Factors affecting Technology transfer performance in the Petrochemical Industry in Thailand: A Case study

ปัจจัยที่ส่งผลต่อประสิทธิภาพของการถ่ายทอดเทคโนโลยีใน อุตสาหกรรมปิโตรเคมี: กรณีศึกษา

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Abstract

The Petrochemical Industry in Thailand relies on the importance of technology transfer from the more advanced companies in order to develop its production process and competitive ability. However, technology transfer from one country to another country or from one company to another relies on several factors regarding technology sender and recipient. These factors clearly affect the effectiveness of technology transfer. Therefore, this research study aims to investigate the factors influencing the performance of technology transfer in the petrochemical industry in Thailand. This study is a quantitative study using questionnaires as a tool to collect data. Data is analyzed through the Exploratory Factor Analysis (EFA) technique and the Structure Equation Model (SEM). The research findings shows that the crucial factors influencing the performance of technology transfer are: 1) absorptive capacity, 2) partner characteristics, 3) the complexity of technology, and 4) inter-organizational relationships. These factors are grouped into two groups, namely human-oriented factors and technology-oriented factors. This research contributes to a better understanding of technology transfer in the pharmaceutical industry context. These findings can be used as the basis for technology transfer process development in Thailand.

Keywords: Technology transfer; licensing; petrochemical industry

Paper Type: Research

บทคัดย่อ

อุตสาหกรรมปิโตรเคมีของประเทศไทยได้รับการถ่ายทอดเทคโนโลยีสมัยใหม่ที่สำคัญจากต่างประเทศเพื่อพัฒนากระบวนการผลิตและสร้างความสามารถในการแข่งขัน แต่อย่างไรก็ตามการการถ่ายทอดเทคโนโลยีจากประเทศหนึ่งไปยังอีกประเทศหนึ่งขึ้นอยู่กับปัจจัยหลายประการโดยเฉพาะปัจจัยที่เกี่ยวกับผู้ให้และผู้รับการถ่ายทอดเทคโนโลยี ซึ่งปัจจัยต่างๆเหล่านี้จะส่งผลต่อประสิทธิภาพของการถ่ายทอดเทคโนโลยี ดังนั้นงานวิจัยในครั้งนี้จึงมีวัตถุประสงค์เพื่อศึกษาปัจจัยที่ส่งผลต่อประสิทธิภาพในการถ่ายทอดเทคโนโลยีการผลิตในอุตสาหกรรมปิโตรเคมีของประเทศไทย การศึกษาในครั้งนี้เป็นงานวิจัยเชิงปริมาณ ซึ่งใช้แบบสอบถามเป็นเครื่องมือในการเก็บรวบรวมข้อมูล วิเคราะห์และประมวลผลโดยใช้เทคนิคการวิเคราะห์องค์ประกอบเชิงสำรวจ (Exploratory Factor Analysis: EFA) และ โมเดลสมการเชิงโครงสร้าง (Structure Equation Model: SEM) ผลการศึกษาพบว่าปัจจัยที่ส่งผลต่อประสิทธิภาพในการถ่ายทอดเทคโนโลยีประกอบด้วย ปัจจัย 4 กลุ่ม ได้แก่ 1) ความสามารถในการดูดซับความรู้ 2) ลักษณะของผู้ถ่ายทอดเทคโนโลยี 3) ความซับซ้อนของเทคโนโลยี และ ความสัมพันธ์ระหว่างองค์กร ผลจากการวิจัยในครั้งนี้ทำให้เข้าใจการถ่ายทอดเทคโนโลยีในบริบทของอุตสาหกรรมปิโตรเคมีมากขึ้นและสามารถนำไปใช้เป็นแนวทางในการพัฒนากระบวนการในการถ่ายทอดเทคโนโลยีให้มีประสิทธิภาพเพิ่มมากขึ้น

