CHAPTER 5

INTER-FIRM TECHNOLOGY TRANSFERS BETWEEN FIRST-TIER AND LOWER TIER SUPPLIERS

From previous chapters, entries of MNE automakers are not only for the purpose of assembling automobiles for the domestic market, but automakers have also used Thailand as a regional hub for automobile exports. As a result, first-tier suppliers must be able to supply auto parts meeting automakers' requirements e.g. high quality, cost effectiveness, and on-time delivery. Thus, it is a new challenge to first-tier suppliers after liberalization that they have to compete with others in order to retain their positions in assembly lines.

In addition, entries of MNE automakers do not only affect to first-tier suppliers, but their entries also affect to lower tier suppliers because they encourage first-tier suppliers have to deal with lower tier suppliers in terms of monitoring, evaluating, and training them. So, in the next section it is going to investigate what factors influencing first-tier suppliers to transfer technologies to lower tier suppliers.

5.1 Factors Influencing Technology Transfers to Lower Tier Suppliers

From surveys 22 first-tier suppliers (table 5.1), including MNE, joint-venture, and purely Thai-owned, it is found that 83 per cent of first-tier suppliers employ lower tiers to co-operate in auto part productions because most auto parts consist many components that cannot be totally produced at first-tiers' plants and their production capacity are limited. Consequently, first-tier suppliers decide to solve this problem by employing lower tiers suppliers to co-operate in part productions instead of building new factories because it requires a lot of money and it takes long time to recover their investments.

Table 5.1

List of Company Surveys

Company	Ownership	Year of establishment	Registered capital	Employees (2007)	Product*	Co-operations by lower tiers and transferring technologies to them
A	Joint venture	1992	100 MB	700	S	No
B	Thai-owned	1985	N.A.	95	S	No
C	Thai-owned	1977	420 MB	580	E&S	Yes
D	Thai-owned	1994	100 MB	150	M&S	Yes
E	Thai-owned	2000	2 MB	110	S	Yes
F	Joint venture	1977	15 MB	225	E&S	Yes
G	Thai-owned	1977	100 MB	400	M&S	Yes
H	Foreign	1972	200 MB	7,000	E&S	Yes
I	Thai-owned	1993	10 MB	300	S	Yes
J	Joint venture	1989	60 MB	1,010	D	No
K	Foreign	1996	50 MB	150	S	Yes
L	Thai-owned	1986	100 MB	500	M&S	Yes
M	Thai-owned	1997	1 MB	110	M	Yes
N	Thai-owned	1959	462 MB	1,900	S	Yes
O	Foreign	1991	80 MB	175	M&S	Yes
P	Joint venture	1994	60 MB	200	E	Yes
Q	Joint venture	1997	160 MB	300	S	Yes
R	Thai-owned	1986	100 MB	2,500	S	Yes
S	Thai-owned	1977	100 MB	2,500	S	Yes
T	Foreign	1997	100 MB	375	C	Yes
U	Thai-owned	1953	150 MB	1,400	S	Yes
V	Foreign	1992	1,800 MB	800	C&S	Yes

Source: From surveys (2007)

C = Chassis D = Driving Mechanism E = Some Engine Parts

M = Mold & Die S = Stamping & Casting Parts N.A. = Data is not available

* = See classifications of products in Appendix C

More importantly, in practice first-tier suppliers produce main components and lower tier suppliers produce simple components. Then, all finished components are assembled at first-tier plants before delivered to automakers. So, it is unnecessary to first-tiers to expand production capacity by building new factories just only for producing simple components. Alternatively, they are able to rely on outsourcing by employing lower tier suppliers. As a result, first-tier suppliers are able to make more profits.

However, the big problem of employing lower tier suppliers[1] to co-operate in part productions is they have low technologies in the production stage, including in-house productions and management. As a result, they cannot produce auto parts meeting automakers' requirements. Thus, technology transfers are necessary to lower tier suppliers.

As a matter of fact, technology transfers from first-tier to lower tier suppliers have taken place in the past ten years. However, the transfers were not widely operated because top management of first-tiers did not strengthen on them. In other words, they have not built closed relationships with lower tier suppliers.

However, this study finds that technologies have been intensively transferred by first-tiers to lower tier suppliers in the last five to seven years because of a competitive environment. Automakers need to gain competitive advantage through assembly lines and their stringent requirements such as higher quality and on-time delivery are passed on lower tier suppliers. As a result, it automatically encourages first-tier suppliers have to build long-term relationships with lower tier suppliers.

In the study, case 1 is provided in order to investigate how competitive environment and stringent requirements from automakers directly influence first-tier suppliers to transfer technologies to lower tiers. So, Toyota and its first-tier suppliers are picked up as a case study.

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[1] Many of them are former first-tier suppliers which have been relegated as lower tiers because they have low technological capabilities and they just rely on simple parts productions. They cannot compete with foreign first-tier which has more technological capabilities.

Case 1

Before 2001 first-tier suppliers delivered auto parts to Toyota by relying on their own deliveries. However, they could not deliver part to Toyota just in time. As a result, Toyota's production process was delayed caused by late deliveries. Besides, there were too many inventories stocked in Toyota's warehouses because first-tier suppliers did not deliver the right parts at the right time. Consequently, Toyota had to burden cost of inventory holding. So, in order to gain competitive advantage by reducing delays in in-house production and cost of inventory holding, Toyota has introduced the milk runs[2] to its first-tier suppliers since 2001.

