TECHNOLOGY TRANSFER AND SUCCESS FACTORS OF SMES FOOD INDUSTRY IN THAILAND: AN EXPLORATORY STUDY

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Abstract - Technology transfer is one of the tools to enhance productivity and efficiency of businesses, thus increases competitiveness. SMEs regularly rely on the external sources of technical and technological assistances. This study aims to explore and identify factors and indicators that affect the success of technology transfer projects in Thai's SMEs. From literatures, the External factor, the Strategic and Management factor, the R&D factor, the Technological and Manufacturing factor, the Marketing factor, and the Human Resource factor were outlined. A group of SMEs was interviewed, and results showed positive consensus on all factors. The interviews also revealed new factors, included an ability to find the right solution for marketing needs, an ability to understand scientific and technical elements in actual patents, and an ability to translate patent's technical data to actual production.

Keyword - Food Industry, SMEs, Technology Transfer

I. INTRODUCTION

In the past, Thailand's economic development models emphasis on agriculture (Thailand 1.0), light industry (Thailand 2.0), and advanced industry (Thailand 3.0) respectively. As a result, Thailand is currently facinga number of economic challenges such as "a middle-income trap", "an inequality trap", and "an imbalanced trap".

In order to unlock the country from those economic challenges and achieve pleasurable economic growth rate, Thai government launches Thailand 4.0 policy aimed to create a value-based economy that is driven by innovation, technology and creativity.

The model aims to increase Research and Development expenditure to 4% of GDP, increase economic growth rate to 5-6% within 5 years (BOI, 2017). Together with the12thNational Economic and Social Development Plan (2017 - 2021) (NESDB, 2016), which focuses on utilizing Science, Technology, and Innovation in strengthening economic and industrial growth, Thailand 4.0 model is believed to propel new economic growth through the shift from "comparative advantage" to "competitive advantage". The objective of Thailand 4.0 is to increase the revenue and contribution of SMEs from 37% of total GDP to 50% of national GDP within 10 years.

The Government plans to develop Small and medium sized enterprises (SMEs) through financial support, knowledge and management skills development, enhance digital transformation, and develop open innovation for SMEs. To compete in the global market, SMEs' lack of necessary resources and skills required. These enterprises with low technology capabilities are struggling to make innovative products. Collaboration allows ill-equipped firms to acquire external knowledge and resources from many sources (Spithoven and Knockaert, 2012; O'Reilly and Cunningham, 2017).Collaborative R&D is regarded as a significant driver of firms' innovation performance (Belderbos et al., 2004, 2015).

A study by Shane (2002) categorized university-entrepreneurial firm collaboration into 4 dimensions: (1) contract research, (2) consulting, (3) technology licensing, and (4) technology development and commercialization. Contract research is the most common form of collaboration in Thailand. According to Thailand's National Science and Technology Development Agency (2016), in 2015, 235 researches were licensed from NSTDA. But those licensed researches accounted for 2% of NSTDA's total revenue.

This information suggests that the technology transferred could not fully translate into a fruitful product. And while the number of IPs registered is growing every year, the licensing and commercialization revenue is not growing proportionally.

To achieve better technology transfer outcome, we need to bridge the gap between transfer agent and transfer recipient. Reviews of previous researches indicate several factors that impact technology transfer process. These factors include influence from external institutes, firms' strategic and management factors, research and development factors, technological and manufacturing factors, marketing factors, and human resources factors.

A. Purpose

The study aims to explore and identify factors and indicators that affect the success of technology transfer projects from Government's research institutes to SMEs in food industry in Thailand as perceived by the recipients. As a result, the underlying indicators shall be revealed and highlighted.

II. LITERATURE REVIEWS

In order to conceptualize the framework of this study, the literatures in Entrepreneurial and SMEs Development, Technology Transfer, and Knowledge Management are thoroughly reviewed as follows;

A. Entrepreneurial Development

Small and medium sized enterprises (SMEs) encounter unique research and innovation challenges. The scarcity of necessary resources (including technological expertise, financial, infrastructure, and human resources)limits the innovation capability of SMEs (Spithoven and Knockaert, 2012; Love and Roper, 2015). O'Reilly and Cunningham (2017) suggests that SMEs may acquire access to the resource essential for innovation. Shane (2002) studies and categorizes the collaborations between universities and firms into (1) contract research, (2) consulting, (3) technology licensing, and (4) technology development. The result indicates that entrepreneurial firms are interacting with university differently from those larger firms.