1. Introduction

A sharp increase in business transactional competition at both organizational and national levels, including the rapid change and expansion of technological advances, distresses organizations that use technology as a developmental tool. Those organizations must frequently revise and adjust their strategies so that they are consistent with changes in the business transactional environment (Daghfous, 2004). Development of knowledge and technology, including good management, became crucial instruments in building up competitive advantages among organizations (Lee & Wu, 2010); however, technological development is very expensive due to several factors such as natural resources, capital, knowledge, capability and experts. It is likely to be time-consuming and risks unsuccessful outcomes. As a result, applying advanced technology is a significant means of mitigating against this for unready organizations (Siti Aishah and Othman, 2011; Liu, 2006; Lin and Berg, 2001). In developing countries, the development of technology transfer is vital for industrial and economic growth, especially those spontaneously growing countries in Asia such as China, Sri Lanka, Myanmar and Thailand (Waroonkun and Stewart, 2008).

Petrochemical Industry is one of the most important primary industries to Thailand's economic development and has a significant effect on the development of the country directly and indirectly (Industrial Economic Conditions in 2015 and Outlook for 2016). It is a fundamental industry that expands and adjusts its strategies to serve social demands and it is the industry which relates to numerous other industries for example, plastic and container, packaging, spare parts, electronic parts, textile, rubber, construction, etc. (Department of Alternative Energy Development and Efficiency, 2016; Plastic Intelligence Unit, 2011). Petrochemical Industry is important because it is a resource of continuous development, that is, it starts bringing the elements or raw materials of automobile and computer industries into industrial processes and uses them for the production of the basic products necessary for human beings (Lueprasithikul, 1992; The Office of Industrial Economics, 2015). At present the Petrochemical Industry has dramatically expanded and is demanded at both regional and national levels (BASF, 2013). This type of industry needs scientific and technological knowledge. As competitive advantage depends on feedstock imported from foreign countries, a high level of capital is required in the production processes. Additionally, the value added during the production process causes an increase in income and profit, and this is another important factor that must be taken into account. It is obvious that production technology and readiness of raw materials, together with organizational strategies, are crucial to build organizational success. Thailand has still lacked readiness in terms of production technology development; therefore, the petrochemical industry needs to take technology transfer from other foreign countries.

Technology is considered to be one of many factors that help support the overall growth of the economy of a country, especially the developing countries. Therefore, these countries desire access to the transfer of modern technology from the industrial countries in order to apply it to their own context. It is obvious that the petrochemical industry is a fundamental industry, crucial for the economic system of Thailand (The Office of Industrial Economics, 2015), and is the base industry for other industries. There are several forms of international technology transfer, such as direct investment, licensing, joint venture or the movement of persons. Kim and Vonortas (2006) find that licensing is a channel that generates competitive advantages for organizations that lack advanced technology within a context of extreme competition and rapid changes in technology. This creates similar technology profiles and market profiles with the technology owners, and this intellectual property is also legally protected, subject to the contract.

It is certainly the case that the technology can create economic value added. This accords with May (2006), who states that licensing from foreign countries is the purchase of software that is an intellectual property and readily used in production processes, including related services. Moreover, technology transfer within the same country and from other countries differs. There are more factors to be considered in transferring technology from foreign countries due to different working styles and cultures in each country, which stakeholders should be aware of. Furthermore, technology transfer is a complex process that is not always successful as there are many related factors, such as the complex

characteristics of technology itself that are difficult to understand, characteristics of knowledge, capability of technology owners, including the characteristics and learning capability of the transferee. If the transferee cannot learn what transferred through technology, it causes ineffective transfer. In addition, communication and friendship between organizations are also important for technology transfer (Lin and Berg, 2001).

As mentioned earlier, not only does the petrochemical is one of the most important industries, but it is also the industry which depends greatly on advanced technology and highly specific expertise, very much unlike most other industries. It requires for advice and technology transfer from foreign experts which is making the cost very high. Therefore, it is important to study the factors that influence the performance of technology transfer in order to prepare and find out the ways to effectively manage and administer the technology transfer and achieve maximum benefits in the Thai Petrochemical Industry.

RQ: What are the factors that influence the performance of technology transfer?

