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Jarunee Wonglimpiyarat

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The Innovation Incubator, University Business Incubator and Technology Transfer Strategy: The Case of Thailand

by

Jarunee Wonglimpiyarat*

*College of Innovation, Thammasat University, Anekprasong 3 Bldg., Prachan Rd., Bangkok 10200, Thailand. Tel: (662) 623 5055 8, Fax: (662) 623 5060, Email: jaruneew@tu.ac.th.
The Innovation Incubator, University Business Incubator and Technology Transfer Strategy: The Case of Thailand
Abstract

This study reviews the role of the innovation incubator and university business incubator (UBI) in supporting the entrepreneurial development in Thailand. The university business incubator (UBI) is defined in this paper as an incubator set up by the university to provide office space, equipment, mentoring services as well as other administrative supports to assist the formation of new ventures). In particular, the paper compares the operation of the university business incubators (UBIs) and technology incubators to understand their technology transfer strategies. The analyses, based on the Triple Helix model, also include the government policies to support innovation commercialization in Thailand. The study examines case studies of leading university business incubators (UBIs) (Mahidol University, Chulalongkorn University and King Mongkut’s University of Technology Thonburi) and science and technology incubators of the National Science and Technology Agency (NSTDA) and the National Innovation Agency (NIA). The results have shown that the incubation program is one of the major policy mechanisms to support innovation and suggested that UBIs should act as an intermediary between the spheres of university and industry to provide interactive linkages and promote effective utilization of university research. The empirical study provides insightful implications on the move towards the entrepreneurial university and the dynamics of the Triple Helix system in stimulating innovation development and diffusion.

Key words: university business incubator (UBI), technology transfer, Triple Helix, entrepreneurial development, technology commercialization
1. Introduction

Business incubation strategy is one of the mechanisms to reduce the rate of small business failure and support vibrant businesses that help drive the national economic development. After the Asian financial crisis in 1997, Thailand has increasingly paid attention to reviving its economy through promoting entrepreneurial development and supporting new business creation. As one of the emerging tigers in Asia with an average growth rate of 5 percent per year, the Thai government has attempted to leverage a business technology incubator strategy in order to make the transition from lower middle income economy towards upper middle income economy.

The purpose of this paper is to analyze the business incubation strategy and the role of the innovation incubator and university business incubator (UBI) in supporting the entrepreneurial development. The university business incubator (UBI) is defined in this paper as an incubator set up by the university to provide office space, equipment, mentoring services as well as other administrative supports to assist the formation of new ventures. In particular, the study compares the operation of the university business incubators (UBIs) and technology incubators to understand their technology transfer strategies. The paper is organized as follows. Section 2 reviews the theoretical framework on technology incubator and the Triple Helix model. Section 3 discusses the government policies to support technology commercialization. Section 4 discusses the research methodology and presents the research findings. The analyses of findings cover case studies of university business incubators (UBIs) and technology business incubators. The case studies of UBIs include three major universities in Thailand: Mahidol University, Chulalongkorn University and King Mongkut’s University of Technology Thonburi (KMUTT).
whereas the science and technology incubator cases include national incubation centers of National Science and Technology Agency (NSTDA) and National Innovation Agency (NIA). It also presents the multi-faceted discussions of policy issues with regard to the capacity of university technology transfer and commercialization. The analyses and discussions are based on the Triple Helix model emphasizing the integration of three institutional spheres (university-industry-government relations). Section 5 proposes the model of university technology commercialization in Thailand. Section 6 concludes the paper by drawing lessons and insights that can be used as policy guidelines for other developing economies in the process of technology transfer and commercialization through the incubation mechanism.

2. Theoretical framework

2.1 Technology incubator

The incubator is an umbrella term referring to a mechanism for technology transfer to promote the growth of innovation and entrepreneurship. The incubator is usually seen as a catalyst enabling the process of knowledge transfer and innovation commercialization (Bakouros et al., 2002; Wonglimpiyarat, 2010, 2014). In various studies, the concept of technology park is used interchangeably with science park, research park, business park and innovation center, etc. (Currie, 1985; Eul, 1985; Monck et al., 1988). In particular, the term ‘technology incubator’ refers to a mechanism enabling the process of technology transfer which help promote growth through innovation and support economic development strategies for small business development (Smilor and Gill, 1986, 1987; Allen and McCluskey, 1990; Phillips, 2002). In this study, the university business incubator (UBI) is defined as an incubator set up by the university
to provide office space, equipment, mentoring services as well as other administrative supports to assist the formation of new ventures).