B. External influence on firm's technology competency

In previous researches, various external factors were confirmed to be influential in developing firms' technological capabilities; those factors included government's policy on specific industry, government support, country's trade system, supply chain and infrastructure, current market status, and growth potential (Panda and Ramanathan, 1996; Hemmert, 2004) A study by Bessant and Rush (1995) also found that the role of intermediaries such as technology licensing offices was critical in technology transfer process. The study (EU, 2016) suggested that, by linking main participants, intermediaries or mediators play important role in knowledge and technology transfer process. Intermediaries and other support units were also found to have influence on development of innovation capabilities of micro, small and medium enterprises (MSMEs) and have important role in stimulating new business formations (Rogers et al., 2001; Liu et al., 2013).

C. Strategic and Management

Many strategic and management related factors could affect firm's technological development capabilities (Panda and Ramanathan, 1996) Organizational factors such as firm's policy and strategy, firm's structure, executives commitment, organization culture, and organization size were recognised as firm's technology performance (Premkumar and Ramamurthy, 1995; Panda and Ramanathan, 1996; Bozeman, 2000; Cohen, 2004) Learning and communication factors, such as knowledge management, firm's network of experts, and communication within organization and between stakeholders, were also reported to be affect organization's capability to acquire technology (PremkumarandRamamurthy, 1995; Rogers et al., 2001; Takata, 2011; Markarian, 2016).

Various studies found that firm's ability to acquire and assimilate knowledge is directly influence organization's technology readiness and performance (Galy, 2003; Ford et al., 2012; Cooper and Molla, 2014). Zahra and George (2002) and Martin et al. (2003) went further to address that firm's absorptive capacity was consist of 4 elements: Acquisition, Assimilation, Transformation, and Application. In the study of firms' technological absorptive capacity development , Rush et al. (2007) concluded that there are four types of organization; Unaware - not responsive to the changing world, Reactive - able to sense the technology trend and can adapt accordingly, Strategic - can predict or foresight the change and has a strategic plan to cope with the challenges, and Creative - risk takers, has significant absorptive capability and can utilize technology in business context to achieve competitive advantage.

D. Research and Development

Research and Development resources are critical to the success of technological innovation projects (Rogers et al., 2001; Spithoven and Knockaert, 2012; Matzmorr, 2016). In order to finish technology transfer project, firms need to have sufficient R&D expenditure and adequate internal resources (Hemmert, 2004; Hu et al., 2005; Okamuro et al., 2011). Firms' R&D intensity is confirmed to be an important success factor by a number of studies (Autio and Laamanen, 1995; Hu et al., 2005; Maietta, 2015). Wang et al. (2008) also points out that firm's R&D innovativeness has an impact on knowledge transfer and technology cooperation. Additionally, educated and experienced R&D personnel are proved to be significant in technology transfer process (Rogers et al., 2001; Hemmert, 2004; Matzmorr, 2016).

E. Technological and Manufacturing

Manufacturing capabilities are considered to be the crucial part of firms' technological development (Guan and Ma, 2003; Yam et al., 2004). For technological knowledge transfer to be success, "Knowledge Distance" is a crucial factor (Cummings and Teng, 2003). If the distance or "gap" between the source and the recipient is excessive, it will require both parties to overcome too many learning steps.

Some scholars proposed that, should both parties have some alignment and overlapping areas in term of knowledge and expertise, the transfer process will be more likely to be successful (Hamel, 1991; Nonaka and Takeuchi, 1995; Inkpen and Dinur, 1998). Parasuraman (2000) also suggest that, for technology transfer project to be sustainable, the recipient should have an ability to cope with complications and issues from adopting new technology.

Firms' capability to effectively manage cross-functional projects also regarded as an important success factor for R&D knowledge transferring (Cumming and Teng, 2003; Matzmorr, 2016). Additionally, a research by Wang et al. (2008) suggests that product cycle time and product delivery time is directly impact firms' technological innovative capability.

F. Marketing

Marketing capabilities are crucial for the success of technology transfer process (Wang et al., 2008.) Firm's capability to develop a competitive new product in the marketplace is critical for firm to turn technology into profitable commercial goods (Wang et al., 2008).

Bozeman (2000) and Wang et al. (2008) cites firm's ability to foresight and satisfy market needs by utilizing technology as important attribute. Moreover, market attractiveness altogether with suitability of marketing channel are vital for commercialization of new technology product (Heslop et al., 2001).

G. Human Resource

Previous studies have indicated that human resources are the key element for technology or knowledge transfer (Lehman et al., 2002). Essential human resource aspects include staff attributes, staff motivation, willingness to use technology (Lehman et al., 2002; Richey et al., 2007).