Figure 5.1 shows the logistic system of Toyota suppliers before and after introducing milk runs. Before introducing milk runs, Toyota suppliers were responsible to part deliveries on their own and the frequency of part deliveries was low. Besides, each of part delivery relies on big lots. As a result, there were high inventory holding for Toyota and its first-tier suppliers. In contrast, after Toyota has introduced milk runs to its suppliers by employing two firms, which are K-Line (Thailand) Ltd. and TTK Logistics (Thailand) Co., Ltd[3] to be responsible to the part deliveries. These two firms will send their trucks to collect auto parts at first-tier plants based on schedules. The key characteristics of milk runs are high frequency of part delivery and each delivery relies on small lots. As a result, there are low inventory holdings. Thus, the benefit of milk runs is just in time because the firms employed by Toyota will cooperate and organize delivery schedules to first-tier suppliers. So, all the right parts will be delivered to Toyota at the right time. It helps Toyota to be able to reduce inventory holding and improve in-house production. Besides, first-tier suppliers are able to know when they have to produce the parts based on the production schedules. Consequently, they can deal with inventories more effectively.

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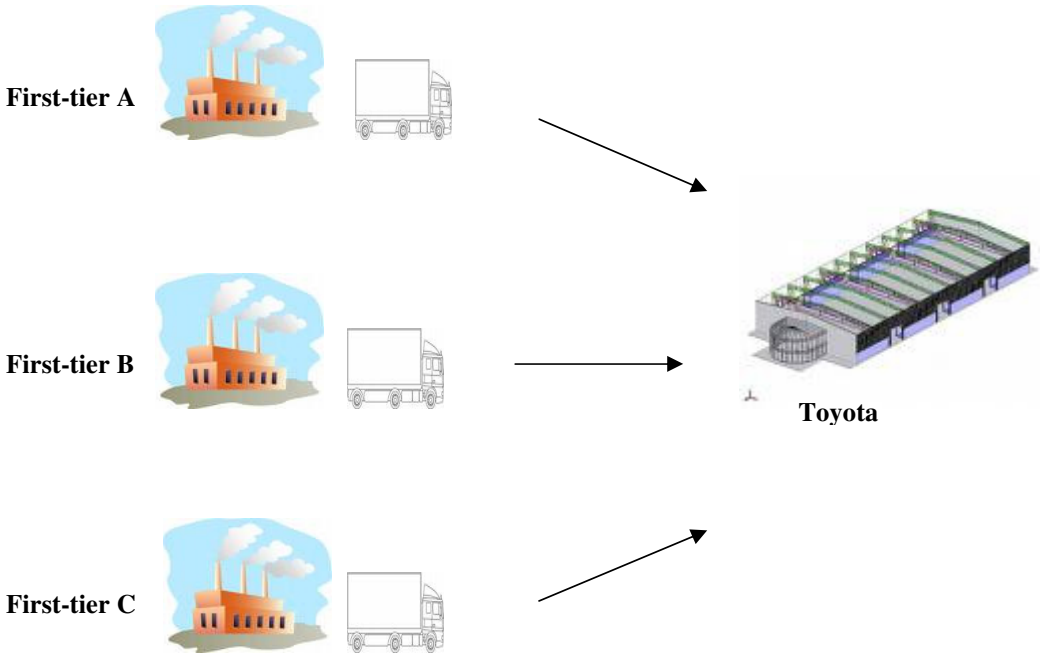
[2] Milk runs are the combination of shipments from multiple vendors in close geographic proximity into one shipment received by the customer, normally done for a defined route on a recurring basis.

[3] TTK Logistics (Thailand) Co., Ltd. is a subsidiary of Toyota Tsusho (Thailand) Co., Ltd.

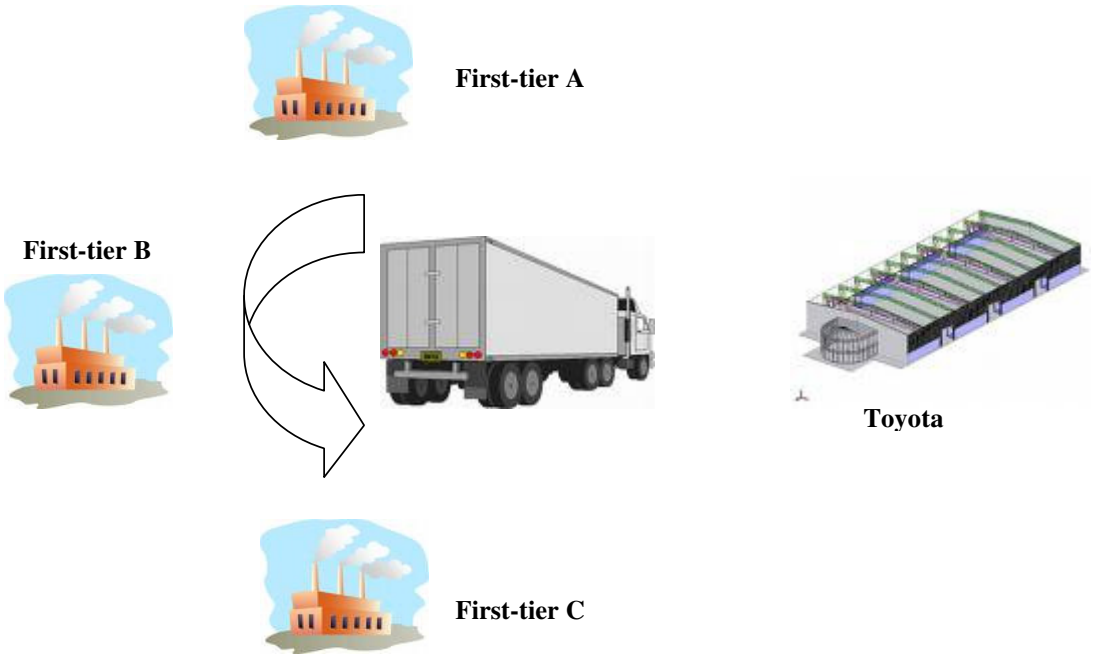
Figure 5.1

Part Delivery before and after Introducing Milk Runs

Before Introducing Milk Runs



After Introducing Milk Runs



Source: From surveys (2007)

