TECHNOLOGY TRANSFER IN JAPANESE ELECTRONICS COMPANIES IN THAILAND

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อุตสาหกรรมอิเล็กทรอนิกส์ถือได้ว่าเป็นอุตสาหกรรมหลักอันหนึ่งในประเทศไทยซึ่งมีการลงทุนจากญี่ปุ่นจำนวนมากเช่นเดียวกับอุตสาหกรรมยานยนต์ และเพื่อให้การพัฒนามีความยั่งยืน รัฐบาลไทยได้มีการใช้นโยบายหลายอย่างในการส่งเสริมให้เกิดการถ่ายทอดเทคโนโลยี ซึ่งแม้นว่ารัฐบาลได้พยายามดำเนินการดังกล่าวแล้ว แต่ผลที่ได้เป็นเพียงการการดัดแปลงเทคโนโลยีที่ใช้และความช่วยเหลือด้านเทคนิคมากกว่าการทำนวัตกรรม การวิจัยนี้มีวัตถุประสงค์ที่จะส่งเสริมความเข้าใจเกี่ยวกับการถ่ายทอดเทคโนโลยีภายในกิจการที่มีการลงทุนจากญี่ปุ่นให้ดีขึ้น และเสนอแนะนัยเชิงนโยบายสำหรับหน่วยงานที่เกี่ยวข้องในการนำเรื่องการถ่ายทอดเทคโนโลยีไปใช้ในอนาคต

การวิจัยนี้ได้นำวิธีการวัดความสามารถทางเทคโนโลยี ซึ่งได้มีงานศึกษาที่ทำมาก่อนหน้านี้มาใช้ และสรุปคุณลักษณะต่างๆ ของการถ่ายทอดเทคโนโลยีในกิจการอีเล็กทรอนิกส์ของญี่ปุ่นในประเทศไทยโดยการเก็บรวบรวมข้อมูลปฐมภูมิจากกิจการอีเล็กทรอนิกส์ของญี่ปุ่นในประเทศไทย จำนวน 11 แห่ง พร้อมทั้งการสัมภาษณ์บริษัทแม่ในญี่ปุ่นเพิ่มเติม เพื่อสนับสนุนข้อมูลที่ได้จากแบบสอบถาม ผลการศึกษาพบว่า การถ่ายทอดเทคโนโลยีในกิจการอิเล็กทรอนิกส์ของญี่ปุ่นในประเทศไทยยังอยู่ในระดับต่ำ เนื่องจากลักษณะของสินค้าที่ผลิตและทรัพยากรมนุษย์ (บุคลากร) ที่มีอยู่ ดังนั้นจึงควรมีการสนับสนุนให้มีกิจกรรมด้านการวิจัยและพัฒนามากขึ้น โดยการให้แรงจูงใจมากกว่าที่เป็นอยู่ และในขณะเดียวกันก็ควรมีการลงทุนในการพัฒนาทรัพยากรมนุษย์มากขึ้นทั้งในระยะกลางและระยะยาว

สาขาวิชา : เศรษฐศาสตร์ธุรกิจและการจัดการ ลายมือชื่อนิสิต.....斎藤俊克.....

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SHUNSUKE SAITO : TECHNOLOGY TRANSFER IN JAPANESE ELECTRONICS COMPANIES IN THAILAND. THESISADVISOR : ASSOC. PROF. SAMART CHAISAKUL, THESIS CO-ADVISOR : ASSOC. PROF. WARANYA PATARASUK, Ph.D., 115 pp.

The electronics industry in Thailand is the leading sector in the Thai economy where the Japanese investments are made significantly paralleling to the automobile industry. In order to achieve the sustainable development, the Thai government has introduced several policies to promote technology transfer. Despite such efforts, much of what they get relates to adaption and technical support rather than innovation. The study aims to improve understanding about the actual practice of technology transfer at intra-firm level in the Japanese electronics companies in Thailand and to provide some policy implications for the Thai agencies concerned for the better application of the technology transfer in the future.

The study adopted the measurement of technological capability, which was used in the previous studies, and summarized the characteristics of the technology transfer in the Japanese electronics companies in Thailand by collecting primary data from eleven companies and by interviewing some parent companies to support the data obtained from questionnaires. The results showed that the level of technology transfer of the Japanese electronics companies in Thailand remains at the lower level because of the nature of the products and human resources. The policy implications arising from the study are to have more R&D activities by providing more incentives, and investment in human resource development in the middle and long term.

Field of Study : Business and Managerial Economics
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Student's Signature 舟藤俊亮
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ABBREVIATIONS

ADB	…..Asian Development Bank
ASEAN	…..Association of South East Asian Nations
BOI	…..Board of Investment
BUILD	…..BOI Unit for Industrial Linkage Development
FDI	…..Foreign Direct Investment
GDP	…..Gross Domestic Product
ISO	…..International Organization for Standardization
JBIC	…..Japan Bank for International Cooperation
JCC	…..Japanese Chambers of Commerce
JEITA	…..Japan Electronics and Information Technology Industries Association
JETRO	…..Japan External Trade Organization
JSIC	…..Japan Standard Industrial Classification
MNCs	…..Multi National Corporations
NIEs	.....Newly Industrializing Economies
NSTDA	…..National Science and Technology Development Agency
POS	…..Point of Sale
R&D	…..Research and Development
SPT	…..Software Park Thailand
STI	…..Skill, Technology and Innovation
TDRI	…..Thailand Development Research Institute
TNI	….. Thai Nichi Institute of Technology
UNCTAD	…..United Nations Conference on Trade and Development

CHAPTER I

INTRODUCTION

1.1 Problem Statement

The United Nations Conference on Trade and Development (UNCTAD) mentions that the impact of foreign direct investment (FDI) on technology generation in developing countries has so far been limited. Multinational corporations (MNCs) tend to centralize their research and development facilities in their home countries and a few other industrially advanced countries. On the whole, developing countries continue to attract only marginal portions of foreign affiliate research, and much of what they get relates to adaptation and technical support rather than innovation. Indeed, the majority of developing countries do not have the technological infrastructure to make it economical for MNCs to set up local research and development (R&D) facilities. On the other hand, a number of companies from developing countries are emerging that specialize in niches of opportunity for R&D in such area as biotechnology, information technology or new areas of services, while there are also some instances of MNCs accessing science and technology resources in some developing countries for their R&D activities. Given the greater willingness on the part of MNCs to move their technological assets around the world, such companies may offer useful allies for MNCs from both developed and developing countries in the evolution of new technologies.

Japan's singular economic success during the 1950s and 1960s, and stable growth through the 1970s and 1980s, has led many business leaders and organizational scholars to look to Japan as the model for economic success in this era.

Rodgers and Wong (1996) note the attention that the “exceptional performance” of Japanese companies had garnered by the early 1970s. In particular, they discuss the success of Japanese companies in transferring their business operations to overseas subsidiaries. The record of some of the high-profile auto transplants, as well as of many other highly successful affiliates, demonstrates that some affiliates in distant locations are able to achieve highly efficient and flexible operating systems.

These scholars go on to note that Japanese companies could transfer machines and tools very easily and, although there involved somewhat more difficulty, they could transfer standardized technical skills.

Since there is very little empirical studies to what extent Japanese companies transfer technology, it is interesting to survey such technology transfer applied to their employees.

1.2 Objectives of the Study

The objective of this study is to identify the tendencies of technology transfer practiced in Japanese companies in Thailand. The electronics industry is the subject of this study because the electronics industry in Thailand is the sector where Japanese investments are made significantly and is leading Thai economy by its large amount of exports. Specifically, the study attempts to do the following:

(1) To study the developments of Thai investment policies and Japanese FDI in Thailand;

(2) To improve understanding about the actual practice of technology transfer at intra-firm level in Japanese electronics companies in Thailand; and

(3) To provide some policy implications for Thai agencies concerned for the better

application of the technology transfer in the future.

1.3 Scope of the Study

This study concentrates on the intra-firm technology transfer and looks into to what extent technology is transferred to the company's personnel once a company introduces imported technology. In identifying such technology transfer, this study is concerned with the capacity of the recipient to absorb the technology transferred or how much technical knowledge the companies' employees have absorbed. In particular, the construct proposes to measure the technical capability of the company after the technology has been transferred.

The work by Thailand Development Research Institute (TDRI) (1989) and Asian Development Bank (ADB) (1995) on different levels of technological capability are used as a benchmark to generate attributes for the technology transfer measure. Both the TDRI and ADB divided an industry's technological capability into four levels; (1) acquisitive, (2) operative, (3) adaptive, and (4) innovative, brief definitions are as follows:

(1) acquisitive capability includes search, assess, negotiate, process, transfer, and install machinery and equipment; (2) operative capability includes operation and control, maintenance, training, skill, and management style; (3) adaptive capability includes new knowledge acquisition, technology digestion, minor product modification, and minor process modification; and (4) innovative capability includes R&D, radical product modification, radical process modification, major change in the company's production methods/ product design and new inventions.

This study focuses only on three levels, namely; operative, adaptive and

innovative technological capabilities. Acquisitive technological capability is in a sense dealt in advance to such new technology takes place and should not be concerned in the study since this study draws attention to the intra-firm technology transfer.

1.4 Expected Benefits

The study will provide some background information on Japanese FDI in general as well as Japanese FDI in Thai electronics industry. The nature and characteristics of Japanese intra-firm technology transfer in Thai electronics industry are also provided. The study will also offer some policy implications for Thai agencies or authorities responsible for technology transfer and /or technological development.

1.5 Organization of the Report

This study analyzes the possible sources of technology transfer practiced in Japanese companies located in Thailand. The study is divided into six chapters. The trend of Japanese FDI overseas is presented in Section 2.1. Attention is then turned in Section 2.2 to Japanese FDI inflow to Thailand. Section 2.3 presents Thailand's investment policy.

Chapter 3 touches upon the electronics industry including definition of electronics, trend of Japanese electronics industry, successful case of Korean electronics industry, technology transfer in Thai electronics industry, Thai government's efforts to enhance technology transfer and Japan's R&D trend.

The research design for this study including definition of technology and technology transfer as well as measurement of technology transfer and the method of data collection are described in Chapter 4.

The results of the study both answers to the questionnaires and the interview of the parent company will be presented in Chapter 5, followed by conclusions of the study as well as recommendations for future research in Chapter 6.

CHAPTER II

JAPANESE FOREIGN DIRECT INVESTMET

2.1 Japanese FDI Overseas

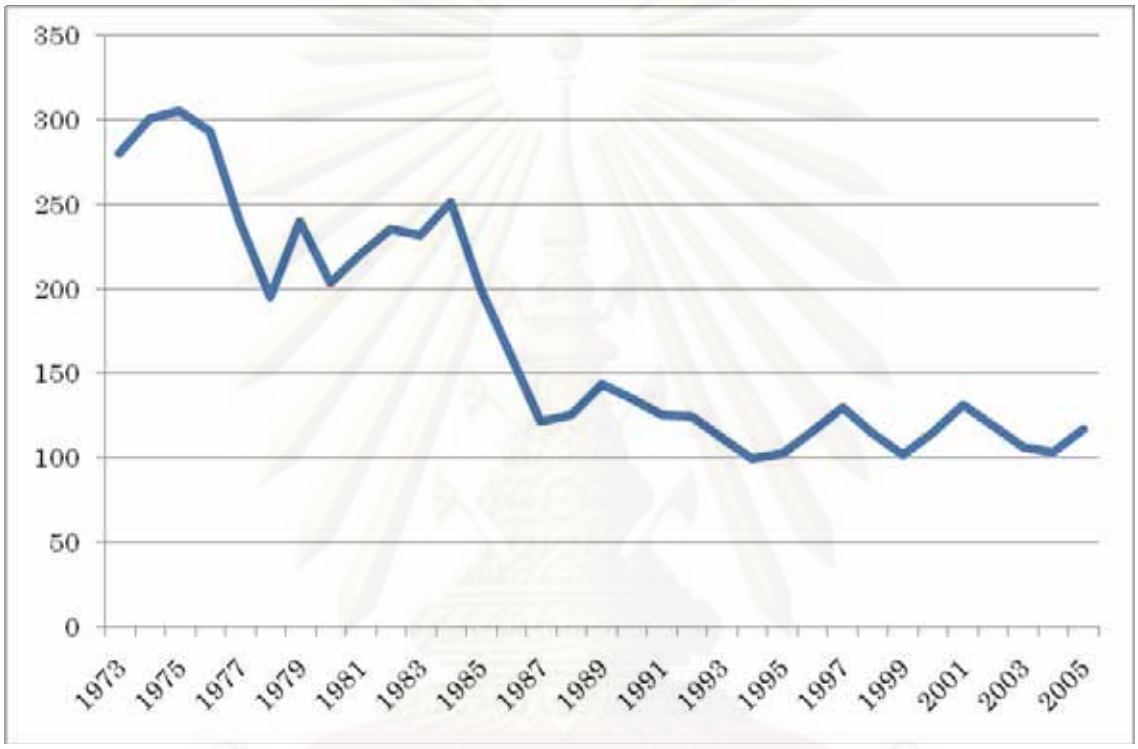
The second oil crisis in 1979 created a shift in Japan's industrial structure from emphasis on heavy industry to development of new fields, such as the computer, semiconductor, along with other technology and information-intensive industries. This started a period of rapid growth.

In 1985 the deregulation of interest rates on deposits began in Japan. This change led the competition between banks for their procurement and lending. For the international side, Plaza Agreement, which aimed to depreciate the US dollar (USD) in relation to Japanese Yen (JPY) and Deutsche Mark by intervening in currency markets, was signed in September 1985 and consequently caused JPY to appreciate dramatically. The Louvre Agreement, signed two years later in order to bring a halt to USD depreciation, also forced Japanese central bank to ease monetary policy, which was eventually maintained further by the central bank because of New York market crash in October1987. These altogether caused economic boom in Japan during those years.

It was not only the JPY appreciation but also the trend of protectionism imposed by the developed countries which promoted Japanese FDI. In the past, Japanese FDI in the developed countries was concentrated mainly on the financial or service sector which supported Japanese trading industry. However, as the developed countries tightened their regulations by, for example, imposing local content

requirement, many manufacturers in the automobile and electronics industries started their local production in these countries in order to avoid trade frictions.

Figure 2-1 Foreign Exchange (JPY/1USD)



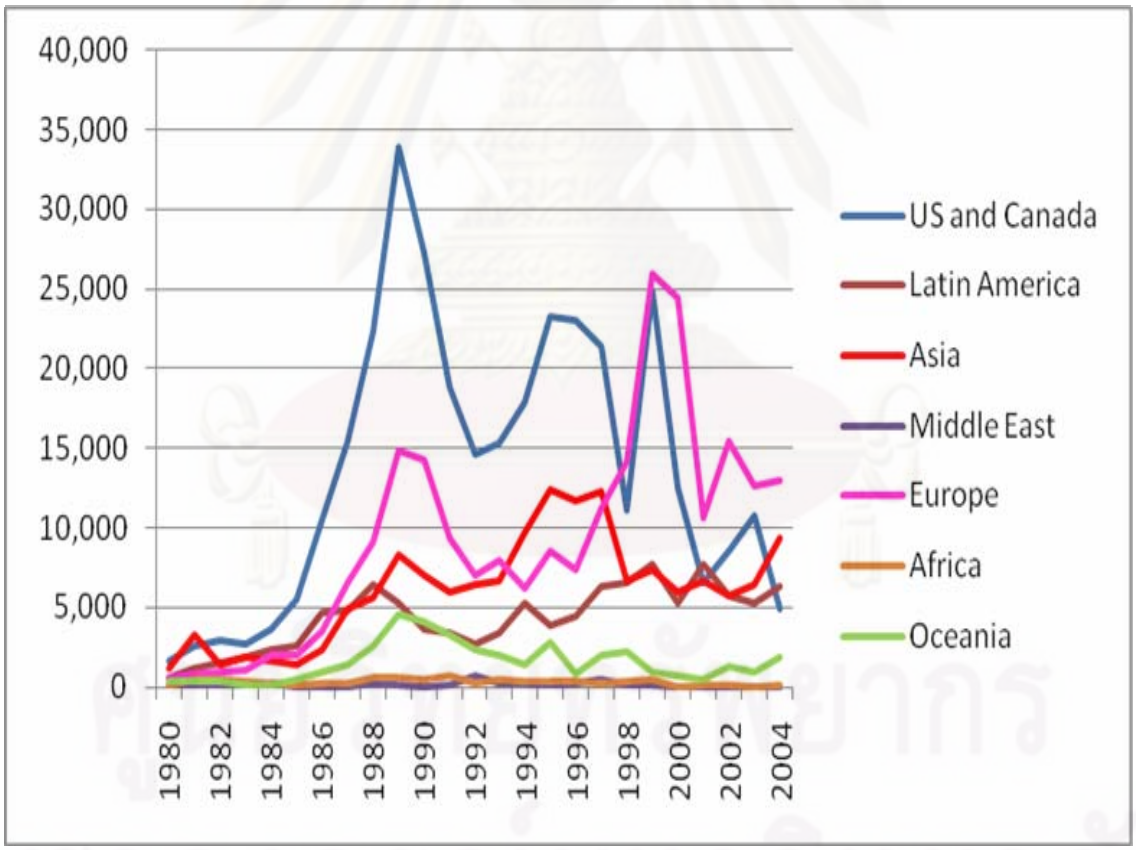
Source: Ministry of Internal Affairs and Communication

As the liquidity was pumped into the money market, corporate investment rose sharply in 1988 and 1989. New equity issues rose in value as a result of higher stock prices, thus making them an important source of financing for corporations. In the meantime, banks sought for funds in the outlet of real estate development. In turn, corporations used their real estate holding as collateral for stock market speculation. A direct result of this was the doubling of land value prices and a 180 % rise in the Tokyo Nikkei stock market index. Such incidents had a positive impact on Japanese FDI.

JPY appreciation also reduced Japan's international price competitiveness. In order to cope with the new international price structure, many Japanese companies moved their production base outside the countries.

Japanese FDI in the 1980s was mainly invested in North America and Europe consisting about 45 % and 18 % of Japan's total FDI outflows, respectively. Amount invested in Asia was about 15 % of total FDI outflows during that period. Japan's FDI to Asia started to rise in the late 1980s.

Figure 2-2 Japanese FDI Destinations



Source: JETRO

In Asia, Indonesia attracted Japanese investments in the 1970s. These investments were mainly made in the energy and mineral resources sector, such as oil and natural gas, in order to secure the sustainable supply of such products in Japan after the oil crisis of the 70s. Substantial amount of FDI inflow in Asia started in the 1980s.

FDI in Asia was focused mainly in manufacturing sector. Apart from JPY appreciation, other Asian countries attracted Japan's FDI for their healthy economic growth, low labor costs, favorable FDI promotion policies, etc.

Since the mid-1980s, geographical distribution of Japan's FDI to Asia had changed significantly, from the Asian newly industrializing economies (NIEs) to Association of South East Asian Nations (ASEAN), and then to China and other Asian countries. The Asian NIEs, with their FDI promotion policy, attracted FDI until the late 1980s. Korea, Taiwan, and Singapore promoted inward FDI in order to achieve their high-tech industrialization. These countries enjoyed positive growth brought about by both expansion of trade and inward FDI. However, as the wage increased and their currency appreciated, Asian NIEs started to lose their advantages for investment (Urata 1996). Japanese companies then sought ASEAN countries and China as their next investment destination.