Many countries use the technology business incubator programs as part of the innovation and entrepreneurship policies to support economic development (Acs and Naude, 2011). Business incubator and technology incubator are a kind of infrastructure geared to support and nurture the development of small and medium-sized enterprises (SMEs) (Barrow, 2001; Bøllingtof and Ulhøi, 2005). Business incubator provides business assistance to firms in the early stages of development to increase firm survival rates (Bøllingtof and Ulhøi, 2005; Bøllingtof, 2012). Business incubators typically provide office space, administrative support and mentoring services (Peters et al., 2004). Technology incubators are business incubators focusing on new companies with advanced technologies and often have the characteristics shown in Table 1. Generally, technology incubators are known under various names such as innovation centers, science parks and technology centers (OECD, 1997). The incubator resources could help young entrepreneurial firms access new knowledge, expertise and industrial networks (Barrow, 2001; Rothschild and Darr, 2005).

[Insert Table 1 around here]

Figure 1 demonstrates a schematic presentation of technology incubator. The highlighted box of ‘incubator’ represents the theme of this study (comparison of the operation of university business
incubators (UBIs) and technology incubators to understand their technology transfer strategies). The university business incubator (UBI) provides services such as laboratories and equipment, management and technical support, legal advice and networkings which add value to incubating companies (OECD, 1997, 2010). Given the high risks associated with the formation of new enterprises, many governments attempt to use technology incubator as a vehicle for linking technology, entrepreneurs, small and large firms and sources of capital for technology development and commercialization (OECD, 1997; Lofsten and Lindelof, 2005; McAdam and McAdam, 2008; Wonglimpiyarat, 2010, 2014).

[Insert Figure 1 around here]

2.2 Triple Helix Model

Given that innovation is increasingly regarded as an important factor in driving economic growth, the nation needs policy coordination among various agents participating in the innovation system to promote sustainable economic growth and long-term competitiveness (Lundvall, 1998; Freeman, 1987). The governments in developing countries are considered the national agents playing a crucial role in strengthening technological capability to support the national system of innovation. Promoting S&T specialization would influence a nation’s future economic performance since countries with technological strengths in rising areas are likely to benefit from increasing returns, which in turn allow them to expand technological and production capabilities (Archibugi and Michie, 1997).
Figure 2 illustrates the development of the Triple Helix model. The arrow in Figure 2 shows the sequence of Triple Helix model development from the old model to the new model. It explains the progress or development from the old model (representing weak linkages and interactions among the institutions) to the new model (emphasizing strong linkages and interactions among the institutions). The old model shown on the left hand side of Figure 2 shows the structure of the innovation system comprising various institutions including the government agencies, universities, industries and research organizations. However, the old model suffers from weak linkages and interactions among the institutions (industry-university-research institutions) in achieving an effective innovation system. The new model is thus developed to address the problems/limitations of the old model. As can be seen from the right hand side of Figure 2, the new model emphasizes the linkages and interactions among the three institutional spheres (university–industry–government relations or trilateral interactions) (Etzkowitz, 2002; Etzkowitz and Leydesdorff, 1998, 2000) in order to build an effective innovation system. Indeed, the networks connecting the industrial sector and the government aim to enhance economic development and competitiveness.

[Insert Figure 2 around here]

The value of the Triple Helix can be seen from the application of the model to explore how institutions interact which is very useful to support the formulation of government policies in enhancing the innovation system. However, the model may have limitations in explaining a level of interactions and interdependencies among institutional spheres. Indeed, the government
policies should support these interactions for knowledge generation and industrial development (Etzkowitz and Leydesdorff, 1998, 2000; Gay and Dousset, 2005). In high technology sectors, the Triple Helix model provides a platform for innovators through university–industry–government relations. Early stage investments in high-technology companies are of high risk and thus need the government support programs for venture development. The Triple Helix model postulates an interaction among the institutional spheres to foster the conditions for innovation in both advanced industrial and developing economies. (Etzkowitz, 2002, 2004, 2011; Etzkowitz and Leydesdorff, 1998, 2000; McEvily et al., 2004). The interactions help facilitate the move of technologies from universities/research organizations to the private sector.

3. Government policies to support technology commercialization

The Thai government has enacted various sets of policies and programs as a means to revive the economy after the 1997 financial crisis. The National Economic and Social Development Plan and SME Promotion Master Plan are major SME policies to support entrepreneurship. Realizing the importance of SMEs in terms of job creation and economic growth, the government has paid special attention towards supporting new start-ups and entrepreneurial ventures. The eleventh National Economic and Social Development Plan (Years 2012-2016) is a continuation of the tenth plan (Years 2007-2011) placing emphasis on SME development in order to meet the challenges of the 21st century. Table 2 lists the responsible ministries and specific policies to support business incubation and SME innovation in Thailand.
From Table 3, it can be seen that the major ministries responsible for business incubation and SME innovation in Thailand are the Ministry of Education, Ministry of Industry, Ministry of Science and Technology, Ministry of Commerce and Ministry of Finance. These ministries enact specific policies, strategies and programs to support the growth and development of SMEs. Realizing the importance of incubation program as a platform to support SME innovation, the Thai government, through the Office of the Higher Education Commission, Ministry of Education, launched the innovation policy of setting up university business incubators (UBIs) with an aim to support new ventures which would thereby create jobs and strengthen the country’s economic competitiveness. The purpose of establishing UBIs is to encourage wide use of university research as well as of intellectual properties (IPs). Currently, there are 35 UBIs established with 327 cases incubated and 60 new enterprises established (OECD, 2011). The UBI has been implemented to foster linkages between university and industry so as to improve the process of technology commercialization.