Table 5.2

Characteristics of Part Delivery before and after Introducing Milk Runs

Before milk runs	After milk runs
Low frequency	High frequency
Big lots	Small lots
High inventory	Low inventory

Source: From surveys (2007)

So, first-tier suppliers have to face a new challenge because high frequency and small lots in part deliveries are expected by Toyota. In addition, first-tiers have to rely on the delivery schedules and any delay cannot take place; otherwise they will have to deliver parts to Toyota on their own. As a result, if relying on their own deliveries is not just in time, they will be deducted points in the supplier evaluations by Toyota.

From interview one of Toyota first-tier supplier, which is firm C. It is found that in early of introducing milk runs to firm C, Toyota sent technicians to transfer know-how involved in stock management, organizing delivery schedule, loading, and packing to firm C (socialization). In addition, not only firm C has to adjust itself to milk runs, but lower tier suppliers delivering parts to firm C also have to adjust themselves because lower tiers are also expected to supply parts on-time and more frequently[4].

The study finds that before milk runs were introduced to firm C, its lower tier suppliers had to deliver parts around 1-2 times a month. However, after firm C has been introduced milk runs, its lower tiers have to deliver parts around 4 times a month and to be just in time (see table 5.3). As a result, firm C has to assist its lower tiers by

[4]According to Liker and Woo (2000), Toyota expects U.S first-tier suppliers to deliver the right part at the right time. So, it has to organize production schedule to them. As a result, second- and third-tier suppliers are able to cut their inventories and ship on a JIT basis.

sending technicians to organize delivery schedules and teach them about stock management and packing technique to its lower tier suppliers (socialization). If any lower tier supplier is late in part delivery, it will be deducted points in supplier evaluations by firm C.

Table 5.3

Frequency of Part Deliveries by Lower Tier Suppliers to Firm C

Before milk runs	After milk runs
1-2 times/month	4 times/month

Source: From surveys (2007)

So, competitive environment and stringent requirements from automakers directly influence technology transfers to lower tier suppliers, specifically tacit knowledge (socialization). Besides, case 1 implies that technologies transferred by an automaker are not only diffused in it, but they are also diffused to lower tier suppliers.

Furthermore, the study finds that there is another factor influencing technology transfers to lower tier suppliers, which are types of products manufactured by lower tier suppliers. In practice, first-tier supplier produce main components and simple components are produced by lower tier suppliers. In the end, auto parts are assembled at first-tier plants before delivering to automakers[5].

Even though lower tier suppliers are employed by first-tier suppliers to co-operate in simple part productions, but it does not mean every lower tier involved will be transferred technologies. The word ‘simple part productions’ can be classified into

[5] Remarkably, from surveys it is found that those products that can be completely produced at first-tiers’ plants and there is no need of assembling as the big parts such as glasses and tires, first-tier suppliers do not have to employ lower tier suppliers to co-operate in production.

two groups. The first group is the lower tier suppliers that only rely on producing raw material such as metal, plastic, knot, and screw and they do not need any transformation process on those raw materials. Besides, these lower tiers do not only produce raw materials that only serve the automotive industry, but they also produce raw materials to serve other industrial sectors. As a result, this group of lower tier suppliers are not transferred technologies by first-tier suppliers because they do not need special know-how or proprietary to enhance their transformation processes.

On the other hand, the second group is the lower tier suppliers that do not only produce raw materials, but they also have to transform those raw materials into simple finished parts that are used specifically for automotive industry e.g. lower tier suppliers do not only produce aluminum as raw material, but they also have to transform it as aluminum pipe that is needed and connected to radiators. As a result, the second group of lower tier suppliers will be transferred technologies by first-tier suppliers.

So, in this section it can be concluded that a competitive environment, stringent requirements from automakers, and types of products produced by lower tiers are the factors influencing technology transfer to lower tier suppliers.

5.2 Purposes of Technology Transfer between First-tier and Lower Tier Suppliers

The study finds that the most important purpose of technologies transferred by first-tier suppliers is for quality of part productions, which accounts for 38 per cent (see figure 5.2). First-tier suppliers expect lower tier suppliers to receive ISO 9000[6] in order to guarantee their quality of part productions. As it was mentioned earlier that automakers did not only assemble automobiles for domestic demands, but they also exported automobiles to other markets. Thus, the quality of locally assembled automobiles has to meet international standards.

The second important purpose is on-time delivery which accounts for 23 per cent. The study finds that automakers expect first-tier suppliers to be able to supply auto parts on-time. If the deliveries from the first-tiers are delayed, all production

[6] ISO 9000 is a worldwide quality standard. Businesses that are certified to this standard have documented repeatable processes for ensuring that they deliver quality products.

plans cannot be preceded. As a result, what components that first-tier suppliers employ lower tier suppliers cooperating in part productions, they have to be on-time as well. From first-tier's point of views, most of them have relied on the Japanese automakers' management which is the lean production. All the right parts have to be delivered at the right time. They encourage lower tier suppliers to supply parts in small-lot deliveries.