2. Objective

The purpose of this research is to investigate the factors that influence the performance of technology transfer in production processes, in terms of licensing from foreign countries of petrochemical companies to Thai petrochemical company.

3. Technology Transfer in Petrochemical Industry

3.1. The Petrochemical Industry in Thailand

The petrochemical industry is considered to be different from general industries in three ways: 1) it is an industry that requires advanced technology, 2) it is an industry that requires very high investment, and 3) it is an industry that further affects the other relevant industries (Petroleum Institute of Thailand, 2006). It has been seen that, the petrochemical industry in Thailand has changed its role from the importer to the exporter of plastic beads. It is becoming one of the main plastic bead exporters in Asia and ASEAN. This industry in Thailand is no restriction to entry. Therefore there are many private sectors establishing petrochemical plants, leading to certain types of petrochemical products (Kowasiwarat and Songlork, 2011). These investors are ready to adjust themselves to severe competitions. This drives to the connection of the petrochemical materials, to the middle process materials, until the end of the process materials. They collaborate the work function in terms of business groups both inside and outside the country. Finally, it has been seen that there are only a few big groups of petrochemical businesses in Thailand. This leads to dramatic expansion of Thai petrochemical industry, from simple products to the more various types of products or special grade and more innovative products (The office of Industrial Economics, 2015). As such, the industry requires the modern production technology seen on the world scale to serve the domestic and international market demand. This situation highlights the importance of technology transfer in creating competitive advantage of the petrochemical industry in Thailand, and that the modern technology is indeed needed in order to produce the high volume and high quality petrochemical products for the market.

3.2. Technology Transfer

Technology transfer generally means the operation of sending technology from origin to expected destination, or the transfer of people who facilitates the use of this technology. Depending upon the purpose of technology transfer, this can consist of methods of transferring knowledge, information, data, ideas and regulation to transferees through technological devices, in order to serve a targeted group of people's demands and requirements, and those people can apply the technology and knowledge effectively in their own situations (Williams and Gibson, 1990; Souder et al., 1990; Ramanathan, 1994; Osman-Gani, 1999; Siti Aishah and Othman, 2011). It is also possible to conclude that technology transfer is the movement of technological knowledge, data transformation and know-how, across organizations that have different cultures. This movement is from developed organizations to developing organizations, in order to expand production activities. The technology transfer is successful when the transferees are skilful in the capture, learning, comprehension and application of the received knowledge in product and service production; and equally, when they acquire the same administrative techniques and economic profits as the transferor (Bozeman, 2000; Sazali and Raduan, 2011; Gibson and Raymon, 1991; Williams and Gibson, 1990).

Technology transfer is important for social and economic development (Li-Hua and Khaill, 2006; Chen and

Sun, 2000). Khalil (2000) shows the classifications of technology transfer as follows:

1. International Technology Transfer

This is the transfer of technology from one country to another country. An example is the international company that establishes a branch in Thailand and hence transfers the knowledge concerning the application of technology to Thai employees. As can be seen, this kind of investment is crucial globally and it becomes the main driver for technology transfer, especially from the more developed countries to the less developed countries. International technology transfer is the crucial key for the development of national industry and economy (Chen and Sun 2000).

2. National Technology Transfer

Industry in rural areas requires more technology in the research and development at the lower level than the urban area industry. The technology transfer in this case is frequently the result of support from the government in business and human resources management, which are considered more important for them than for industry in urban areas.

3. Cross-Industry or Cross Sector Technology

This is the transfer of technology between different industries.

4. Inter-firm Technology Transfer

This is the transfer of technology from one organization to another with multiple devices.

5. Intra-firm Technology Transfer

This is technology transfer within one organization, and can be in the form of transfer from one branch to another or from one department to another within the same organization.