Table 2-1 Japanese FDI Destinations in Asia

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Hong Kong	2	2	1	1	5	9	41	29	123	51
India	0	3	2	1	0	1	2	0	0	1
Indonesia	16	6	52	42	43	49	112	119	341	375
Korea	0	3	2	1	10	17	28	146	211	77
Malaysia	5	6	4	2	5	14	12	13	126	48
Philippines	0	2	9	5	4	29	5	10	43	59
Singapore	2	1	1	1	4	9	15	42	81	51
Taiwan	1	3	13	14	21	25	12	10	34	33
Thailand	6	2	8	10	19	13	9	30	34	31
Vietnam										
China					0	0	0	0	0	0

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Hong Kong	105	69	109	158	225	156	329	401	563	412
India	15	1	0	0	6	2	15	3	7	14
Indonesia	589	931	425	610	150	529	2,434	410	374	374
Korea	93	102	95	222	95	35	73	103	129	107
Malaysia	52	52	69	48	33	146	31	83	140	142
Philippines	149	15	27	53	102	78	72	34	65	46
Singapore	52	27	66	174	255	140	266	180	322	225
Taiwan	24	28	18	40	39	47	54	55	103	65
Thailand	14	19	49	32	55	33	31	94	72	119
Vietnam							–	–	–	–
China	0	0	0	0	14	12	26	18	3	114

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Hong Kong	131	502	1,072	1,662	1,898	1,785	925	735	1,238	1,133
India	13	11	21	24	18	30	14	122	35	96
Indonesia	408	250	545	586	631	1,105	1,193	1,676	813	1,759
Korea	134	436	647	483	606	284	260	225	246	400
Malaysia	79	158	163	387	673	725	880	704	800	742
Philippines	61	21	72	134	202	258	203	160	207	668
Singapore	339	302	494	747	1,902	840	613	670	644	1,054
Taiwan	114	291	367	372	494	446	405	292	292	278
Thailand	48	124	250	859	1,276	1,154	807	657	578	719
Vietnam	–	–	–	–	0	0	0	10	46	176
China	100	226	1,226	296	438	349	579	1,070	1,691	2,565

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Hong Kong	1,147	1,487	701	639	975	946	348	208	396	639
India	130	219	434	259	208	168	145	310	87	97
Indonesia	1,605	2,414	2,514	1,116	959	420	627	529	648	311
Korea	449	416	442	304	980	817	563	626	284	845
Malaysia	575	572	791	521	527	232	257	80	463	125
Philippines	717	559	524	381	637	465	791	410	196	317
Singapore	1,185	1,115	1,824	655	1,038	457	1,147	752	322	715
Taiwan	455	521	450	224	287	511	321	375	152	479
Thailand	1,240	1,403	1,867	1,405	837	932	884	504	629	1,184
Vietnam	200	319	311	51	99	21	78	60	70	109
China	4,478	2,510	1,987	1,076	770	1,008	1,453	1,766	3,143	4,567

Source: JETRO (unit USD million)

According to the comprehensive survey of overseas activities of Japanese firms conducted by the Ministry of Economy, Trade and Industry of Japan on Japanese overseas affiliates whose 50 % or more shares are held by a Japanese parent company, 41% of them or 2,156 overseas affiliates located in China as of 2004. Apart from China, there are 750 overseas affiliates in Thailand followed by 398 in Malaysia and 396 in Indonesia. And in almost every industrial sector, Thailand has the largest number of affiliates if China is excluded. (See Table 2-2)

Table 2-2 Japanese Overseas Affiliates

	China	Hong Kong	Philippines	Malaysia	Thailand	Indonesia	Singapore	Taiwan	Korea
Food and tobacco	125	12	7	12	45	14	9	10	2
Textiles	216	17	2	8	41	31	2	9	7
Wood, pulp and paper	37	2	4	15	10	7	1	2	0
Chemicals	237	26	22	47	88	59	53	71	70
Ceramics, stone and clay	6	0	0	1	2	3	3	1	2
Iron and steel	51	4	6	8	31	13	5	6	7
Non-ferrous metals	55	13	8	24	33	12	9	14	3
Industrial machinery	234	25	15	25	69	27	31	43	39
Electrical machinery	223	29	17	26	56	20	31	39	24
IT communications	293	95	57	109	62	52	69	65	41
Transportation	258	2	40	36	172	87	8	49	39
Precision instruments	70	30	5	9	15	2	11	8	17
Other	351	65	34	78	126	69	57	67	35
Total	2156	320	217	398	750	396	289	384	286

Source: Kaigai Jigyo Katsudo Kihon Chosa (2004)

Because of its huge potential market within the country, redundant natural resource, cheap labor cost in the past, driven by economic and technological forces as well as the ongoing liberalization of FDI and trade policies, Japanese manufacturing companies have moved their production bases to China in order to compete in their business.

After becoming a member of the World Trade Organization, China has introduced or revised many relative laws and regulations. The central government has been very quick in publishing laws and regulations via website right after these laws and regulations are promulgated so as to satisfy investor's needs. However, investing and trading with China has created many obstacles during the implementations. Study

conducted by Japan China Investment Facilitation Organization in 2005 shows that labor management and relationship with the government had become severe problems. They say that low transparency, wide administrative discretionary, and inconsistency exist in the implementation.

The study conducted by the Japan Bank for International Cooperation (JBIC) in 2006 mentions that when asked about policies to address localization in Asia, primarily in China and ASEAN, for management, procurement, and R&D, around 80 % companies responded “localization is necessary and the head office is encouraging localization through setting goals and other promotion measures” or “localization is necessary and local bases are promoting localization in accordance with local conditions,” thereby indication that the companies intend to move ahead with localization for management and procurement. In contrast, over 30 % of companies responded that they would “centralize authority in Japan rather than localize” for R&D. Results for R&D were thus polarized between companies that would and would not promote localization.

When asked to self-evaluate the progress of localization, based on localization policies, over 60 % of the companies responded that they had made sufficient or somewhat sufficient progress for management and procurement, while only a little over 20 % had done so for R&D.

Among the issues in promoting localization, many companies cited a lack of human resources for localization of management, insufficient technological capacities of local companies for procurement, and a lack of local technical staff for R&D. More companies also pointed out communication difficulties in China, as well as concern for confidential information leakage in China.

This implies that technology may not be fully transferred in Japanese companies in China even though technology transfer is one of the key factors for the development that one country can get through FDI. One Japanese manager operating manufacturing companies both in China and in Thailand mentions that sometimes Japanese companies may not transfer technology to the affiliates in China intentionally for fear of technology leakage.

As old adage says, there is a concern for "putting all the eggs in one basket". Japanese manufacturers diversify their production base. Therefore even though China is the most favored destination for Japanese manufacturers to invest overseas, Thailand also attracts Japanese investment as "China plus one" in Asia. According to the Japanese Chamber of Commerce in Bangkok (JCC) (2006), more than 1,250 Japanese companies are registered to JCC and there are more than 6,000 companies investing in Thailand including non-registered as members of JCC. The number of Japanese companies has the increasing trend. These companies are creating job opportunities to local Thai people that are estimated about 433,300. These Japanese companies constitute important elements in Thailand's industrialization, and they also have provided valuable management experience for Thai people.

2.2 Japanese FDI Inflow to Thailand

From Table 2-3, it appears that foreign direct investment inflows to Thailand increased remarkably since late 1980s with some fluctuations in accordance with ups and downs of Thai economy. FDI inflow from Japan is the largest among other leading economies and remained relatively stable from the mid-1990s to the mid-2000s. And the value of Japanese investment, in terms of both stock and flow, now accounts

about 40 % of the total investment in Thailand.

Table 2-3 Net FDI Inflow to Thailand

	1981	1982	1983	1984	1985	1986	1987	1988	1989
Japan	63.5	45.1	105.6	110.2	56.2	115.6	128.1	577.5	730.9
U.S.	108.1	37.3	55.0	158.5	87.1	49.1	70.9	125.9	203.2
EU	35.6	67.5	91.9	20.2	17.4	22.5	38.5	90.7	159.0
Hong Kong	14.5	25.8	37.7	15.6	23.1	36.3	31.3	110.6	222.6
Taiwan	0.5	0.1	1.2	1.9	6.3	5.0	26.8	124.0	197.0
Korea	0.0	0.0	0.9	0.2	−0.2	0.2	0.9	12.0	9.9
Switzerland	0.9	4.2	3.9	5.1	2.9	10.5	30.7	22.0	47.8
Others	66.0	8.2	59.8	100.3	−32.9	22.9	26.9	43.3	209.6
Total	289.0	188.0	356.0	412.0	160.0	262.0	354.0	1106.0	1780.0

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Japan	1096.0	615.2	344.1	305.7	123.4	556.5	523.5	1348.0	1484.7
U.S.	241.5	233.2	466.7	286.0	155.9	260.0	429.5	780.7	1283.3
EU	173.5	166.3	288.5	243.3	121.6	179.9	168.2	360.0	912.3
Hong Kong	276.5	457.5	582.4	193.6	318.8	279.1	215.1	442.4	393.9
Taiwan	280.9	108.5	88.0	48.9	82.6	96.6	138.0	133.8	106.3
Korea	19.1	11.7	10.4	14.6	12.9	12.4	24.8	29.9	72.7
Switzerland	28.9	48.2	30.7	10.9	26.8	15.9	52.0	120.5	73.2
Others	425.5	392.6	340.3	629.1	483.1	603.6	719.7	411.4	815.8
Total	2542.0	2033.0	2151.0	1732.0	1325.0	2003.9	2270.6	3626.8	5142.2

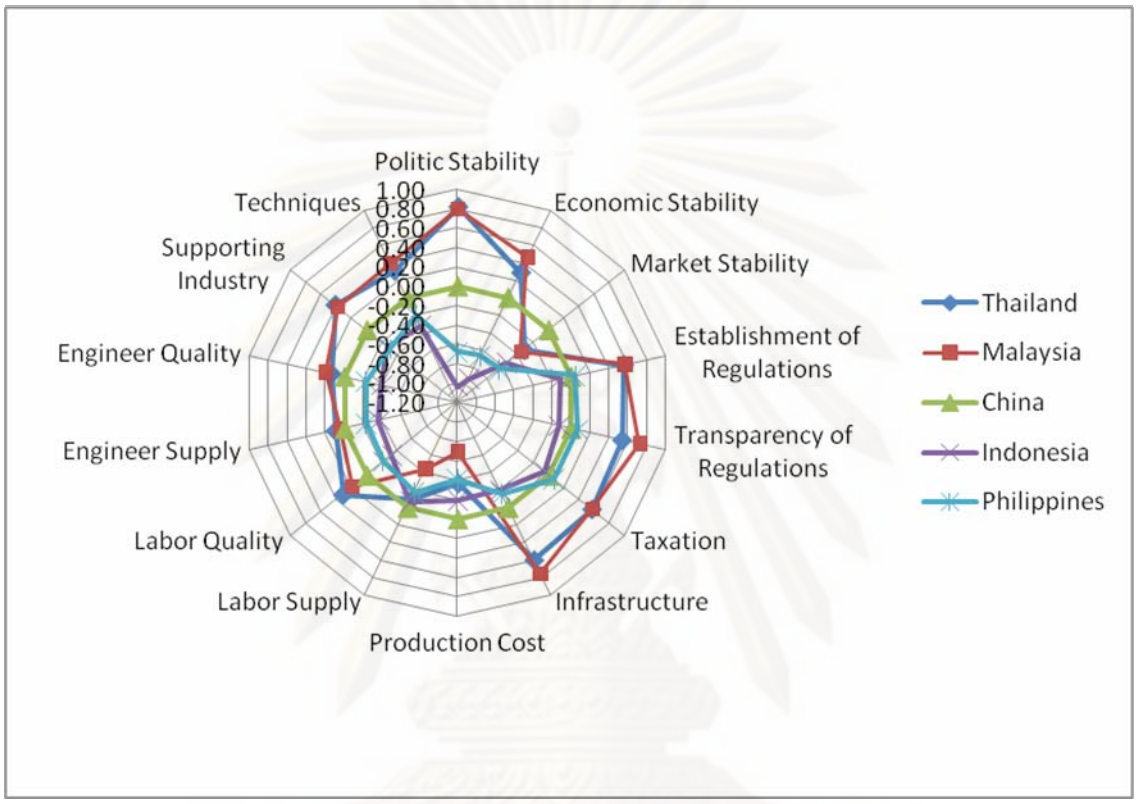
	1999	2000	2001	2002	2003	2004	2005	2006	2007 p
Japan	488.4	869.9	1955.1	1892.4	2297.7	2749.9	2926.5	2576.4	3135.7
U.S.	641.2	617.6	395.0	182.3	336.2	540.4	750.5	165.8	570.1
EU	1368.5	509.6	282.9	−216.1	607.6	697.3	335.0	955.4	1561.9
Hong Kong	233.7	331.3	150.6	86.3	613.1	141.4	7.2	−77.8	390.4
Taiwan	121.5	159.0	156.8	103.7	75.3	124.2	29.2	−94.6	91.5
Korea	5.5	−3.7	50.6	93.2	23.8	93.5	29.5	79.5	75.3
Switzerland	60.4	32.2	55.3	48.1	124.1	167.3	99.8	153.9	172.4
Others	642.8	297.5	2001.6	1221.1	1087.3	441.9	2325.4	6721.1	4201.9
Total	3561.8	2813.3	5048.0	3411.0	5165.0	4956.0	6503.2	10479.7	10199.1

Source: Bank of Thailand (unit USD million)

From the survey conducted by Japan External Trade Organization (JETRO) in early 2000s, during the Thaksin administration, shows how Thailand was competitive compared with other ASEAN countries and China. And the annual JBIC's survey shows that Thailand continues to constitute the most promising destination for Japanese mid-term investment. (See Table2-4) From the comparison of investment environment, it shows that Thailand and Malaysia are superior to China in many attributes such as political stability, economic stability, and the establishment of regulations, transparency of regulations, taxation, infrastructure, and supporting industry. But in terms of market

stability, production cost, and labor supply, China is second to none.

Figure 2-3 Comparison of Investment Environment



Source: JETRO (China is 0 as standard. If the number is positive, then it is superior to China)

As shown in Table 2-4, Thailand has been attracting Japanese investors for a long time. Even after the financial crisis in 1997, Thailand was the most promising destination for Japanese mid-term investment after China and U.S. and in 2002 through 2004 Thailand was the most promising destination for Japanese investors after China. India with a huge market in the background becomes the second in 2005 and Vietnam took over Thailand in 2006, but Thailand still attracts many Japanese investors. The JBIC research concludes that Japanese investors regard Thailand as a good destination for investment due to following reasons; 1) inexpensive source of labor, 2) future

growth potential of local market, 3) supply base for assemblers, 4) concentration of industry, 5) current size of local market.

Table 2-4 Most Promising Destination for Japanese Mid-term Investment

	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997
1st	China	China	China	China	China	China	China	China	China	China	China
2nd	India	India	India	**Thailand**	**Thailand**	**Thailand**	U.S.	U.S.	U.S.	U.S.	U.S.
3rd	Vietanam	Vietnam	**Thailand**	India	U.S.	U.S.	**Thailand**	**Thailand**	**Thailand**	**Thailand**	Indonesia
4th	**Thailand**	**Thailand**	Vietnam	Vietnam	Vietnam	Indonesia	Indonesia	Indonesia	India	Indonesia	**Thailand**
5th	Russia	U.S.	U.S.	U.S.	India	Vietnam	India	Malaysia	Indonesia	India	India
6th	U.S.	Russia	Russia	Russia	Indonesia	India	Vietnam	Taiwan	Vietnam	Philippines	Vietnam
7th	Brazil	Brazil	Korea	Indonesia	Korea	Korea	Taiwan	India	Malaysia	Malaysia	Philippines
8th	Indonesia	Korea	Indonesia	Korea	Taiwan	Taiwan	Korea	Vietnam	Philippines	Vietnam	Malaysia
9th	Korea	Indonesia	Brazil	Taiwan	Malaysia	Malaysia	Malaysia	Korea	U.K.	Brazil	Brazil
10th	Taiwan	Taiwan	Taiwan	Malaysia	Russia	Brazil	Singapore	Philippines	Brazil	U.K.	Taiwan

Source: JBIC

The table below shows the number of Japanese investments made in Thailand. In terms of the number of cases, textile was the leading industry to attract Japanese investments in Thailand in the early 1990s. There were about 50 cases of investments in the textile industry around 1990 on a single year basis, however as the years go by the number of the investments in the textile industry has dropped significantly partly because some other Asian countries have emerged as a better destination since the textile industry does not require sophisticated technologies compared with other industries. Metal and electrical industries were also attracting Japanese investments in Thailand. There have been constant investments in the transporting industry since 1990. Investments in the electrical industry have dropped but are still making the large amount after transport industry. Number of cases has dropped after the financial crisis in almost every industry.

Table 2-5 Number of Cases Invested into Thailand

FY	1989	1990	1991	1992	1993	1994	1995	1996
Food	19	28	24	8	13	7	5	5
Textile	44	48	52	26	16	12	10	18
Lumber&Pulp	15	13	5	2	1	2	3	3
Chemical	21	17	6	10	5	7	8	10
Metal	43	25	14	9	8	7	17	37
Machinery	23	21	18	6	14	3	12	9
Electrical	34	36	24	14	9	18	31	27
Transport	9	15	7	5	7	19	16	22
others	64	42	34	11	18	21	23	16
Manufacturing Total	272	245	184	91	91	96	125	147
Farming&Forestry	14	17	18	5	6	1	–	1
Fishery	1	–	1	–	–	–	–	–
Mining	1	1	–	–	–	–	1	–
Construction	8	5	3	7	4	3	5	10
Trade	22	23	21	9	7	5	5	9
Finance&Insurance	1	7	2	2	2	1	2	6
Service	22	31	15	3	5	2	4	9
Transportation	15	15	7	8	4	3	1	5
Real Estate	47	33	7	5	3	2	1	8
others	–	–	–	–	–	–	–	–
Non-Manufacturing Total	131	132	74	39	31	17	19	48
Total	403	377	258	130	122	113	144	195

FY	1997	1998	1999	2000	2001	2002	2003	2004
Food	6	1	9	7	2	3	5	2
Textile	5	3	1	1	1	4	2	–
Lumber&Pulp	–	–	1	–	1	–	–	–
Chemical	8	4	6	8	5	8	3	3
Metal	16	7	7	10	5	6	4	4
Machinery	8	6	11	1	4	4	3	3
Electrical	18	7	7	11	10	3	7	7
Transport	26	12	15	7	10	8	20	10
others	16	2	3	6	3	7	7	5
Manufacturing Total	103	42	60	51	41	43	51	34
Farming&Forestry	–	–	–	–	–	–	–	–
Fishery	–	–	–	–	–	–	–	–
Mining	–	1	–	–	–	–	1	–
Construction	8	5	–	1	1	–	–	1
Trade	15	12	7	3	4	3	6	1
Finance&Insurance	7	6	2	1	2	–	2	4
Service	5	1	1	2	3	2	4	11
Transportation	1	2	3	3	–	3	–	–
Real Estate	14	3	–	1	–	–	1	1
others	–	–	–	–	–	1	–	–
Non-Manufacturing Total	50	30	13	11	10	9	14	18
Total	153	72	73	62	51	52	65	52

Source: Ministry of Finance, Japan

In terms of the value of the investments, it is the electric industry where the large Japanese investments have been made throughout the period. While transport industry has taken over from the electric industry and has become the largest industry

since 1995, electric industry has followed the transport industry and these two industries become emblematic of Japanese investments in Thailand. As Japanese investments have a huge presence in Thailand, it is obvious that these two industries have led the growth of Thai economy. Following the successful Eastern Seaboard Development Project, such as Map Ta Phut industrial estate and port, investments in the chemical industry also showed a steady development.

Table 2-6 Amount Invested into Thailand

FY	1989	1990	1991	1992	1993	1994	1995	1996
Food	40	73	117	13	23	58	34	33
Textile	55	127	74	39	24	11	33	32
Lumber&Pulp	14	14	5	1	4	6	6	26
Chemical	71	73	81	52	75	37	53	130
Metal	180	86	54	76	62	64	225	258
Machinery	241	86	104	36	121	31	66	52
Electrical	327	260	280	103	110	168	301	264
Transport	23	173	25	53	32	73	119	153
others	103	153	77	16	34	134	128	99
Manufacturing Tota	1,054	1,045	816	389	485	583	966	1,047
Farming&Forestr	16	25	25	4	7	2	-	2
Fishery	4	2	1	1	-	-	-	-
Mining	2	2	-	-	-	-	4	-
Construction	62	34	61	61	4	6	18	49
Trade	75	89	46	31	49	11	56	66
Finance&Insuran	16	73	44	7	9	35	49	57
Service	201	188	45	6	9	13	15	61
Transportation	38	32	14	324	76	6	2	81
Real Estate	212	161	33	17	13	23	19	30
others	-	-	-	-	-	-	-	-
Non-Manufacturing	626	605	268	452	167	95	164	347
TOTAL	1,680	1,651	1,084	841	651	678	1,131	1,394

FY	1997	1998	1999	2000	2001	2002	2003	2004
Food	17	9	41	15	7	24	22	17
Textile	13	140	3	17	17	21	30	8
Lumber&Pulp	14	20	2	-	4	-	-	-
Chemical	176	63	65	104	150	147	46	46
Metal	238	268	237	51	145	27	39	38
Machinery	51	40	110	26	69	35	22	37
Electrical	516	144	80	147	180	49	86	69
Transport	546	305	117	195	114	170	192	344
others	90	40	35	101	116	61	128	45
Manufacturing Tota	1,662	1,030	689	656	803	535	564	603
Farming&Forestr	4	2	-	-	-	-	-	-
Fishery	-	-	-	-	-	-	-	-
Mining	-	2	-	-	-	-	3	5
Construction	95	32	16	1	34	28	-	4
Trade	57	476	119	51	14	13	49	63
Finance&Insuran	141	96	83	67	15	11	55	73
Service	31	16	6	7	56	18	38	59
Transportation	1	75	18	21	5	8	1	-
Real Estate	193	10	4	5	2	-	1	9
others	-	-	-	-	-	1	-	-
Non-Manufacturing	521	710	245	152	126	79	147	213
TOTAL	2,184	1,740	934	809	930	614	711	815

Source: Ministry of Finance, Japan (unit JPY 100 million)

2.3 Thailand's Investment Policy

Electronics industry is one of the promoted areas for attracting FDI in Thailand. With the effort of the Thai government, the industry has established as one of the leading industries which contributes to Thai gross domestic product (GDP) growth.