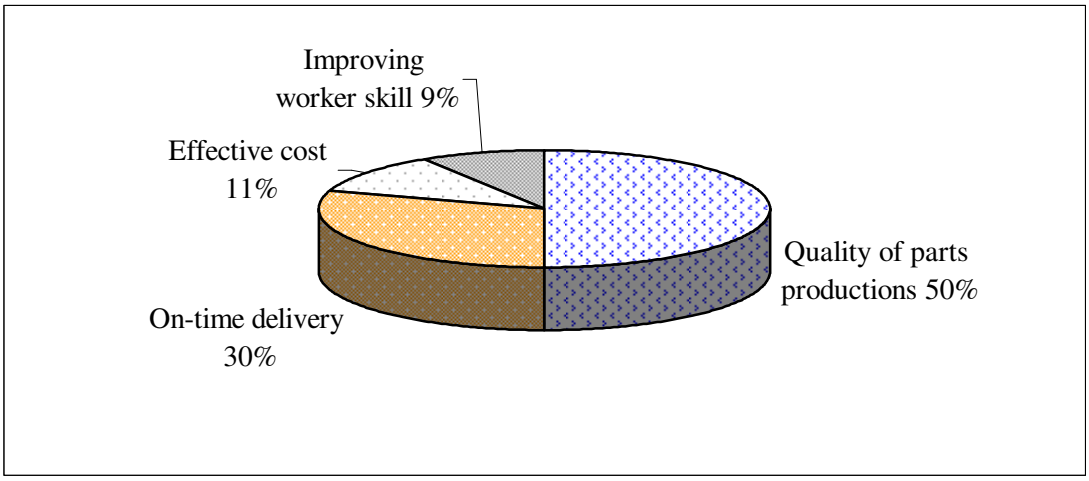
The next purpose of technology transfers is for both quality and cost effectiveness which accounts for 19 per cent. However, the mere purpose of cost-effective accounts only for 11 per cent. From surveys, it is found that if lower tier suppliers are able to produce auto parts meeting the quality standards, it can automatically reduce cost because the reproduction processes caused by defective parts productions can be avoided. Furthermore, on-time delivery of lower tier suppliers can also reduce cost as well. If they deliver parts to first-tier suppliers on schedules, they can avoid carrying cost. Thus, the purposes of producing parts meeting high quality and delivering on-time are more important than the mere purpose of cost reductions.

And the last purpose of technology transfers is for improving workers skills which accounts for 9 per cent. Skilled workers directly contribute to the quality and efficiency of parts productions[7]. Besides, it is found that lower tier suppliers produce components which are not as complicated as first-tier suppliers, which rely on advanced machines. As a result, lower tier suppliers get involved in labor forces in many processes. Thus, lower tier workers have to be skillful. For instance, one of firm U's lower tier supplier, it produces stamping parts. Most stamping parts are not completely produced by machines, but they also have to be produced by workers such as Plate Spring Support RH / LH. This part is stamped by machine and workers get involved in garnishing before it becomes finished components. Thus, workers have to be skillful in garnishing; otherwise the product will not meet the requirements.

[7] From a previous literature such as Techakanont and Terdudomtham (2004), the success of any technology transfers would be an increase in the technological capabilities of the employees of the recipient firm enhancing the efficiency of the firm's production process a whole.

Figure 5.2

Purposes of Technology Transfer to Lower Tier Suppliers



Source: From surveys (2007)

5.3 Patterns of Technology Transfer between First-tier and Lower Tier Suppliers

According to previous chapter, Japanese automakers expect first-tier suppliers not only to be capable in producing auto parts with high quality and effective cost, but they also expect first-tier suppliers to be capable the product development and process engineering because they expect first-tiers to play active roles in the Thai automotive industry. As a result, technical advices and close supervisions in those two stages are provided to first-tier suppliers.

However, it is found lower tier suppliers are employed to cooperate in part production, which are not expected to play active roles as first-tier suppliers, specifically in product development and process engineering because they just rely on simple part production and have limited absorptive capacity. So, technology transfers between first-tier and lower tier suppliers are only knowledge involved in the production stage, which mainly concerns in-house production and plant management.

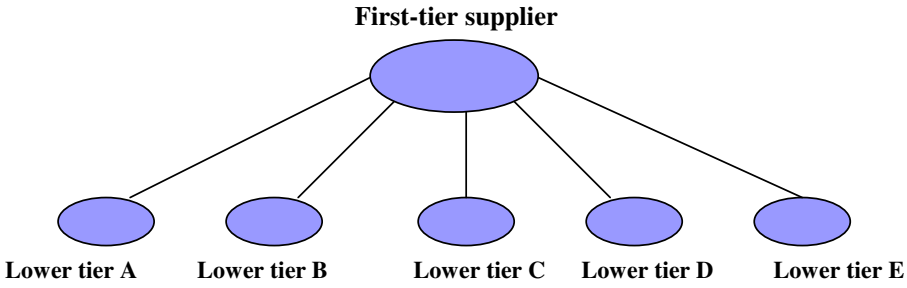
Besides, it is found that the pattern of technology transfers between first-tier and lower tier suppliers occur in the form of bilateral relationship, which technologies are only transferred by first-tier suppliers (see figure 5.3). The study finds that there are two reasons that technology transfers between first-tier and lower tier suppliers occur in the form of bilateral relationships, instead of occurring as a network.

Firstly, first-tier suppliers deal with few numbers of suppliers. As a result, the business values of first-tier suppliers are less than automakers. So, it is not worthwhile to first-tier supplier to form a network that has a small group of members.