Moreover, there are also several transferring channels (see Kinoshita, 1999; Khalil, 2000; Kokko, 1992; Hoekman, Maskus and Saggi, 2004; Wie, 2005; Wang and Blomstrom, 1992):
1) Joint Venture: between two organizations to cooperatively produce products and services, which are responsible or share profits based on investment ratio, 2) Licensing: when the owner of technology allows the licensee to use the technology, based on scope and conditional agreements such as producing, purchasing, using or having for sell without making any new owner over. The purchaser has to pay royalty fees for the technology owner, based on the agreement, and internal administration depends on the purchaser, 3) Franchising: a business process developed by a group of people who have demonstrated that it is a successful business, and transfers the right of business engagement to other people, with the underlying label and services, subject to conditions and standards fixed by the owner, 4) Outsourcing: appointing other people to operate the organizational tasks when the organizations are not themselves ready to use their own resources, 5) Co-research: jointly conduct long-term research and development between industrial sectors, research institutions or universities that have researchers who are knowledgeable and skilled, 6) Turnkey Project: a project where all operational scope and processes, from survey to design and construction, are completed by a single organizer, 7) Foreign Direct Investment: an investment and channel of technology transfer to developing countries, whereby foreign investors use resources and partly administer and control the business in other countries, so as to develop the economy of those countries. This research study aims to study the technology transfer in the form of licensing.

3.3. Factors Affecting Technology Transfer Performance

There are several related research areas that address technology transfer. These include the specification of the scope of technology transfer for maximum benefit; explaining definitions of the technology transfer processes; studying factors affecting the effectiveness and evaluation of technology transfer. There are few studies of holistic factors in all dimensions (transferor, transferee and environment) in terms of both the internal and external factors of the organization of the petrochemical industry in Thai context. According to many studies (e.g., Cohen and Levinthal, 1990; Dogra, Garg and Jatav, 2013; Awang et al., 2013; Fang et al., 2010; Jabar, Soosay and Santa, 2011; Nguyen and Aoyama, 2014; Mohamed et al., 2012), it can be concluded that there are four categories of factors that influence the success of technology transfer: 1) absorptive capacity, 2) partner characteristics, 3) the complexity of technology and 4) inter-organizational relationships.

3.3.1 Absorptive capability

Absorptive capability is ability to recognize the value of new information, assimilate it, and apply it to commercial ends (Cohen and Levinthal, 1990). This ability

could create new knowledge and transfer and exploit existing and shared knowledge by integrating external knowledge and prior knowledge (Lane and Lubatkin, 1998). The absorptive capacity allows access to knowledge outside the company, bridging information between an organizations internal and external staff (Dogra, Garg and Jatav, 2013; Easterby-Smith et al., 2008, Jones, 2006). Many studies show that absorptive capability has a significant impact on the performance of technology transfer (e.g., Argote and Ingram, 2000; Awang et al., 2013; Fang et al., 2010; Jabar, Soosay and Santa, 2011; Mahboudi and Ananthan, 2010; Teece, 2000; Siegel et al., 2003; Smith and Sharif, 2007). It is an ability to identify, understand and imitate the core technology and knowledge of the partners. (Grant, 1996; Zahra and George, 2002).

3.3.2 Partner characteristics

There are many research studies that show that technology transferor and technology receiver have significant influence on technology transfer. Purushotham, Sridhar and Sunder (2013) found that the technology transferor and the technology receiver are the key to successful technology transfer. Schlie et al. (1987) demonstrate that characteristics of transferor and transferee can influence the absorptive capacity. Ganesan and Kesley (2006), Malik (2002), Mohamed et al. (2012) and McBeath and Ball (2012) express that a significant factor in the success of technology transfer is a willingness of transferor and transferee to transfer technology and apply the transferred technology in other tasks. Lin and Berg (2001) also state that an experienced transferor who has worked in foreign countries also affects the quality of technology transfer. This idea is consistent with Waroonkum and Stewart (2008) who's finding (based on the study of technology transfer processes in a construction project in Thailand, that transferred technology from a foreign country) state that the characteristics of transferor are the willingness to transfer technology, technology transfer experience, their managerial processes and a basic knowledge influencing on successful technology transfer. Jafari et al. (2014) also support the view that experience, expertise and knowledge relating to technology directly affects the success of technology design and transfer. Moreover, Balas and Elkin (2013) express that the technology transfer capability of the technology owner is necessary, and the willingness of the transferor enables knowledge to be extended independently. Mahboudi and Ananthan (2010) also state that one of the major criteria for technology transfer is organizational criterion, which are the factors relative to technology recipient. In the context of petrochemical industry, Mohaghar et al. (2012) explore that technology transferring is affected with technology provider.