The subsequent subsections explain how Thailand's investment policies were accorded through time.

2.3.1 Government-led industrialization (1950s)

After the World War II, Thai economic recovery mainly relied on the increase in production and exportation of the primary products. Therefore, industrialization policy of Thailand at that time was nothing much to be mentioned until the Thai government issued Industry Promotion Act in October of 1954 and established Board of Investment. The background of launching such industrialization policy was that the import-substituting industry called for urgent attention as the price of the primary

products in the international market hovered at a low level, due to the end of special procurements from the Korean War, which eventually made Thai trade deficit expand. Another background of industrialization policy was aiming at the diversion of the domestic commercial capital, accumulated among the local Chinese, into industrial capital. However, the purpose of the Act was industrialization led by the government and, for instance, the Act ordained the government to hold some shares of the investment. Therefore, the Act was not attractive enough to the foreign investors and outstanding foreign direct investment was not seen until 1960s.

2.3.2 Beginning of private-sector-led industrialization (1960s)

As the government-led industrialization did not achieve solid results and did not attract foreign investors, the government changed its stance from the government-led industrialization to the private-sector-led industrialization, which is to invite FDI in a constructive manner, around 1960. This eventually made the activities of the Board of Investment (BOI) takes wings and the improvements in the investment procedures had taken place.

To begin with, the government amended Industry Promotion Act in October 1958 and in January 1959. The amendment stipulated the denationalization as well as the restrictions on the entry of the competitive companies in the sector where the investment promoted companies participate in.

Furthermore, following the recommendation made by the World Bank in 1959 on the improvement of trade balance and the application of the market mechanism, the government issued new Investment Promotion Act for Industry Business in 1960 and adopted a more proactive stance on the private-sector-led industrialization and foreign

capital inflow. This Act, including the following essential features; 1) introduction of market mechanism to the private sector activities and avoidance of the competition between private and public entities, 2) fostering the import-substitution industry, 3) proactive stance on the foreign capital inflow, played an important role in introducing foreign direct investments until 1972.

2.3.3 Selective foreign capital inflow (early 1970s)

Deterioration of the trade balance especially imbalance between Thailand and Japan as well as the growing nationalism against the foreign capital inflow after 1969 forced the Thai government to address restrictive stances against the foreign investment.

In 1972, the government issued new Investment Promotion Act and Alien Business Act, etc. in order to take the selective policy on the foreign investment. Investment Promotion Act included following features; 1) promotion on export industry, 2) decentralization of investment locations, 3) strengthening BOI's authority.

2.3.4 Invitation of foreign investment by strengthening BOI's authority (late 1970s through early 1980s)

In the late 1970s, it was seen that the Third Economic and Social Development Plan (1972-1976) did not prove to be fruitful. As the country faced the economic downturn, the government again shifted the main emphasis to attracting foreign investment and revised Investment Promotion Act in 1977. Major revisions were allowing the BOI to have more authority and promoting invitation of foreign investment, such as appointment of the Prime Minister as the chairman of the BOI, establishment of the investment service centers, etc.

As it moved into the 1980s, out of regret that the industrial development was not satisfactory so far, the Thai government advocated the development policy in the Fifth Economic and Social Development Plan (1982-1986) such as nurturing export competitiveness, expanding employment opportunities, promoting SME governance, decentralizing investment locations, improving self-sufficiency of energy supply, nurturing basic industries, improving scientific and technological capabilities. During this period, the development of natural gas in the Thai Gulf became operational on a commercial basis and the Eastern Seaboard Development Plan had started. However, as the world's economy stagnated due to the oil price shock, the price of the primary products, which were Thailand's flagship products, went down which eventually made the public debt increase and forced the Eastern Seaboard Development Plan to be discontinued. On the foreign investment front, the government eased the import restriction, set up an industrial adjustment committee, and enhanced the incentives to the investments which were export oriented, made in the rural province, or energy-saving.

2.3.5 Increase in foreign investment (late 1980s)

Following the Plaza Accord, signed in September 1985, fast-paced exchange fluctuations drove the labor-intensive industry out of Japan and Asia NIEs countries where labor cost is relatively high. This brought an investment boom in ASEAN countries where human resources were abundant and the labor cost was reasonable. Within 3 years from 1986 to 1989, the number of investment applied to the BOI increased fivefold and their amount increased ninefold. Among these investment, 60 to 70 % of them were FDI. Many of the foreign investments were export-oriented

and this brought about changes to the domestic industrial and trade mechanism in Thailand. The Sixth Economic and Social Development Plan (1987-1991) put forward the export promotion, privatization, as well as the diversion of the policy from the quantitative expansion to the qualitative expansion. During the period, annual GDP growth rate marked 10.5 %, however, there were many social and economic problems arose in accordance with the economy developed. For example, the interregional income differential was widened, bottlenecks in supplying infrastructure and human resources were ingenerated, saving-investment gap was widened, and the environmental problems were seen. As for the foreign investment policy, the BOI enhanced the privileges on taxes zone 3 programs in order to promote further foreign investment in the province.

2.3.6 Multifaceted development (early 1990s)

As the investment boom ended and as there was an economic downturn in Japan, new investments grew stagnant in the early1990s, however, those companies which already made investments steadily continued their operation. Hence the Thai economy continued to grow. Although the Thai economy sustained high rates of growth, as many social and economic problems described above become evident, the Thai government aimed moderate development, equality in income distribution, human resource development, improvement of the quality of life, protection of the environment, and exploitation of natural resources in the Seventh National Economic and Social Development Plan (1992-1996). In accordance with the Seventh National Economic and Social Development Plan, the BOI announced the basic principles of the new direction of the operation as enhancement of the investment in the rural area, promotion

of the investment in the IndoChina area, and promotion of the supporting industry.

Following these principles, the BOI started supporting Thai investments to the IndoChina area.

2.3.7 Asian Financial Crisis (After 1997)

Asian financial crisis, triggered by the transition of the floating exchange rate regime, made the Thai government undertake economic structural adjustments by following the International Monetary Fund's instruction. This forced the Thai government to tackle the issues of decline in exports, stagnant economy, efflux of foreign capital, etc.

In order to curb the outflow of the foreign capital, it was necessary to support import substitution industry and high-value added industry. Furthermore, as the domestic industry faced cash-flow problems, the government eased the restrictions on the ratio of capital contribution by the foreign investors and the foreign investors could hold more than 50 % of shares as long as Thai shareholders admitted. As for the export promotion plan, the government eliminated the restrictions on the import tax on the imported materials in accordance with the ratio of the production to be exported.

After that, as the recovery from the financial crisis was seen, the BOI revised the investment promotion policy and implemented it since August 2000.

This new investment promotion policy includes improvement of international competitiveness, promotion of the rural development, ensuring appropriate incentives on the taxation, adjustments of the investment zoning, requirements of International Organization for Standardization (ISO), relaxing the restrictions on the ratio of foreign capital, such as, allowing the 100 % foreign capital in the manufacturing sector

regardless of the location, etc. As the Aliens Business Act was amended, the sectors which impose restrictions on the foreign investors reduced from 63 sectors to 42 sectors.

After the Thaksin administration took place, the BOI put focus on several important sectors as promoted sectors namely agro-industry, automotives, fashion, electronics & electrical appliances, and high value-added services. In order to improve the particular industry, the BOI eased the investment zoning regulations to some industry.

Since 2004, in addition to the focus on the promoted sectors, the BOI promoted incentives on the research and development and human resource development in order to develop STI (skill, technology & innovation).

CHAPTER III

THE ELECTRONICS INDUSTRY

3.1 Definition of Electronics

The Ministry of Economy Trade and Industry defines electronic production as 1) Electronics including Audio Visual equipment, communications, computer and peripheral, other electronics, 2) Electronic parts/ semiconductor including display devices, and 3) IT solution/ Service.

The Ministry of Internal Affairs and Communications of Japan stipulates in its cabinet order the Japan Standard Industrial Classification (JSIC), a set of statistical standards used to classify all economic activities involving the production and provision of goods and services performed at business establishments in the form of a social division of labor and, under this statistical standards, most of electronics industry is defined in three major groups.

First one is “electronic parts, devices and electronic circuits” and the second one is “information and communication electronics equipment”, then the last one is “electronic equipments”. Contents of each group are described in the following sub sections.

3.1.1 Electronic parts, devices and electronic circuits

Electronic parts, devices and electronic circuits comprise six categories, namely 1) electronic devices, 2) electronic parts, 3) storage media, 4) electronic circuits, 5) unit parts, and 6) miscellaneous electronic parts, devices and electronic circuits.

"Electronic devices" are comprised of several classes such as electron tubes, photoelectric conversion element, semiconductor devices, except photoelectric conversion element, integrated circuits, and liquid crystal panel and flat-panel. Electronic tubes comprise establishments principally engaged in manufacturing electron tubes other than those for light sources. Establishments principally engaged in manufacturing electron tubes for mercury discharge lamps and other light sources are not classified under this criterion. The principal products include vacuum tubes for reception, vacuum tubes for transmission, discharge tubes, Braun tubes, X-ray tubes, mercury rectifier tubes, etc. Photoelectric conversion element refers to the establishments engaged in manufacture of primarily photoelectric conversion element (except the semiconductor element). The major product is light-emitting diode. Semiconductor devices, except photoelectric conversion element, refer to the establishments primarily engaged in manufacture of semiconductor element. The major products are diode, transistor, thyristor, and thermistor. Integrated circuits comprise establishments principally engaged in manufacturing and assembling semiconductor integrated circuits, thin-film integrated circuits and hybrid integrated circuits. Establishments principally engaged in manufacturing integrated circuits fitted with resistors, capacitors, semiconductor devices, and other individual parts, and electronic parts with ultra-compact structure (i.e. those with a device mounting density of at least 3 per square centimeter) are also included in this class. However, establishments principally engaged in manufacturing composite parts (i.e. those in which conventional resistors, capacitors, and other individual parts are integrated to comply with circuit standardization) are not classified under this group. Liquid crystal panel and flat-panel refers to establishment primarily engaged in manufacture of liquid

crystal panel and plasma panel etc.

"Electronic parts" are divided into three categories. First category comprises establishments principally engaged in manufacturing resistors, capacitors, transformers and composite parts (i.e. those in which conventional resistors, capacitors, and other individual parts are integrated to comply with circuit standardization). Second category is a group of electro acoustic transducers, magnetic heads and small motors. This category comprises establishments principally engaged in manufacturing speakers, microphones, headphones, and other parts, magnetic heads and small motors (i.e. those with input power of less than 3 watts). However, establishments that manufacture electric acoustic machinery and accessories (complete products) are not classified under this group. Third group comprises establishments principally engaged in manufacturing connectors, switches and relays.

"Storage media" is classified into two groups. One is semiconductor memory media including establishments primarily engaged in manufacture of a semiconductor memory card, memory stick, and other memory cards. Another one is optical discs and magnetic tapes and discs. This refers to establishments primarily engaged in manufacture of laser disk, magnetic disk, magnetic tape before recording. However, the establishments, primarily engaged in manufacture of laser disc, magnetic disk, and magnetic tape, with recorded information, are not classified in the electronics group.

"Electronic circuit" is classified into two groups. First is electronic circuit board. The major products are printed circuit board (board having conductive pattern formed by printing on the surface or on the surface and inside the insulated substrate based on circuitry to be connected between parts), module substrate (board provided on printed circuit board which is made electric interconnecting possible) and other such

boards. Second is electronic circuit implementation board. The major products are printed circuit implementation board (those composed of printed circuit board and mounted parts, having electric interconnecting), module implementation board (those composed of module board and mounted parts, having electric interconnecting), etc.

"Unit parts" consist of power supply unit, radio frequency unit (receiving tuner, receiving antenna), control unit, and other miscellaneous unit parts.

"Miscellaneous electronic parts, devices and electronic circuits" comprise establishments principally engaged in manufacturing rectifiers (except for power), magnetic material parts (i.e. those created by powder metallurgy) and other electronic parts that are not classified elsewhere.

3.1.2 Information and communication electronics

Information and communication electronics equipment comprise three categories, namely 1) communication equipment and related products, 2) image and audio equipment, and 3) electronic data processing machines, digital and analog computer, equipment and accessories.

"Communication equipment and related products" may be classified into six types. First type is the establishments primarily engaged in manufacture of telephone, switchboard, telegraph, carrier, cable broadcasting device and other cable broadcasting communication instrument and device. Second type is those engaged in manufacture of mobile phone, PHS telephone. Third type is radio communication equipment. The major products are radio broadcaster, television broadcaster, fixed station communications equipment, portable communications equipment, vehicle communications equipment, marine application communications equipment,

communications equipment for aviation, communications equipment for carrying, communications equipment for lifeboats, long-range navigation device, direction detector, beacon equipment, radar system etc. Fourth is the radio and television set receivers. Fifth is the railway signal and safety appliance. This class comprises establishments principally engaged in manufacturing electric signal safety equipment and machinery signal safety equipment provided for transport safety, as well as railway points and other turnouts. Sixth is miscellaneous communication equipment and related products. This class comprises establishments principally engaged in manufacturing acoustic signal equipment, warning equipment, and other telecommunication equipment that is not classified elsewhere.

"Image and Audio Equipment" can be classified into three types. They are video equipment, digital camera, and electric audio equipment instrument and device. Electric audio equipment instrument and device includes recording device, playback equipment, public address system and accessories (finished product) and their major products are stereo set, IC recorder, amplifier for high-fidelity, audio disk player, public address system, loud speaker system, pickup, microphone, headphones etc.

"Electronic data processing machines, digital and analog computer, equipment and accessories" can be classified into six types. First type is computer, except personal computer. This class comprises establishments principally engaged in manufacturing digital computers (limited to those with internal programs, and which use program languages). Second type is personal computer used for multiple purposes such as business, science and technology, measurement and control, education, hobbies, etc. Compact computers, whose main memory devices can be programmed freely, also be included. Third type is External storage. This refers to the establishment

primarily engaged in manufacture of storage device to which central processing unit (CPU) can write and read data through input-output channel. Fourth type is printer including line printers, page printers and other printing equipment. Fifth type is display unit such as CRT display, liquid crystal display etc. Sixth type is miscellaneous peripheral equipment including peripheral equipment such as scanner, terminal, and other input devices.

3.1.3 Electronic Equipment

Electronic Equipment comprise three categories, namely 1) X-ray equipment, 2)medical instruments electronic equipment, and 3) miscellaneous electronic equipment.

“X-ray equipment” includes X-ray equipment for medical and industrial uses. Establishments principally engaged in manufacturing X-ray tubes and X-ray rectifier tubes are not included.

“Medical instruments electronic equipment” comprises establishments principally engaged in manufacturing electronic application equipment for medical purposes using electronic energy.

“Miscellaneous electronic equipment” comprises establishments principally engaged in manufacturing particle acceleration equipment, radioactive substance application equipment, elastic wave application equipment, ultrasound application equipment, electromagnetic detection equipment, electric detection equipment, high-frequency power application equipment, electron microscopes and other electronic application equipment that is not classified in other area.

3.1.4 Classification in the Harmonized Commodity Description

These products mentioned above are classified in the Harmonized Commodity Description and Coding System (HS) of tariff nomenclature, which is an internationally standardized system of names and numbers for classifying traded products developed and maintained by the World Customs Organization. Four digits HS code descriptions, which Japan Electronics and Information Technology Industries Association (JEITA) employs, with regard to electronics industry are shown as below.

Table 3-1 HS Code Description of Electronics Products

8443	Printing machinery used for printing by means of the printing type, blocks, plates, cylinders and other printing components of heading 84.42; ink-jet printing machines, other than those of heading 84.71; machines for uses ancillary to printing."
8469	Typewriters other than printers of heading 84.71; word-processing machines.
8470	Calculating machines and pocket-size data recording, reproducing and displaying machines with calculating functions; accounting machines, postage-franking machines, ticket-issuing machines and similar machines, incorporating a calculating device; cash registers.
8471	Automatic data processing machines and units thereof; magnetic or optical readers, machines for transcribing data onto data media in coded form and machines for processing such data, not elsewhere specified or included.
8473	Parts and accessories (other than covers, carrying cases and the like) suitable for use solely or principally with machines of headings 84.69 to 84.72.
8501	Electric motors and generators (excluding generating sets).
8504	Electrical transformers, static converters (for example, rectifiers) and inductors
8514	Industrial or laboratory electric furnaces and ovens (including those functioning by induction or dielectric loss); other industrial or laboratory equipment for the heat treatment of materials by induction or dielectric loss
8517	Electrical apparatus for line telephony or line telegraphy, including line telephone sets with cordless handsets and telecommunication apparatus for carrier-current line systems or for digital line systems; videophones.
8518	Microphones and stands therefor; loudspeakers, whether or not mounted in their enclosures; headphones and earphones, whether or not combined with a

	microphone, and sets consisting of a microphone and one or more loudspeakers; audio-frequency electric amplifiers; electric sound amplifier sets.
8519	Turntables (record-decks), record-players, cassette-players and other sound reproducing apparatus, not incorporating a sound recording device.
8521	Video recording or reproducing apparatus, whether or not incorporating a video tuner
8522	Parts and accessories suitable for use solely or principally with the apparatus of headings 85.19 to 85.21.
8523	Prepared unrecorded media for sound recording or similar recording of other phenomena, other than products of Chapter 37
8525	Transmission apparatus for radio-telephony, radio-telegraphy, radio-broadcasting or television, whether or not incorporating reception apparatus or sound recording or reproducing apparatus; television cameras, still image video cameras and other video camera recorders; digital cameras
8526	Radar apparatus, radio navigational aid apparatus and radio remote control apparatus
8527	Reception apparatus for radio-telephony, radio-telegraphy or radio-broadcasting, whether or not combined, in the same housing, with sound recording or reproducing apparatus or a clock
8528	Reception apparatus for television, whether or not incorporating radio-broadcast receivers or sound or video recording or reproducing apparatus ; video monitors and video projectors
8529	Parts suitable for use solely or principally with the apparatus of headings 85.25 to 85.28
8532	Electrical capacitors, fixed, variable or adjustable (pre-set)
8533	Electrical resistors (including rheostats and potentiometers), other than heating resistors
8534	Printed circuits
8536	Electrical apparatus for switching or protecting electrical circuits, or for making connections to or in electrical circuits (for example, switches, relays, fuses, surge suppressors, plugs, sockets, lamp-holders, junction boxes), for a voltage not exceeding 1,000 volts
8540	Thermionic, cold cathode or photo-cathode valves and tubes (for example, vacuum or vapour or gas-fillled valves and tubes, mercury arc rectifying valves and tubes, cathode-ray tubes, television camera tubes)

8541	Diodes, transistors and similar semiconductor devices; photosensitive semiconductor devices, including photovoltaic cells whether or not assembled in modules or made up into panels; light emitting diodes; mounted piezo-electric crystals
8542	Electronic integrated circuits and micro-assemblies
8543	Electrical machines and apparatus, having individual functions, not specified or included elsewhere in this Chapter
9008	Image projectors, other than cinematographic; photographic (other than cinematographic) enlargers and reducers
9012	Microscopes other than optical microscopes; diffraction apparatus
9014	Direction finding compasses; other navigational instruments and appliances
9018	Instruments and appliances used in medical, surgical, dental or veterinary sciences, including scintigraphic apparatus, other electro-medical apparatus and sight-testing instruments
9019	Mechano-therapy appliances; massage apparatus; psychological aptitude-testing apparatus; ozone therapy, oxygen therapy, aerosol therapy, artificial respiration or other therapeutic respiration apparatus
9021	Orthopaedic appliances, including crutches, surgical belts and trusses; splints and other fracture appliances; artificial parts of the body; hearing aids and other appliances which are worn or carried, or implanted in the body, to compensate for a defect or disability
9022	Apparatus based on the use of X-rays or of alpha, beta or gamma radiations, whether or not for medical, surgical, dental or veterinary uses, including radiography or radiotherapy apparatus, X-ray tubes and other X-ray generators, high tension generators, control panels and desks, screens, examination or treatment tables, chairs and the like
9025	Hydrometers and similar floating instruments, thermometers, pyrometers, barometers, hygrometers and psychrometers, recording or not, and any combination of these instruments
9026	Instruments and apparatus for measuring or checking the flow, level, pressure or other variables of liquids or gases (for example, flow meters, level gauges, manometers, heat meters), excluding instruments and apparatus of heading 90.14, 90.15, 90.28 or 90.32
9028	Gas, liquid or electricity supply or production meters, including calibrating meters therefor

9030	Oscilloscopes, spectrum analysers and other instruments and apparatus for measuring or checking electrical quantities, excluding meters of heading 90.28; instruments and apparatus for measuring or detecting alpha, beta, gamma, X-ray, cosmic or other ionising radiations
9032	Automatic regulating or controlling instruments and apparatus
9106	Time of day recording apparatus and apparatus for measuring, recording or otherwise indicating intervals of time, with clock or watch movement or with synchronous motor (for example, time- registers, time-recorders)

Source: Customs Department

Describing electronics products more accurately more segmentalized HS codes in custom tariff codes of Japan which are provided by the Ministry of Finance are as follows. HS 844311 to 844313, HS 844331 to 844399, HS 846900 to 847190, HS 847310 to 847330, HS 850110, HS 850431, HS 850450, HS 851440, HS 851711 to 852290, HS 852351 to 852990, HS 853221 to 853400, HS 853641 to 853690, HS 854011 to 854320, HS 900820, HS 901210 to 901290, HS 901480, HS 901811 to 901819, HS 901849 to 901920, HS 902212 to 902290, HS 902519, HS 902610 to 902680, HS 902830, HS 903010 to 903090, HS 903289, HS 910610.

