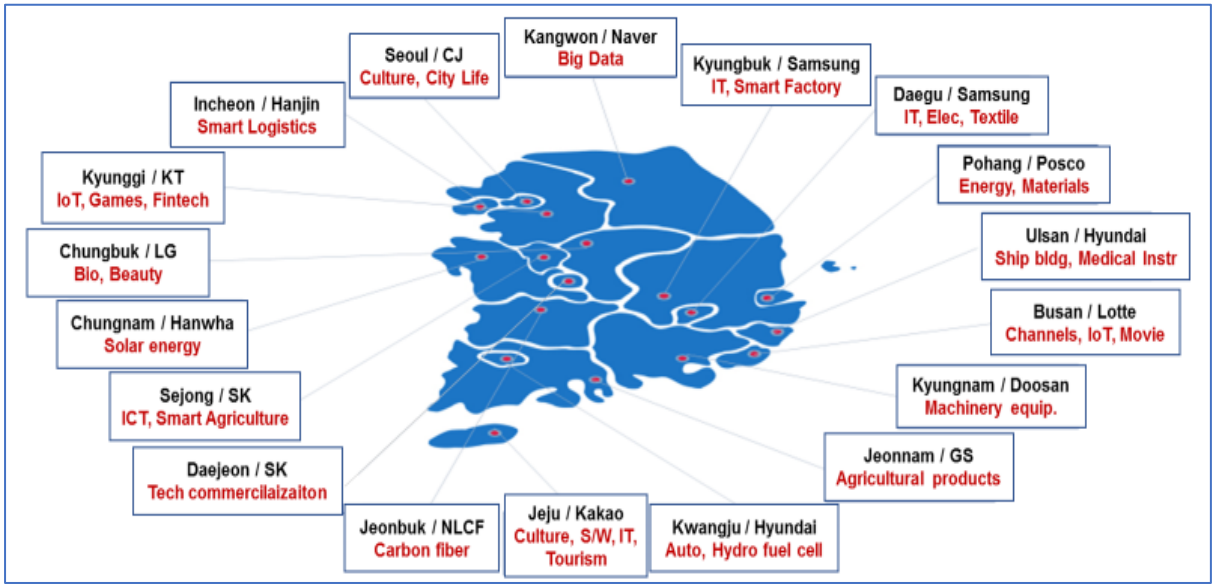
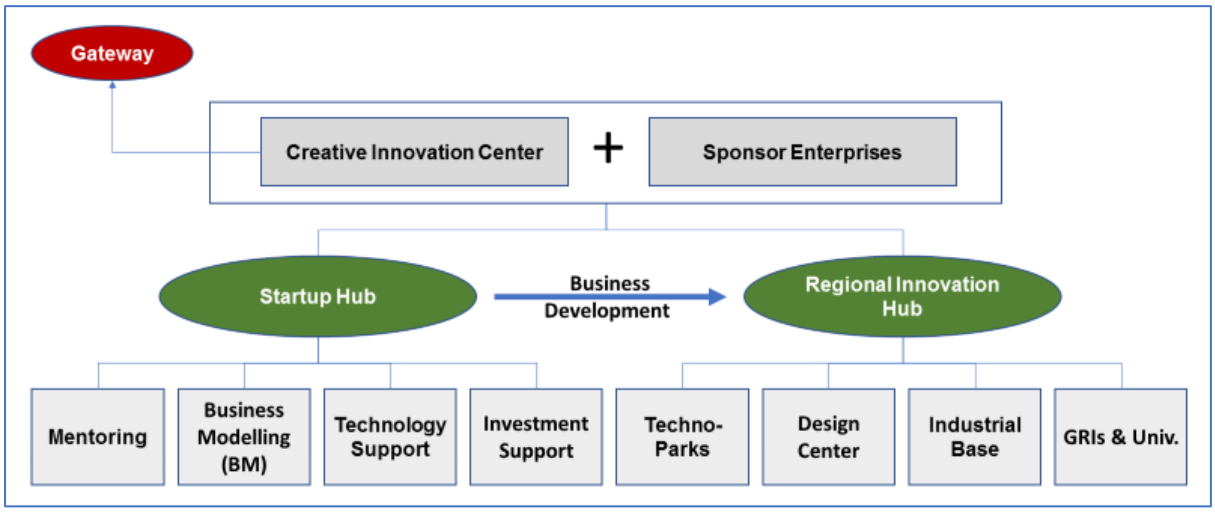


Figure 5-10. Eco-System of Creative Innovation System



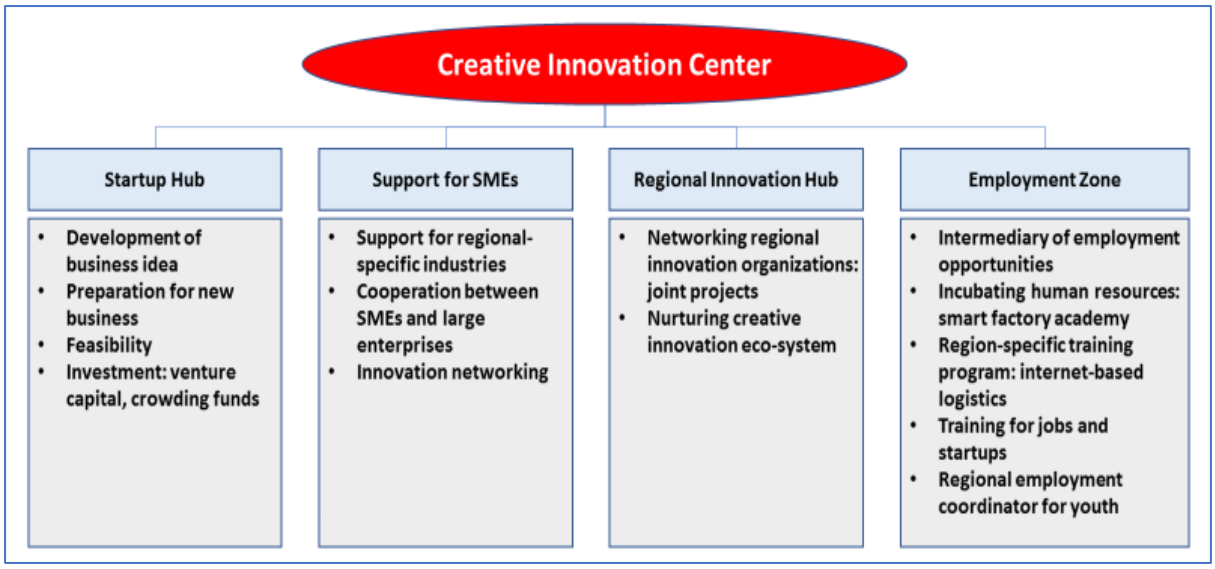
The creative innovation center plays a role as startup hub on the regional base, and provides various services such as mentoring, business modelling, technology support and investment support, etc. That is, through the services provided by the center, the entrepreneur would be able to develop his/her own business ideas. When the startup becomes ready to bring innova-

[17] As the former government ended up with a failure whose policy vision was "Creative Economy," it is possible that the creative innovation centers might be reorganized.

tion and make business, the regional innovation hubs provides services for business development; such as techno-parks, design center, public research organizations/universities, and industrial base.

The creative center has several functions such as startup hub, support for SMEs, regional innovation hub and employment zone. So, the government attempted to develop the centers as a strategic vehicle for job creation and economic growth.

Figure 5-11. Creative Innovation Center



It is noted that the sponsor enterprise is designated and to participate in management of the center. They are, for example, Samsung, Hyundai, LG, GS, POSCO, Lotte, Doosan, SK, Hanwha, Hanjin, KT, CJ, and Naver, who are Korea's representative global companies in their own areas. Main functions of the sponsor enterprise are financial support, package support, resources/network support, coexistence cooperation, and joint development of regional strategic industry. In details, they are

- Financial support
  - Financial support for startups and management of innovation centers after creating a fund: about 1,700 billion KRW
  - Cloud funding
- Package support
  - Support as a package ranging from ideas, mentoring, technical assistance, to commercialization
  - "6-Months Challenge Platform Project"
  - New support programs
- Resource/Network support
  - Support for startups using resources and network possessed by large enterprises
  - Patents possessed by large enterprises but not commercialized.

Table 5-3. Creative Innovation Centers

Centers	Est. Year	Flagships	Regional Specialty Areas	# of firms supported[1)]	Cases of mentoring/Consulting	One-Stop Service
Kangwon	2015	Big data	Big data/Smart O2O/Tourism	39	221	424
Kyeonggi	2015	IoT/Game/Fintech	Mobile Comm./Game/Fintech	74	1,001	771
Kyeongnam	2015	Machinery/Equip.	Mechatronics/Water/Anti-aging bio	84	899	340
Kyeongbuk	2015	Smart Factory	Smart factory/convergence new industry/Agriculture 6 generation industry	75	2,088	691
Kwangju	2015	Fuel Cell	Fuel-cell vehicle infrastructure/Branding conventional market/creative cultural village	56	1,048	236
Daegu	2014	Electronics/Textile	Fashion & textile/intelligent machinery & auto-parts/ Medical IoT & healthcare	94	3,805	1,229
Daejeon	2014	Technology Commercialization	ICT/Semi-conductor/Energy	37	535	864
Busan	2015	Channels/Movies	Channels/Movie/IoT	30	908	607
Seoul	2015	Culture/Life	Food-tech/Urban culture/K-fashion	147	807	627
Sejong	2015	ICT/Smart Agriculture	Smart farm/Smart learning/Creative education	19	361	120
Ulsan	2015	Ship-Building/Medical Instruments	Eco-ships/Medical automation/3D printing	48	414	249
Incheon	2015	Smart Logistics	Smart logistics/Korea-China exchange platform/Aviation & autos	52	810	336
Jeonnam	2015	Agriculture/Fisheries/Foods	High-tech agriculture & fisheries/Well-being tourism/Bio-chemicals	54	970	151
Jeonbuk	2014	Carbon Fibre	Carbon cluster/Agricultural bio/convergence/Traditional culture	102	1,191	642
Jeju	2015	Software/Tourism	Culture SW/Tourism/CO_2 free island	47	185	302
Chungnam	2015	Solar Energy	Solar energy/Agricultrue-Fisheries-foods/Trade zone	110	1,524	150
Chungbuk	2015	Bio/Beauty	K-beauty/Bio/Environment-friendly energy	65	535	429
Pohang	2-15	Energy/Materials	Advanced materials/Energy-saving solution	76	828	180
Total				1,209	18,130	8,348