Secondly, in practice lower tiers produce simple components, which mainly concern simple techniques in stamping and casting process and those techniques are not much different to each plant. So, the necessity of having a network facilitating technologies to lower tier suppliers is slight because they just rely on simple productions.

Figure 5.3

Technology Transfers between First-tier and Lower Tier Suppliers



Source: From surveys (2007)

So, comparisons of pattern and context of inter-firm technology transfers between Japanese automakers and first-tier suppliers, and first-tier and lower tier suppliers can be made in table 5.4.

Table 5.4

Comparisons of Context and Pattern of Technology Transfers between Japanese Automakers and First-tier Suppliers and First-tier and Lower Tier Suppliers

	Japanese automakers and first tier suppliers	**First-tier and lower tier suppliers**
Context of inter-firm technology transfers	Product development, process engineering, and production stage	Only production stage
Pattern of inter-firm technology transfers involved in production stage	One of Japanese automaker, namely Toyota, has relied on both bilateral and multilateral relationship	Only bilateral relationship

Source: From surveys (2007)

5.4 Channels of Technology Transfer between First-tier and Lower Tier Suppliers

The study finds that the most widely used channel by first-tier suppliers in transferring technologies to lower tier suppliers is sending technicians on training visit to lower tier plants (see figure 5.4). Technicians will visit lower tier plants in order to evaluate and investigate their problems, and provide them corrective actions. The study finds that the main reason of relying on this channel by first-tiers is because each lower tier has different technological capability. So, relying on this channel allows first-tier technicians to be able to see production process of lower tier suppliers and can solve their problems on a case by case basis. According to Reddy (1996), difference in technological capability is a barrier in technology transfers. So, technological modification fitting into technological capability of each lower tier is needed. Besides, lower tier suppliers have low technological capabilities and in order to transfer them technologies, it needs first-tier technicians to provide them close supervisions and technical advices. So, relying on this channel allows them to transfer tacit knowledge, which is difficult to be codified (socialization).

The next channel used in technology transfers is organizing a seminar at first-tiers' plants. Lower tier suppliers will send their staffs to join the seminar in order to

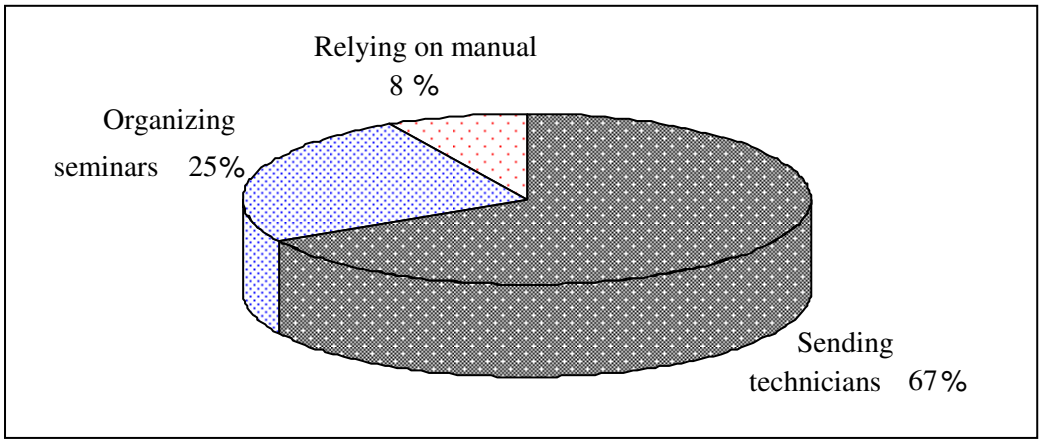
absorb new technologies. The study finds that the channel is employed by first-tier suppliers because lower tier staffs can be trained once a time. So, it is less time consuming for first-tiers to visit each lower tier plant. However, the limitations of relying on this channel are lower tiers participated should have the same background in part productions and their technological capabilities should be slightly different. As a result, this channel allows first-tiers to transfer technologies, which are less difficult to be codified (internalization).

And the last channel is relying on manual. First-tier suppliers do not have interface training because they just only send manual to lower tier suppliers. Remarkably, this channel is not widely used because it lacks interactions between first-tier and lower tier suppliers. If lower tiers have any problem, it is hardly possible for first-tier suppliers to identify and eliminate the problems. According to literature (Nonaka and Takeuchi, 1995; Kim, 1997; Ernts and Kim, 2002; and Techakanont, 2007), tacit knowledge can be only shared through interaction. So, relying on this channel only allows explicit knowledge that can be shared e.g. which parts lower tiers have to produce and what materials should be used in production (combination).

For better understanding how knowledge can be shared to lower tier suppliers through sending technicians and organizing seminars. So, case 2 and case 3 are provided as follows.

Figure 5.4

Channels of Technology Transfers between First-tier and Lower Tier Suppliers



Source: From surveys (2007)

Case 2 (Sending Technicians on Training visits to Lower Tier Plants)

Firm C mainly produces stamping & casting parts and some engine part such as fuel tank, radiator, and engine gasket. From surveys lower tier suppliers are employed to co-operate in part productions because each auto part consists of many components that exceeds firm C's production capacity. In practice, it produces main components and lower tier suppliers produce simple components, which mostly concern stamping and casting parts. Then, all finished parts are assembled at plant C before delivered to automakers.