Furthermore, Wang, Tong and Koh (2004) and Malik (2002) studied the technology transfer from transnational to subsidiary companies in China. They found that the success of technology transfer depends on two factors: capability and the willingness of the transferor and the transferee. Working experience with foreigners of the transferor and the transferee, technology and transferring knowledge and infrastructure system are also factors encouraging effective transfer of technology (Waroonkun and Stewart, 2008). Moreover, proper managerial administration in terms of resources, working systems and problem solving methods also lead to effective technology transfer (Dogra, Garg, and Jatav, 2013; Mohamed et al., 2012; Nguyen and Aoyama, 2014).

3.3.3. The complexity of technology

According to the related research, Mohamed et al. (2012) express that the environment, such as government policy, is a holistic factor of the country and affects technology transfer. It causes interaction between technological transferor and transferee, including complexity of technology. In contrast, Liu (2006) claims that the transferring environment is a life cycle of industry and affects the success of technology transfer. It consists of 1) complexity of technology (Mohamed et al., 2012). Waroonkun and Stewart (2008) say that technology transfer is a tough process because it uses the tacit knowledge. The more complex the technology is, the longer time duration is spent, the more expertise required and the more capital used for the transfer. Lin and Berg (2001) also support the view that technology transfer is a complex process. Tanaka (1992) studied technology transfer in the petrochemical industry and explored that technology level is one of the affecting factors to technology transfer, 2) Government support: the governments of developing countries support the technology transfer because it is a development of industrial advance in the country.

3.3.4. Inter-organizational relationships

Good interaction and communication between organizations influences knowledge and technology transfer (Distanont et al., 2012). Waroonkun and Stewart (2008) express that the communication between the transferor and transferee is extremely important for technology transfer. This relies on both a willingness to communicate and on trust between communicators. Chen et al. (2014) and Distanont et al. (2012) state that trust usually results in a willingness to transfer technology and in knowledge absorption; moreover, it is produced when administrators of both parties – transferor and transferee –observe the agreement (Black, Akintoye and Fitzerald, 2000). Responsibility and honouring promises are vital for technology transfer between several countries, particularly as it is based on specific technical knowledge, working methods and problem solving methods. The administers must continuously give priority to transferring processes, both before and after the transferring processes, even though they do not directly relate to the technology transfer (Nguyen and Aoyama, 2014; Mohamed et al., 2012; Waroonkun and Stewart, 2008). In addition, Lucas (2006) finds that increasing the effectiveness of technology transfer from the international investors depends on the relationship between the technology sender and recipients. Tanaka (1992) also states that relationship between companies is important for performance of technology transfer performance in the petrochemical industry.

3.4. The performance of technology transfer

The performance of technology transfer can be evaluated by many methods. Waroonkun and Stewart (2008) evaluated technology transfer from three aspects: 1) economic growth, 2) increasing knowledge and 3) the effectiveness of the project based on financial figures; finishing the project within the due date; and project's quality. Additionally, Mohamed et al. (2012) evaluated success from two aspects: 1) economic benefits – competition advantages, holistic financial advantages and effectiveness, and 2) increasing knowledge. Jafari et al. (2014) evaluated the success from the increase in turnover and market share, product development and quality adjustment. Daghfous (2004) states that the technological transferee needs a learning system. Technology transfer is a learning process, and its effectiveness is evaluated by an increase in the quantity of work, customer satisfaction and an increase of market share. It also gives inadvertent advantages such as increases in technological knowledge, learning within partnership, better project administration and an increase in learning opportunities. In this research study there are two indicators of the success of technology transfer, namely economic advantages and knowledge increase advantages.