3.2 Trend of Japanese Electronics Industry

In 2005, the value of global production by the electronics industries was JPY 139.7 trillion. Of the JPY 139.7 trillion in global production by the electronics industry, production of electronic equipment accounted for JPY 89.4 trillion and electronic components and devices accounted for JPY 50.3 trillion. The most produced electronics product in value worldwide was Semiconductor (18.4 % of total production) followed by PC (15.2 % of total production). Electronic parts and peripheral such as HDD, laser disk devices, semiconductor memory card, LCD monitor,

printer, scanner, etc, were also manufactured in large volume.

Table 3-2 Global and Japanese Production by Electronics Category

Electronics category		global production (a)	Japanese products (b)	% (b)/(a)
AV		15.0	7.2	48.0
	TV	7.4	2.9	39.2
	DVD/Digital camera Video camera	3.1	2.2	71.0
	Car AVC	2.7	1.6	59.3
	Audio	1.8	0.5	27.8
Communication		24.7	4.0	16.2
	Cellular phone	11.5	1.9	16.5
	Cable broadcasting communications	8.6	1.3	15.1
	Base station/ Fixed communication	4.6	0.8	17.4
Computer and peripheral		40.9	7.9	19.3
	PC	21.2	1.6	7.5
	Peripheral	14.8	5.7	38.5
	Server/ Storage	4.9	0.6	12.2
Other electronics		8.8	2.6	29.5
	Electric measuing instruments	4.1	0.8	19.5
	Electronic applied equipment	4.1	1.4	34.1
	Office equipment	0.6	0.4	66.7
Electronic parts/ device		50.3	16.2	32.2
	Semiconductor	25.7	5.4	21.0
	Display device	7.6	2.4	31.6
	Electronic parts	17	8.4	49.4
Total		139.7	37.9	27.1

Source: JEITA 2005 (Unit: JPY trillion)

Production by Japanese companies was JPY 37.9 trillion, equivalent to 27 % of

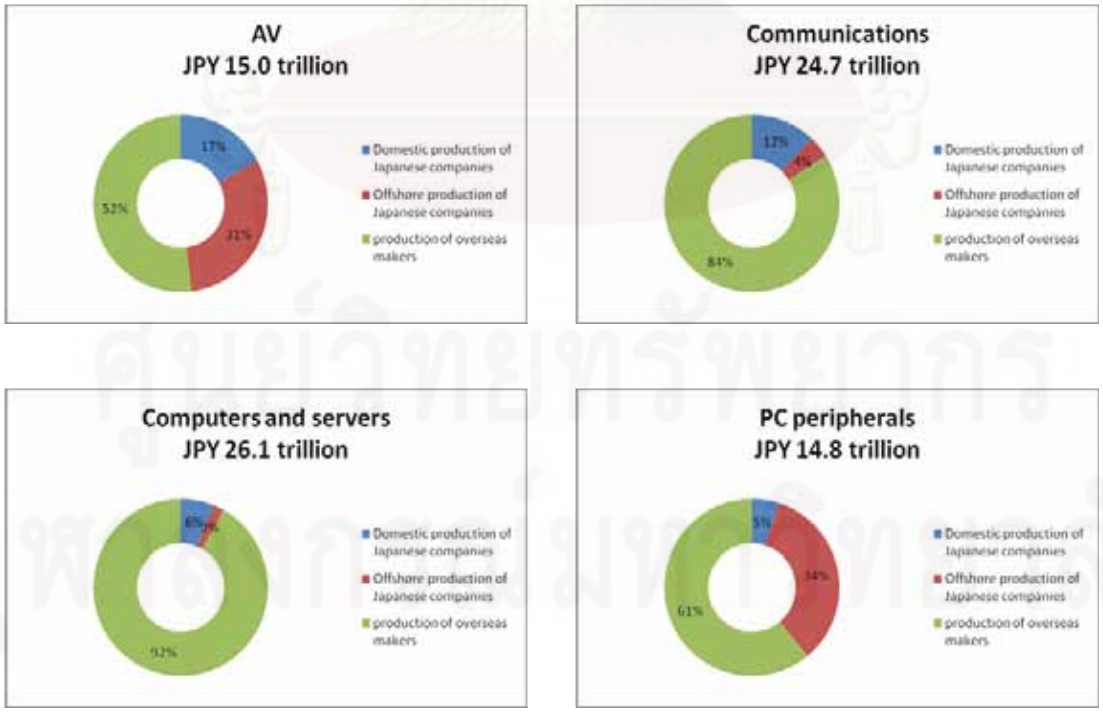
world's total production. Amongst JPY 37.9 trillion, JPY 8.4 trillion came from electronic parts covering about 22 % of Japanese total production. PC peripherals and semiconductors follow with JPY 5.7 trillion and JPY 5.4 trillion, consisting of 15 % and 14 % of Japanese total production respectively.

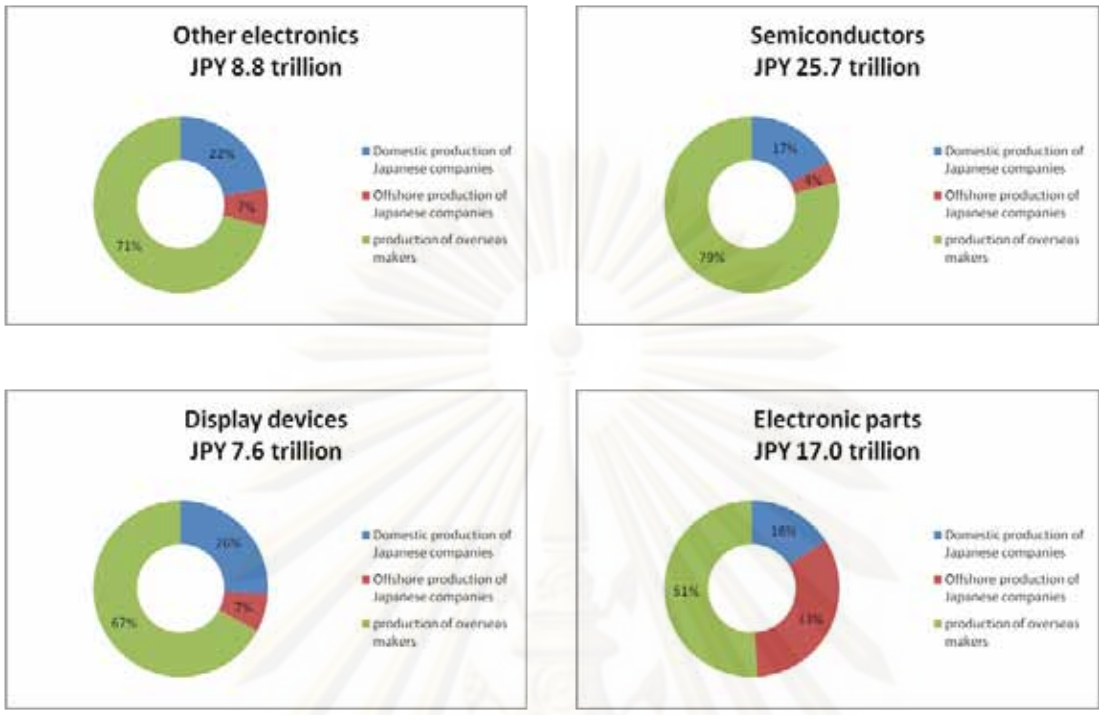
It is interpreted from the figure that many AV devices and electronic parts/ devices made by Japanese companies recorded huge global shares in terms of production value. More in detail, products such as DVD, digital camera and video camera (71%), office equipment (i.g. copier, 67%), car AVC (59%), and electronic parts (49%), are the fields where Japanese products are significant.

The total offshore production ratio for Japanese companies in 2005 was about 50 %, which implies that Japanese industry has already achieved the same overall level of production offshore as in Japan. However, distinctive patterns are read from the figure that it is either domestic production oriented or offshore production oriented. For instance, Japanese AV production make up about 50 % of the total worldwide production and more than 65 % of those Japanese products are made in the factory located outside Japan. The common pattern applies to PC peripherals and electronic parts. Japanese PC peripherals capture about 40 % of the total worldwide production, at the same time 87% of these Japanese products are manufactured oversea. Similarly, Japanese electronic parts such as connector, transformer, PCB etc. comprise almost 50 % of total worldwide production and 67 % of these Japanese electronic parts are manufactured in the production bases outside Japan. On the other hand, communications, computers and servers, other electronics, semiconductors, and display devices are domestic production oriented. Japanese communication equipments such as mobile phones hold 16 % shares of the total worldwide production and 75 % of them

are produced domestically. Japanese computers and servers comprise 8% of the total worldwide production and Japanese domestic production manufactures 75 % of them. As for other electronics such as electronic applied devices (X-ray/ supersonic wave application/ industrial televise), electric measuring instruments, office equipment (copier/calculator/ register), 29 % of them are manufactured by Japanese companies and 76 % of them are manufactured domestically. Japanese semiconductors hold 21 % shares of total worldwide production and 81 % of them are manufactured domestically. Display devices such as LCD device, PDP module, and electron tube made by Japanese companies hold 33 % shares of the total worldwide production and 79 % of them are manufactured in Japan. It is seen that products that have high market share by Japanese companies in the world market are likely to be manufactured in the offshore production base of Japanese companies.

Figure 3-1 Production Shares by the Electronics Industries





Source: JEITA

Japanese manufacturing operations overseas can be divided into two groups. First group is aiming at import-substitution production and marketing bases for host countries (e.g., automobiles, white goods and consumer electronics), and second group is aiming at production and export bases for the world market (e.g., electronics). For electronics manufacturers and other Japanese companies positioning ASEAN as their global production centers, the key factor of investing abroad is to maintain and strengthen international competitiveness so as to compete with inexpensive Chinese products. Following an influx of foreign direct investment toward China, ASEAN countries have drastically relaxed restrictions on foreign investment and expanded measures to promote foreign direct investment (JETRO 2003).

3.3 Successful Case of Korean Electronics Industry

During the early years of its electronics industry, Korea was in the primitive

stage of simply assembling vacuum tube model AM radios. Despite Korea's later start than advanced economies, the electronics industry has contributed significantly to the country emerging as the world's 12th largest economy. Korea is currently taking the lead in the world's electronics and IT industries as a major supplier of numerous high-tech products such as DRAM and SRAM. In this process, Korean electronics engineers have devoted their energy and efforts to a point beyond the imagination.

It was a national commitment and there have been timely efforts by the government and conglomerate that orchestrate towards the successful development. There are many researches on this subject and one of the researches conducted by Kim (1997) indicates that, unlike other developing countries, “Korea restricted FDI and foreign licensing but promoted technology transfer through other means such as capital goods imports in the early years.” They tried to achieve skills by reverse engineering. “Such a policy, designed to maintain Korea’s management independence from foreign multinationals, was effective in forcing Korean firms to take the initiative and a central role in learning, that is, acquiring, assimilating, and improving imported technologies, rather than relying entirely on foreign sources.” After two decades of restrictive policy toward foreign direct investment and foreign licensing, Korea liberalized its technology transfer policies in the 1980s and 1990s. With the skills developed during reverse engineering stage associated with added value nurtured from technology transfer in the later stage from FDIs, Korea has become a leading country in the world’s electronics and IT industries. It cannot simply be explained that different approaches in the government level policy or different characteristics of nationality led to different status in the industry, however, it is worthwhile looking into the level of commitment in developing their industries between one country to another.

Table 3-3 Korean Government's Policy Change in Electronics Industry

Policies	1960s and 1970s	1980s and 1990s
Industrial Policies	Deliberate promotion of big businesses Export orientation Promotion of heavy and chemical industries Repression of labor to maintain industrial peace	Promotion of SMEs Export orientation Antitrust and fair trade Trade liberalization Financial liberalization Intellectual property rights protection Shifting emphasis on R&D, manpower development
Science and Technology Policies	Restriction on FDI and FLs Promotion of capital goods import Promotion of GRIs in lieu of university research Promotion of GRIs	Promotion of FDI and FLs Extensive diffusion networks Promotion of university research Promotion of corporate R&D activities Promotion of national R&D projects

Source: Kim

3.4 Technology Transfer in Thai Electronics Industry

Technology transfer in Thailand is made through FDI and trade. Through FDI, production, management and marketing technologies have transferred. Thailand, which has the characteristics as a contract manufacturer and component producer in general, has obtained some of the technologies required for assembling and manufacturing the products from their parent companies.

In order to make use of such technologies, technology diffusion should take

place. This has required the technology owners, other potential beneficiaries and relevant public institutions to have them linked together.

There are in general three major stages in the production of electronics products. They are design, manufacture and assembly. In the design stage, wide-ranging and meticulous technical knowledge, and sufficient R&D for the development of novel products and processes are required. Whilst in the manufacture stage, sufficient capital for investment is required. As for the assembly stage, sufficient capital and labor are required. As the stage goes from assembly to design, skills necessary for such levels become more sophisticated. Nevertheless, each of these stages involves significant learning and innovation processes.

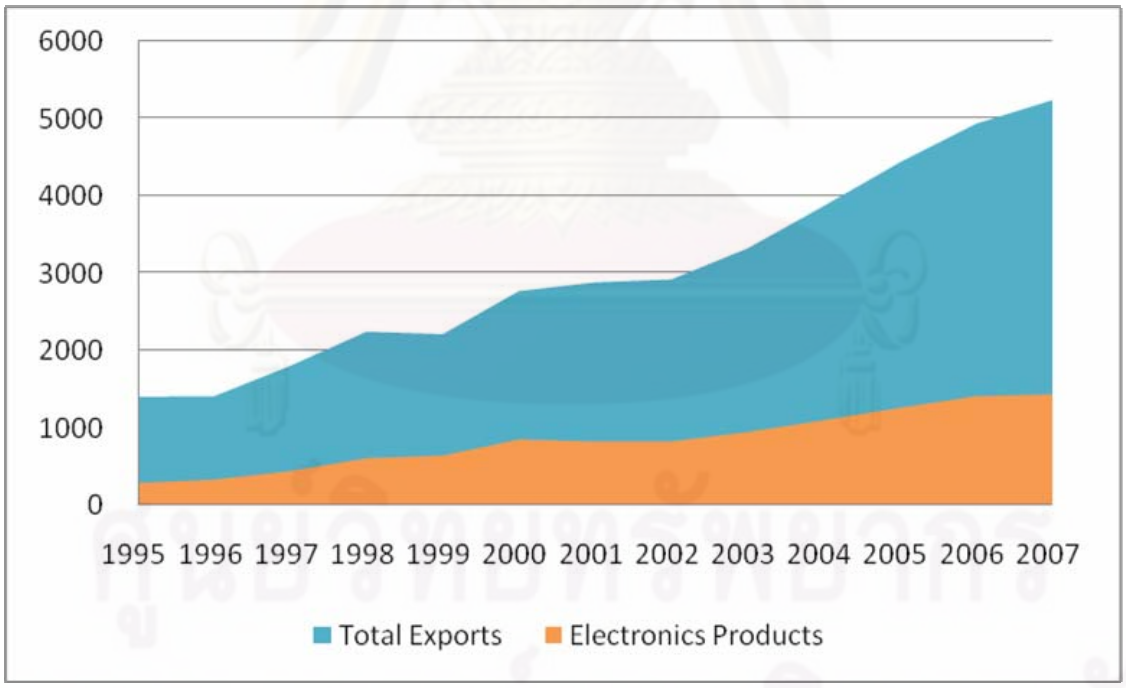
As has often been the case in the other industries, the main process that Thai electronics industry conducted has been the assembly of low-technology consumer products, however, it has also developed into assembly and manufacture of high-technology products. In the formative stages, Thai electronics industry largely acquired technology for assembling consumer products such as radios and television. Subsequently, it has acquired more sophisticated technologies for assembling more advanced products such as Printed Circuit Board, FDD and HDD since 1980s.

That is to say, Thai electronics industry has achieved its competence to adapt and operate foreign technologies. Yet manufacture capabilities remained in some limited products such as HDD. There have been prominent foreign manufacturers investing in producing HDD in Thailand. However, Thai HDD manufacturers have not attained research and development capabilities so as to design products by themselves yet. The MNCs are said to perform most of the design and product development activities in their home country or their subsidiaries in the developed

countries.

Overall, Thai electronics companies have become very productive and efficient assemblers, hence they have turned out to be well competitive in the international market. In other words, companies have assimilated production, management and process technologies. From the graph below, it could be interpreted that such Thai electronics industry's development backed by the steady assimilation of the production, management and process technologies have made it possible for Thai electronics manufacturers to constantly increase their exports every year consisting about 30 % of total Thai export.

Figure 3-2 Exports of Electronics Products in Thailand



Source: Bank of Thailand Unit: Billion Baht

3.5 Thai Government's Efforts to Enhance Technology Transfer

FDI facilitated the transfer of production, management and process technologies to Thailand (Enos, 1989). And the involvement of MNCs has enhanced the development of local contract manufacturers and provided knowledge of external market needs to some extent. However, as contract manufacturers, the domestic manufacturers are prone to assemble products that are required by the contractors which eventually end up without developing novel products that compete with other recognized companies. Accordingly, few companies have assimilated and mastered foreign technologies to enable them to undertake technology upgrading or reverse-engineering activities. Even fewer companies have the capacity to design and develop novel products.

Because the technology diffusion in the electronics industry has largely occurred within the production networks of MNCs, this has limited the innovative activities to process upgrade and design.

Thus, the Thai government has initiated several projects aiming to upgrade the electronics industry from assembly to the manufacture and design stages. For instance, the National Science and Technology Development Agency (NSTDA) established the Industrial Consultancy Services in 1992. The objectives of the project were providing technical consultancy for Thai industry by supporting them to use technical consultants efficiently at reasonable cost; providing technical experts for problem-solving or production development; and communicating problems or needs of industry to technology institutes such as universities and research institutes.

Technical services include diagnosis of preliminary technical problems by experts and identification of experts, both local and overseas, to solve technical

problems as well as assist in production development, which includes technology management, but not administration and marketing.

Local experts are mainly high caliber technical personnel from universities and research institutes or consulting companies. Experts from overseas include international cooperating organizations, such as Canadian Executive Services Organization, International Executive Service Corporation, Japan Overseas Development Corporation, Australian Executive Service Overseas Program Limited, Senior Experten Service, Steinbeis Foundation for Economic Promotion, British Executive Service Overseas, and Netherlands Management Consultancy Program.

Technology Management Center of NSTDA provides both tangible and intangible support to increase the success rate of technology start-up companies. The main goal is to create the technology companies successfully and to transfer innovations and technologies to entrepreneurs as well as to enhance their capacities on the commercialization of technologies and increasing their competency to respond innovatively to global market changes.

In order to fulfill such objectives, NSTDA set up the Software Park Thailand (SPT) in 1997. SPT is a government agency to stimulate the development of Thai software industry, promote innovation and facilitate the development of start-up companies by offering a technology transfer service. Among its strategic partners are Oracle, IBM, Intel, Microsoft, Centre of Excellence for Computer Security, and Internet Thailand. The establishment of SPT has facilitated technology transfer within and outside the Park and encouraged knowledge flows between Thai industry, NSTDA, participating universities and MNCs.

The BOI also initiated a project called the BOI Unit for Industrial Linkage

Development (BUILD). BUILD is a project that provides a channel of communication with the manufacturing sector in Thailand.

The BOI had a policy to promote and develop supporting industries to boost the country's manufacturing sector. To this end, it established BUILD in 1992. The objectives of BUILD are to act as an intermediary between manufacturers of ready-made products and small and medium sized manufacturers of parts, which will result in the linkage of industries and the transfer of production technology.