Parasuraman (2000) also defines people's desire or hesitation to embrace and use new technology as a critical factor that influence firms' technology readiness. Van der Heiden et al. (2015) stresses that technology transfer is directly affected by employees' education level and training on related technology issues.

III. METHODOLOGY

To answer the research questions, in-depth interviews were conducted. The participants were purposively selected from a list of SMEs in food industry, from materials supplier to manufacturer, that have production activities and have successfully transferred the technology from government research institutes. The interviewees are in the position that oversee or directly involved in the technology transfer process. For business secrecy reason, the organizations participated in this study shall remain anonymous. The related attributes of each organizations are shown in table 1.

Table 1. Attributes of the participants.

	Company A	Company B	Company C	Company D	Company E	Company F
Nature of Business	Ingredient supplier	Specialized ingredient supplier	Beverage manufacturer	Bakery	Processed foods	Processed foods
Manufacturing Capability	ODM	OBM	OEM	ODM	ODM	OEM
Type of Technology	New Product Development - Contract research	TechnologyLicensing	New Product Development - Consulting	Process Improvement - Consulting	New Product Development - Contract research	Process Improvement - Consulting
Number of Employee	180	120	150	50	140	100
Owns R&D Department	Yes	Yes	Yes	No	Yes	Yes
Technology Transfer Project Owner	No	Yes	No	No	Yes	No

IV. RESULTS

Table 2. Participants' opinions toward influential factors gathered from literatures

Factors	Participants opinions,where 1 = Least Influential and 5 =Most Influential						
	A	B	C	D	E	F	Factor Average
External Factors							
Government's policy regarding the Industry	5	5	5	5	5	5	5
Policy regarding Technology Transfer of the research institutes	5	5	5	5	5	5	5
Accessibility of patents database	5	3	5	5	5	5	4.67
Technology Licensing Office	5	5	5	5	5	5	5
Business mentoring from research institutes	5	3	5	5	5	5	4.67
Supporting services from other institutes	5	5	5	5	5	5	5
Company Average	5	4.33	5	5	5	5	
Strategic and Management Factors							
Organization characteristics	5	5	5	5	5	5	5
Openness	5	5	5	5	5	5	5
Support from executives	5	5	5	5	5	5	5
Communications	5	5	5	5	5	5	5
Understanding of IP exploitation	5	5	5	3	5	5	4.67
Company Average	5	5	5	4.6	5	5	
R&D Factors							
R&D resources	5	5	5	5	5	5	5
Level of firm's innovativeness	5	5	5	5	5	5	5
R&D intensity	5	5	5	5	5	5	5
Company Average	5	5	5	5	5	5	
Technological and Manufacturing Factors							
Level of firm's existing technology	5	5	5	5	5	5	5
Firm's capability of project management	5	5	5	5	5	5	5
Timeframe of production cycle	3	5	5	3	5	5	4.33
Company Average	4.33	5	5	4.33	5	5	
Marketing Factors							
Firm's ability to develop new product	5	5	5	5	5	5	5
Firm's ability to analyze business and market	5	5	3	5	5	2	4.17
Firm's ability to construct market strategy	5	5	2	5	5	2	4
Company Average	5	5	3.33	5	5	3	
Human Resource Factors							
Personnel characteristics	5	5	5	5	5	5	5
Training	5	5	3	5	3	2	3.83
Personnel relationship	5	5	5	5	5	5	5
Change management	5	3	5	5	5	5	4.67
Company Average	5	4.5	4.5	5	4.5	4.25	

Table 2 summarizes the opinions of participants toward the factors and indicators obtained from the literature review. The feedbacks from the interviews for each indicator were registered from 1 to 5, where 1 means the interviewer considered the indicator to be of least influential to the success of technology transfer and 5 means the indicator is conceived to be most influential. The interview results showall participants' approval of factors in all areas, despite some reservations. For the External factor, Company B, which supplies specialized ingredients to food manufacturers, claimed that they gained better access to patent information through a network of researchers than from the database. And given their specialized technical background, Company B also found business mentoring not to be much useful for their business; however, they concurred that business mentor would be advisable for other entrepreneurs. For the Strategic and Management factor, Company D, a bakery shop, argued that, given their relatively small size and product offering, they would not consider IP exploitation to be the influential factor, but agree that it might be significant for bigger business. For the R&D factor, every interviewee strongly agreed with all factors. For Technological and Manufacturing factor, Company A, a general ingredient supplier, and Company D, argued that for their conventional business approaches, the product cycle time was put in considerationbut not the essential concern in their projects. For Marketing factor, Company C and Company F, both are OEM manufacturers, declared that business and marketing features were not considerable since they did not have any control of product's marketing (both rated marketing factors at 3.33 and 3, respectively). But both companies agreed that it would be valuable in the future. Finally, for Human Resource factor, Company C, Company E, and Company F, all admitted the importance of personnel training but reserved that small-scaled training would be more suitable for their business. While Company B considered change management to be critical in the project level.