3.5. Research Model

According to the literature reviews, most of the factors influencing technology transfer performance relate to people, technology, the capacity to transfer in terms of absorptive capacity, and the context which is relates to organizations or relationships among people within and between organizations. In addition, in terms of the transfer of knowledge, Distanont et al. (2014) classified factors that are challenges to knowledge transferred into three groups, namely the human group, which is related to transferor and transferee of knowledge; the process group, which relatives to transfer mechanism; and the context group, which is related to organization. Mahboudi and Ananthan (2010) state that the effective factors on technology transfer are classified in to seven groups, namely organization, absorption and application, structure, culture, infrastructure, global factors and technology. This research classifies the factors influencing the performance of technology transfer into four categories, based on previous studies and the context of the case study: 1) absorptive capacity, 2) inter-organizational relationships,

3) partner characteristics, and 4) technology complexity.

The aforementioned research model can be developed as shown in Figure 1 and the hypothesis is presented below.

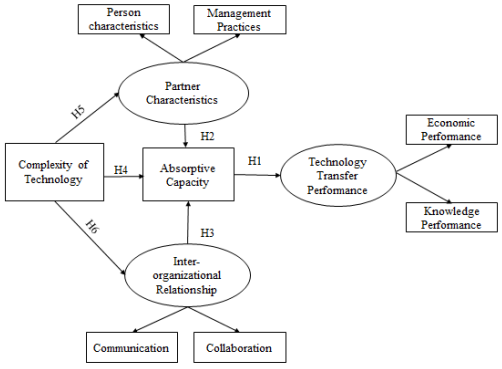

Fig.1. Research Model

- Hypothesis 1. Absorptive capacity has a significant influence on the performance of technology transfer.
- Hypothesis 2. Partner characteristics have a significant influence on absorptive capacity.
- Hypothesis 3. The inter-organizational relationships have a significant influence on absorptive capacity.
- Hypothesis 4. The complexity of technology has a significant influence on absorptive capacity.
- Hypothesis 5. The complexity of technology has a significant influence on partner characteristics.
- Hypothesis 6. The complexity of technology has a significant influence on the inter-organizational relationships.

4. Research Methodology

This research study is a quantitative study aiming to investigate the factors influencing the performance of technology transfer in the Petrochemical Industry in Thailand. The unit of analysis of this research is the technical staffs who are working in relation to the technology transfer process in the case company. The case company in this research is Thailand's largest petrochemical company. The instrument employed in this research is the questionnaire, developed from the primary questionnaire under the research framework and variables, so that the data obtained is in accordance with research purposes. The questionnaire is validated through Index of Item Objective Congruence (IOC) and the reliability is tested through Cronbach's Alpha. The number obtained from IOC, from three experts in the organization, shows IOC to be higher than 0.5. Then, the reliability is tested through a pilot test with the group that possesses the qualification similar to the samples. There are in total 30 sets of questionnaires tested and the Cronbach's Alpha gained is 0.935.

Statistical techniques were used to analyze the survey data in order to test the hypotheses. These techniques included exploratory factor analysis (EFA) and structural equation modeling (SEM). The determination of appropriate sample size is a critical issue in SEM. Previous studies suggested that the minimum sample size for SEM approach should be greater than 200 (Golob, 2003; Hussey and Eagan, 2007). Thus, the questionnaires are distributed to all 328 technical staff in the case company. The return rate is 64.63% (212 of 328).

EFA is used for testing the appropriateness and the structure of relations of the theoretical framework, which is the assumptions testing correlation shows that each factor is independent to each other. With Varimax rotation, the results are illustrated in Figure 2. This is followed by a stage of testing the direct and indirect affects and influences. Testing the logic relation in the form of multivariate analysis is using SEM technique. It is the analysis for the appropriateness of the model (Goodness-of-Fit) between empirical model and theoretical model so that the most appropriate model can be obtained for the case study. After that, the in-depth interviews with three organizational executives were conducting in order to suggest the policy.

5. Results

The results of factor analysis are from EFA where the principles are: 1) the Eigen Value of each factor must be above 1, and 2) Factor Loading must be higher than 0.5.