It aimed to promote the establishment of an industrial linkage network by strengthening the relationship between assemblers and parts suppliers; to promote the development of supporting industries, which will enhance the competitiveness of assemblers in Thailand; to help small-and medium- sized manufacturers of parts increase production efficiency and product quality; to promote cooperation between foreign investors, Thai parts manufacturers, and government offices; to promote Thailand as the region's center for parts manufacturing and source of raw materials; and to eliminate obstacles in subcontracting and to push for policy changes that will facilitate industrial linkage development.

Activities of the Industrial Linkage Project are providing information about subcontracting opportunities in Thailand by utilizing a computerized database, which lists buyer's requirements for types of parts and raw materials, as well as items that can be produced in Thailand; providing assistance for foreign buyers wishing to buy from a Thai parts manufacturing source; linking sellers and buyers in related businesses; providing technical and management support for domestic parts manufacturers who wish to become subcontractors, with officers from BUILD acting as coordinators on both the buyers' and sellers' behalf; preparing investment manuals, complete with

technical details and marketing information, for prospective subcontractors; managing and coordinating training programs to enhance the marketing and technological capacity of small-and medium-sized manufacturers; arranging for Thai parts manufacturers to participate in trade shows and exhibitions abroad; coordinating and providing assistance for manufacturers in acquiring services in technology, management, finance and marketing from other government offices.

The BOI aims that companies participating in the project as well as the country as a whole will benefit through these activities. For example, benefits for assemblers are cost saving in investment in component production and raw materials; reduction in the cost of maintaining inventory; reduction in risks associated with transportation of components and raw materials; greater opportunities for selection of components and raw materials.

Benefits for manufacturing subcontractors are investment opportunities; new export markets for surplus domestic goods; improvement in the manufacturing process; financial consultation for investment; information service regarding quality, quantity, marketing of goods and technology.

Benefits to the country are expansion of markets for local small-and medium-sized companies of producing components and raw materials; technology transfer; opportunity for complete integrated processes in Thai industry; reduction of obstacles in the existing industrial development process; opportunity for expansion of industry in the country through investment by multinational companies.

Electronics industry was the one of the targeted industry, hence manufacture of material for microelectronics and electronic design were regarded as priority activities. Projects in these activities are entitled to the exemption of import duty on machinery

regardless of location; corporate income tax exemption for eight years, regardless of location; and other privileges entitled for each Zone.

A number of companies in the electronics industry, such as Hitachi, Toshiba, IBM, Fujitsu, Canon and Sony, are involved in BUILD. Issues such as business policies on purchasing and subcontracting and technology confidentiality are addressed.

In terms of technology transfer and upgrading, the program played an important role in encouraging the development of contract manufacturers and the transfer and development of technologies, as well as encouraging technology diffusion and spillovers.

However, most of the electronic exports have high import content. In order to ameliorate the situation, the Thai government has developed the Thailand IC Design Incubator to promote semiconductor design capabilities, and the training and certification of IC layout designers. It is anticipated that it will attract IC layout designers from outside Thailand and help bring other concerned expertise together in the semiconductor sub-sector (industry, universities and public institutions) to collaborate to promote knowledge exchange. This may encourage innovation, skills development and the creation of stronger linkages.

The NSTDA has implemented several projects to address the needs of the HDD sub-sector for the purpose of making the HDD sub-sector competitive, increase the local content of assembled products, and promote design and product development capabilities. So far, this industry depends high- technology components on imports.

In early 2004, the BOI adopted a new incentives program for companies, which contributed to developing skills, technology and innovation in the Thai workforce, called Skills, Technology & Innovation (STI) incentive package. This program was

originally set to enhance Thailand's attractiveness as a site for the hi-tech industry, the STI incentive supports the nation's drive to enhance human resources and improve its international competitiveness, and aims at projects with components investing in research or design or developing Thai staff or supporting educational or research institutions. When it was adopted, the STI initiative marked a significant change in the investment incentives offered by the BOI, which were previously directed towards targeted industries, whereas STI cut across all sectors.

The STI program has since been amended to allow for greater flexibility in making qualifying investments and today, in order to support the investment into capacity development, the BOI policy designates two groups that fall under the policy, as follows: Companies that promote skills, technology and innovation through minimum expenditures on R&D, human resources and vendor development; and companies that are engaged directly with STI development by being engaged in eight specified activities. These activities include electronics design, R&D, and human resource development.

For companies or projects that qualify on some conditions, which are set in accordance with the amount or percentage of sales on investments or expenditures on R&D or design, advanced technology training, or supporting an educational or research institution, BOI provides the additional corporate income tax exemptions as shown in the Table 3-4, however the total duration of the exemption shall not exceed eight years.

Table3-4 STI Incentives

% of First Three Years' Sales	Additional tax holidays
1% or max. 150 million baht	1 year
2% or max. 300 million baht	2 years
3% or max. 450 million baht	3 years

Note: Corporate income tax holiday may not exceed eight years.

Source: BOI

This policy also serves to create a linkage between the educational institutions and the manufacturing sector, in terms of supply and demand, with education providing the right qualifications for human resources to meet the needs of the manufacturing sector. In turn, this results in increased employment opportunities.

To this end, these efforts, among other initiatives, are expected to help overcome the current challenges and accelerate the development of high-value electronic products. There are increasing efforts to provide incentives to stimulate industry to perform R&D activities in Thailand as a way to promote innovation and technology upgrade and development.

According to BOI, Thailand is now ranked in the top three for R&D in Southeast Asia, behind Singapore and Malaysia,

It is said that local operators have had a greater awareness of the importance of R&D since facing tough competition in labor-intensive industries from China and

Vietnam. The R&D moves by those leading companies are also the key to enhancing their business competency.

However, NSTDA revealed that 15 % of companies have R&D facilities, while 48 % have no facilities at all. The majority of the companies surveyed possess mainly quality control assurance and testing facilities. The survey also revealed that the linkage between private companies and public research institutions is still weak.

The limited R&D investment and human resource development within Thai companies and the weak linkages between public research institutions and industry may be affecting further performance of the Thai electronics industry.

3.6 Japan's R&D Trend

According to the Ministry of Internal Affairs and Communication of Japan, Japan's total expenditure on R&D during fiscal year 2007 stood at 18,944 billion yen, an increase of 2.6 % from the previous fiscal year. It is the highest figure and it has the increasing trend for eight consecutive years. Expenditure on R&D as a percentage of GDP was 3.67 %, maintaining the highest rate in the past years. R&D expenditure for transportation equipment increased 8.0 % from the previous fiscal year while information and communication electronics equipment increased 7.6 %, drugs and medicines increasing of 6.8 %, respectively.

With regard to technology balance of payments by private companies, receipts for technology exports such as patent licensing or know-how transfer reached 2,482 billion yen, a record figure and up by 4.4 % from the previous fiscal year.

Payments for technology imports reached 711 billion yen, also a record figure, and up by 0.7 % from the previous fiscal year. Ratio of receipts for technology exports to payments for technology imports was 3.49, the highest in the past years.

Regions where Japanese technology exports are concentrated are North America and Asia. In the manufacturing industry, technology with the estimated value of JPY 1 trillion is exported to North America and JPY 796 billion to Asia. Technologies exported to North America mainly fall under the categories of transportation equipment, and drugs and medicines amounting JPY 671 billion and JPY 178 billion, respectively. Technologies exported from Japan to Asia are mainly categorized in transportation and electronics industries. Asia receives more than half of the technologies in electronics industry exported from Japan to the world.

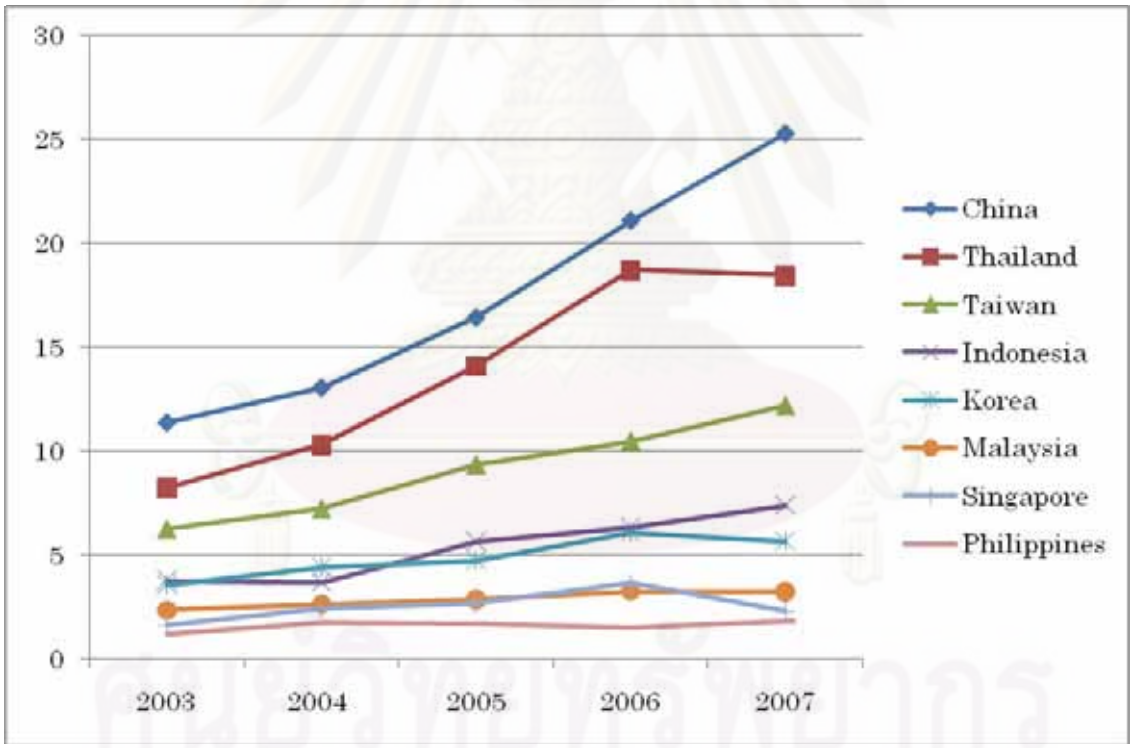
Table 3-5 Receipts of Technology Exports from Japan by Industry in 2007

Industry	Asia (excl.West Asia)	West Asia	North America	South America	Europe	Other area	Total
Agriculture, Forestry and Fisheries	31	–	–	–	–	–	31
Construction	6, 923	4, 400	0	0	2	–	11, 325
Manufacturing	796, 720	26, 121	1, 065, 683	52, 561	413, 797	46, 162	2, 401, 045
Food	5, 500	–	6, 016	1, 373	4, 417	98	17, 403
Textile	6, 305	–	3, 207	–	3, 768	–	13, 279
Drugs and Medicines	1, 554	65	177, 585	–	103, 778	3	282, 985
Chemical and Allied Products	42, 695	1, 979	12, 571	199	15, 371	326	73, 141
Petroleum and Coal Products	776	–	1, 377	20	69	4	2, 247
Plastic Products	9, 543	40	4, 466	11	2, 982	240	17, 282
Rubber Products	18, 756	926	14, 528	2, 437	13, 432	1, 280	51, 359
Ceramic, Stone and Clay Products	44, 837	25	3, 029	377	4, 694	565	53, 527
Iron and Steel Products	3, 265	217	1, 205	118	344	27	5, 176
Non-ferrous Metals and Products	12, 364	–	3, 162	–	1, 340	51	16, 916
Fabricated Metal Products	5, 308	14	2, 513	5	1, 495	77	9, 413
General-Purpose Machinery	28, 322	73	4, 722	19	32, 707	86	65, 930
Production Machinery	16, 699	–	19, 833	897	24, 861	61	62, 351
Business Oriented Machinery	11, 850	–	13, 168	14	12, 266	102	37, 401
Electronic Parts, Devices and Electronic Circuits	60, 666	498	8, 977	52	2, 423	15	72, 631
Electrical Machinery, Equipment and Supplies	51, 842	193	43, 864	1, 133	14, 569	1, 009	112, 609
Information and Communication Electronics	136, 457	7	70, 889	506	37, 484	252	245, 594
Transportation Equipment	335, 628	22, 084	670, 552	45, 297	135, 076	41, 589	1, 250, 226
Miscellaneous Manufacturing Industries	2, 628	–	3, 784	–	2, 112	378	8, 902
Electricity, Gas, Heat Supply and Water	1, 450	57	235	98	49	1	1, 890
Information and Communications	13, 984	81	9, 830	–	16, 216	–	40, 111
Wholesale and Retail Trade	298	–	407	–	181	111	998
Scientific Research, Professional and Technical Services	19, 331	1, 271	842	1, 230	1, 720	1, 419	25, 812
Total	838, 948	31, 931	1, 077, 600	53, 890	432, 169	47, 728	2, 482, 267

Source: Ministry of Internal Affairs and Communication Unit: JPY million

As the outstanding number of Japanese investments flow to China, Japanese technology exports to China also show the same tendency. Thailand, as the second largest Japanese FDI recipient country in Asia, receives the second largest amount of technology exports from Japan in Asia. As the Table 3-5 shows the receipts of technology exports from Japan to Asia by country, there is an increasing trend of the technology exports from Japan to Asia.

Figure 3-3 Receipts of Technology Exports from Japan to Asia by Country



Source: Ministry of Internal Affairs and Communication unit: JPY 10 billion

Taking a look at public-private cooperation, there are several schemes by the Japanese government related agencies that promote the improvement of Thai industry.

For instance, Japan Overseas Development Corporation (JODC) dispatches highly qualified Japanese experts to developing countries, with the support of Japanese private businesses and organizations, to assist those countries in human resource development. Such technical guidance mainly aims at contributing to the industrial development of those countries, vitalizing of Japanese affiliated companies and supporting the global expansion of Japanese small or medium-sized enterprises. This cooperation is carried out with subsidies from the Ministry of Economy, Trade and Industry of Japan.

The number of the total experts dispatched to Thailand was 72 experts in 2006, 58 experts in 2007, and 56 experts in 2008. However these experts were mainly dispatched in the automobile sector and as to the electronics sector, there were 3 experts, 6 experts, and 6 experts in those years.

According to the official of the JODC, there was a plan to establish a technology transfer project in Thai electronics industry imitating the successful case of the routine teaching visit by Japanese experts in Thai automobile industry. However, as it became apparent that the electronics industry was not that coherent compared to the automobile industry and, in addition, there were very few common electronics parts that were universally used among the electronics manufacturers therefore each company applied its own technology rather than the technology used in general. Hence, the plan to establish a technology transfer project was not materialized.

Apart from the cooperation by JODC, there is a human resource development program by JETRO called JETRO Expert Service Abroad for Improving Business Environments (JEXSA). This program utilizes the network formed by JETRO with the industry associations in the developing countries. It entails the dispatch of Japanese experts to relevant industry associations and human resources development

institutions in order to support industry development in developed countries. By utilizing JEXSA scheme, there were some experts dispatched to Thailand in the automobile industry. In this case, Thailand requested the assistance of the Government of Japan for technical cooperation to establish the human resource development system. This request initiated the Automotive Human Resource Development Project (AHRDP), which began in December 2006 for public-private cooperation in Japan and Thailand utilizing Japan's Official Development Assistance (ODA). This project was unique in that ODA was used with the backing of the Government of Japan, the private sector, and their respective counterparts in a developing country. An expert advised the Government of Thailand on policies and qualification systems so that it could, with the help of local instructors with previous experience working with Japanese companies, provide people in supporting industries with training in a sustainable manner.

Unlike automobile industry, there is no expert dispatched in the electronics industry in Thailand recent years.

CHAPTER IV

RESEARCH DESIGN

4.1 Definition of Technology

The UNCTAD draft international code on the transfer of technology describes "technology" as "systematic knowledge for the manufacture of a product, for the application of a process or for the rendering of a service, which does not extend to the transactions involving the mere sale or mere lease of goods". This means that the technology is the knowledge that goes into the creation and provision of the product or service and the finished product or service are not included as such.

Hayashi (1990) defines technology as including widely ranging kinds of knowledge, including scientific knowledge deliberately and purposefully used for production, operation, distribution, and utilization of information.

Kim (1997) refers to technology as "a collection of physical processes that transforms inputs into outputs and knowledge and skills that structure the activities involved in carrying out these transformations. That is, technology is the practical application of knowledge and skills to the establishment, operation, improvement, and expansion of facilities for such transformation and to the designing and improving of outputs therefrom."

Kaosa-ard (1987) mentions that "technology" includes not only "knowledge or methods that are necessary to carry on or to improve the existing production and distribution of goods and services" or indeed to develop entire new product or processes, but also "entrepreneurial expertise and professional know-how".

Teece (1997) describes technology in two types. One is "hardware" technology

and another is “software” technology. “Hardware” technology can be described as physical objects, such as machine, equipment, patents, production manuals, blueprints. And “software” technology is knowledge that resides in human beings, i.e., skills that relate to “methods of organization and operation, quality control, and various other manufacturing procedures”. These skills are of importance for the efficient utilization of “hardware” technology.

4.2 Definition of Technology Transfer

“Technology transfer” is the process by which commercial technology is disseminated. This takes the form of a technology transfer transaction, which may or may not be covered by a legally binding contract (Blakeney, 1989). The UNCTAD draft International code on the Transfer of Technology has listed the following as the types of “technology transfer” transactions.

(a) The assignment, sale and licensing of all forms of industrial property, except for trademarks, service marks and trade names when they are not part of transfer of transfer of technology transactions;

(b) The provision of know-how and technical expertise in the form of feasibility studies, plans, diagrams, models, instructions, guides, formulae, basic or detailed engineering designs, specifications and equipment for training, services involving technical advisory and managerial personnel, and personnel training;

(c) The provision of technological knowledge necessary for the installation, operation and functioning of plant and equipment, and turnkey projects;

(d) The provision of technological knowledge necessary to acquire, install and use machinery, equipment, intermediate goods and/or raw materials which have been

acquired by purchase, lease or other means;

(e) The provision of technological contents of industrial and technical co-operation arrangements.

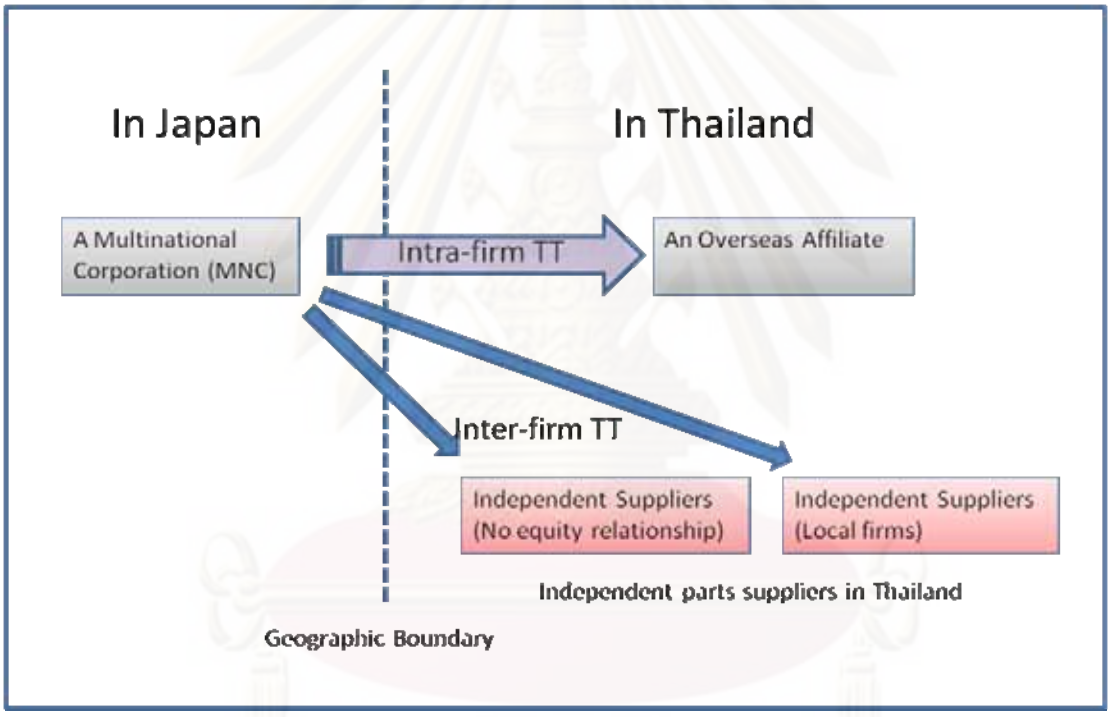
Although technology can be transferred through many channels such as licensing, it is well understood that FDI is the most important mode of technology transfer. It is regarded as one of the most important issues for many policymakers in developing countries to attract FDI to their countries. They expect that the inflow of FDI may contribute to the economic development by an improvement of productivity, a job creation, and an increase of exports. In particular, they have a strong interest in technologies and managerial know-how spillover by the MNCs, which are considered to be transferred through FDI.