From interview, it has begun to provide supplier development programs to its lower tiers since 2001. In order to provide supplier development programs, firm C relies on transferring know-how to lower tiers through the channel of sending technicians to audit lower tier suppliers. The main reason that the company has relied on this channel is because it perceives that each lower tier has different problems and technological capabilities. Besides, sending technicians are able to see the real production processes of lower tiers. As a result, they can solve the problems accurately. Lower tiers' problems should be eliminated case by case.

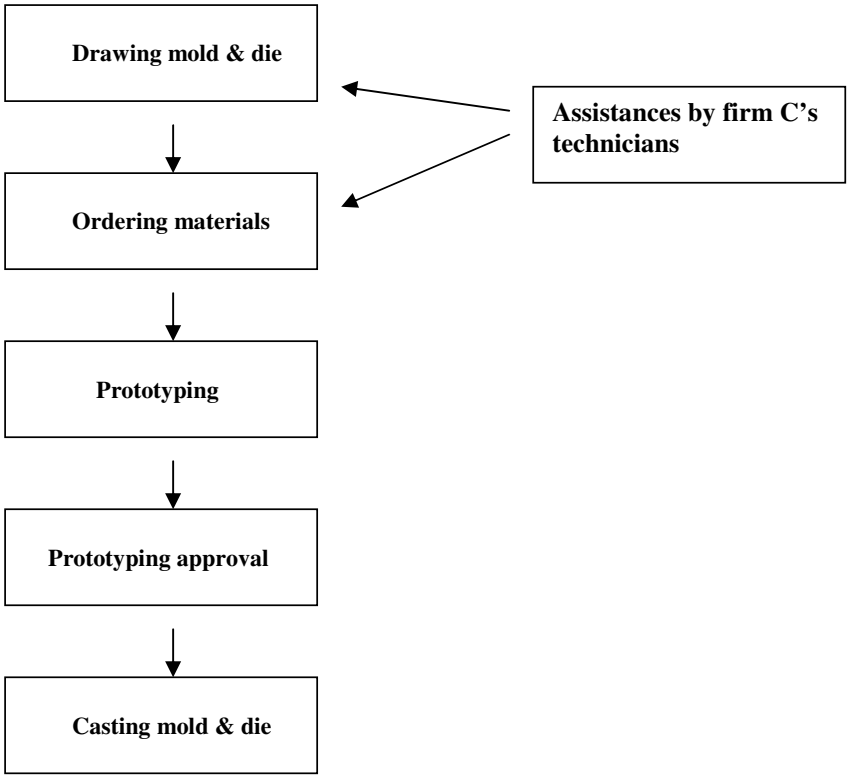
Each visiting, there are around 3 to 5 technicians in a team to audit each lower tier supplier. Each visiting takes time around 1 or 2 days. Besides, it is costly around 1,500-2,000 baht in each visiting. The expenditure covers food, transportation cost, and documentation.

When technicians arrive at lower tier plants, they will figure out the problems that make lower tiers cannot produce parts meeting requirements as the first step. The problems most frequently found in their part productions concern dimension errors of manufactured parts in metal stamping and casting processes. Metal stamping is a manufacturing process in which metal sheets are stamped and shaped into specific parts, and they are usually assembled with other components for a large structure. On the other hand, casting is a manufacturing process in which molten material such as metal or plastic is injected into a mold, cooling it within the mold, and then taken off as a part. In practice, casting is used for making a part having complicated structure that would be difficult or worthless to be made by other methods, for instance cutting solid material for a complicated structure.

For the corrective actions, technicians will teach lower tier suppliers how to make mold & die used in stamping and casting processes (socialization). If mold & die are made incorrectly, then all stamping and casting parts will have error dimensions. There are 5 processes in making mold & die (see figure 5.5), which are drawing mold & die, ordering materials, prototyping, prototyping approval, and casting mold & die. However, firm C's technicians provide close supervision and guidance to lower tiers' staffs in the step of drawing a blueprint for making mold & die. Besides, the technicians have to give them advice in the step of ordering materials.

Figure 5.5

The Processes of Making Mold & Die



Source: From surveys (2007)

In addition, the technicians will teach lower tiers about techniques in stamping and casting processes. For the stamping techniques, technicians begin to teach lower tiers about ordering materials used in the stamping (socialization). Most metal stamping machine will accept these materials such as alloys of aluminum, cold rolled