Note: 1) Tenants + non-tenants

Table 5-4. Performance of Creative Innovation Centers: As of 20 January, 2017

Programs	Units	Outcomes
Development/Nurturing startups		
· Number of startups	E/A	1,713
· Employment	persons	2,547
· Sales	B. KRW	287
· Investment	B. KRW	372
Support SMEs		
· Technical support	E/A	1,388
· Marketing support	E/A	676
· Investment	B. KRW	78
· Others	E/A	398
Other Support Services		
· Mentoring/consulting	E/A	22,994
· Manufacturing prototypes	E/A	16,405
· Fund raising	B. KRW	808
· Invested funds	B. KRW	291

Source: https://ccei.certivekorea.or.kr/info/info.do [2 April 2017]

  - Developing overseas market using global marketing channels
- Coexistence cooperation
  - Cooperation between suppliers (of the large enterprise) and startups, and Industry-research organization
  - Procurement or M&A by suppliers, after the large enterprise provides the package support.
  - Nurturing startup to a global firm
  - Joint development of regional industryDeveloping regional strategic industries
  - Collaborative projects such as joint commercialization and investment

Then, the large enterprise would play a leading role in developing/nurturing startups together with related organizations; industry, research organizations/universities, and government organizations. In this sense, the creative innovation center has a different feature from other STI parks such as Techno-Parks and Innopolis.

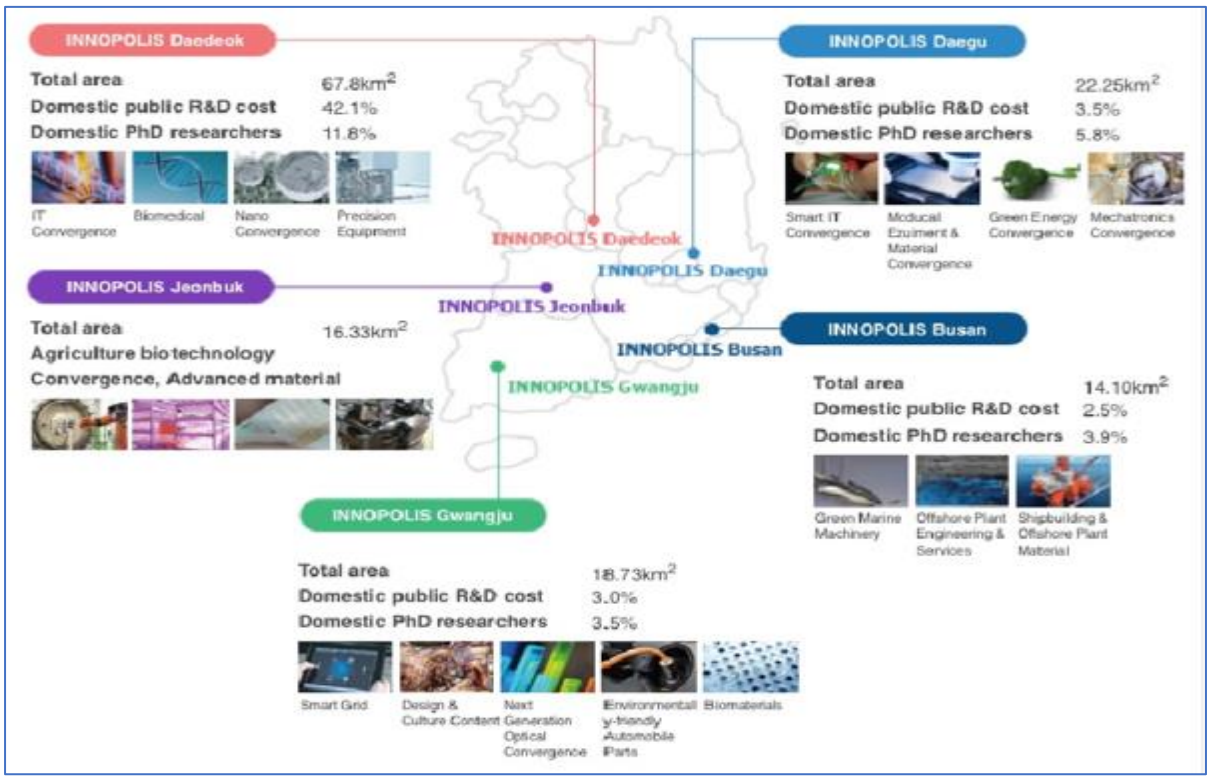
It is too early to talk about the impact of the creative innovation center, because most of them were established after 2014. Nonetheless, some statistics related to their impact was released

as in Table 5-4. First, 1,713 startups are developed and nurtured through the center support; employment is created by 2,5476; sale accounts for 287 billion KRW; investment for 372 billion KRW, as of 20 January 2017. On the other hand, various support services are also provided to both incubated and non-incubated startups/SMEs. For example, 1,388 cases are for technical support; 676 cases for marketing support; 22,994 cases for mentoring/consulting; and 16,405 for manufacturing prototypes, etc.

(2) R&D Special Zones: Innopolis

The MSIP has established and supported the "Innopolis" to create an innovation cluster, on the ground of the government research institutes. The motivation was based on that GRIs in the Daedeok area should make a contribution to industrial innovation, and the government constructed industrial complex for high-tech industry nearby Daedeok area, expecting that technological dissemination might stimulate industrial innovation. As new government was established in 2012, the government turn the attention to expand the startup policy. This was pursued by newly created ministry, MSIP.

Figure 5-12. Overview of Innopolis (R&D Special Zones)



Source: http://www.innopolis.or.kr/eng_sub0201 [7 April 2017].

R&D Special Zones is also called "Innopolis". Innopolis is now under the umbrella of MSIP (Ministry of Science, ICT, and Future Planning). There are four R&D Special Zones in Korea including Daedeok, Gwangju, Daegu and Busan. R&D Special Zones in Kwangju, Daegu and

Busan were created in a different way from Daedeok. Daedeok R&D Special Zone has developed based on the platform of Daedeok Science Town which was established in 1970s. Meanwhile, the others do not have such platform, and therefore the R&D capacity of other Zones falls behind to a large extent.

The R&D Special Zone in Daedeok includes 25 GRIs and 35 corporate research institutes. More than 11.8 percent of Korean researchers with a Ph.D. degree in the fields of science and engineering are working in Daedeok. The R&D Special Zone in Daedeok is managed by "Daedeok Innopolis" since 2005. Daedeok Innopolis and its partner institutions supported technology transfer of more than 900 cases so far between the domestic/global stakeholders; 31 of startups registered at KOSDAQ—technology stock market. On the other hand, the number of internationally registered patents exceeds 10,000.

Other R&D Special Zones are recently established:

- Kwangju was designated as R&D Special Zone (Kwangju Innopolis) by the Korean Government in January 2011. Kwangju Innopolis is focusing on the fields of n**ext generation photonic, smart grid,** g**reen car with eco-components & materials, and** d**esign/culture technology.**
- Innopolis Daegu is specialized in in the fields of smart IT, green energy, mechatronics and medical science, etc.
- Innopolis Busan was designated in November 2012 in order to promote Busan area as a R&D hub for the offshore plant industry and a business center.

Table 5-5. Number of Resident Organizations in Innopolis

		2005	2006	2007	2008	2009	2010	2011	2012	2013
R&D	GRIs	18	19	23	23	24	28	32	36	36
	Universities	6	6	6	6	5	17	17	23	25
	Others	26	26	29	29	31	42	49	54	56
Non-R&D	Government agencies	5	7	10	8	8	9	20	24	25
	Non-Profit Organizations.	12	12	14	14	15	14	18	17	13
	Others	6	11	20	22	24	44	59	62	66
Enterprises		742	848	977	1,059	1,089	1,945	2,264	2,958	3,203
Total		2,820	2,935	3,086	3,169	3,205	4,109	4,470	5,186	5,437

Note: 1,575 enterprises are resident in Daedeok Innopolis.

In 2013, the number of resident organizations in Innopolis is 5,437. Out of them, enterprises account for 3,203, and research organizations for 117. In terms of the number of resident organizations, Daedeok Innopolis is the largest one. Most of government research institutes

(GRIs) are located in Daedeok Innopolis.

Domestic patent applications and registrations in 2013 are 115,279 and 61,247, respectively. Overseas patent applications and registrations are 49,824 and 17,918, respectively. Technology transfer accounts for 191 cases, from which royalties of 80,440 billion KRW are collected in the same year.

On the other hand, production in Innopolis accounts for 35,398 billion KRW in 2014; the employment for 145,018 including research and production/administration. 134 RI firms are in business. R&D expenditure in Innopolis accounts for 8,303 billion KRW.