The objective in the stage of survey factor analysis is to see the relationships of factors that affect the performance of technology transfer. Additionally, using the survey factor analysis with principle component analysis method, which is the most acceptable option for extract the main component and use varimax rotation method with the consideration with statistic values as KMO (Kaiser-Meyer-Olkin Measure of Sampling Adequacy), Approx. Chi-Square, Total Variance Explained and Sig. as shown in Table 1.

Table 1 Results of EFA Analysis

Factor	KMO (>0.5)	Approx. Chi-Square	Total Variance Explained (>65)	Df.	Sig. (<0.05)
Complexity of Technology	0.602	121.515	83.171	1	.000
Partner Characteristics	0.856	736.376	70.825	36	.000
Absorptive Capacity	0.650	187.402	69.172	3	.000
Inter-Organisztional Relationships	0.685	319.757	72.477	10	.000
Technology Transfer Performance	0.870	987.313	67.252	36	.000

After that, the results from EFA analysis are used to analyze the Structure Equation Model (SEM). It is beginning with the analysis of proper values of Goodness-of-fit-indices and Measure Model. The Goodness-of-fit values indicated that the designed model was appropriate to the context of the study. The findings of the research study show that the values of CMIN/df, AGI, AGFI and RMSEA were 1.340, 0.983, 0.944 and 0.040 respectively (Table 2). These values were consistent with empirical data, and when they were analyzed by the model, as shown in Figure 2, the p-value is significantly at 0.001 (***) 0.01 (**) 0.05 (*). The results of the Linear Structural Relationship test among parameters in the model through Path Analysis can be used to conclude the relationship among parameters as presented in Figure 2 and Table 3.

Table 2 Goodness-of-fit-indices and Measure

Fit indices	Recommended value	Value
CMIN/df	< 3	1.340
GFI	> 0.9	0.983
AGFI	> 0.9	0.944
RMSEA	< 0.05	0.040

Table 3 Parameter Results

Hypothesis	Parameter			Standardised	P
1	Technology Transfer Performance	<---	Absorptive Capacity	1.007	.000
2	Absorptive Capacity	<---	Partner Characteristic	.658	.000
3	Absorptive Capacity	<---	Collaboration	.571	.000
4	Absorptive Capacity	<---	Complexity of technology	-.289	.030
5	Partner Characteristics	<---	Complexity of technology	0.813	.000
6	Collaboration	<---	Complexity of technology	0.425	.002
7	Person Characteristics	<---	Partner Characteristics	0.742	.000
8	Management Practice	<---	Partner Characteristics	0.748	.000
9	Communication	<---	Collaboration	.973	.000
10	Inter-Organisational Relationship	<---	Collaboration	.317	.000
11	Economic Performance	<---	Technology Transfer Performance	.744	.000
12	Knowledge Performance	<---	Technology Transfer Performance	.833	.000

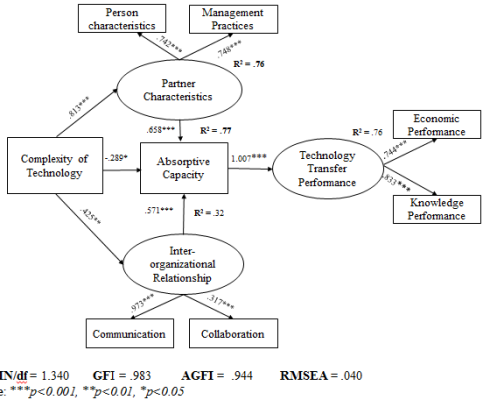

Fig.2. Relationships between factors related to technology transfer performance.

It can be concluded that there are three factors: the characteristics of transferor and transferee, inter-organizational relationships and technological complexity have an indirect influence on the performance of technology transfer. Additionally, the absorptive capacity has a direct influence on the performance of technology transfer. It indicates that the absorptive capacity effectively encouraged performance of technology transfer at the percentage of 76 (R2 = .76). On the other word, the absorptive capacity plays a vital role in mediating the relationship between those three factors and the performance of technology transfer.