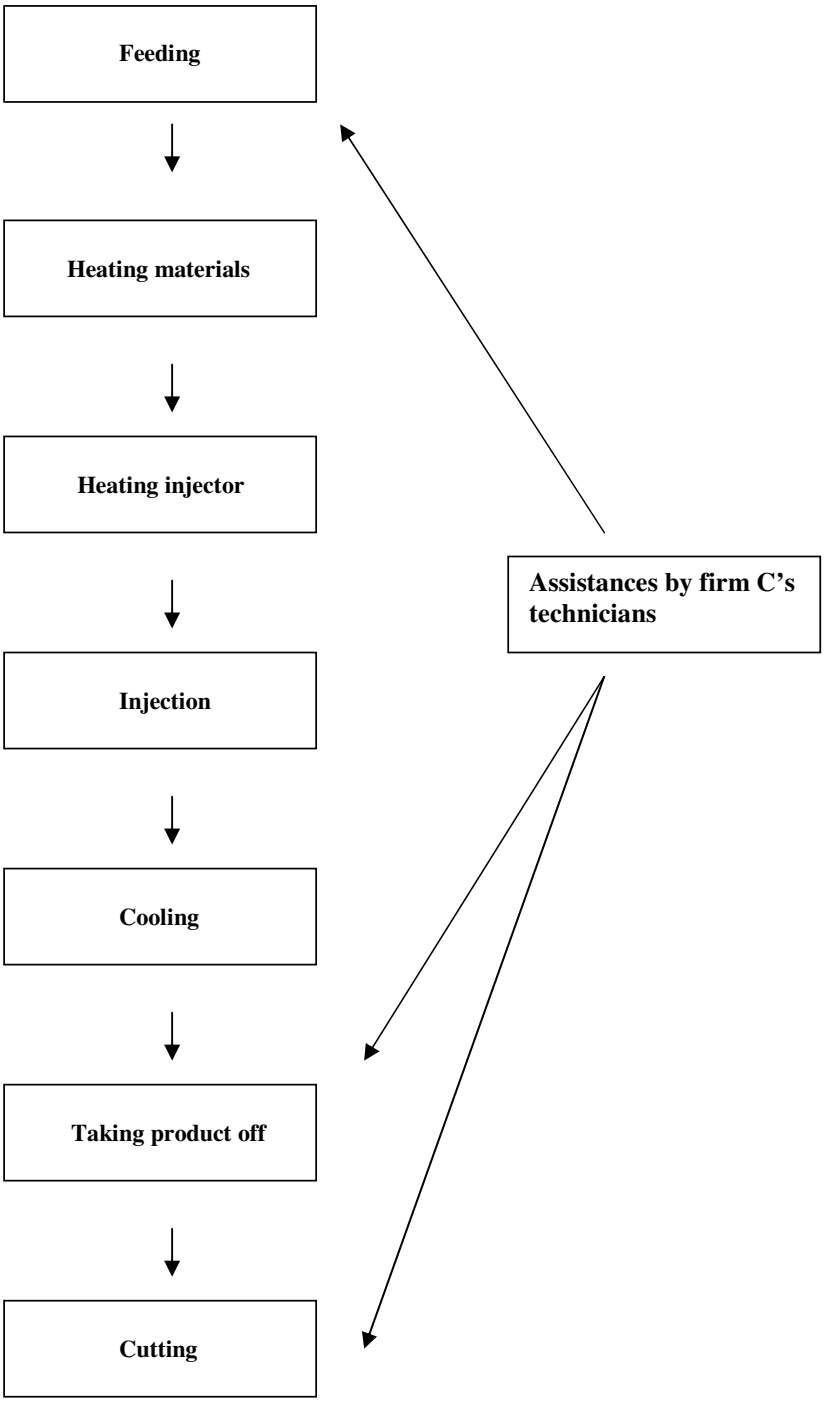
steel, hot rolled steel, brass, galvanized steel, stainless steel, titanium, copper, and zinc. In addition, technicians will have to teach lower tiers about thickness of materials used in the stamping. Most metal stamping machines cannot deal with a metal sheet that is much thicker than 0.25 inch. As a result, the metal sheet thicker than this is very difficult to be stamped effectively, and it may damage the stamping machine.

In addition, most of first-tier suppliers rely on advanced stamping machines, which do not require workers to control every stamping station. For the advanced stamping machines, metal sheets are stamped from several stamping stations automatically. So, it is less time consuming in the overall process since the workers do not need to feed metal sheets into stamping machines for every stamping process. However, many lower tier suppliers still rely on simple machines which require workers to get involved in each stamping station. So, technicians have to teach workers how to put metal sheet on the stamping machines in order to stamp it dimensionally because the fitting of the upper die over the lower one by having the metal sheet in between is an very important step (socialization). Finally, the last step of stamping, the technicians will teach workers how to garnish finished parts and how to reuse the metal sheet.

Furthermore, for casting processes, there are 7 steps, which are feeding, heating material, heating injector, injection, cooling, taking product off, and cutting (see figure 5.6). Technicians will teach workers about setting appropriate degree in order to melt metal (socialization). If workers melt metal inappropriately, there might be problem such as blow hole or shrinkage on a surface of product. The most appropriate degree in melting metal is 600 C. In addition, technicians will teach workers in order to take product off (from fixed and moved side), cut the product, and maintain die because there might be leaks in a die after casting metal (socialization).

Figure 5.6

The Casting Processes



Source: From surveys (2007)

Case 3 (Organizing Seminar at First-tier Plant)

Firm G is a first-tier supplier, which produces stamping and casting parts, and mold & die. It has begun to provide supplier development programs since 2001.

In order to transfer know-how to lower tier suppliers, it has relied on organizing seminar at its plant. From an executive's point of view, the benefit of the seminar is to be able to train many lower tier suppliers once a time and it is less time consuming. Each seminar, it takes 1 or 2 days. There are 5 to 6 lower tier suppliers participating in each seminar. Each lower tier will send their 2 or 3 staffs to join the seminar.

This company, there are 4 stages in productions, which are die-casting, machining, rubbing, and painting. Because production capacity of firm G is limited, so lower tier suppliers get involved in rubbing and painting stage. For rubbing, it is about the techniques in rubbing metal face before all finished products are painted (internalization). Notably, before rubbing a product, it must be cleaned first. For plastic product, it should be cleaned by water. In contrast, if it is metal, it should be cleaned by phosphate.

Besides, for painting, technicians will teach lower tiers "how far they should stay from objects in painting" and techniques "how to paint the surface of parts smoothly" (internalization). In addition, technicians also teach participating lower tiers in packing and classifications of tags (internalization). As a result, after joining the seminar, these lower tiers can stock know-how that they receive as their own knowledge (internalization and then externalization)[8].

Notably, the lower tiers participating in the seminar must have the same background in parts productions e.g. involving in the same stage in the production process; otherwise it is hardly possible to firm G to transfer know-how to lower tier suppliers, which do not have the same background.