Table 5-6. Patents and Technology Transfer

	Domestic		Overseas		Technology transfer (E/A)	Royalties (B. KRW)
	Application	Registration	Application	Registration		
2005	41,368	22,625	15,872	5,935	611	52,408
2006	46,333	27,165	17,695	6,584	723	61,205
2007	46,355	29,193	17,893	5,978	815	77,798
2008	55,154	30,737	20,492	6,544	974	95,723
2009	66,764	32,664	28,822	7,684	910	109,394
2010	80,432	39,052	32,779	9,005	796	96,905
2011	99,408	49,781	37,120	11,282	1,030	90,258
2012	106,758	58,212	46,303	11,834	1,444	90,678
2013	115,279	61,247	49,824	17,918	1.91	80,440

Table 5-7. Main Indicators by Innopolis (2014)

	Production (Billion KRW)	Employment (Persons)			RI firms (E/A)	R&D Expenditure (Billion KRW)
		Research	Production/Admin	Sum		
Daedeok	16,416	28,877	38,177	67,054	76	6,937
Kwangju	9,000	6,358	20,260	26,618	18	395
Daegu	5,296	9,920	16,587	26,507	29	551
Busan	4,686	9,142	15,697	24,839	11	420
Total	35,398	54,297	90,721	145,018	134	8,303

Note: RI firms represents the startup established by the researcher of the research institute.
Source: MSIP (2015)

The R&D Special Zone, just like the techno-park, aims to grow towards an innovation cluster by fostering development of technology-based startups. This approach is pursued by the Ministry of Science, ICT and Future Planning (MSIP). It can be said that the R&D Special Zone is developed in a science-push approach (started from S&T policy) while techno-park in a demand-pull approach (started from industrial policy). However, they are in the same domain of

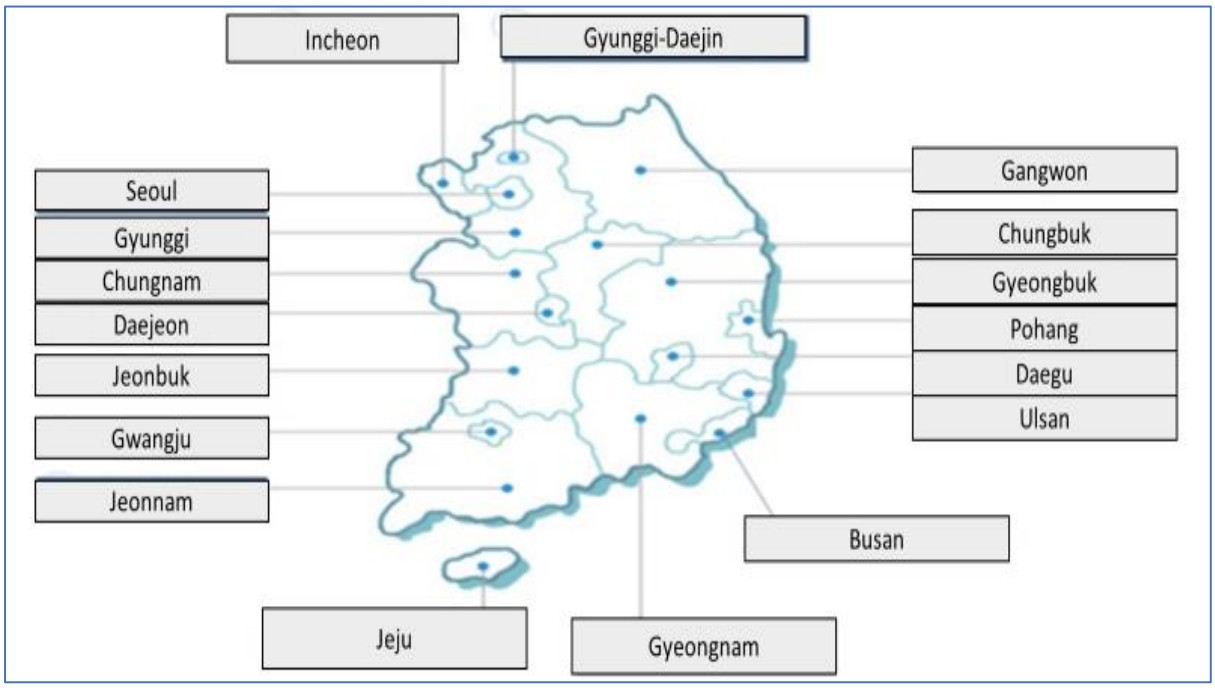
policy, but pursued by different policy-making units.

(3) Techno-Park

The "techno-park" refers to an industrial and technological complex in Korea where STI resources such as human and technological resources, etc. are gathered in a single place. It also denotes a co-location of land, buildings and facilities that are provided by businesses, universities, research labs, and local/central governments.

As the ministry of industry changed its policy direction towards industrial technology development since the early 1990s, from conventional industrial policy, it began to build techno-parks across the country, starting with establishing technological infrastructures for supporting business. The techno-park focuses on development of S&T-based firms, by building networks of local businesses, universities, research institution and governments. As of 2015, 18 techno-parks in 16 cities/provinces take the initiative in the development of local industries.[18]

Figure 5-13. Location of Techno-Parks in Korea



Source: http://www.ctp.or.kr/

The function of the techno-park includes strategic/policy planning, developing technology-based SMEs and local networks, among others. The strategic/policy planning focuses on making strategy and policy for regional industrial development and supporting business strategy formulation for the local firms. Meanwhile, in order to develop technology-based SMEs, the techno-park is building infrastructure and business-friendly environment to efficiently bring

[18] http://eng.technopark.kr/eng/technopark/about.php?pn=1&sn=1 [7 April 2017]

technological innovation. It also implements various support programs for technology transfer and commercialization. To support business activities of tenant SMEs, the techno-park installs experiment, test, and production equipment/facilities, which can be rented at lower costs. In addition, the techno-park also provides services for management consulting and domestic/overseas marketing; and human resource development is another objective pursued by the techno-park. It networks related institutions in the region, which would lead to public-private partnership for technological innovation. Networking also facilitate exchange between innovation units in the region.

Table 5-8. Establishment of Techno-Parks

No.	Names	Year	Location	Specialization Areas	Homepages
1	Chungnam TP	1995	Cheonan-si	Automotive, electronics, bio, display, information & video	http://www.ctp.or.kr/
2	Kyeonggi TP	1997	Ansan-si	ICT, automotive, robot, bio-tech	http://www.gtp.or.kr/
3	Kwangju TP	1997	Gwangju-si	Automotive, bio-materials, electronics, robot, 3D	http://www.gjtp.or.kr/
4	Daegu TP	1998	Daegu-si	Nano, mobile, bio-health, Korean medicine	http://www.ttp.org/dtp/Dtp-Main.dtp
5	Pohang TP	1999	Pohang-si	Metal, energy parts/materials, bio, S/W	http://www.pohangtp.org/
6	Kyeongnam TP	2000	Changwon-si	Intelligent machinery, material/parts, aero-space, ship-building, ICT	http://www.gntp.or.kr/
7	Kangwon TP	2002	Chuncheon-si	New materials, ceramics, energy, bio,	http://www.gwtp.or.kr/
8	Daejeon TP	2002	Daejeon	IT, bio, nano	http://www.daejeontp.or.kr/index.php
9	Chungbuk TP	2003	Cheongju-si	Bio, solar energy, electronics, machinery, semi-conductor	http://www.cbtp.or.kr/
10	Jeonnam TP	2003	Suncheon-si	New materials, ceramics, laser, polymer	http://www.jntp.or.kr/
11	Ulsan TP	2003	Ulsan-si	Chemical, auto parts	http://www.utp.or.kr/
12	Seoul TP	2004	Seoul	Microsystem packaging, next generation packaging,	http://www.seoultp.or.kr/
13	Kyeongbuk TP	2006	Kyeongsan-si	Digital parts, energy, fabrication,bio, mobile	http://www.ktp.or.kr/
14	Jeonbuk TP	2007	Jeonju-si	Automotive, machinery, green energy, foods, new materials	http://www.jbtp.or.kr/
15	Incheon TP	2010	Incheon-si	Auto parts, nano-materials, bio-industry	http://www.itp.or.kr/
16	Busan TP	2010	Busan-si	Intelligent machinery, precision parts, die-casting/furnace, digital contents, bio-health,	http://www.btp.or.kr/
17	Jeju TP	2011	Jehu-si	bio-convergence, marine bio	http://www.jejutp.or.kr/index.htm
18	Kyeonggi-Daejin TP	2014	Pocheon-si	Environment	http://gdtp.or.kr/index.php

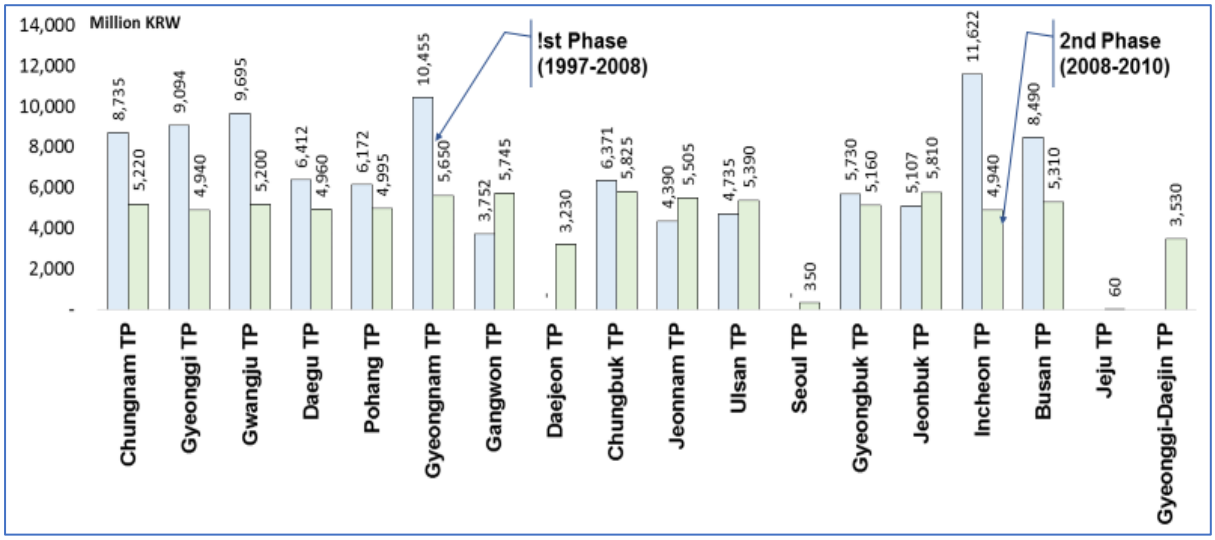
Source: based on homepage of the respective techno-park.