New factors

From the interviews, the interviewees occasionally referred to factors that were not mentioned in previous literatures. Those factors include an ability to find the right solution for marketing needs, an ability to understand scientific and technical elements in actual patents, and an ability to translate patent's technical data to actual production.

CONCLUSIONS

This study shows SMEs' opinion towards success factors of technology transfer process. All participants agree that external factor, strategic and management factor, research and development factor, technological and manufacturing factor, marketing factor, and human resource factor are important success factor. New factors also emerge from interviews: include an ability to find the right solution for marketing needs, an ability to understand scientific and technical elements in actual patents, and an ability to translate patent's technical data to actual production. This provides better understanding of the technology transfer process from the government research institutes to food SMEs in Thailand. These factors will be valuable for policy makers in formulating technology and innovation driving strategy. The operational agencies, including SME Bank and NSTDA, also benefit from this information to resource allocation. As for future research, this study should extend the data collection to a broader group of Thai food industry. An exploratory quantitative method shall be conducted. A comprehensive list of factors and indicators can be used to develop a tool for assessment and evaluation of SMEs' characteristics for successful technology transfer to increase competitiveness.

REFERENCES

[1] Autio, E., & Laamanen, T. (1995). Measurement and evaluation of technology transfer: review of technology transfer mechanisms and indicators. International Journal of Technology Management, 10(7-8), 643-664.

[2] Belderbos, R., Carree, M., &Lokshin, B. (2004). Cooperative R&D and firm performance. Research policy, 33(10), 1477-1492.

[3] Belderbos, R., Carree, M., Lokshin, B., &Sastre, J. F. (2015). Inter-temporal patterns of R&D collaboration and innovative performance. The Journal of Technology Transfer, 40(1), 123-137.

[4] Bessant, J., & Rush, H. (1995). Building bridges for innovation: the role of consultants in technology transfer. Research policy, 24(1), 97-114.

[5] Bozeman, B. (2000). Technology transfer and public policy: a review of research and theory. Research policy, 29(4), 627-655.

[6] Cohen, W. M. (2004). Patents and Appropriation: Concerns and Evidence1. The Journal of Technology Transfer, 30(1-2), 57-71.

[7] Cooper, V. A., &Molla, A. (2014). Absorptive capacity and contextual factors that influence green IT assimilation. Australasian Journal of Information Systems, 18(3).

[8] Cummings, J. L., & Teng, B. S. (2003). Transferring R&D knowledge: the key factors affecting knowledge transfer success. Journal of Engineering and technology management, 20(1), 39-68.

[9] European Union. (2016). "Report on National Understanding of Transfer Processes and Reference Model of Transnational Transfer". EU.

[10] Ford, S. J., Mortara, L., & Probert, D. R. (2012). Disentangling the complexity of early-stage technology acquisitions. Research-Technology Management, 55(3), 40-48.

[11] Galy, E. (2003). The mediating role of organizational learning between absorptive capacity and performance in companies employing enterprise resource planning software. Doctoral dissertation, The University of Texas - Pan American.

[12] Guan, J., & Ma, N. (2003). Innovative capability and export performance of Chinese firms. Technovation, 23(9), 737-747.

[13] Hamel, G. (1991). Competition for competence and interpartner learning within international strategic alliances. Strategic management journal, 12(S1), 83-103.