The Ministry of Industry via the Office of the Small and Medium Enterprises Promotion (OSMEP) enacts SME promotion policies to support SMEs via grants, venture capital financing, business matching programs. The OSMEP also established the SME VC Fund, a major financing program, to assist SME businesses with VC investments. In particular, the OSMEP formulates the SME Promotion Master Plans to support innovation in SMEs. The Ministry of Science and Technology via the National Science and Technology Development Agency
(NSTDA) and the National Innovation Agency (NIA) also introduced various financing policies and a range of financial programs to support SMEs including grants, low interest rate loans, venture capital financing programs.

Figure 3 lists the major government policies to support SME development according to the phases of national economic development in Thailand. In the 1960s, the government policies were strategically focused on import-substitution industrialization. The policy framework in the 1970s then shifted to the export-oriented industrialization whereby the government promoted foreign direct investment (FDI) inflows to support economic development. From 1990s onwards, the Thaksinomics policy was a major policy framework to support entrepreneurship. The policy initiatives since 2000s were aimed at enabling Thailand to transition from middle income trapped economy to higher income economy. Interestingly, the Bank of Thailand also introduced the Financial Sector Master Plan II (Years 2010-2014) as a national entrepreneurship policy to revive economic growth (supporting and developing entrepreneurs through policy-based institutions including commercial banks and financial institutions).

[Insert Figure 3 around here]

The Thai government has played a significant role in establishing the national research universities so as to increase research outputs in the fields of study that are important to national competitiveness. To enhance national competitiveness, the government has set the policies to develop the National Research University program in 2009. The Office of the Higher Education
Commission has selected nine universities as flagship national research universities to improve research capacity and promote university research for production which would further support social and economic development. The national research universities are Chulalongkorn University, Thammasat University, Mahidol University, Kasetsart University, King Mongkut’s University of Technology Thonburi, Chiang Mai University, Khon Kaen University, Suranaree University of Technology, and Prince of Songkla University. The purpose of establishing national research universities is to encourage entrepreneurship and research commercialization.

Thailand can be seen as a late adopter of SME policy to support entrepreneurial development (Thailand adopted policies later than other Asian countries like Taiwan and Singapore whose SME innovation policies were adopted since the 1980s). A set of entrepreneurship policies (termed ‘Thaksinomics policies’) was implemented in the late 1990s to upgrade the capacities of SMEs after the Asian financial crisis. The first SME Promotion Master Plan (Years 2002-2006) and the second SME Promotion Master Plan (Years 2007-2011) were initiated to mainly solve the problems on financial crisis and support the revival of SMEs. Currently, the third SME Promotion Master Plan (Years 2012-2016) continues its focus on improving SMEs’ competitiveness to be ready for greater competition in the upcoming Asean Economic Community (AEC) (SMEs would face increasing competition among ASEAN countries under the AEC by the Year 2015).

4. Research methodology and analysis of findings
This study employs the use of case study methodology (Eisenhardt, 1989; Yin, 2013) to understand in-depth the logical or causal drivers of phenomena (rather than statistical generalization). The research derives evidence from a collection of interviews and documentary investigation. The sample size in this study covers the case studies of university business incubators (UBIs) and technology business incubators. The case studies of UBIs include three major universities in Thailand: Mahidol University, Chulalongkorn University and King Mongkut’s University of Technology Thonburi (KMUTT) whereas the science and technology incubator cases include national incubation canters of National Science and Technology Agency (NSTDA) and National Innovation Agency (NIA).