Table 5-9. Incubation by Techno-Parks

Techno-Parks	Est. Year	# of Tenants (2016)	Focus Areas	Performance
Kangwon	2002	79	New materials, ceramics, energy, bio,	Custom-tailored support (18 firms), Diagnsis/analysis (20cases),, growth/roadmaps (7 firms of 3 industries), Identifying/developing regional enterprises (20 companies), Target analyses for exporting enterprises (270comapnies), Commercialization of creative business ideas (17companies), and others in 2015
Kyeonggi	1997	116	ICT, automotive, robot, bio-tech	Support for SMEs (2,300cases a year): Management target in 2016
Kyonggi-Deajin	2014	50	Environment	Tecnology transfer (24 cases), new technology incubation (7), Attracting enterprise (4) & investment (4), etc.
Kyeongnam	2000	254	Intelligent machinery, material/parts, aero-space, ship-building, ICT	Support for SMEs (500cases in 2015)
Kyeongbuk	2006	69	Digital parts, energy, fabrication,bio, mobile	Support for SMEs (> 90a year): Management target
Kwangju	1997	112	Automotive, bio-materials, electronics, robot, 3D	Creating startup (48): Management target
Daegu	1998	266	Nano, mobile, bio-health, Korean medicine	Start enterprises (172),, Technology transfer (44 cases), Techdnology assistance (502cases), Attracting enterprises (5), Marketing support (529companies) in 2016
Daejeon	2002	65	IT, bio, nano	Integrated services (77companies), Technology development (18companies), etc.: Management target in 2017

Busan	2010	101	Intelligent machinery, precision parts, die-casting/furnace, digital contents, bio-health,	Support for SMEs (989), Hidden champions (16) in 2015
Seoul	2004	96	Microsystem packaging, next generation packaging,	Support for SMEs (122) in 2012
Incheon	2010	96	Auto parts, nano-materials, bio-industry	Policy funding (903companies), Support for export (62 companies), TP hub support program (70companies), Global SMEs (7 companies), Network program for technology trade (8companies), and others in 2015
Ulsan	2003	137	Chemical, auto parts	Developing competitive enterprises (50companies), Package support for commercialization (11 companies), Network program for technology trade (48 companies), Commercialization (34), and others in 2016
Jeonnam	2003	96	New materials, ceramics, laser, polymer	Support for regional enterprises (154companies) in 2015
Jeonbuk	2007	98	Automotive, machinery, green energy, foods, new materials	Support for problem-solving technology (86 cases) , Development of core technology (45): Management target in 2017)
Jeju	2011	105	bio-convergence, marine bio	Developing competitive SMEs (15): Management target in 2017
Chungnam	1995	173	Automotive, electronics, bio, display, information & video	Support for export (10), Commercialization of R&D outcomes (10), Commercialization of business ideas (20), and others: Management target in 2017
Chungbuk	2003	89	Bio, solar energy, electronics, machinery, semi-conductor	Support for SMEs (150), Technology transfer and commercialization (65 cases), Establishing eco-system (40) Development of global market (30), and others: Management target in 2017
Pohang	1999	58	Metal, energy parts/materials, bio, S/W	Developing competitive enterprises (17): Management target in 2017

Figure 5-14. Investment by TPs and by Phases



Source: KISTEP (2012)

Table 5-10. Number of Tenant Firms, Production and Employment by TPs

	Number of tenant firms	Production (Million KRW)	Employment (Persons)
Kangwon	79	77,700	298
Kyeonggi	116	684,400	804
Kyeonggi-Daejin	50	14,300	108
Kyeongnam	254	605,300	824
Kyeongbuk	69	88,600	566
Kwangju	112	135,100	1,024
Daegu	266	191,700	1,832
Daejeon	65	113,700	957
Busan	101	20,800	272
Seoul	96	68,900	486
Incheon	96	2,358,700	3,011
Ulsan	137	340,700	1,143
Jeonnam	96	25,200	--
Jeonbuk	98	45,300	269
Jeju	105	9,500	103
Chungnam	173	207,200	952
Chungbuk	89	772,800	1,790
Pohang	58	150,800	530
Total	2,060	5,910,700	14,969

Note: The number of tenant firms is in 2016; others are in 2010.

Source: KISTEP (2012) and Korea Venture Business Association, http://www.venture.or.kr/#/home/bizNotice/h0203/2 .

The development of Techno-Parks was pursued by two phases; the first phase (1997-2008) and the second phase (2008-2010). In the first phase, total investment of about 101 billion KRW was made for 14 parks, and in the second phase, about 82 billion KRW for 18 parks. Four parks were established in the second phase; i.e., Daejeon, Seoul, Jeju and Kyeonggi-Daejin Park.

The number of tenant firms are steadily increased to 2,060 in 2016. Daegu and Kyeongnam accommodate a relatively large number of 266 and 254, respectively. Meanwhile, Pohang, Kyeonggi-Daejin, Daejeon and Kyeongbuk Techno-Parks are relatively smaller. Those numbers are the startups being incubated by each Techno-Park as of 2016. The period of incubation varies across Techno-Parks, but usually startups are being incubated for 3 years and up to 7 years by renewal of contract. There are also dropouts during the incubation period, if the startup cannot meet the criteria.

The mission and goal of techno-park in Korea is primarily placed on the regional economic development, making use of the techno-park as an innovation hub of the region. Sizable investment has been made to build 18 techno-parks across the country. For development and support of the techno-park, the government enacted a special law, "Act on special cases concerning support of techno-parks." (See Appendix). It has been about 15 years since the first techno-park was established. Only a few of them are considered to exhibit good practices.

5.3. CHUNGNAM TECHNO PARK: A MANAGEMENT PRACTICE[19]

5.3.1. DEVELOPMENT OF CHUNGNAM TECHNO PARK

(1) Overview of CTP's Activities

Chungnam Techno Park (CTP) is located in the middle of South Korea. It was established in 1997 and today, is known as a best practice of Korea's techno-parks. The CTP is an organization that develops technology-based business and also that brings R&D results into business by creating R&BD eco-system, and hence make a contribution to the regional economic development of the province of Chungnam.

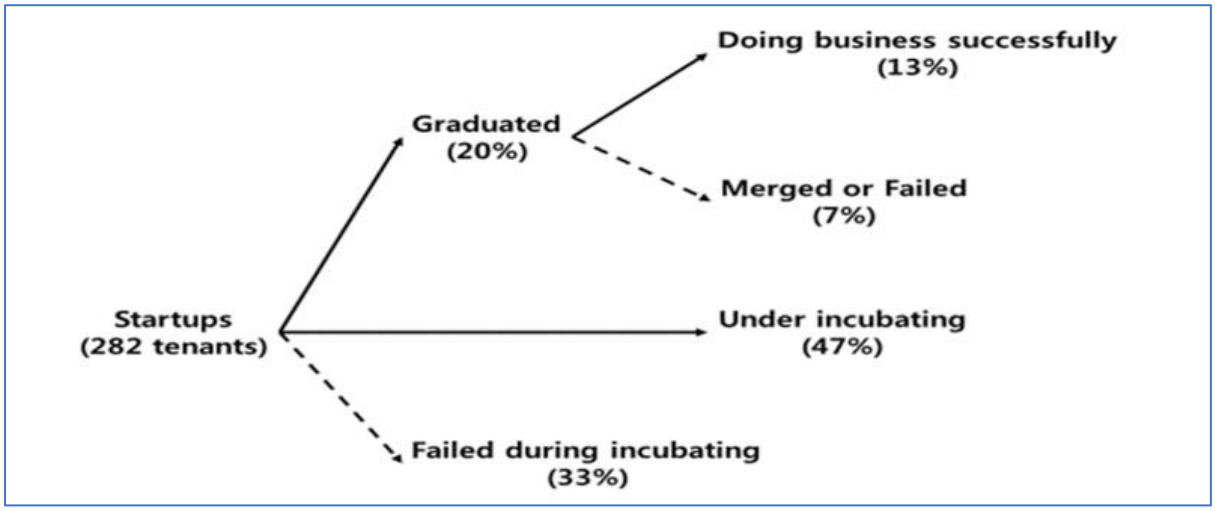
In the region, there are global enterprises such as Hyundai Motors and Samsung Electronics. There are also 36 colleges/universities, and 623 public and corporate research institutes. With such a favorable environment, the CTP plays a role as the regional innovation platform.

The CTP graduated about 600 startups for the last 15 years. It is estimated that about 100 graduate firms successfully registered on the Korean stock market. (Interview with CTP staff). This is a remarkable performance, in light that technology business incubation has to overcome a number of difficulties. For example, during the period of 2000~2009, total number of tenant startups was 282. Out of them 33 per cent failed during the incubation process, while 20 per cent graduated successfully, as shown in Figure 5-15.[20]

[19] Earlier version of this part is in T. Shin & A. Vilamovska (2016).