In short, such contribution may take the form of (i) an intra-firm technology transfer within MNCs and (ii) a technology spill over from foreign companies to domestic companies. The former means the technology transfer from a parent company of MNCs to its foreign affiliates, and the latter means the technology transfer from foreign affiliates to domestic companies (see Figure 4-1).

The UNCTAD draft International code on the Transfer of Technology distinguishes the latter type from the technology transfer by describing it as the technology diffusion. The technology diffusion is better seen as another benefit that the transfer of technology may bring to a host economy. This can be achieved by the fact that the introduction of a technology into a host country creates an awareness of that technology. That awareness may spill over into the economy as a whole. This may occur without any deliberate intent, simply through the passage of time, or it may occur as a result of deliberate policies on the part of the host country, such as training

requirements for local personnel or the compulsory licensing of technology to local companies, or as a result of MNCs strategy in the form of purchase of inputs, components and services from local companies, requiring the latter to become familiar with the technology involved so as to be able to perform the functions required by MNCs.

Figure 4-1 Intra- and Inter-firm Technology Transfer



Source Techakanont (2003)

Obviously, MNCs are interested in the intra-firm technology transfer since the successful intra-firm technology transfer leads to a favorable performance of its foreign affiliates. Meanwhile, it is understood that host countries of FDI are rather interested in the technology diffusion since it would raise the productivity of their domestic companies.

JBIC Institute (2002) describes some mechanisms how FDI transfers technology to the host country, either directly or indirectly. They are vertical linkages, horizontal linkages, labor turnover, and international technology spillovers.

Vertical linkages take place when MNE affiliates transfer technologies to local firms that supply them with intermediate goods, or to buyers of their own products.

Horizontal linkages take place when local firms in the same industry or phase of the production process adopt technologies through imitation, or may be forced to upgrade their own technologies due to increased competition from MNE affiliates.

Labor turnover is where workers trained or previously employed by MNE affiliates transfer their knowledge to other local firms when they switch employers or set up their own businesses.

International technology spillovers occur when MNEs enhance local technological capability through R&D activities in the host country or through intra-firm transfer of technology (i.e. from the parent firm to its foreign affiliates).

The extent of technology transfer sometimes derives from the balance between suppliers and recipients of technology. Figure 4-2 schematically represents the implications for suppliers. Kim (1997) mentions that in quadrant 2, where suppliers transfer technologies but catching-up firms do not have absorptive capacity, the suppliers enjoy technological power and recipients suffer from the syndromes of technological dependency. This represents the typical outcome of a zero-sum game. In contrast, no one gains in quadrant 4, where suppliers are unwilling to transfer their technology and catching-up firms do not have the skill to benefit from the existing technology.

It is in quadrants 1 and 3, where firms in catching-up countries have absorptive

capacity that technology suppliers in advanced countries worry about the backfiring effects of transfer. But regardless of whether or not a particular firm in an advanced country is willing to transfer technology through formal mechanisms, firms in catching-up countries in quadrants 1 and 3 would be able to acquire foreign technologies, either from alternative sources or through informal mechanisms. It is also in quadrant 1 that firms in catching-up countries do not end up technologically dependent on suppliers. That is, quadrant 1 is the best alternative for both suppliers and recipients.

Figure 4-2 Strategy for Suppliers of Technology

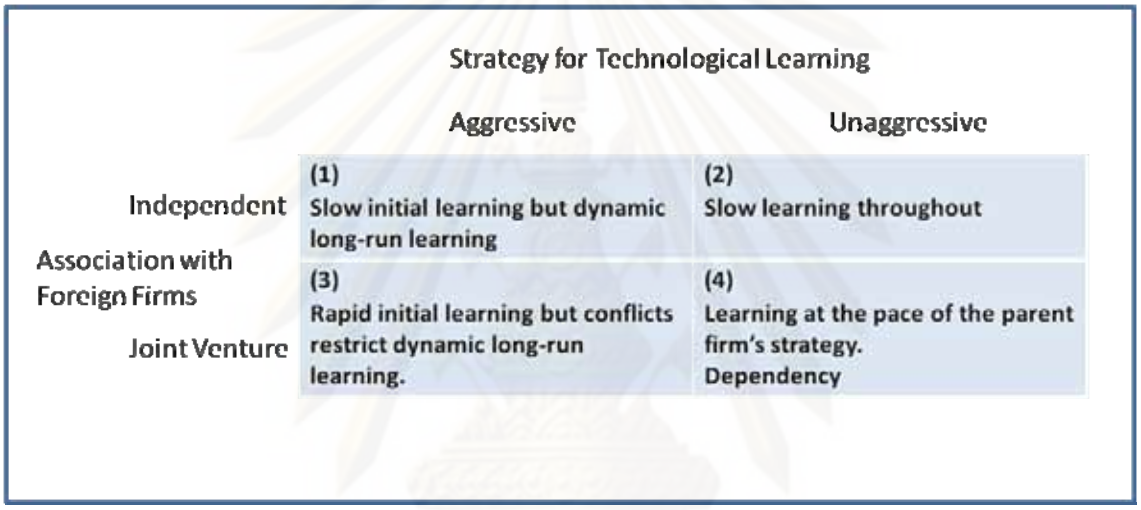
		Absorptive Capacity of Recipients	
		High	Low
Willingness of Suppliers to Transfer Technology to Recipients through Formal Mechanisms	Yes	(1) Technology transfer takes place. Both suppliers and recipients gain.	(2) Technology transfer takes place. Suppliers gain but recipients become dependent.
	No	(3) Technology transfer takes place. Suppliers lose but recipients gain.	(4) Technology transfer does not take place. Neither suppliers nor recipients gain.

Source: Kim (1997)

Kim also notes that, from the standpoint of Recipients of technology, for those which invest aggressively in technological learning to accumulate capability, particularly if they have a global vision, it is better to eschew foreign equity participation (1). Even if such an interest is allowed, management should maintain its independence. Otherwise, conflicts arise (3) when the learning and marketing strategy

of the subsidiary can be constrained by that of the parent company. But recipients of technology which are not aggressive in acquiring technological capabilities can definitely benefit from joint venture (4); however, the parent company usually controls the pace of the learning. As a result, the recipients become dependent on the parent.

Figure 4-3 Strategy for Recipients of Technology



Source: Kim (1997)

However, many Japanese electronics companies in Thailand are mainly 100% owned by the parent companies as Thai investment policy allows them for such equity participation. Therefore, strategy for recipients of technology is limited in this sense.

4.3 Measurement of Technology Transfer

Kim refers to technological capability as "the ability to make effective use of technological knowledge in efforts to assimilate, use, adapt, and change existing technologies. It also enables one to create new technologies and to develop new products and processes in response to changing economic environment. It denotes

operational command over knowledge. It is manifested not merely by the knowledge possessed, but, more important, by the users to which that knowledge can be put and by the proficiency with which it is used in the activities of investment and production and in the creation of new knowledge." For this reason, the term "technological capability" is used interchangeably with the term "absorptive capacity": a capacity to absorb existing knowledge and in turn generate new knowledge. Technological capability has three elements: production, investment, including duplication and expansion, and innovation. According to Kim, "Production capability", refers to numerous technological capabilities required to operate and maintain production facilities. These may be divided into two broad subsets. The first subset includes those capabilities required to achieve efficient operation within the parameters of the original technology and the capability to repair and maintain existing physical capital according to a regular schedule or as needed. The second subset encompasses capabilities needed to adapt and improve the existing production technology, still within the original design parameters, in response to changing circumstances and to increase productivity. Adaption and improvement start almost simultaneously with the operation of technology. Secondly, "Investment capability" refers to abilities required for expanding capacity and establishing new production facilities. It includes investment feasibility analysis and project execution. The former involves ability to undertake the initial analysis of its profitability, detailed specifications of the project, and ability to ascertain prospects for viability under alternative design concepts. The latter involves abilities in project engineering – both basic and detailed engineering – project management that organizes and oversees the activities involved in project execution, procurement to choose, coordinate, and supervise hardware suppliers and

construction contractors, embodiment in physical capital to accomplish site preparation and construction of plants, and start-up operations to attain predetermined norms of manufacturing facilities. Thirdly, “Innovation capability” consists of abilities to create and carry new technological possibilities through to economic practice. The term covers a wide range of activities from capability to invent to capability to innovate and to capability to improve existing technology beyond the original design parameters. Invention and innovation are the products of both formal and informal activities. The term “innovation” is often associated by many with technological change at international frontiers. Most innovations in advanced countries generally denote a change of the frontier. Major technological innovations, however, are neither the only, nor perhaps the main, sources of productivity improvement in the history of industrial development in advanced countries. Minor changes to given technologies are a vital and continuous source of productivity gain in practically every industry in both advanced and catching-up countries.”

The work by TDRI (1989) and ADB (1995) on different levels of technological capability which are similar to what Kim has indicated are used as a benchmark to generate items for the technology transfer measure. TDRI and ADB divided an industry’s technological capability into four levels which are (1) acquisitive, (2) operative, (3) adaptive, and (4) innovative.

(1) acquisitive capability includes search, assess, negotiate, process, transfer, and install machinery and equipment; (2) operative capability includes operation and control, maintenance, training, skill, and management style; (3) adaptive capability includes new knowledge acquisition, technology digestion, minor product modification, and minor process modification; and (4) innovative capability includes R&D, radical product

modification, radical process modification, major change in the company's production methods/ product design and new inventions.

Different aspects of technological capability in each level from the ADB and TDRI studies are summarized, extended, and confirmed by Waranya (2005). This study follows the final items in each level of technological capability confirmed by Waranya. However, while it seemed quite difficult to distinguish minor product modification and radical product modification as well as minor process modification and radical process modification, this study combined minor and radical into one item. Acquisitive technological capability is in a sense dealt in advance to such new technology takes place and should not be concerned in the study since this study draws attention to the intra-firm technology transfer. The final items in each level of technological capability are as follows:

1. Operative technological capability

1) operation and control (V1)
2) maintenance of machines (V2)
3) training of production personnel (V3)
4) human resources development (V4)
5) adequate know-why of using technology (V5)
6) adequate know-how of using technology (V6)
7) capable of solving technical problems (V7)
8) transfer the technology used to all levels of personnel concerned (V8)
9) utilized all functions of the technology used (V9)
10) follow-up and assess the use of existing technology (V10)

2. Adaptive technological capability

1) defining market needs (V11)
2) searching for new markets (V12)
3) arranging funds for business development (V13)
4) reorienting enterprise business and technology strategies (V14)
5) testing of products (V15)
6) product modification (V16)
7) process modification (V17)
8) searching for strategic alliance in technology (V18)
9) having more R&D infrastructure (V19)
10) having more R&D personnel (V20)

3. Innovative technological capability

1) heavy investment on R&D (V21)
2) duplicating imported technology (V22)
3) building of prototypes and facilities for testing (V23)
4) up-grade the technology level (V24)
5) continuous development for better technology (V25)
6) new invention for product design or process (V26)
7) acquiring patent for new/modified product or process (V27)
8) establishing R&D information centre (V28)

For each of these 28 items, companies are asked to indicate their level of technological capability after using the imported technology. The following “Likert”

scale is used to gain responses:

5 = very high degree of technology transfer (most)

4 = high degree of technology transfer (more)

3 = medium degree of technology transfer (moderate)

2 = low degree of technology transfer (less)

1 = very low degree of technology transfer (least)

4.4 Data and Data Collection

The survey instrument used in this study is a questionnaire. The questionnaire consists of two parts. In the first part, respondents are requested to indicate the levels of technological capability after using the technology imported from overseas. There are 28 technological capabilities to measure the technology transfer level as described in the previous section. The Likert scale was chosen for this study because of its ease of administration, which makes it an extremely popular means for measuring technology transfer level. In the second part, the respondents are requested to answer to some demographic questions about their company.

The questionnaire was initially made in English. Then, it was translated into Japanese language. Japanese version of the questionnaire was translated back into English again and the accuracy of translation was confirmed.

Japanese electronics companies in Thailand were selected from the list of the JCC.

The JCC Bangkok was established in 1954 and is the second largest JCC in the world with 1,252 member companies registered as of the end of March 2006. JCC's

objectives are providing services to Japanese companies in Thailand, safeguarding their interests and contributing toward the growth of the economy in Thailand and Japan. Their service also promotes education, social welfare and cultural interchange between the two countries.

A total of 623 companies are categorized in the manufacturing sector of JCC Bangkok. Within the manufacturing sector, automobile industry has the largest number of companies with 202, followed by electric and electronics industry with 162 companies. From the description provided by the JCC, it is estimated that 60 companies out of 162 companies are engaged in the electronics industry whose products are categorized in the electronics products as provided in the definition in the earlier chapter (see Appendix 3: List of Japanese electronics companies in Thailand).

The target population for this study is 60 companies. As was always the case that sending questionnaire via ordinary postage service could not achieve the high collecting rate, this study conducted the phone approach first. Thereafter, if a person in charge could, during a phone conversation, at least agree to receive the questionnaire, the questionnaire was sent to the company directly to the person in charge via e-mail. Since the target population was relatively small and it was necessary to get the sample size more than 2/3 of the target population if it were to meet the sufficient tolerable error, it was estimated that the results of the questionnaire per se would not be enough to present as the findings of the study. Hence, the study would conduct in depth interview with Japanese parent electronics companies in order to support the findings from the questionnaires.

The analysis of the answers to the questionnaires is described in Section 5.1 and the result of the interview is summarized in Section 5.2.

CHAPTER V

RESULTS OF THE STUDY

5.1 Analysis of the Answers to the Questionnaires

Among 60 Japanese electronics companies registered to JCC Bangkok, more than a half of them are manufacturing electronic devices and electronic parts. This fact suggests that there have been a substantial number of investments in the supporting industry of electronics sector. Seven companies are manufacturing storage media and another seven companies are engaged in communication equipment and related products followed by electronic data processing machines manufactures, electronic circuit manufacturers, and image and audio equipment manufacturers.

It is interesting to note that 53 % of the companies established their subsidiaries during 1987-1989. This figure can be explained by the fact that Japanese direct investment overseas increased dramatically after the Plaza Accord was signed and the JPY appreciation was significant.

As Japanese electronics companies have made genuine efforts to their investments, each Japanese electronics company employs quite a large number of Thai workers while the presence of Japanese workers is limited. Table 5-2 shows the demographic background of the Japanese electronics companies in Thailand and it becomes obvious that almost a half of the companies employ more than 1000 Thai workers in this sector.

Table 5-1 Demographic Background of Japanese Electronics Companies in Thailand

Category	No. of Company	%
1. Type of Product		
Communication Equipment and Related Products	7	11.7
Electronic Circuit	4	6.7
Electronic Data Processing Machines, digital computer, Accessories	5	8.3
Electronic Devices	16	26.7
Electronic Equipment	1	1.7
Electronic Parts	16	26.7
Image and Audio Equipment	4	6.7
Storage Media	7	11.7
2. Year of Establishment		
1984-1986	1	1.7
1987-1989	32	53.3
1990-1992	9	15.0
1993-1995	8	13.3
1996-1998	7	11.7
1999-2001	2	3.3
2001<	1	1.7
3. No. of Japanese		
0-10	32	53.3

11-20	14	23.3
21-30	7	11.7
31-40	5	8.3
40<	2	3.3
4. No. of Thai Employees		
10>	1	1.7
10-29	3	5.0
30-49	0	0.0
50-99	1	1.7
100-299	7	11.7
300-499	7	11.7
500-999	13	21.7
1000 and over	28	46.7

Source: JCC (2006)

In order to acquire the sufficient number of response, phone calls were made to all sixty companies. Questionnaires were sent via e-mail to Japanese managers in eighteen companies which provided their e-mail address during the phone conversation.

The final number of companies responded to the questionnaire was eleven so the collection rate was 18.3 %. It was unfortunate that many companies replied in the phone conversation as well as in the e-mail that they were not in the position to answer questions which relate to the strategy of the parent company since such information are regarded as confidential.

Since the number of respondent represents 18% of the total target population, it is not enough to measure if the answers collected has the acceptable levels of reliability and validity. However, the responses from the eleven companies tend to provide the similar answers, hence they may ,without prejudice, give some indications how technology transfer takes place in Japanese electronics companies in Thailand.

Demographic backgrounds of eleven respondents are quite similar. They are the subsidiaries of Japanese famous manufacturers. One of them is the joint venture with a Thai company, where a Japanese company holds 60 % of its share. Two companies are almost 100 % owned by Japanese parent companies. Other eight companies are wholly owned by Japanese companies. Nine companies out of eleven were established in Thailand between 1987 and 1991 when the sixth National Economic and Social Development Plan was implemented.

These companies are categorized into four groups by their products. Seven companies out of eleven companies manufacture electronic devices such as light emitting diodes, graphic screen, and glass substrates for HDD, etc. Two companies are engaged in manufacturing electronic parts such as connector and thermal management products. One company manufactures storage media like semiconductor integrated circuits devices and one company manufactures electronic circuits such as flexible printed circuits.

Five companies are quite big companies with the size of more than 1,000 employees and among these companies it is appeared that there is one company alone employs more than 10,000 Thai workers. Those companies which manufacture storage media and electronic circuits employ many workers for its relatively large investments. Electronic parts and electronic devices also require many workers,

however as there are wide ranging products, the number of the employees depend on products that the companies manufacture. The brief background of the respondents is summarized in Table 5-2.

Table 5-2 Demographic Background of Respondents

Company	Main Products	Year of Establishment	Number of Japanese	Number of total employees
Asian Stanley International Co., Ltd.	Electronic Devices	1987	13	500-999
Chiyoda Integre (Thailand) Co., Ltd.	Electronic Devices	1995	3	300-499
Fujipoly (Thailand) Co., Ltd.	Electronic Parts	1989	4	100-299
Kansai Felt (Thailand) Co., Ltd.	Electronic Devices	1988	4	500-999
Kyocera Kinseki (Thailand) Co., Ltd.	Electronic Devices	1989	14	over 1000
MMC Electronics (Thailand) Ltd.	Electronic Devices	1987	3	100-299
Murata Electronics (Thailand) Ltd.	Electronic Devices	1988	33	over 1000
NEC Tokin Electronics (Thailand) Co., Ltd.	Electronic Parts	1988	16	over 1000
Oki (Thailand) Co., Ltd.	Storage Media	1990	12	over 1000
Panasonic Electronic Devices (Thailand) C	Electronic Devices	1996	13	500-999
PCTT Ltd.	Electronic Circuit	1988	40	over 1000

5.1.1 Operative technological capability

Table 5-3 shows the summary of responses in the operative level. From the table, it is interpreted that technological capabilities in many areas in operative level are seen not sufficient. Within 10 attributes, only three of them are sufficient in average. They are, namely, 1) operation and control, 2) maintenance of machines, 3) training of production personnel. Attribute 1) operation and control has the highest mean with 3.7273 since this attribute is very basic by the nature of FDI. It has the standard

deviation of 0.64667, which is quite marginal compared with other attributes. Tables 5-4 and 5-5 show the cross tabulations between this attribute and main products, and this attribute and number of Japanese personnel. A company that manufactures electronic circuit has very high degree of technology transfer in this area and a company producing storage media also has high degree of technology transfer. It is also worthwhile noting that those companies with 31 to 40 Japanese workers shows higher degree of technology transfer compared with others.