The analyses focus on the operations of major university business incubators and technology business incubators in enhancing the process of technology commercialization. The operations and incubating policies are analyzed through the lens of Triple Helix model. The interviews were carried out using the semi-structured questionnaire to understand the views of trilateral parties (the government, university and industry) related to the concept of Triple Helix model. The interviews were carried out with major stakeholders including policy makers, policy analysts, government officials, managers running incubators, incubates, university professors, research managers. Interview data were supported by an examination of secondary data so as to provide a cross check on internal validity. The use of triangulation thereby increases the robustness of results as the findings can be strengthened through cross-validation of multiple data sources (Benbasat et al., 1987).
Table 3 compares the operation of major university business incubators (UBIs) and technology incubators to gain an understanding of their technology transfer strategies. The case study focuses on leading university business incubators (cases of Mahidol University, Chulalongkorn University and King Mongkut’s University of Technology Thonburi) and national technology business incubators (cases of the National Science and Technology Development Agency and National Innovation Agency). The UBIs of Mahidol University, Chulalongkorn University and King Mongkut’s University of Technology Thonburi (KMUTho) are selected because they represent major authorized university business incubators and also are recognized as major national research universities in Thailand. The National Science and Technology Development Agency (NSTDA) and the National Innovation Agency (NIA) under the management of the Ministry of Science and Technology are major technology business incubators providing incubation services to support the entrepreneurial process. The operation of NSTDA’s Science Park and NIA’s Innovation Park is structured in clusters to provide infrastructure for facilitating technology transfers of UBIs. The linkages between NSTDA’s Science Park and NIA’s Innovation Park with UBIs help utilize the university research-based knowledge and increase the survival rate of university spin-offs.

[Insert Table 3 around here]

The incubation program is one of the policy mechanisms to support innovation in SMEs in Thailand. The UBI program was coordinated by the Office of Commission on Higher Education (CHE) and universities to provide entrepreneurial mentoring and advisory services. Most UBIs
were set up in 2004-2005 (as can be seen in Table 3) to support high potential projects which could be further developed to become university spin-off companies. In other words, UBIs support university faculties, researchers and students to start new ventures from research outputs/projects. The national research universities have been allocated the budget amounting USD 100 million annually to develop their research and development (R&D) capacities. In 2013, the Office of Commission on Higher Education (CHE), Ministry of Education, has set up a USD 172 million venture capital (VC) fund to support entrepreneurial start-ups with an aim to create 5,000 - 10,000 new enterprises annually.

From the use of case study methodology to analyze the technology transfer strategy of the university business incubators (UBIs) and technology business incubators in Thailand, Table 4 summarizes the points from interviews with regard to factors affecting an effective operation of the incubation programs. Their views reflect the importance of the Triple Helix interactions (university-industry-government relations) to accelerate the process of technology commercialization. The interviewees have pointed out some problems that need to be overcome before the incubator programs in Thailand could be more effective. In order to enhance the effectiveness of the incubation programs, the interviewees advised that the incubating firms need to focus heavily on undertaking R&D activities. In particular, the incubator should make arrangements to facilitate coordination with the private sector as well as the universities, the primary source of basic research. They viewed that universities are the major source of creating insightful basic research to develop commercial technology whereby the linkages with the private sector would help bring academic research towards the commercialization stage. They
also commented that the technology transfer legislation is needed in the same way as the US Bayh-Dole Act to encourage the process of technology transfer and effective commercialization.

[Insert Table 4 around here]

Many interviewees view that financial constraints are one of the major problems of incubators and incubatees. The incubatees express consistent views that incubators should provide mentoring and referral services. Particularly, the service offering network linkages and partnerships should be in place to support innovation development and commercialization. This is because most of the interviewees comment that they have to depend on their own network relations and connections. It is thus recommended that the incubator should establish a special unit to support technology-based spin-offs and encourage the commercialization of research projects.

The empirical findings have shown that the process of technology transfer from university to the industrial sector (bringing academic research towards commercialization) is not effective. Most of the university research is in the embryonic stage and could not reach the marketplace. Although the government has introduced various entrepreneurship policies/programs to support SMEs, the public innovation schemes for SMEs are seen as inefficient and bureaucratic, obstructing the process of commercializing university research. The main problem is a lack of policy coherence among the government agencies dealing with SMEs as many programs are overlapping among those launched by the Ministry of Science and Technology and the Ministry
of Industry. Further, there is a limitation in terms of providing finance to SMEs due to scarcity of VC funds and private equity investments. There are no networks of venture capitalists for firms seeking venture funding. Also, the university researchers suffer from a lack of government funding support and discontinuities of operations due to frequent changes of the government and policies.

5. Model of university technology commercialization in Thailand

The analyses and discussions of the incubation program and policy mechanisms to support innovation in SMEs in Section 3 and 4 have shown the importance of the Triple Helix interactions (university-industry-government relations) in facilitating the process of transferring technology to commercialization (Figure 4).