[20] It is actually a remarkable performance compared with less than 7 per cent of the success rate of the venture business

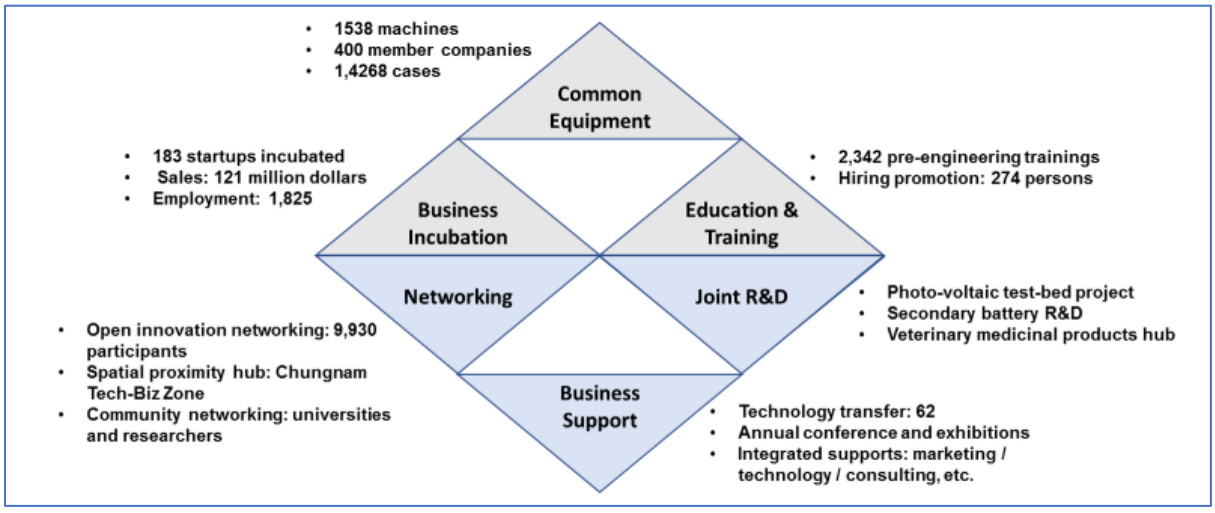
Figure 5-15. Development Paths of Startups in CTP



Source: H.M. Kim (2015).

In 2014, 183 startups were under incubation, whose sales amounted to 121 million USD and employment to 1,825 people. For business incubation, the startup is selected usually on the basis of financial status and technological potential. The CTP runs a technology database of technologies to be transferred and technology-owners. For the dissemination of technological and business information, various conferences and exhibitions are held annually, where SMEs and technology-owners can contact each other. On the other hand, integrated business support is provided along the stages of the value chain, i.e., from business model development to marketing and services.

Figure 5-16. Major Activities of CTP in 2014



across the country.

CTP brings together universities, research institutes and startups/other enterprises. In 2014, 9,930 innovation units participated in the CTP innovation network. One of most powerful methods to link the innovation units, i.e., linking SMEs to universities and/or research institutes (R&D) used at CTP is joint R&D. To this end, CTP creates consortia of enterprises, universities and research institutes. After their creation, the consortia submit research proposals to the central/local government research fund.

For example, some joint R&D projects are undertaken in the areas of photo-voltaic, the second battery and veterinary medicinal products. In addition, education and training program provided opportunities for employing 274 persons in 2014 and training pre-engineering 2,342 persons in 2014. CTP installs 1,538 machines, and 400 member companies consumed 14,268 rental cases of equipment services in 2014.

(2) CTP's Development

When the CTP was established in 1995 as a pilot project of Korea's techno-park, the idea was initiated by professors in local universities, and it had drawn an attention of the local government, which eventually decided to actively support the development of the techno-park. The joint efforts of university professors and local government played an important role for implementation of the initial idea. The CTP was able to begin to invite startups after the land grant of 18.5 hectares was made by the local government. Meanwhile, 11 professors from various universities were invited and made a research team for the master plan of CTP. The project manager was Professor Hwang, Hee-Yung, who used to be a professor of Seoul National University and transferred to a local university for the development of CTP. His dedication and leadership played a critical role for CTP development.

The master plan for CTP included the role of the CTP with regard to the regional industrial development based on analysis of region-specific industry, creation of regional innovation network, and roadmaps for long-term development of CTP, etc. The master plan underpins the development of CTP for more than 10 years.

The CTP made the roadmaps for the long-term development at the beginning, which indicate "what to do in which direction" over time period. In the first stage 1999~2007, in the course of development, the creation of innovation infrastructure was envisaged in the region. This included business incubation facilities/programs, and business support programs. In the second stage 2008~2012, the CTP started to produce innovation outcomes in the areas of the regional strategic industries such as automotive, display, media contents, and agro-biotechnology. Three innovation clusters were developed in the region; Valleys of Cheonan City, Asan City, and Yesan County. In the third stage 2012~2020, an attention was paid to sustainable growth of the CTP. Three valleys had to develop towards "Technopolis" as an urban area including technology and residence for sustainable development of CTP.

Figure 5-17. Campus Plan of CTP

Source: http://www.ctp.or.kr/

Figure 5-18. Roadmaps of CTP Development

Stages	Innovation Infrastructure (1998-2007)	Innovation Outcomes (2008-2012)	Sustainable Innovation System (2013-2020)
Develop-ment	• Cheonan Valley: Business Incubation (BI) and Post-BI • Business support programs • Innovation network • Strategic Industry Center	• Expanding the regional innovation system: 3 local innovation valleys • Comprehensive promotion eco-system • Strategic industries clusters	• Further expanding the regional innovation system: development of 3 techno-polis • Comprehensive agency of innovation eco-system • Hub of global network in strategic industries • Development of world-class cluster
Focusing Industries	Manufacturing in electronic devices, automobiles & bio products	Software business in contents, service business & renewable energy	System business for future growth in contents + energy

Source: Revised from H.M. Kim (2015)

The CTP is the model of the network-based techno-park in Korea. SMEs are supported by techno-park in cooperation and collaboration with the central/local government, universities

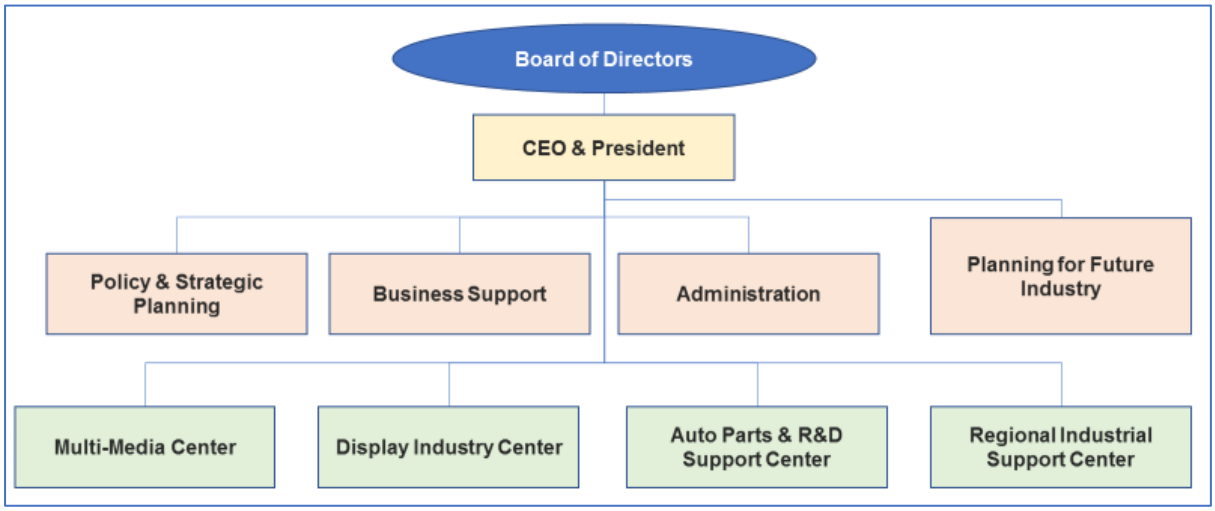
and research institutes. The regional innovation network includes 17 universities in the region, of which experts had participated actively from the beginning. The total investment for the first 10 years amounted to about 200 million USD from the various sources such as central/local government, universities, industry, and others.

The goals of the CTP are to be; i) hub of business, logistics, and marine industry, ii) hub of culture and tourism, iii) hub of environment and agriculture, and iv) hub of high-quality life and welfare. That is, CTP aims to play a role as an innovation intermediary in promoting business development through cooperation between universities and industries, and hence promoting regional economy

(3) Organization and Main Businesses

In general, the organization of an institution well represents its roles and major activities. The CTP has two Divisions and five Centers; Policy/Strategic Planning Division, Business Support Division, Multi-media/Display/Auto Parts/Bio Centers, and Regional Industry Support Center. The Divisions are related to strategy formulation and management, while the Centers have the research and production equipment/facilities. The units function as follows.

Figure 5-19. Organization of CTP



Source: http://www.ctp.or.kr/ [10 April 2017].

The Policy/Strategic Planning and Business Support divisions are important that makes social sciences approach to “what to do” and “how to do” with regard to the mission of CTP. The Planning Division for Future Industry is a special unit, but similar to the Policy/Strategic Planning Division. The Division is to build up a cooperative system between industry and universities, and to envision prospective industries in the region, and also to foster strategic industries through R&D support for local industries such as the electronics/information and auto parts industry. It is also the core capacity in planning and evaluating the development of Chungnam's local industries, and builds an industry-university network. Meanwhile, the Business Support

Division promotes exchange between industry and universities to develop technology-based business, and provides various services such as management counsel, marketing, technology transfer, finance, and others.