Table 5-3 Summary of the Responses (Operative Level)

Degree or level or level of technology capability within the company after using the imported technology	N	Minimum	Maximum	Mean	Std. Deviation
1) operation and control	11	3.00	5.00	3.7273	.64667
2) maintenance of machines	11	2.00	4.00	3.1818	.87386
3) training of production personnel	11	2.00	4.00	3.0909	.83121
4) human resources development	11	2.00	5.00	2.5455	.93420
5) adequate know-why of using technology	11	1.00	4.00	2.5455	.82020
6) adequate know-how of using technology	11	2.00	4.00	2.9091	.83121
7) capable of solving technical problems	10	2.00	4.00	2.9000	.87560
8) transfer the technology used to all levels of personnel concerned	11	1.00	3.00	2.0909	.83121
9) utilized all functions of the technology used	11	1.00	3.00	2.1818	.75076

10) follow-up and assess the use of existing technology	11	1.00	3.00	2.1818	.75076

Table 5-4 Cross Tabulation of Attribute 1) and Main Products

		Main Products				Total
		Electronic Devices	Electronic Parts	Storage Media	Electronic Circuit	
operation and control	3.00	3	1	0	0	4
	4.00	4	1	1	0	6
	5.00	0	0	0	1	1
Total		7	2	1	1	11

Table 5-5 Cross Tabulation of Attribute 1) and No. of Japanese Personnel

		No. of JP			Total
		1-10	11-20	31-40	
operation and control	3.00	2	2	0	4
	4.00	2	3	1	6
	5.00	0	0	1	1
Total		4	5	2	11

Attributes 2) maintenance of machines and 3) training of production personnel have their mean above average, which are 3.1818 and 3.0909 respectively, however, they are just above 3 and it indicates that the degree of technology transfer is moderate. Apart from these three attributes, 6) adequate know-how of using technology and 7) capable of solving technical problems show their mean of 2.9091 and 2.9000 respectively, which are quite close to moderate level. These attributes are very basic attributes in operative level and therefore it should be expected much higher than

moderate level. Cross tabulations of these two attributes with main products show that those companies producing storage media and electrical circuit consider that they have high degree of technology transfer whereas many companies producing electronic devices and electronic parts are opposite. (See table 5-6 and 5-7)

Table 5-6 Cross Tabulation of Attribute 6) and Main Products

		Main Products				Total
		Electronic Devices	Electronic Parts	Storage Media	Electronic Circuit	
adequate know-how of using technology	2.00	3	1	0	0	4
	3.00	3	1	0	0	4
	4.00	1	0	1	1	3
Total		7	2	1	1	11

Table 5-7 Cross Tabulation of Attribute 7) and Main Products

		Main Products				Total
		Electronic Devices	Electronic Parts	Storage Media	Electronic Circuit	
capable of solving technical problems	2.00	2	2	0	0	4
	3.00	3	0	0	0	3
	4.00	1	0	1	1	3
Total		6	2	1	1	10

Apart from these two attributes, attribute 8) transfer the technology used to all levels of personnel concerned also shows that there is a different evaluation between the group of electronic devices and electronic parts and the group of storage media and electronic

circuit. (See table 5-8) It may be interpreted that within the electronics industry, degree of technology transfer can be separated into some types in line with their main products.

Attribute 8) also shows the least degree of technology transfer in the operative level. This can be interpreted that the production lines are mostly based on the division of labor and workers are required to be only responsible to their job description.

Table 5-8 Cross Tabulation of Attribute 8) and Main Products

		Main Products				Total
		Electronic Devices	Electronic Parts	Storage Media	Electronic Circuit	
transfer the technology used to all levels of personnel concerned	1.00	2	1	0	0	3
	2.00	3	1	0	0	4
	3.00	2	0	1	1	4
Total		7	2	1	1	11

Attribute 4) human resources development has the largest standard deviation. It is because a company which produces electronic circuit has a good evaluation on this attribute. Most of other companies evaluate low degree of technology transfer in this area. (See table 5-9)

Table 5-9 Cross Tabulation of Attribute 4) and Main Products

		Main Products				Total
		Electronic Devices	Electronic Parts	Storage Media	Electronic Circuit	
human resources development	2.00	5	2	0	0	7
	3.00	2	0	1	0	3
	5.00	0	0	0	1	1
Total		7	2	1	1	11

It is interesting to note that even in the operative level, aside from the very basic technology capabilities such as operation, control, and maintenance, many technology capabilities are not regarded as sufficient.

5.1.2 Adaptive technological capability

Table 5-10 shows the summary of responses in the adaptive level. From the table, it is interpreted that technological capabilities in many areas in this level are also seen not sufficient. Within 10 attributes, only two of them are sufficient in average. They are, namely, 15) testing of products, and 16) minor product modification. These two attributes are slightly above medium degree where their mean are 3.3636 and 3.1000 respectively.

Except for attribute 17) process modification, standard deviations of adaptive level remain within 0.5 to 0.6. This means that outcome of evaluation in many of attributes are organized and, as seen in the table 5-10, stayed at lower degree of technology transfer.

At the adaptive level, many companies could not answer to the question with

regard to R&D. They explain in the responses that the subsidiaries in Thailand mainly conduct the assembly process therefore they don't have R&D infrastructure or R&D personnel. Moreover, when it comes to the strategies of the company like attributes 13) arranging funds for business development, 14) reorienting enterprise business and business strategies, and 18) searching for strategic alliance in technology, they say that such matters are subject to parent company's decisions. Since most of the subsidiaries are assembling products, the degree of defining market needs and searching for new markets are also very low.

Table 5-10 Summary of the Responses (Adaptive Level)

Degree or level or level of technology capability within the company after using the imported technology	N	Minimum	Maximum	Mean	Std. Deviation
11) defining market needs	9	2.00	3.00	2.4444	.52705
12) searching for new markets	9	2.00	3.00	2.3333	.50000
13) arranging funds for business development	9	2.00	4.00	2.8889	.60093
14) reorienting enterprise business and technology strategies	9	2.00	3.00	2.3333	.50000
15) testing of products	11	3.00	4.00	3.3636	.50452
16) product modification	10	2.00	4.00	3.1000	.56765
17) process modification	11	2.00	4.00	2.8182	.87386
18) searching for strategic alliance in technology	8	2.00	3.00	2.6250	.51755
19) having more R&D infrastructure	7	2.00	3.00	2.5714	.53452
20) having more R&D personnel	7	2.00	3.00	2.5714	.53452

As for testing of products, again, it seems that storage media and electronic

circuit manufacturers provide better degree of technology transfer than electronic devices and electronic parts manufacturers. (See Table 5-11)

Table 5-11 Cross Tabulation of Attribute 15) and Main Products

		Main Products				Total
		Electronic Devices	Electronic Parts	Storage Media	Electronic Circuit	
testing of products	3.00	5	2	0	0	7
	4.00	2	0	1	1	4
Total		7	2	1	1	11

5.1.3 Innovative Technological Capability

Table 5-12 shows the summary of responses in the innovative technological level. From the table, it is interpreted that almost all technological capabilities in this level are also seen not sufficient. Within 8 attributes, only one attribute is at the moderate level in average. Attribute 22) duplicating imported technology has its mean at 3.000.

Table 5-12 Summary of the Responses (Innovative Level)

Degree or level or level of technology capability within the company after using the imported technology	N	Minimum	Maximum	Mean	Std. Deviation
21) heavy investment on R&D	7	2.00	3.00	2.1429	.37796
22) duplicating imported technology	11	1.00	4.00	3.0000	.89443

23) building of prototypes and facilities for testing	11	1.00	4.00	2.5455	1.03573
24) upgrade the technology level	11	1.00	4.00	2.6364	.92442
25) continuous development for better technology	10	2.00	4.00	2.6000	.69921
26) new invention for product design or process	9	1.00	4.00	2.4444	.88192
27) acquiring patent for new/modified product or process	7	1.00	2.00	1.7143	.48795
28) establishing R&D information centre	7	1.00	4.00	2.0000	1.00000

Attribute 21) heavy investment on R&D has very low standard deviation at 0.37796 with its mean at 2.1429. One electronic parts company has medium degree of technology transfer on heavy investment on R&D and other companies have low degree of technology transfer. (See Table 5-13)

Table 5-13 Cross Tabulation of Attribute 21) and Main Products

		Main Products				Total
		Electronic Devices	Electronic Parts	Storage Media	Electronic Circuit	
heavy investment on R&D	2.00	3	1	1	1	6
	3.00	0	1	0	0	1
Total		3	2	1	1	7

Attribute 27) acquiring patent for new/modified product or process has the lowest mean at 1.7143. Even storage media and electronic circuit companies indicate

their degree of technology transfer is low. Even product modification has medium degree of technology transfer in the adaptive stage, acquiring patent for such product modification is far away for them. (See Table 5-14)

Table 5-14 Cross Tabulation of Attribute 27) and Main Products

		Main Products				N Total
		Electronic Devices	Electronic Parts	Storage Media	Electronic Circuit	
acquiring patent for new/modified product or process	1.00	2	0	0	0	2
	2.00	1	2	1	1	5
Total		3	2	1	1	7

Attribute 28) establishing R&D information centre has its mean at 2.0000 and standard deviation at 1.00000. This broad deviation comes from electronic circuit manufacture being positive on establishing R&D information centre. Except for this company, this attribute is evaluated at low or very low degree of technology transfer. (See Table 5-15)

Table 5-15 Cross Tabulation of Attribute 28) and Main Products

		Main Products				Total
		Electronic Devices	Electronic Parts	Storage Media	Electronic Circuit	
establishing R&D information centre	1.00	1	1	0	0	2
	2.00	2	1	1	0	4
	4.00	0	0	0	1	1
Total		3	2	1	1	7

Throughout those attributes, one company engaged in the electronic circuit products constantly evaluated good technology capability level. It can be estimated that there is a different degree in the technology transfer in line with electronics products they are manufacturing. Just to clarify the difference between including storage media and electronic circuit and not including them, Table 5-16 is presented. As a result, only five attributes namely, 2) maintenance of machines, 16) product modification, 18) searching for strategic alliance in technology, 19) having more R&D infrastructure, and 21) heavy investment on R&D, have increased their mean slightly and other 23 attributes have their mean slightly decreased. .

Table 5-16 Summary of the Responses (Electronic Devices and Parts Manufacturers)

Degree or level or level of technology capability within the company after using the imported technology	N	Minimum	Maximum	Mean	Std. Deviation
1) operation and control	9	3.00	4.00	3.5556	.52705
2) maintenance of machines	9	2.00	4.00	3.3333	.86603
3) training of production personnel	9	2.00	4.00	3.0000	.86603
4) human resources development	9	2.00	3.00	2.2222	.44096
5) adequate know-why of using technology	9	1.00	3.00	2.3333	.70711
6) adequate know-how of using technology	9	2.00	4.00	2.6667	.70711
7) capable of solving technical problems	8	2.00	4.00	2.6250	.74402

8) transfer the technology used to all levels of personnel concerned	9	1.00	3.00	1.8889	.78174
9) utilized all functions of the technology used	9	1.00	3.00	2.1111	.78174
10) follow-up and assess the use of existing technology	9	1.00	3.00	2.1111	.78174
11) defining market needs	7	2.00	3.00	2.4286	.53452
12) searching for new markets	7	2.00	3.00	2.2857	.48795
13) arranging funds for business development	7	2.00	4.00	2.8571	.69007
14) reorienting enterprise business and technology strategies	7	2.00	3.00	2.2857	.48795
15) testing of products	9	3.00	4.00	3.2222	.44096
16) product modification	8	3.00	4.00	3.2500	.46291
17) process modification	9	2.00	4.00	2.7778	.83333
18) searching for strategic alliance in technology	6	2.00	3.00	2.6667	.51640
19) having more R&D infrastructure	5	2.00	3.00	2.6000	.54772
20) having more R&D personnel	5	2.00	3.00	2.4000	.54772
21) heavy investment on R&D	5	2.00	3.00	2.2000	.44721
22) duplicating imported technology	9	1.00	4.00	2.8889	.92796
23) building of prototypes and facilities for testing	9	1.00	4.00	2.4444	1.13039
24) upgrade the technology level	9	1.00	4.00	2.4444	.88192

25) continuous development for better technology	8	2.00	3.00	2.5000	.53452
26) new invention for product design or process	7	1.00	3.00	2.2857	.75593
27) acquiring patent for new/modified product or process	5	1.00	2.00	1.6000	.54772
28) establishing R&D information centre	5	1.00	2.00	1.6000	.54772

In the response to the questionnaire, some respondents point out that the employees in the 100 % Japanese owned companies tend to be unconcerned about the new technology whereas the management level in the joint venture of Thai and Japanese companies are very eager in obtaining new technology. One respondent indicates that Thai employees have no tendency to meddle in other's affairs and to share their knowledge and skills to others. Therefore, even though Japanese management staffs transfer their knowledge or technology to their Thai employees, such knowledge or technology may not disseminate from one employee to another in a positive manner, despite the fact that such technology dissemination is ideal for a company.

5.2 Interviews with the Parent Companies

To summarize the characteristics of the technology transfer in Japanese electronics companies in Thailand, the level of technology transfer remains at the lower level. The result of the questionnaire indicates that only in the area of operation,

control, and maintenance of machines and testing of product show sufficient level of technology transfer. In order to fortify such outcome, interviews are made to some parent companies in Japan.

Conducting interviews with managers of parent companies is quite a difficult task since many companies are not positive in disclosing their strategies; however, approaching through some channels, Fujitsu, Fujikura Ltd., and NEC Infrontia Corporation accepted the request for interviews.

5.2.1 Fujitsu

Fujitsu is a leading provider of IT-based business solutions for the global marketplace. With approximately 175,000 employees supporting customers in 70 countries, Fujitsu combines a worldwide corps of systems and services experts with highly reliable computing and communications products and advanced microelectronics to deliver added value to customers. The company is the world's fourth largest IT services provider and No. 1 in Japan and also among the world's top five providers of servers. Among other subsidiaries around the world, there is a manufacturing subsidiary in Thailand called Fujitsu (Thailand). It was established in December 1988 with 100% share held by the parent company. Fujitsu (Thailand) employs about 8,000 Thai employees. It has been manufacturing mobile HDD, however, it is said that, with some recent developments in the industry, HDD division of Fujitsu has been sold to Toshiba. Regardless of such recent developments, a manager of Fujitsu responded to the interview as follows.

The main purpose of establishing a subsidiary in Thailand was for its cheap labor. The plant established there only assembles HDD for laptop computers and

small servers. Because of the division of labor, HDD manufactured in Thailand are mainly exported to other countries such as Singapore where Fujitsu has production hub for computers. The buyers are not only the group companies, but also other computer and server companies such as Toshiba, Hitachi, and IBM etc.

As for operative technological capability level, the result of the questionnaire is considered reasonable and proper for Fujitsu (Thailand). Since the products have certain degrees of difficulties in manufacturing or particular types of problems in particular process, the company provides FAQ manuals for the workers to sort out such day to day issues. With such manuals, it is expected that workers can operate, control, and maintain technologies to a certain extent. The company also conducts training of production personnel, however, as there associates the turnover cost, the company is not very active in human resources development. Measuring the level of know-why of using technology is difficult since such factor is dependent on individual skills, however, as the average service years of employees in Fujitsu (Thailand) is relatively short, it appears that digging a little deeper in order to understand the background of their work or necessity of using technology is limited to a small area in general. It shall be noted that the company introduces division of labor and job description for each employees are precisely defined, therefore it appears that Thai workers are not interested to other tasks that are beyond their job description and at the same time, the company is not expecting to transfer the technology used to all levels of personnel concerned.

As for adaptive technological capability level, the company is not expecting Thai employees to develop such technologies. The main reasons for this are, firstly, the products they produce are not so much different from other companies' products since their products have certain standards they have to follow and they are more or less

the same in any market worldwide. Secondly, defining market needs, searching for new markets, or reorienting enterprise business and technology strategy, etc. are something people in the parent company or Japanese representative in the subsidiary consider. Sellout of HDD division is a good example for explaining such matter.

As for innovative technological capability level, since the subsidiary only covers the assembly stage, the company is not expecting anything in this level. However, the manager of the company mentioned that if the subsidiary would be the joint venture with a Thai company, the level of expectation for the technology transfer in the innovative level might be different.

5.2.2 Fujikura Ltd.

Fujikura Ltd. was established as a silk and cotton winding company in 1885. When Japan's first electric lamp company, Tokyo Electric Lamp, started sales, the company went into the electric wire business. After the Russo-Japanese War, thanks to the boom in the rubber businesses, the wire and rubber businesses developed rapidly, and the "Fujikura Electric Wire Corporation" was founded in 1910. In 1992 the name "Fujikura Electric Wire Corporation" was changed to "Fujikura Ltd." Currently, the company manufactures flexible print circuits, which are fundamental parts for cell phone and digital still camera, with world’s second market share, optical fiber cable with the world’s third market share, and electric wire with the world’s third market share, etc. The company has established the manufacturing base in Thailand since 1984 and, with seven subsidiaries in Thailand, the company employs the largest number of Thai workers among other Japanese manufacturers in Thailand.

Fujikura Ltd. is the parent company of PCTT Ltd., the company responded to

the questionnaire. PCTT Ltd. was established in 1988 in Thailand in order to meet the rapidly increasing demand for electrical interconnections and accelerating trend toward compact electronic devices. The company specializes in the design and manufacturing of flexible printed circuits used in simple consumer products to complex telecommunication and computer equipments. The company has manufacturing bases in Pathumthani, Prachinburi, and Ayutthaya, and each manufacturing base employs 2,650 persons, 4,000 persons, and 7,200 persons respectively.

From the questionnaire, it is viewed that the company has a high level of technological capability in R&D. Indeed, in order to enhance the user's sense of reliability, raw materials used in flexible printed circuit manufacture such as base materials, adhesives, foil clad laminates, etc. are tested to verify their ability to meet requirements. The ability to produce flexible printed circuit and the performance of the product is determined in the product design; therefore design for manufacturability and design for total performance are very critical in this industry. The performance of the manufacturing process is determined to a large extent during the process development and process design. In such processes, the parameters and tools must be controlled to assure that the process that is conducted is always the right process to produce the right product. Bearing such notion in mind, the company supports troubleshooting of ongoing production process and develops solutions for the root cause. Also, the company leads development and introduction of new manufacturing technologies and continuous improvement of existing process.

However, the respondent mentions that even the parent company transfers its technology to a large extent, the parent company would follow its policy not to bring high technology to their subsidiaries. Those subsidiaries that set up their R&D centre

in Thailand still face the problems that the efficiency of R&D is not maximized as was expected. In some cases, the parent company is not committed to the improvement of R&D centre, since the motive of setting up R&D centre does not come spontaneously from the parent company but rather requested by the hosting country. As the company establishes many subsidiaries and has a high profile in Thailand, it is not easy to refuse such request for political circumstances. For this reason, even though the manager of PCTT Ltd. evaluates the technological capability in a rather favorable manner, the reality is that the extent of the technology transfer remains within a certain limited scope.

5.2.3 NEC Infrontia Corporation

NEC Infrontia Corporation was founded in 1918, and began as a company that develops, manufactures and markets telecommunication equipment and components. Currently, the NEC Infrontia Group is engaged in three business areas, i-Communication System, i-Appliance, and i-Solution, and has established a wide market base both overseas and in Japan.

“i-Communication System” is where the cores of Internet technology and mobile communication technology are based on. The company is expanding its business in communication systems such as key telephones, security equipment and mobile terminals.

“i-Appliance” is the area where various key components are integrated such as wireless LAN, contact and contactless IC card reader/writer, bar code reader, and fingerprint authentication equipment, the company offers a wide array of the terminal

equipment including POS system, business-use PDA, Web terminal, and handy terminal that can match various business types and operations

"i-Solution" is the area where business-use terminals and network are combined in accordance with the customers' needs. It includes mobile solution (PHS, wireless LAN, PDA), security solution (IC cards, RFID, fingerprint authentication), settlement solution (IC cards, handy terminals), communication solution (IP-PBX), and business solution (sales management, ordering management, production control, personnel management, self systems, CRM, call center) etc.

The Group consists of a network of 50 operation bases run directly by the company throughout Japan, as well as affiliated companies in Japan and overseas that provide a total service, from development and manufacturing to sales, installation and after sales services.

There was a change in overseas investment in 1980s. Many electronics companies invested their manufacturing base in Korea and Taiwan at that time and NEC Infrontia was one of them to invest manufacturing base in Taiwan. In the early 1980s Korea and Taiwan companies were beginning to break into the global consumer electronics market. Electronics manufacturers successfully penetrated the US and European markets. However, during the same period the US, which was largest export market for them, was experiencing record trade deficits, and the US press often emphasized the growing economic strength of Japan and its neighbors. Thus there had been strong popular feeling in the United States that the US government should limit the market access of goods from these countries.

Such sentiments tended to strengthen the various US market restriction measures vis-à-vis Japan and its neighbors' exports. Especially bothersome to many

were the ant-dumping measures which the United States used to limit consumer electronics and steel.

As a result, many Japanese companies shifted their investments from Korea and Taiwan to ASEAN countries where the production cost is low. In the beginning, NEC Infrontia sought to invest in Latin America where they can enjoy better market access to the US. However, as there had seen the existence of barriers on investment in Latin America while there were many Japanese electronics companies including small and middle sized companies already invested and constituted a sort of good grounding in Malaysia and Thailand, the company decided to invest in Thailand in 1988.

Currently, NEC Infrontia has its manufacturing basis in Japan, Thailand and China and R&D function in Japan and the US. In Japan the company manufactures business phone for the domestic market as well as POS system. A subsidiary in Thailand is 100 % owned by the parent company. It manufactures business phone for the oversea market. In China, the company has a contract with the Chinese company to manufacture telephone sets in the form of electronic manufacturing service or EMS. In this form, the company orders the Chinese company to procure the specific standard materials from Hong Kong.