[Insert Figure 4 around here]

The analyses in Section 4 and 5 have shown the useful application of the Triple Helix model (Etzkowitz, 2002; Etzkowitz and Leydesdorff, 1998, 2000) in the context of Thailand particularly the role of incubators to support entrepreneurial development. It is argued that the right institutional settings and infrastructure allow the Triple Helix parties in the innovation system to work collaboratively in promoting spin-off companies. The incubator policy to assist SMEs can be seen as an important link between academia and industry under the Triple Helix model (Figure 2). Although the university business incubator (UBI) mechanism has been implemented to foster linkages between university and industry, the process of commercializing
university intellectual properties (IPs) through licensing/technology transfer office is not very successful in Thailand. During the years 1995-2004, there were 140 patents awarded to the universities but only 6 of them were transferred to industry, showing the low level of university research commercialization (Krisnachinda, 2009).

Based on the Triple Helix model of tri-lateral networks among the government, university and industry (Figure 2), Figure 5 presents the model of university technology commercialization in Thailand. The technology clusters of Science Park in the Northern Bangkok and Technolopolis or Innovation Park in a metropolitan area were established to emulate the success of US Silicon Valley. The Science Park is situated in the area surrounded by universities and industries. In the Northern Bangkok Industrial Cluster, Asian Institute of Technology (AIT), Sirindhorn International Institute of Technology (SIIT), Thammasat University, Rangsit University, Bangkok University were formed near the areas of Navanakorn, Rojana, Bangkradi industrial estates to enhance R&D collaboration and commercialization.

The Technolopolis or Innovation Park of the National Innovation Agency is located at the nexus of universities in central business district of Bangkok. It is surrounded by many universities: Mahidol University, King Mongkut’s University of Technology North Bangkok, King Mongkut’s Institute of Technology Ladkrabang, King Mongkut’s University of Technology Thonburi, Kasetsart University, Chulalongkorn University. These universities are in the Bangkok metropolitan area and in close proximity to industrial estate and export zones.
Although the national clusters are established to improve the capacity to innovate, the linkages and interactions among the institutions are relatively weak. That is to say, while the Triple Helix settings are represented by the clusters shown in Figure 3, there is a lack of active interactions among the state/government, industry and academia. Under the Triple Helix model, the successful commercialisation of university technologies needs strong interactions among academia, industry, policies and stimuli (such as grants, subsidies, tax incentives, tax credits for innovation activities, etc.) supported by the government. To encourage the process of university research commercialisation, the operation of UBIs should have close coordination with the commercialized unit of university technology transfer office/technology licensing office. Further, the process of commercialisation needs financial and tax incentives to improve IP exploitation and promote IP commercialisation apart from the government incentive of 200% tax deduction for R&D expenses.

It is argued that the UBIs should work collaboratively with the government agencies such as NSTDA Science Park and NIA Technopolis/Innovation Park to promote the utilization of university research. In particular, the networks of angel and venture capital investors should be established and maintained closely with the university incubators. Given the difficulties faced by firms in accessing financial resources during their early stages of business development, the UBIs should act as an intermediary to give advice and guidance in helping start-up firms get access to alternative sources of finance. In the future, the move towards the entrepreneurial
university may need the university-owned VC fund to facilitate technology transfer and commercialisation. To catalyze cluster development, the key performance indicator (KPI) should include the number of university spin-offs as measurement of incubator performance. As discussed in Section 4 on the analysis of findings, it is recommended that the linkages between NSTDA’s Science Park and NIA’s Innovation Park should be strengthened to encourage the process of technology transfer. The fund-of-funds established under the Ministry of Science and Technology would facilitate the formation of new entrepreneurial businesses. When the research at the NSTDA’s Science Park is developed to a certain stage, the government, through the Ministry of Science and Technology, should encourage the NIA’s Innovation Park to follow up and determine the commercial and licensing potential. In this process, the Ministry of Science and Technology should also encourage the private sectors to share investments in the stages of commercial development. Based on the Triple Helix model, the university should establish a special unit within the university business incubator (UBI) to facilitate the creation of university spin-offs. In line with the knowledge-based strategy for economic growth of Thailand, the government policies on university financing should be developed to increase efficiency in business incubation and technology commercialisation.

6. Conclusions

This paper reviews the role of the innovation incubator and university business incubator (UBI) in supporting the entrepreneurial development. The study also explores the government policies to support innovation commercialization in Thailand. The empirical study compares the operation of university business incubators (UBIs) and technology incubators to understand their technology transfer strategies. The case studies include the leading university business
incubators (UBIs) (Mahidol University, Chulalongkorn University and King Mongkut’s University of Technology Thonburi) and technology incubators (National Science and Technology Agency (NSTDA) and the National Innovation Agency (NIA)).

The analyses of findings have shown that the Thai government has introduced various policies and programs to encourage the creation of new entrepreneurs as well as the development of technological and innovative capabilities of firms, for example, the SME Promotion Master Plan, the Bank of Thailand Financial Sector Master Plan, the National Economic and Social Development Plan. The technology clusters of Science Park in the Northern Bangkok and Technolopolis/ Innovation Park provide necessary infrastructure that could help reduce the risks in new venture formation.