There are four centers for technology business incubation (TBI). The Multi-Media Center is a foothold established for fostering the contemporary culture industry. The Center activates network between the community's innovative actors. On the other hand, it provides technological assistance with equipment and nurtures specialized manpower in order to support developing technology for high-tech digital contents. The Display Industry Center is specialized in supporting the display industry, and manages R&D for display parts, materials and equipment technology. It builds a display R&D cluster by undertaking various supports not only for tenant firms, but also for other related firms and organizations through R&D; by operating a precision measuring lab, a reliability evaluation lab, an optic feature evaluation lab, and environmental authentication room.

The Auto Parts R&D Support Center is supporting the R&D activities of auto parts manufacturing companies, and provide auto parts-related companies. The Bio Center supports and foster bio companies through supporting commercialization, such as formulating R&D projects for technological development, marketing, prototype production and others in the area of agriculture and livestock. The CTP also manages others organization such as the Regional Industrial Support Center and Training Center.

5.3.2. FUNCTIONAL MODELS OF CTP

Broadly speaking, there are four major functions of the CTP, including technology incubation, technology transfer and commercialization, business support program, and being the innovation hub of the regional innovation system. We discuss below those functions of CTP in detail.

(1) Technology Business Incubation

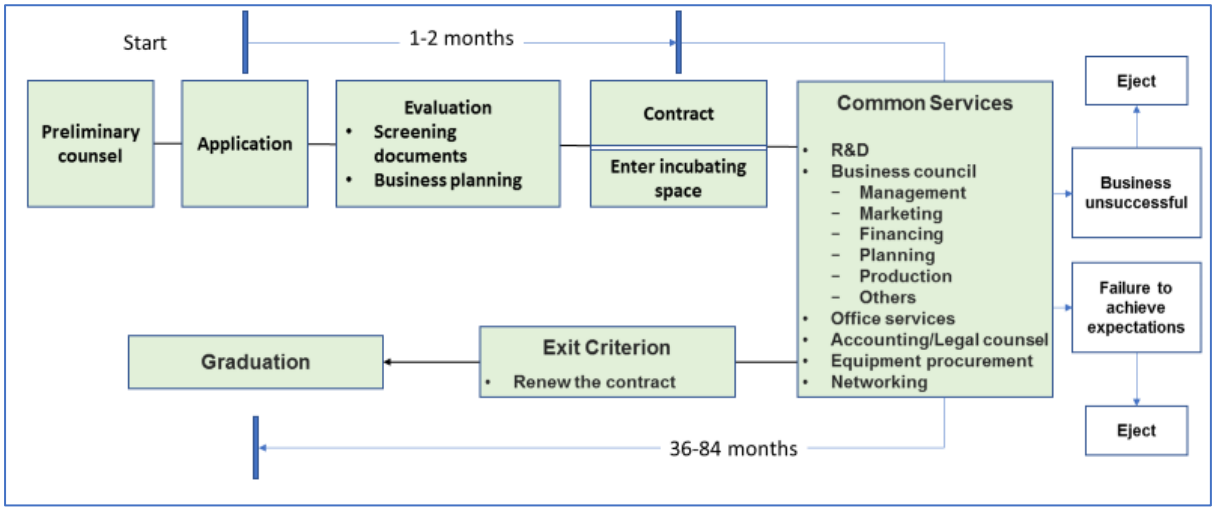
Business incubation is considered as a tool to meet various needs of the region/nation, such as job creation, fostering an entrepreneurial climate in the community, technology commercialization, identifying potential (spin-in or spin-out) business opportunities, business promotion, development of local industry clusters, and/or community revitalization.

Potential tenant firm which wants to join a business incubation program must apply for admission. Criteria of acceptance vary from program to program, but in general only those with viable business ideas and a workable business plan are admitted.[21] The amount of time a company

[21] Sometimes, incubation provides consulting service for business planning, before the applicant firm is admitted.

spends in an incubation program would vary widely depending on a number of factors, including the type of business and the entrepreneur's capacity/expertise. For example, life science bears a long R&D cycles and the firm in this field requires more time in the incubation program, relative to other manufacturing companies that can immediately produce and bring a product to market.

Figure 5-20. Incubation Process: CTP



The CTP invites tenant startups on contractual base. Once the tenant firm move into the incubation facility, it is allowed to stay for three years, and then additional two-year contract is renewable twice. Therefore, the tenant firm may stay in the incubation facility up to 84 months of duration. The incubation program imposes graduation requirements, such as company's sales/revenues or the number of employers, rather than time. During the tenant firm stays in the incubation, the CTP provides various equipment and business support programs, such as R&D, business counsel, office service, networking, and others.

Table 5-11. Progression of Services Needed

Pre-incubation	In-wall incubation	Out-wall incubation	Post-incubation
• Hot desks • Business-plan assistance • Validation of entrepreneur potential	• Counsel and training • Facilitation and networking • Workspace and shared facilities	• Mentoring • Prestigious address • Preferred access to seminars, publications, etc.	• Consulting links to incubator and clients • Reciprocal support as alumni

Source: R. Lalkaka (2006).

During the incubation phase, if the company does not achieve a successful financial state significantly, the tenant firm would be ejected from the facility. In addition, if the tenant firm does not meet the criterion given by the CTP, it would be also ejected from the incubation program. After successful incubation, the tenant firm is graduated from the facility. The graduate firm would make its own production site and/or move into the industrial base in the region. It could

be also sold to the large firm through the M&A market, by which the entrepreneur and/or investors will exit with returns. In either way, such a successful incubation will make eventually a contribution to job creation and value-added production in the region.

As shown Table 5-1, additional services can be provided according to the incubation progression such as pre-incubation, in-wall incubation, out-wall incubation and post-incubation. This shows an illustration which can be modified to the situation facing the techno-park.

5.3.3. SUPPORT PROGRAMS

(1) Technology Transfer and Commercialization

Simply speaking, technology transfer is to endorse over the IPR of a specific technology for commercialization. The difficulty lies in that the firm does not know who has suitable/promising technology, while the owner institution of IPR cannot find his/her customer firm. Figure 5-21 shows the process of technology transfer. It includes R&D, technology value assessment, technology marketing, technology transfer, and commercialization and post-contract management.

At R&D stage, the patent assets will be inspected, and an analysis of the patent maps will provide the potential of the patent. Based on the inspection and patent analysis, technology value can be assessed. Then, there will be two ways to make technology transfer. i.e., joint R&D and technology marketing.

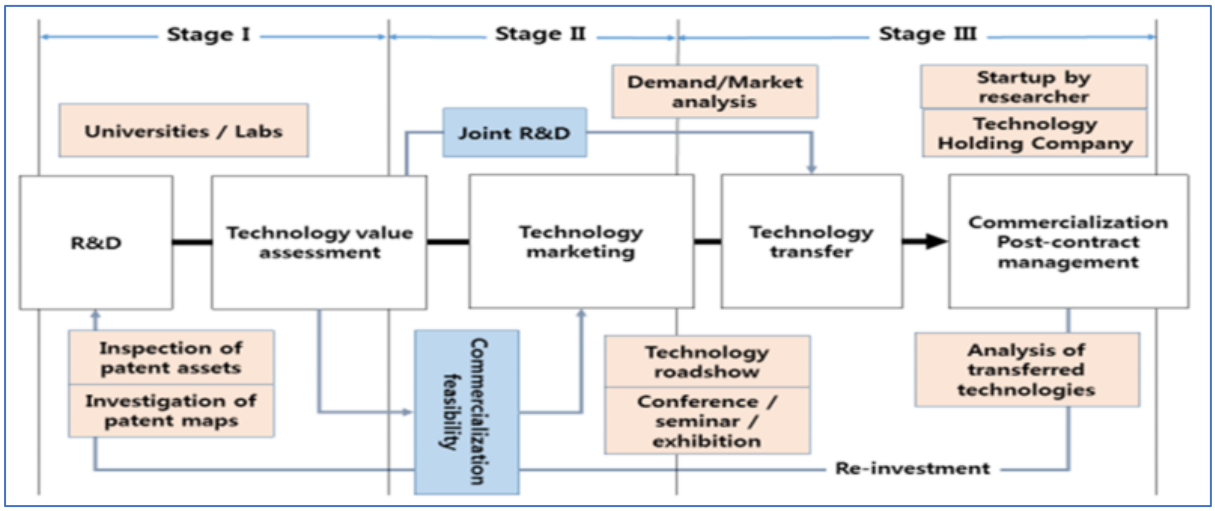
Joint R&D can be undertaken based on the contract between the firm and technology provider institution. In this case, the firm's need is well reflected in cooperation with the technology provider institution. Otherwise, the technology provider institution (or intermediary) would investigate the commercial viability of his/her own technology (IPR), and then undertake technology marketing to find the customer firm.

Once the technology is transferred to the customer firm, the technology provider institution will make an analysis of the transferred technology and feedback. Reinvestment can be made back into the research activity. On the other hand, the technology provider institution may spin off the startup by the researcher, or establish a technology holding company (THC). If we divide such a process into three stages, the techno-park usually plays a role as a middleman at Stage II.

At the national level, there exists the Korea Technology Transfer Center (KTTC) to facilitate technology transfer from the technology providers to SMEs. KTTC usually plays a role as a middleman with a database. KTTC reviews the technology, estimates the commercial viability, the market and industry trends; and identify potential licensees or partners. On the other hand, KTTC provides the technology valuation service. That is, KTTC investigates feasibility on

early-stage technologies through market, technical/economic analysis, and undertakes business and technology valuation. In addition, KTTC also provides mergers & acquisitions service. KTTC promotes M&A between large-scale enterprises and lab ventures, and provides services from finding a partner for a contract.

Figure 5-21. Process of Technology Transfer



Likewise, techno-parks and universities also have a special organization for the same purpose, i.e. the technology transfer center (TTC) and the technology licensing office (TLO). Those organizations make a database of technologies to be transferred and provides technology marketing through various events such as technology roadshow, conference/seminar, and exhibition, etc.