6. Discussion

According to the research findings, the crucial factors influencing the performance of technology transfer are:1) absorptive capacity, 2) partner characteristics, 3) the complexity of technology, and 4) inter-organizational relationships. They are divided into two groups: human-oriented factors (partner characteristic, inter-organizational relationship and absorptive capacity) and technology-oriented factors (the complexity of technology).

In terms of human-oriented factors, technology transfer should emphasize many significant issues: 1) Technological transferor or owner selection. They should be expert and skillful in technical support and willing to transfer knowledge and freely reveal crucial techniques. It is better if they are the owners in the same regions, in terms of convenient and rapid communication, and dexterous comprehensible managerial administration, due to similar

cultures and working styles. 2) Skilful transferee selection. They should be experienced experts who have background knowledge of the technology. It helps encourage more rapid knowledge comprehension and capture because technology transfer is time-limited. If it is not completed by deadlines, there may be more expenses, affecting the business advantages. Moreover, they should participate in the project from the beginning steps, so as to understand the whole picture. Furthermore, staff working in the technology transfer project should be qualified, willing and interested to learn new things and apply ideas from the project. This enables them to further the study in their own context in the future and gain self-sufficiency and technological development. The administrators should also give support in terms of policy, good planning and provision of the necessary resources for learning processes, such as infrastructure, information technology systems, gathering and collecting knowledge, and providing workshops as they help encourage the absorptive capacity, including generating positive feelings and attitudes towards new things and influence on performance of technology transfer. 3) Emphasis on communication. This is a high-effect element in building relationships and cooperation between transferor and transferee in case of technology transfer from foreign countries. Differences in language may not encourage knowledge comprehension, perception and capture. There should then be workshops for English language usage for staff, helping them to communicate more effectively with foreign technology owners. Moreover, they can comprehend what they perceive; state what they want and ask for suggestions, and the exchange of ideas. This leads to more knowledge capture and creates positive feelings towards learning. Moreover, the administrators must also consider the communicative channels, and how this can be formalized through a classroom, face-to-face learning, and on the job training, again affecting the effectiveness of technology transfer.

In addition, in terms of technology-oriented factors, if there is good management of human-oriented factors, the complexity of technology can be learned and transferred effectively. Accordingly, the process of technology transfer should emphasize professional development, managing the transferred technology effectively and building up maximum benefits for the working system and organization.

7. Conclusion

This research study investigates the factors influencing the performance of production technology transfers in the form of licensing in the context of Petrochemical Industry in Thailand. The questionnaire was used as a research instrument to collect data from 212 samples. These were the staff at a Petrochemical Industrial factory responsible for technology transfer, and the executives who made decisions related to the technology transfer. They were interviewed in order that the researcher could gain a deep understanding of the context, analysis and interpretation of the data through Exploratory Factor Analysis (EFA) and Structure Equation Model (SEM). The research found that the main factors influencing the performance of technology transfer in the organization in the case study were 1) absorptive capacity, 2) characteristics of partners, 3) the complexity of technology, and 4) inter-organizational relationships. These can be categorized in to two groups, human-oriented factors and technology-oriented factors.

In the organization level, these findings presents that effective transfer of technology needs a strong personal relationship between the transferor and transferee. Therefore, company should pay an intention to build the good relationship between organizations in order to ensure that real learning and transfer takes place. Moreover, government should have a policy for increase firms' absorptive capacity by planning and developing human resources in the Petrochemical Industry. Human resource development in the Petrochemical Industry is vital for performance of technology transfer. Government could support in many ways, for example supporting the organizations to send their staff to take courses/ study trips in petrochemical production abroad, so that they will come back to train others in turn, or granting incentives and taxes exemption for companies that provide the training for their staffs. These policies could enhance the firms' absorptive capacity which is the most important factor affecting the technology transfer as well as could encourage learning of know-how from abroad and research in production technologies. These findings can be used for the planning of future organizational technology transfers in the case study for maximum benefits, and can be used as guidelines for production technology transfers from foreign countries to the Petrochemical Industry in Thailand.

8. References

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