In view of building up the innovation capacities, it is argued that the government should function as a catalyst in the process of techno-economic development. The results of this study have shown that the aspect of fostering linkages (government- university-industry linkages) among institutional settings within the Triple Helix system is an important factor to stimulate innovation development and diffusion. The results of this study could partly fill the gap in the innovation policy studies and provide some useful lessons to other developing countries in the process of technological catch-ups.

References


Table 1  Characteristics of technology incubators

<table>
<thead>
<tr>
<th>Host institution</th>
<th>University</th>
<th>Research facilities</th>
<th>Production facilities</th>
<th>Technology transfer office</th>
<th>Park facilities</th>
<th>Incubator</th>
<th>Venture capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science and research parks</td>
<td>x</td>
<td>x</td>
<td>o</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Innovation center</td>
<td>o</td>
<td>o</td>
<td>x</td>
<td>x</td>
<td>o</td>
<td>x</td>
<td>o</td>
</tr>
<tr>
<td>Technology park</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

Notes:  
- x = Essential or integrated feature  
- o = Desirable feature; accessible through science and technology (S&T) infrastructure and industry

Source: The Working Group on Innovation and Technology Policy (TIP) of the OECD Committee for Scientific and Technological Policy (CSTP).
Table 2  Responsible ministries and specific policies to support business incubation and SME innovation in Thailand

<table>
<thead>
<tr>
<th>Ministries and policies to support business incubation and SME innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Ministry of Education</td>
</tr>
<tr>
<td>• The Office of the Higher Education Commission under the Ministry of Education introduced the national policies to support the establishment of university business incubators (UBIs). The UBI program comprises 9 university networks which cover 56 universities in Thailand.</td>
</tr>
<tr>
<td>• The Office of the Higher Education Commission formulates policies to support the establishment of the university technology licensing office (TLO) to encourage the transfer of university research to industry.</td>
</tr>
<tr>
<td>2. Ministry of Industry</td>
</tr>
<tr>
<td>• The Office of the Small and Medium Enterprises Promotion (OSMEP) under the SME Promotion Act B.E. 2543 introduced the SME promotion plans as the national policy framework to support SMEs. The SME promotion plans were formulated in accordance with the National Economic and Social Development Plan.</td>
</tr>
<tr>
<td>• The Ministry of Industry via the Office of the Small and Medium Enterprises Promotion (OSMEP) enacted SME promotion policies through various programs of grants, venture capital, business matching services.</td>
</tr>
<tr>
<td>• The Ministry of Industry introduced SME financing and innovation loans through Small and Medium Enterprise Development Bank of Thailand (SME Bank).</td>
</tr>
<tr>
<td>• The Ministry of Industry via the Department of Industrial Promotion introduced the New Entrepreneurs Creation (NEC) program with linkages to the incubation program to support new venture start-ups.</td>
</tr>
<tr>
<td>3. Ministry of Science and Technology</td>
</tr>
<tr>
<td>• The Ministry of Science and Technology via the National Science and Technology Development Agency (NSTDA) and the National Innovation Agency (NIA) introduced various financing policies to support SMEs including grants, low interest rate loans, venture capital financing programs. The major programs to support SMEs are the Company Directed Technology Development Program (CD) and Industrial Technology Assistance Program (ITAP) programs of NSTDA and Good Innovation … Zero Interest, Technology Capitalization and Innovation Cluster Grant programs of NIA.</td>
</tr>
<tr>
<td>• The Ministry of Science and Technology via the Research and Development Certification Committee Secretariat works with the Ministry of Finance in formulating tax incentive policies to support SMEs undertaking research and development (R&amp;D) projects.</td>
</tr>
</tbody>
</table>
4. Ministry of Commerce
   - The Ministry of Commerce via the Department of Intellectual Property (DIP) introduced policies to support SME intellectual property and innovation.
   - The Ministry of Commerce established the International Trade Promotion Fund to provide financial supports for Thai SME development projects.
   - The Ministry of Commerce introduced trade policies and export promotion measures to provide comprehensive export financing and skills development to promote SME exports via the Export-Import Bank of Thailand (EXIM Bank).

5. Ministry of Finance
   - The Ministry of Finance via the Revenue Department formulates tax concession policies to encourage SME R&D investments (policy allowing 200% deduction for depreciation of machinery and equipment used in R&D activities).