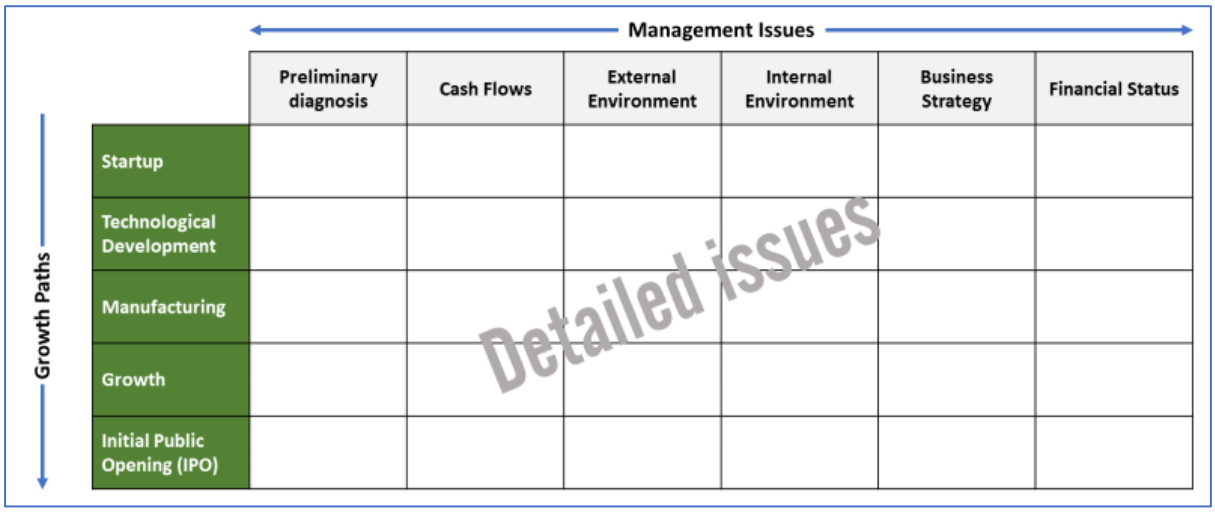
On the other hand, the government encourages for universities and techno-parks to install the Technology Holdings Company (THC). THC identifies technology developed by the knowledge institutions or organizations. THC conveys information about it over to business incubators to develop a business model. THC creates a subsidiary company for this business model through a contract with the technology provider. In so doing, THC creates a new startup.

(2) Business Support Program

After the tenant firm moves into the incubation facilities, business support programs are available. The business support program may differ along with the value chain over which the startup engages; that is, the startup would follow a growth path such as technology start-up with *a business model → technology development → product development → commercialization → manufacturing/marketing*. Then, the management issue can be addressed according to each stage of the path. For example, the management issue of cash flow may be changing along

with the growth path; such as *initial fund → technology development fund → commercialization fund → mass production fund*, etc. Financing each case will be made in a different way. If so, the business support program can provide a counsel for the corresponding case.

Figure 5-22. Matrix for Business Support Service



Source: Revised from H.M. Kim (2015).

For example, Figure 5-22 shows a matrix of the growth path arising issues facing the startup company. Using such a matrix, a manual could be made for business support program. The quality of business support service has to be developed and enhanced according to changes of the industry and overall business environment. The techno-park may modify and use such a scheme for the business support services for its own purpose.

The CTP provides an integrated business service. The business service is customized for the tenant firm according to its growth path and/or value chain momentum. That is, according to the growth path, the startup can draw expected management issues in advance, and receive appropriate services to cope with expected challenges, avoiding a myopic management.

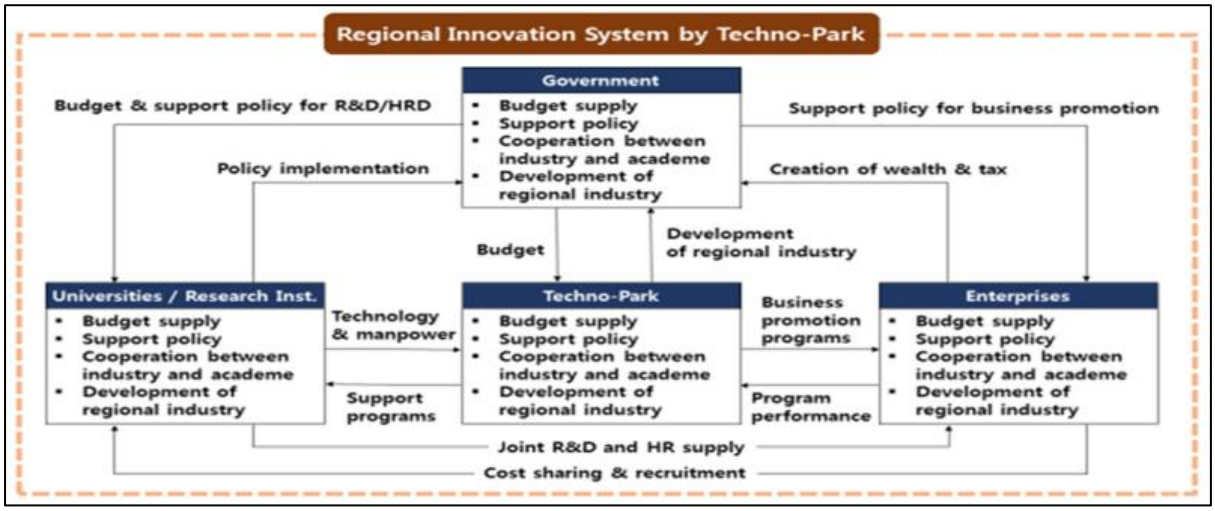
5.3.4. REGIONAL INNOVATION SYSTEM

The regional innovation system is a network of the innovation units of universities, research institutes, enterprises, government, and other related institutions/organizations in a given region. They are placed in the same region and interact with each other, and lead innovation activities and hence the economic development in the region. In such a system, the techno-park can play a role as a hub of the network.

The techno-park can build a network including leaders of government, university, business associations, business service organizations, and venture capital/angels. Based on the network, the techno-park could build a platform of development of the business support program, and

create innovation-friendly environment in favor of technology startups. Figure 5-25 exhibits schematically how the local network is structured.

Figure 5-23. Innovation Platform by Chungnam Techno-park



Source: H.K. Kim (2015).

The core business of the techno-park is technology business incubation, technology transfer and commercialization, and human resource development. In doing such businesses, cooperation between local innovation units is necessary.

Finally, Asheim and Gertler (2004) point out; "…… Regional innovation systems are not sufficient on their own to remain competitive in a globalizing economy. Production systems seem to be more important innovation system at the regional level. Thus, local firms must also have access to national and supra national innovation systems, as well as to corporate innovation systems from the local firms that have been brought. This line of reasoning is followed to a point where the regional innovation system expands beyond its own boundaries through a process of economic integration and globalization." Thus, techno-park could be an innovation hub in the region, building regional network and connecting it to other networks, domestic or international.

5.4. SUMMARY

When Korea launched initiatives for economic development, the government strategy was developed in two tracks; industrial development on the one hand, and S&T development on the other. The government implemented five-years plans, seven times, for both over the period of 1962-1997. The industrial development focused on heavy and petro-chemical industry, for which domestic market is too small. Therefore, the government pursued outward-looking strategy, implying that Korean enterprises could not help facing competition in the world market. On the other hand, the government started to establish GRIs (government research institutes)

to secure R&D capacity of the country, with starting from the scratch.[22] By developing GRIs system, major innovations had been brought in late 1980s and early 1990s. Those innovations underpin, particularly, ICT industry nowadays. In a word, underlying principles in Korea's economic development are competition and learning.

In the course of economic development, R&D investment of both public and private sectors had increased rapidly, keeping pace up with the speed of industrialization. Such resource allocation had an influence on the STI governance, which became increasingly complex since mid-1990s towards securing rationality and transparency. With more stakeholders being involved, the coordination mechanism is unavoidable at the government level, for which PIMEF (planning-implementing-monitoring-evaluation-feedback) framework has been well developed.

Since the end of 1990s, the government paid a good deal of attention to developing/nurturing technology-based startups and SMEs. It is expected that technology-based SMEs would strengthen economic fundamentals in the age of knowledge-based economy. Successes of venture businesses stimulated young entrepreneurs, and challenges continue. It is envisaged that the growth path of the economy would be greatly influenced by those startups in the long run. It is noted that performance of startups is mainly due to (1) eminent S&T platform which has been built up since 1960s, (2) immense entrepreneurship, (3) financial market (stock market for technology), and (4) sound eco-system, in which a number of business service units are developed; that is, various organizations such as associations, non-profit organizations, and private firms, among others, supply the business services to the startup. It makes the government be ready to implement various startup policies/programs. In 2017, there are 72 startup programs implemented through the government budget allocation. It amounts to about 24,268 billion KRW (roughly equivalent to 718 billion THB) in total.

Startup policies/programs are used to be implemented by many ministries, causing fragmented implementation and inefficiency, and hence the government reshaped the governance structure and management of public policy. So that Ministry of Science, ICT and Future Planning (MSIP) and Small and Medium Business Administration (SMBA) became the lead agencies for the startup policies/programs. In 2017, as new government moved in, SMBA is promoted to "Ministry of SMEs and Startups," which is responsible for the startup policy onwards.

[22] It was almost impossible to have strategic approach to securing R&D capacity with universities, which were nearly capable to teach students after the Korean War.

CHAPTER 6
SUMMARY AND POLICY SUGGESTIONS

So far, we have a discussion about current economic situation, STI governance, and startup policy including science parks in Thailand. In addition, Korean startup policies/programs are reviewed to obtain lessons and implications.