[14] Hemmert, M. (2004). The influence of institutional factors on the technology acquisition performance of high-tech firms: survey results from Germany and Japan. Research Policy, 33(6), 1019-1039.
[15] Heslop, L. A., McGregor, E., & Griffith, M. (2001). Development of a technology readiness assessment measure: The cloverleaf model of technology transfer. The Journal of Technology Transfer, 26(4), 369-384.
[16] Hu, A. G., Jefferson, G. H., &Jinchang, Q. (2005). R&D and technology transfer: firm-level evidence from Chinese industry. Review of Economics and Statistics, 87(4), 780-786.
[17] Inkpen, A. C., &Dinur, A. (1998). Knowledge management processes and international joint ventures. Organization science, 9(4), 454-468.
[18] Lehman, W. E., Greener, J. M., & Simpson, D. D. (2002). Assessing organizational readiness for change. Journal of substance abuse treatment, 22(4), 197-209.
[19] Liu, X., Shou, Y., &Xie, Y. (2013). The role of intermediary organizations in enhancing the innovation capability of MSMEs: evidence from a Chinese case. Asian Journal of Technology Innovation, 21(sup2), 50-61.
[20] Love, J. H., & Roper, S. (2015). SME innovation, exporting and growth: A review of existing evidence. International small business journal, 33(1), 28-48.
[21] Maietta, O. W. (2015). Determinants of university–firm R&D collaboration and its impact on innovation: A perspective from a low-tech industry. Research Policy, 44(7), 1341-1359.
[22] Markarian, J. (2016). Technology transfer connections: transferring the manufacturing of a drug from one scale to another or between manufacturing sites presents both technical and business challenges. Pharmaceutical Technology, (4). 20.
[23] Matzmorr, W. (2016). Planning a biologics facility start up: integrating quality and compliance with technology transfer and careful project management are key in starting up a facility and launching a biologic drug. Pharmaceutical Technology, (7). 60.
[24] National Science and Technology Development Agency. (2017). "Annual Report 2016". Bangkok. NSTDA.
[25] Nonaka, L., Takeuchi, H., & Umemoto, K. (1996). A theory of organizational knowledge creation. International Journal of Technology Management, 11(7-8), 833-845.
[26] Office of The National Economic and Social Development Board. (2016). "The Twelfth National Economic and Social Development Plan (2017 – 2021)", Bangkok, NESDB.
[27] O'Reilly, P., & Cunningham, J. A. (2017). Enablers and barriers to university technology transfer engagements with small-and medium-sized enterprises: perspectives of Principal Investigators. Small Enterprise Research, 24(3), 274-289.
[28] Okamuro, H., Kato, M., &Honjo, Y. (2011). Determinants of R&D cooperation in Japanese start-ups. Research Policy, 40(5), 728-738.
[29] Panda, H., & Ramanathan, K. (1996). Technological capability assessment of a firm in the electricity sector. Technovation, 16(10), 561-588.
[30] Parasuraman, A. (2000). Technology Readiness Index (TRI) a multiple-item scale to measure readiness to embrace new technologies. Journal of service research, 2(4), 307-320.
[31] Premkumar, G., & Ramamurthy, K. (1995). The role of interorganizational and organizational factors on the decision mode for adoption of interorganizational systems. Decision sciences, 26(3), 303-336.
[32] Richey, R. G., Daugherty, P. J., & Roath, A. S. (2007). Firm technological readiness and complementarity: capabilities impacting logistics service competency and performance. Journal of Business Logistics, 28(1), 195-228.
[33] Rogers, E. M., Takegami, S., & Yin, J. (2001). Lessons learned about technology transfer. Technovation, 21(4), 253-261.
[34] Rush, H., Bessant, J., & Hobday, M. (2007). Assessing the technological capabilities of firms: developing a policy tool. R&D Management, 37(3), 221-236.
[35] Shane, S. (2002). Executive forum: university technology transfer to entrepreneurial companies. Journal of business venturing, 17(6), 537-552.
[36] Spithoven, A., &Knockaert, M. (2012). Technology intermediaries in low tech sectors: the case of collective research centres in Belgium. Innovation, 14(3), 375-387.
[37] Takata, M. (2011). Study of the Process of University Technology Commercialization: The Roles and Effects of Educational Courses. International Journal of Engineering Innovation and Management, 1(1), 15-28.
[38] Thailand Board of Investment. (2017). "ThailandInvestment Review", 27 (1), Bangkok, BOI.
[39] van der Heiden, P., Pohl, C., Mansor, S. B., & van Genderen, J. (2015). The role of education and training in absorptive capacity of international technology transfer in the aerospace sector. Progress in Aerospace Sciences, 76, 42-54.
[40] Wang, C. H., Lu, I. Y., & Chen, C. B. (2008). Evaluating firm technological innovation capability under uncertainty. Technovation, 28(6), 349-363.
[41] Yam, R. C., Guan, J. C., Pun, K. F., & Tang, E. P. (2004). An audit of technological innovation capabilities in Chinese firms: some empirical findings in Beijing, China. Research policy, 33(8), 1123-1140.
[42] Zahra, S. A., & George, G. (2002). Absorptive capacity: A review, reconceptualization, and extension. Academy of management review, 27(2), 185-203.

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