Source: The author’s design
Table 3 The operations of major university business incubators and technology business incubators in Thailand

<table>
<thead>
<tr>
<th>University business incubators (UBIs)</th>
<th>Technology business incubators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mahidol University</td>
<td>National Science and Technology Development Agency (NSTDA)</td>
</tr>
<tr>
<td>Chulalongkorn University</td>
<td>National Innovation Agency (NIA)</td>
</tr>
<tr>
<td>King Mongkut’s University of Technology Thonburi (KMUTT)</td>
<td></td>
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<tr>
<td>National Innovation Agency (NIA)</td>
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<table>
<thead>
<tr>
<th>Source of budget to support incubation program</th>
<th>Mahidol University&lt;br&gt;• Office of the Higher Education Commission&lt;br&gt;• Ministry of Science and Technology</th>
<th>Chulalongkorn University&lt;br&gt;• Office of the Higher Education Commission (50%)</th>
<th>King Mongkut’s University of Technology Thonburi&lt;br&gt;• Office of the Higher Education Commission (50%)</th>
<th>Ministry of Science and Technology</th>
<th>Ministry of Science and Technology</th>
</tr>
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<tr>
<th>Incubating policies</th>
<th>Policies focused on supporting start-up companies and projects having commercial potential&lt;br&gt;The incubator has clear policies and mechanisms to form spin-off companies</th>
<th>Policies focused on providing true incubation services with intellectual property (IP) management and VC support programs</th>
<th>Policies focused on using the networks within and outside the university in making use of KMUTT research laboratories, university personnel/faculties and providing marketing services</th>
<th>Policies focused on funding early-stage firms to provide incubation support via Science Park and Software Park&lt;br&gt;Provide incubation services according to the venture life cycle stages of pre-incubation, incubation and post-incubation</th>
<th>Policies focused on risk reduction investments&lt;br&gt;Provide late stage investments to finance firms already generating sales with private sector financial holding</th>
</tr>
</thead>
</table>


<table>
<thead>
<tr>
<th>Mahidol University</th>
<th>Chulalongkorn University</th>
<th>King Mongkut’s University of Technology Thonburi (KMUTT)</th>
<th>National Science and Technology Development Agency (NSTDA)</th>
<th>National Innovation Agency (NIA)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Area of support</strong></td>
<td>Healthcare, medicine, life sciences, medical equipment, biological and biochemical materials</td>
<td>Agricultural technology, health and medical technology, educational technology</td>
<td>Material science, biochemistry, composites materials, nanotechnology, agricultural technology</td>
<td>Major technologies of genetic engineering, biotechnology, metal, materials, electronics, computer, nanotechnology</td>
</tr>
<tr>
<td><strong>Operational functions</strong></td>
<td>• Provide technology communalization programs, inventor forum, entrepreneurial know-how and training services • Establish Good Manufacturing Practice (GMP) plant for drug production • Support the university spin-offs through Stang Holding Company Limited</td>
<td>• Implement the cluster support program in line with the national clusters and competitiveness agenda • The incubator is managed under the University Intellectual Property Institute to incubate firms that use technology developed by the university • Provide entrepreneurial support to students and alumni interested in developing early-stage ventures</td>
<td>• Provide matched funding, training and advisory services in marketing new product development • Establish collaborative links with NSTDA’s Industrial Technology Assistance Program (ITAP) program to support entrepreneurial start-ups • Set up Student Entrepreneur Club to encourage new start-up businesses</td>
<td></td>
</tr>
</tbody>
</table>

| No. of patents granted to university from 1995-2004 | 15 | 19 | 36 | n/a | n/a |

Source: Wonglimpiyarat (2014)
Table 4 Summarized views on factors affecting the effective operation of incubation programs