Their products are divided into two types. They are hardware products for the network and the Point of Sale (POS) system. The hardware products for the network consist about 70 % of the total sales and the sales of POS system are about 30 % of the total sales. POS system is manufactured fully in Japan. 90 % of the main products of the company, which are hardware products for the network, are manufactured by the subsidiary in Thailand. Remaining 10 % are manufactured both in China and Japan.

The hardware products for the network can be separated into two groups in broad terms. One is the sophisticated product and another is low-cost product. The sophisticated products are mainly for the US, Japan, and Europe. The low-cost products which do not incorporate functions such as data communication, cost management, speaker phone, etc. or do not furnish displays or many buttons, are mainly for the developing countries in South America and Asia.

Network system ranges from very small type with the size of one office room which does not require many lines to huge type with more than ten thousand lines are involved. There are ready-made software for the small types and custom-made software for the huge type network.

The company holds the largest share of the US and Japanese market and it occupies about 15 % share of the total world market. Its sales in the US and Japan to total sales are 50 % and 30 %, respectively.

In Japanese production facilities, half of raw materials are procured domestically and another half of them are procured from Thailand. As explained, the production share of Japanese manufacturing site is less than 10 % of total sales. They mainly conduct post-process as they procure the central part from Thailand and add the final touch to the external part such as color and external design. The trend of the company is to increase the operation of this last process in the production facility in Japan so as to control the inventory more efficiently and even improve cash flow of the company. If the final process is also done in Thailand, as the time for shipping from Thailand to Japan takes about three weeks, the preference or trend of the market may change.

The subsidiary in Thailand employs more than 900 Thai workers and there are

8 Japanese managers dispatched from the parent company. The subsidiary has two sections. One is production section and another one is administration section. The production section mainly manufacture, maintenance, and conduct testing and the administration section has functions of general affairs, personnel, accounting, planning of budget and cost, etc. Products manufactured here are mainly the central part or common substructure of the telephony system such as electronic circuits. Cheap materials are sourced mainly from China and some sophisticated materials such as CPU and memories are sourced from Japan or the US. Materials which are relatively large and costly to procure overseas are sourced in Thailand and they compose about 20 % of the total procurement. The subsidiary is now encouraging to source materials domestically.

Although there was an attempt to establish a development branch in Thailand in the past, it had proved not efficient to set up such functions and remained only to develop some areas for self-manufacturing some materials.

The reason for the subsidiary not taking root in the development function can be explained by the nature of concerned products. Unlike the automobile products, the electronics products have not many requirements from the users regardless of the region where users reside. These products that are manufactured in Thailand follow the requirement of international standards which means these products are universally common and it is unlikely that there should be the needs to differentiate its capability by each country or region.

Apart from its development branch in Japan, the company has a development branch in North America, too. The background for having such development branch in North America is that the systems used in North America in general are inclined to put

priority on VoIP while other regions in the world still prefer telephone line for its reliable quality. Except for such reason, it is not worthwhile setting up development branch separately.

Therefore, intra-firm technology transfer from the parent company to its subsidiary in Thailand is so far limited to the operative technological capability.

The most common technology transfer conducted from the parent company to its subsidiary in Thailand is job training in Japan. When launching a new manufacturing base in Thailand, Japanese skilled engineer prepared training courses for Thai staff members coming to Japan for training. Thai staffs first took Japanese language course for first three months and skill training for another three months. These Thai staffs were then expected to disseminate what they had learnt in Japan to other Thai staffs in the subsidiary in Thailand.

There were approximately 10 Thai staffs who took training in Japan each year. However, as the production line has stably laid down, the job training in Japan nowadays is conducted occasionally only when the company launches the new product and there are in average approximately 30 Thai staffs who get training in Japan per year. The lengths for the training for them are about a week.

The manager of the company mentioned that despite the fact that it takes about 10 years to nurture skilled staffs, turnover rate of Thai staff is quite high. Even though technologies are transferred, Thai staffs tend to go job-hopping and not to remain on the payroll.

In general, Thai engineers nowadays are knowledgeable in new technology development; however their potential strength or capability seems to be declining compared with Thai engineers a decade ago.

The parent company provides training not only to the subsidiary but also to the suppliers of the subsidiary. When launching a new product, the parent company sends Japanese engineers to these suppliers and provides training and advice to them for about a week since launching a new product sometimes requires hundreds of new molding or appropriate technique for painting, etc.

Furthermore, Japanese staffs from the parent company sometimes take site visits to the suppliers for checking the environmental and safety reasons. For instance, a product exporting to Europe need to pass the Restriction of Hazardous Substances Directives (ROHS) standard and it is not easy to assess whether the materials supplied from the customer passed the ROHS standard by just looking at them. They visit the factory of the customer or supplier and conduct the spot checking to see whether the hazardous substances used for manufacturing products exceed the tolerable range or not.

By the way, a manager of the company responded that in his view, the technology transfer capability in its Thai subsidiary is seen very high degree in operation and control, testing of products, and process modification, high degree in maintenance of machines, utilized all functions of the technology used, follow-up and assess the use of existing technology, product modification, having more R&D personnel, duplicating imported technology, building of prototypes and facilities for testing, and up-grade the technology level. By contrast, the technology transfer capability was conducted in low degree in the following areas; human resource development, capable of solving technical problems, arranging funds for business development, searching for strategic alliance in technology, heavy investment on R&D, acquiring patent for new/modified product or process, and establishing R&D information centre. This can be explained by the fact that there is no R&D function in

the subsidiary in Thailand and moreover that the company has not applied for STI incentives in the past.

CHAPTER VI
CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

The objectives of this study are to achieve three things. First to study the development of Thai investment polices and Japanese FDI in Thailand. Secondly, to improve understanding about the actual practice of technology transfer at intra-firm level in Japanese electronics companies in Thailand. Lastly, to provide some policy implications to Thai agencies concerned for the better application of the technology transfer in the future. To achieve these objectives, the study tried to gather relevant information and collect quantitative data, identifying the levels of technological capability, and qualitative data, interviewing the parent companies.

6.2 Summary of Findings

From the standpoint of Japanese subsidiaries responded in the study, most of which are wholly owned by Japanese parent companies, it is essential to allocate some amount of money on R&D. However, in spite of the fact that they allocate some expenditure on R&D, such money is spent mainly on the training of the workers in the operative level where minimum level of technology standard for utilizing machines are required. As many companies consider that strategy related matters are handled by parent companies, technology transfer in the adaptive and innovative level is practically uncommon.

Some other aspects for a low degree in adoptive and innovative level are inferred from some comments made by the respondents that, for instance, the employee

turnover rate is quite high and it may allow for the leakage of the technology to other companies, or the technology level is not high enough so that the company withhold the technology transfer in the higher level.

Furthermore, most of the products in the electronics industry in general are required to meet a certain level of international standards and, because of such nature of the products in this industry, manufacturers usually do not have many rooms to differentiate their products in accordance with the countries or market needs. So if the manufacturer already has a R&D function in one place, then having another R&D function in some other place does not become an urgent need.

Nevertheless, as a FDI recipient country, the Thai government has made some efforts promoting technology transfer by, for example, providing investment incentives and cooperating with foreign agencies. Approaches that the Thai government undertook is somewhat different from what the Korean government adopted, and therefore, there is not a big Thai original brand in the industry. However, the country has benefitted by huge FDI. Hence, it is difficult to say which approach is better.

6.3 Policy Implications

As it appears that Japanese companies are complacent about the current technology transfer level in Thailand, there may be no spontaneous movement by Japanese companies in boosting the level of technology transfer. In order to make an attempt on such situation, the Thai government should stimulate the private sector to carry out more R&D activities by doing a lot of advertising of STI program or providing more incentives for R&D. In addition to that, the Thai government should utilize every possible resource from other countries. As there is a good example of utilizing

Japanese ODA program in Thai automotive sector, the same kind of project can be applied in the electronics sector too since such schemes are already in hand. These attempts can be conducted in a rather short term period.

In the middle and long term, promoting joint venture may be a good approach to induce higher level of technology as long as the suppliers of technology encourage doing so. In order to best serve such technology suppliers, Thailand should invest in human resources. As the respondents indicated that there seemed a tendency of impaired performance of Thai engineers, some kind of measures should be taken whether public or private. A good example is establishment of Thai Nichi Institute of Technology (TNI). This institute was established in 2007 founded by the Technology Promotion Association with the support from the Japanese government. The objectives of TNI is to provide education at undergraduate level focusing on technology, social sciences and humanities and one of the missions of TNI is to transfer technology from Japan and other countries by linking the relationship with academic institutes, public and private organizations in Japan and other countries, in order to create cooperation by exchange of experts, research and development programs, educational trainings and study tours to other countries. If there will be more qualified human resources in the future, then such human resources will be able to absorb technology transfer more easily in more advanced level.

6.4 Limitation

As the study focused on the area where the ordinary companies regard it as confidential, hence most companies were reluctant to provide such information. This

eventually led the study to have small sample size. Thus, the results of the study must be taken with caution.

Apart from the above, there are two main limitations that should be touched upon. First, the results of this study are not applicable to the joint venture of Japanese and Thai companies. Since the Thai government allows 100% foreign equity participation, almost all respondents of the study are 100% owned by Japanese companies. As mentioned in the definition of technology transfer as well as some comments made by the respondents, technology spillover may be seen more significantly if there involved joint ventures with Thai companies.

Second, the results may be different if the data are collected from Thai employees of these companies. This study collected the data from Japanese managers who belong to subsidiaries of Japanese electronics companies in Thailand. Standpoint of Thai employees may be different. It may be interesting to compare those views of employees with those of subsidiaries of other foreign companies. Subsidiaries of Japanese electronics companies in Thailand may have their own unique corporate culture rather than other companies and industries.

6.5 Further Study

Given the scope of this study and above limitations, further study in this area is encouraged to enhance the existing state of knowledge. First, it might be useful to compare between joint venture and 100% Japanese owned companies whether the level of technology transfer capability is different or not. Second, it might be interesting to compare between sectors such as automobile sector and electronics sector how the level of technology transfer differs between these two sectors. Third, it might be

worthwhile studying same industries between different countries such as China and Thailand. There may be cultural and political factors involved in the level of technology transfer.

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Appendices

Appendix A

Questionnaire sent to Japanese electronics companies in Thailand

A 以下の28項目につき技術移転後の技術能力レベルにつき、5（とても高い）から1（とても低い）のうちいずれかを選択してください。

技術移転後の技術能力のレベル

		とても高い	高い	**普通**	低い	とても低い
1	作業ならびに機械の操作	5	4	3	2	1
2	機械のメンテナンス	5	4	3	2	1
3	製造部門職員の養成	5	4	3	2	1
4	人材開発	5	4	3	2	1
5	技術を活用する必要性を把握する能力	5	4	3	2	1
6	技術を活用するノウハウの取得	5	4	3	2	1
7	技術的問題を解決する能力	5	4	3	2	1
8	技術を活用する全てのレベルの職員に浸透させる能力	5	4	3	2	1
9	移転された技術全てを活用する能力	5	4	3	2	1
10	これまで活用してきた技術をフォローアップならびに評価する能	5	4	3	2	1
11	市場のニーズを明確にする能力	5	4	3	2	1
12	新たな市場を開拓する能力	5	4	3	2	1
13	業務展開のための資金調達能力	5	4	3	2	1
14	事業分野や技術戦略を転換する能力	5	4	3	2	1
15	製品の検査	5	4	3	2	1
16	製品変更能力	5	4	3	2	1
17	工程変更能力	5	4	3	2	1
18	技術面における戦略的提携を追求する能力	5	4	3	2	1
19	研究開発のための設備配置	5	4	3	2	1
20	研究開発のための職員配置	5	4	3	2	1
21	研究開発分野への大きな投資	5	4	3	2	1
22	導入された技術を複製する能力	5	4	3	2	1
23	試験のための設備および試作品を構築する能力	5	4	3	2	1
24	技術レベルを向上させる能力	5	4	3	2	1
25	より良い技術のための持続的開発	5	4	3	2	1
26	製品設計あるいは工程に関する新たな発明	5	4	3	2	1
27	新製品/工程あるいは製品/工程の変更にかかる特許取得	5	4	3	2	1
28	研究開発情報センターの確立	5	4	3	2	1

B 貴社の主力製品は何ですか？

C 貴社の資本構成につき教えてください。
1. タイ資本 %
2. 日本資本 %

D タイの日系電子関連企業における技術移転について特筆すべきことがありましたら教えてください。

APPENDIX B

English translation of Appendix A

A. The degree of technology transfer is measured by the level of technological capability of your company. The following items relate to the technological capability of your company. Using the folowing 1-5 scale, please indicate the company's level of capability after using the technology imported from overseas.

	Degree or level of technology capability within the company after using the imported technology	Very high	High	Medium	Low	Very Low
1	operation and control	**5**	**4**	**3**	**2**	**1**
2	maintenance of machines	**5**	**4**	**3**	**2**	**1**
3	training of production personnel	**5**	**4**	**3**	**2**	**1**
4	human resources development	**5**	**4**	**3**	**2**	**1**
5	adequate know-why of using technology	**5**	**4**	**3**	**2**	**1**
6	adequate know-how of using technology	**5**	**4**	**3**	**2**	**1**
7	capable of solving technical problems	**5**	**4**	**3**	**2**	**1**
8	transfer the technology used to all levels of personnel concerned	**5**	**4**	**3**	**2**	**1**
9	utilized all functions of thetechnology used	**5**	**4**	**3**	**2**	**1**
10	follow-up and assess the use of existing technology	**5**	**4**	**3**	**2**	**1**
11	defining market needs	**5**	**4**	**3**	**2**	**1**
12	searching for new markets	**5**	**4**	**3**	**2**	**1**
13	arranging funds for business development	**5**	**4**	**3**	**2**	**1**
14	reorienting enterprise business and technology strategies	**5**	**4**	**3**	**2**	**1**
15	testing of products	**5**	**4**	**3**	**2**	**1**
16	product modification	**5**	**4**	**3**	**2**	**1**
17	process modification	**5**	**4**	**3**	**2**	**1**
18	searching for strategic alliance in technology	**5**	**4**	**3**	**2**	**1**
19	having more R&D infrastructure	**5**	**4**	**3**	**2**	**1**
20	having more R&D personnel	**5**	**4**	**3**	**2**	**1**
21	heavy investment on R&D	**5**	**4**	**3**	**2**	**1**
22	duplicating imported technology	**5**	**4**	**3**	**2**	**1**
23	building of prototypes and facilities for testing	**5**	**4**	**3**	**2**	**1**
24	upgrade the technology level	**5**	**4**	**3**	**2**	**1**
25	continuous development for better technology	**5**	**4**	**3**	**2**	**1**
26	new invention for product design or process	**5**	**4**	**3**	**2**	**1**
27	acquiring patent for new/modified product or process	**5**	**4**	**3**	**2**	**1**
28	establishing R&D information centre	**5**	**4**	**3**	**2**	**1**

B. What is your company's main product?

C. What is the compositionof your company's registered capital?

Thai %

Japanese %

D. Please kindly make comments on the technology transfer in Thailand (if any).

Appendix C

List of Japanese electronics companies in Thailand

Company Name	Main Products	Year of Establishment	Number of Japanese	Number of total employees
Alpine Technology Manufacturing (Thailand) Co., Ltd.	Image and Audio Equipment	1995	4	B
Apro Technology (Thailand) Co., Ltd	Electronic Equipment	2003	4	A
Asian Stanley International Co., Ltd.	Electronic Devices	1987	13	G
Canon Hi-tech (Thailand) Ltd.	Electronic Data Processing Machines, digital computer, Accessories	1990	49	H
Chiyoda Integre (Thailand) Co., Ltd.	Electronic Devices	1995	3	F
Daihen Electric Co., Ltd.	Electronic Parts	1989	4	E
Daiwa Circuit Module (Thai) Co., Ltd.	Electronic Circuit	1996	3	D
Electro-Ceramics (Thailand) Co., Ltd.	Electronic Parts	1988	5	G
Fujikura (Thailand) Ltd.	Electronic Parts	1984	24	H
Fujipoly (Thailand) Co., Ltd.	Electronic Parts	1989	4	E
Fujitsu (Thailand) Co., Ltd.	Electronic Data Processing Machines, digital computer, Accessories	1988	34	H
Hitachi Metals (Thailand) Ltd.	Communication Equipment and Related Products	1991	12	G
Hoya Glass Disk (Thailand) Ltd.	Electronic Devices	1990	17	H
JFE Ferrite (Thailand) Co. Ltd.	Electronic Devices	1996	5	F
JVC Manufacturing (Thailand) Co., Ltd.	Communication Equipment and Related Products	1989	27	H
Kansai Felt (Thailand) Co., Ltd.	Electronic Devices	1988	4	G

Katolec (Thailand) Co., Ltd.	Electronic Circuit	1996	8	G
Kohnan Electric (Thailand) Co., Ltd.	Electronic Parts	1988	1	G
Kuramo (Thailand) Co., Ltd.	Electronic Parts	1996	3	B
Kyocera Kinseki (Thailand) Co., Ltd.	Electronic Devices	1989	14	H
Ltec Ltd.	Electronic Data Processing Machines, digital computer, Accessories	1989	31	H
Matsushita Electric Works, (Ayuthaya) Ltd.	Electronic Devices	1994	24	H
Mektek Manufacturing Corporation (Thailand) Ltd.	Electronic Circuit	1994	5	H
Mik Denshi Kohgyo (Thailand) Co., Ltd.	Electronic Parts	1989	8	H
Mitsumi (Thailand) Co., Ltd.	Electronic Parts	1989	4	F
Miauki Electronics (Thailand) Co., Ltd.	Storage Media	1987	13	H
MMC Electronics (Thailand) Ltd.	Electronic Devices	1987	3	E
MT Picture Display (Thailand) Co., Ltd.	Electronic Devices	1988	17	H
Muramoto Electron (Thailand) Co., Ltd.	Electronic Parts	1987	84	H
Murata Electronics (Thailand) Ltd.	Electronic Devices	1988	33	H
NEC Infrontia Thailand Ltd.	Communication Equipment and Related Products	1988	9	G
NEC Tokin Electronics (Thailand) Co., Ltd.	Electronic Parts	1988	16	H
Nikkan (Thailand) Co., Ltd.	Electronic Devices	2001	3	B
Nikon (Thailand) Co., Ltd.	Image and Audio Equipment	1990	24	H

Nippon Super Precision Co., Ltd.	Electronic Parts	1995	11	H
Nitto Denko Mterial (Thailand) Co., Ltd.	Electronic Devices	1993	8	E
Oki (Thailand) Co., Ltd.	Storage Media	1990	12	H
Oriental Electronics Device Co., Ltd.	Electronic Devices	1988	5	G
Panasonic AVC Networks (Thailand) Co., Ltd.	Communication Equipment and Related Products	1998	6	F
Panasonic Electronic Devices (Thailand) Co., Ltd.	Electronic Devices	1996	13	G
PCTT Ltd.	Electronic Circuit	1988	40	H
Pioneer Manufacturing (Thailand) Co., Ltd.	Image and Audio Equipment	1994	23	H
Rohm Apollo Electronics (Thailand) Co., Ltd.	Storage Media	1987	8	H
Rohm Integrated Semiconductor (Thailand) Co., Ltd.	Storage Media	1997	27	H
Sanyo Semiconductor (Thailand) Co., Ltd.	Storage Media	1990	10	H
Sharp Thebnakorn Co., Ltd.	Communication Equipment and Related Products	1989	7	F
Siam Asahi Technoglass Co., Ltd.	Electronic Data Processing Machines, digital computer, Accessories	1989	19	G
Siam Engineering Plastic Co., Ltd.	Electronic Devices	1994	2	F
Sony Device Technology (Thailand) Co., Ltd.	Storage Media	1988	25	H
Sony Technology (Thailand) Co., Ltd.	Communication Equipment and Related Products	1988	11	G
Takacom (Thailand) Co., Ltd.	Communication Equipment and Related Products	1988	2	E
Tatara Acoustic Industry (Thailand) Co., Ltd.	Image and Audio Equipment	1988	3	G

TDK (Thailand) Co., Ltd.	Electronic Devices	1991	16	H
Thai Dai-ichi Seiko Co., Ltd.	Electronic Parts	2000	5	E
Thai Tabuchi Electric Co., Ltd.	Electronic Parts	1987	17	H
Thai Wire & Cable Services Co., Ltd.	Electronic Parts	1987	4	H
T.M.S.C Co., Ltd.	Electronic Parts	1991	2	E
Toshiba Lighting Components (Thailand) Ltd.	Electronic Parts	1988	7	F
Toshiba Semiconductor (Thailand) Co., Ltd.	Storage Media	1990	8	G
World Electric (Thailand) Co., Ltd.	Electronic Data Processing Machines, digital computer, Accessories	1988	35	H

A=<10

B=10-29

C=30-49

D=50-99

E=100-299

F=300-499

G=500-999

H=1000 and over

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