Thai economy had made a remarkable achievement during 1980s and onwards, though higher growth rate halted for 1998-2000 by Asian financial crisis. In the past, the government took export-oriented growth strategy by attracting foreign direct investment. As a consequence, Thailand also becomes to participate the global production network. The GDP share of manufacturing has increased and the industrial structure is sophisticated to large extent. It is, then, the expansion of the manufacturing sector that shifted Thai economy from lower-middle income country to upper-middle income country.

However, the national economy has been sluggish after the global financial crisis. In order to move back to the long-term growth path, it would be necessary that new growth engines of the manufacturing sector should be developed in consideration of global value chain. Thus, Thai government recently turns its attention to innovation-driven growth strategy, by developing/nurturing startups and SMEs. Sizable investment is being made to establish science parks across the country, and to promote startups. It can be pointed out that the agricultural sector, tourism and internet services—without major innovation—would have only marginal effect on economic growth.

On the other hand, regionally imbalanced development has brought about an economic concentration in Bangkok+ and Eastern areas. It may have a negative influence on potential growth rate of the nation economy, and in addition, an effect to reduce the domestic market. For example, startups are developed and nurtured, most of them would look for the market in Bangkok+ and Eastern areas. If so, the economic impact of development of startups would be limited.

The governance structure in Thailand seems to be highly segmented and fragmented in policy-making and funding/implementing policies/programs. At present, there are many funding instruments regarding to research, technology development and innovation. Such a situation could stand for a while, because the amount of government budget is not large enough to bring a change. However, when innovation policy is placed in the center of the economic policy and increases the fund size significantly, needs for structural adjustment and/or reform of the STI governance will be increased. (Refer to Korean experience in Chapter 5) Thai government targets to increase R&D investment to about 2 percent of GDP by 2021.

As for policies/programs in developing/nurturing startups in Thailand, several points can be made. Both NIA and the science park pay an attention to establish the eco-system of innovation of startups/SMEs. However, from the view point of the demand side for support services, support programs are not developed enough in terms of quantity and quality. Business incubation of the science park provide services only for three years, and other business services are provided on demand without the systematic design of programs. It is more important for the startup to survive in the market by securing its own market share, not simply to make a business. From the supply side, there seems to be a large room for development of specialty business services focusing on startups/SMEs, such as business consulting, marketing services, and others. (Refer to Table 5-2). Without various specialty service units being developed, it would be difficult to develop and implement new support programs.

Thai government has taken an initiative for developing and nurturing startups, "Startups Thailand," and an effort is made at the inter-ministerial level. The Ministry of Science and Technology designates NIA as the lead agency for the "Startup Thailand," in implementing support policies/programs for startups/SMEs. On the other hand, the government establishes science parks such as Thailand Science Park and three regional science parks. NSTDA and SPA are responsible for developing and managing those science parks.

NIA as the lead agency formulates and implements various support programs, having funding instrument. This implies that NIA has versatility, to greater degree, in its policies/programs to support startups and SMEs. At the circumstance of the government initiating startup policy through the combined efforts of related ministries, NIA should reshape its policies/programs. Meanwhile, NSTDA and SPA provide support programs and services to startups, based on physical facilities. In the future, it will be critical for them to obtain sustainability in maintaining and managing facilities of the science park, by securing revenue sources.

As for Korean experience, when Korea launched initiatives for economic development, the government strategy was developed in two tracks; industrial development on the one hand, and S&T development on the other. The government implemented five-years plans, seven times, for both over the period of 1962-1997. The industrial development focused on heavy and petrochemical industry, for which domestic market is too small. Therefore, the government pursued outward-looking strategy, implying that Korean enterprises could not help facing competition in the world market. On the other hand, the government started to establish GRIs (government research institutes) to secure R&D capacity of the country, with starting from the scratch.[23] By developing GRIs system, major innovations had been brought in late 1980s and early 1990s. Those innovations underpin, particularly, ICT industry nowadays. In a word, underlying principles in Korea's economic development are competition and learning.

[23] It was almost impossible to have strategic approach to securing R&D capacity with universities, which were nearly capable to teach students after the Korean War.

In the course of economic development, R&D investment of both public and private sectors had increased rapidly, keeping pace up with the speed of industrialization. Such resource allocation had an influence on the STI governance, which became increasingly complex since mid-1990s towards securing rationality and transparency. With more stakeholders being involved, the coordination mechanism is unavoidable at the government level, for which PIMEF (planning-implementing-monitoring-evaluation-feedback) framework has been well developed.

Since the end of 1990s, the government paid a good deal of attention to developing/nurturing technology-based startups and SMEs. It is expected that technology-based SMEs would strengthen economic fundamentals in the age of knowledge-based economy. Successes of venture businesses stimulated young entrepreneurs, and challenges continue. It is envisaged that the growth path of the economy would be greatly influenced by those startups in the long run. It is noted that performance of startups is mainly due to (1) eminent S&T platform which has been built up since 1960s, (2) immense entrepreneurship, (3) financial market (stock market for technology), and (4) sound eco-system, in which a number of business service units are developed; that is, various organizations such as associations, non-profit organizations, and private firms, among others, supply the business services to the startup. It makes the government be ready to implement various startup policies/programs. In 2017, there are 72 startup programs implemented through the government budget allocation. It amounts to about 24,268 billion KRW (roughly equivalent to 718 billion THB) in total.

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Finally, recommendations and suggestions are made as follows;

1. Expanding the domain of NIA's policy/program in supporting innovation of startups/SMEs

It would be necessary to formulate and implement policies/programs over the entire range of innovation cycle. In so doing, policies/programs can be categorized into the following eight categories. Startups/SMEs may search a support program in one of the following categories.

- Education/training
  - More extensive education and training programs should be developed ranging from K12, college students, potential entrepreneurs, and to retired persons.

- Mentoring/consulting

- Proactive programs are required to develop business service units. Hence, NIA can better support innovation of startups/SMEs.

・ Commercialization
  - NIA can implement joint programs for commercialization between universities and startups. By evaluation, currently, NIA provides fund to SMEs for innovation. NIA could take more active actions to facilitate technology transfer and commercialization. That is, NIA staff can formulate and manage a joint action between universities and SMEs, including legal support.

・ Financial support
  - NIA has two major funding schemes. Continuing efforts to develop more funding schemes by investigating what startup's financial issues are. Along the growth stages, the startup need to make financial plan differently.

・ R&D
  - NIA may formulate new policy/program for "industrial technology development." As industrial technology development will increasingly important, NIA should have a capacity to formulate and implement R&D programs for it. Such effort is related to develop growth engines of the national economy.

・ Marketing (domestic/overseas)
  - Focusing the market in Bangkok+ and Eastern areas, startups/SMEs would face a limit to growth. Marketing support has to be reinforced particularly for global market. Startup should target penetration to the global market from the beginning. Specialty marketing services are necessary.

・ Networking
  - So far, various networking programs are installed. However, networking to international knowledge hubs are important, since the knowledge base of Thailand is relatively weak at the moment. For example, Chiang Mai university is now undertaking a joint project, about application of Plasma to the agriculture, with a Korean government research institute. NIA could play a role to facilitate such a cooperation. Need to establish database of foreign knowledge hubs.

・ Facilities/space
  - Facilities/spaces are provided mostly by science parks run by NSTDA and SPA. Therefore, NIA may play a role as intermediary between entrepreneurs who look for facilities and spaces, and science parks.

2. Developing and nurturing specialty business service units

Not only implementing support policies/programs, but also providing specialty business services is of vital importance for the innovation eco-system. It seems likely that no agency pay

attention to the latter. Thus, NIA might formulate and implement new programs, particularly for developing and nurturing specialty business service units in various areas.

3. Industrial technology development: Program for new growth engines development

R&D program is necessary to develop new growth engines in Thailand. This requires a well-prepared documentation of the plan by undertaking well-structured technology foresight. The program can be implemented through cooperation between industry, universities, and public research organization. For example, high-speed train could be a good case. It is important how quickly Thailand acquires necessary technologies for it; partly by in-house R&D and partly by outsourcing from abroad. Then, NIA (or other agency) might formulate a development program for the part of in-house R&D.

4. Creating the integrated portal for support programs/services

By creating the integrated portal which connects all support programs/services for startups in Thailand, entrepreneurs can readily get an access to them. To do this, extensive survey has to be undertaken to identify the programs/services in eight categories above, and regularly updated. Standardization of application and evaluation process are also expected.

5. Close cooperation with science parks

It is necessary to keep in a close touch with science parks, because science parks provide services based on facilities and spaces, which lacks other services such as financial support and others. In addition, NIA should make an effort to develop business service units in regions where science parks are located.

6. Developing an innovation center with new concept

NIA may attempt to develop an innovation center, in which multinationals participate as a sponsor enterprise. The sponsor enterprise can assist new startups in many ways, such as mentoring, developing new business and market, sourcing necessary technologies, and so forth. (Refer to Korea's Creative Innovation Center). However, heavy investment in establishment of physical facilities is not recommended. To do so, cooperation would be required at the inter-ministerial level. Because incentives to the multinationals will be necessary.

7. Creating the department of Planning and Coordination within NIA

To do it more efficiently, NIA may reform the organizational structure by creating the department of "Planning and Coordination." The mission/function of "planning and Coordination" department is to prepare annual actions with budget allocation at NIA level. This department has to monitor current programs and develop new programs for the next round actions, constantly. In so doing, it undertakes policy studies to identify new issues and develop corresponding programs, as the socio-economic situation is always changing over time. If the capacity of

policy studies is not enough, NIA could outsource experts from universities and others. Building such capacity will eventually increase competitiveness of NIA as a funding/implementing agency.

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