<table>
<thead>
<tr>
<th>University business incubators (UBIs)</th>
<th>Technology business incubators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enabling factors</td>
<td>Enabling factors</td>
</tr>
<tr>
<td>Financial assistance and marketing services are seen as important factors for successful business start-ups.</td>
<td>The technology business incubators needs a clear policy to support business spin-offs from the national research centers.</td>
</tr>
<tr>
<td>The UBIs should provide a mentoring program and services to support technology-based spin-offs from university.</td>
<td>The provision of business networking opportunities such as business matching opens up new funding opportunities (for example, business partnership matching services between NSTDA and the Market for Alternative Investment (mai)).</td>
</tr>
<tr>
<td>The UBIs need to understand the main purpose of the incubating firms so as to provide the right guidance and support to help the incubating firms develop the products meeting the market needs.</td>
<td>The provision of VC funding support covering various stages of business development particularly the pre-seed stage.</td>
</tr>
<tr>
<td>The UBIs need more financial supports from the university to pursue their missions and further expand services to incubatees.</td>
<td>Marketing support such as innovation fairs/trade shows to help commercialize technology and innovations.</td>
</tr>
<tr>
<td>Reliability of the incubator and expertise of the university are important attributes that the companies decide to participate in the incubation program.</td>
<td>Strengths of public research institutes under the Ministry of Science and Technology with capable researchers in the field to help the incubatees solve specific technical problems.</td>
</tr>
<tr>
<td>University business incubators (UBIs)</td>
<td>Technology business incubators</td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td><strong>Factors</strong></td>
<td><strong>Factors</strong></td>
</tr>
<tr>
<td><strong>Prohibiting factors</strong></td>
<td><strong>Prohibiting factors</strong></td>
</tr>
<tr>
<td>• Insufficient financial support to help successful spin-offs expand their operations or market their innovations abroad.</td>
<td>• Insufficient professional networking services particularly connections with the industrial sector to help the incubating firms develop and market their product innovations.</td>
</tr>
<tr>
<td>• Many UBIs have complaints about the low level of budget support from the government. Therefore, in practice, they tend to select the companies that have profit potential so that the UBIs could receive continuing budget support from the Office of the Higher Education Commission.</td>
<td>• Lack of alternative financial support such as venture capital financing to support SMEs.</td>
</tr>
<tr>
<td>• The incubator managers mention that they need more budget support from other sources to enable them to support start-up firms in developing new product innovations.</td>
<td>• Low publicity of the incubation program. Many interviewees comment that the incubation program is not well informed to the public. The lack of awareness of the program prohibits potential firms from joining the program.</td>
</tr>
<tr>
<td>• At present, many incubating firms cannot generate revenues back to the incubator or the university. Such inability to generate revenue streams and profits has hampered the growth of the incubator program as the university sees no potential of profitable opportunities to support UBI operation.</td>
<td>• Lack of clear policies and program objectives including the intellectual property (IP) policy for revenue and cost sharing purposes. The major problems also include inconsistencies of policies to support SMEs due to frequent changes of government.</td>
</tr>
<tr>
<td>• Many incubator managers comment that the structure of running the incubator program should be independent from that of the university operation. The independent structure and operation would enhance the effective operation of the incubator program since it is independent of the university policies. At present, the UBI operation and its ability to seek additional financial support are constrained by the university policies.</td>
<td>• Lack of resources and managerial skills to manage technology business incubators.</td>
</tr>
</tbody>
</table>
Figure 1 Schematic presentation of technology incubator

Source: OECD (1997)
Figure 2  The development of Triple Helix model: Comparison of the old and new models


Note: The arrow in Figure 2 shows the sequence of Triple Helix model development from the old model to the new model. It explains the progress or development from the old model (representing weak linkages and interactions among the institutions) to the new model (emphasizing strong linkages and interactions among the institutions).
Figure 3  Major government policies to support SME development in Thailand

<table>
<thead>
<tr>
<th>Period</th>
<th>Main Policies/strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960s</td>
<td>The government policies focused on import substitution industrialization</td>
</tr>
<tr>
<td>1970s</td>
<td>The government policies focused on export oriented industrialization</td>
</tr>
<tr>
<td>1990s</td>
<td>Thaksinomics policies and major SME policies to support entrepreneurship and revival of SMEs</td>
</tr>
<tr>
<td></td>
<td>• National Economic and Social Development Plan SME Promotion Master Plan</td>
</tr>
<tr>
<td>2000s</td>
<td>Policies focused on enabling Thailand to move out of a middle income trapped economy towards higher income status</td>
</tr>
<tr>
<td></td>
<td>• National Economic and Social Development Plan (Years 2012-2016)</td>
</tr>
<tr>
<td></td>
<td>• The first SME Promotion Master Plan (Years 2002-2006)</td>
</tr>
<tr>
<td></td>
<td>• The second SME Promotion Master Plan (Years 2007-2011)</td>
</tr>
<tr>
<td></td>
<td>• The third SME Promotion Master Plan (Years 2012-2016)</td>
</tr>
<tr>
<td></td>
<td>• The Bank of Thailand Financial Sector Master Plan II (Years 2010-2014) as a national entrepreneurship policy</td>
</tr>
</tbody>
</table>

Source: The author’s design
Figure 4  Connections of the theoretical framework and the case study analyses

**Theoretical framework – Triple Helix Model**

- Industry
- Government
- University
- Research institution

**Case study analyses**

- Section 3. Government policies to support SME development and technology commercialization
- Section 4. Analyses of the operations of major university business incubators and technology business incubators to enhance technology commercialization in Thailand

Section 5 Model of university technology commercialization in Thailand
Figure 5 Model of university technology commercialisation in Thailand

Source: The author’s design
Highlights

- The study models the process of university technology commercialization
- Incubators should act as intermediary for effective utilization of university research
- The findings fill the gap in the innovation policy studies – government policies to support technology commercialization.
- Technology clusters are established in attempts to emulate Silicon Valley success
- The study provides implications on the move towards the entrepreneurial university