So, inter-firm technology transfers between first-tier and lower tier suppliers can be concluded in figure 5.7.

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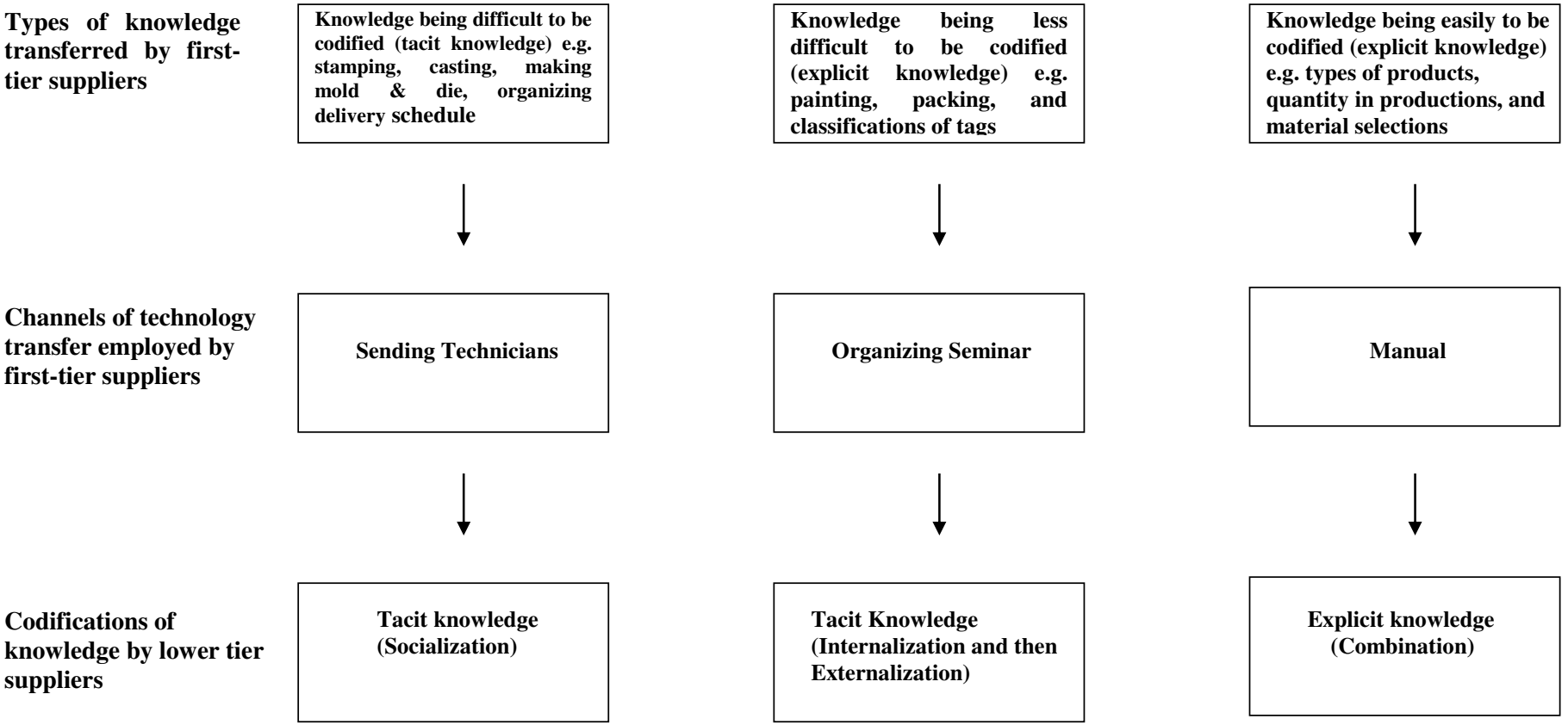
[8]Knowledge transferred through the pull strategy is taken account as internalization and then externalization because most of them are standardized knowledge (e.g. painting and packing), which are not difficult to be codified. So, after absorptions by lower tiers, they can stock as their own knowledge, which is not also difficult to be codified.

Figure 5.7

Inter-firm Technology Transfers between First-tier and Lower Tier Suppliers by Types of Knowledge



5.5 Barriers of Technology Transfer between First-tier and Lower Tier Suppliers

The study finds that the most important barrier of technology transfers to lower tier supplier is lack of motivations in joining supplier development programs of lower tier suppliers (see figure 5.8). From first-tiers' point of views, top management of lower tier suppliers do not understand how technology transfers is beneficial to their organizations, and they do not understand how technology transfers can enhance their parts productions in terms of cost-effective, quality, and on-time delivery. As a result, when they are asked to join the supplier development programs, they refuse to join them or not to be serious in the learning process. However, many first-tier suppliers solve this problem by having supplier evaluations that lower tier suppliers have to achieve.

Supplier evaluations are mostly in the form of giving scores[9]. If any lower tier suppliers fail to achieve minimum scores, they have to improve their performances; otherwise they will not be given new orders. This is the way that first-tier suppliers motivate lower tier suppliers to eager to join the development program and emphasize on the learning processes.

The next barrier of technology transfers to lower tier suppliers is difference in technological capabilities of lower tier suppliers. Normally, first-tier suppliers used to automatic machines which are high speed and can produce parts with higher quality; meanwhile many lower tier suppliers still rely on manual machines which are low speed and require more labor skills in productions. As a result, when lower tiers' staffs join the development program, they may not be able to totally bring know-how to improve their performances when operating at their plants because of the gap of technological capabilities.

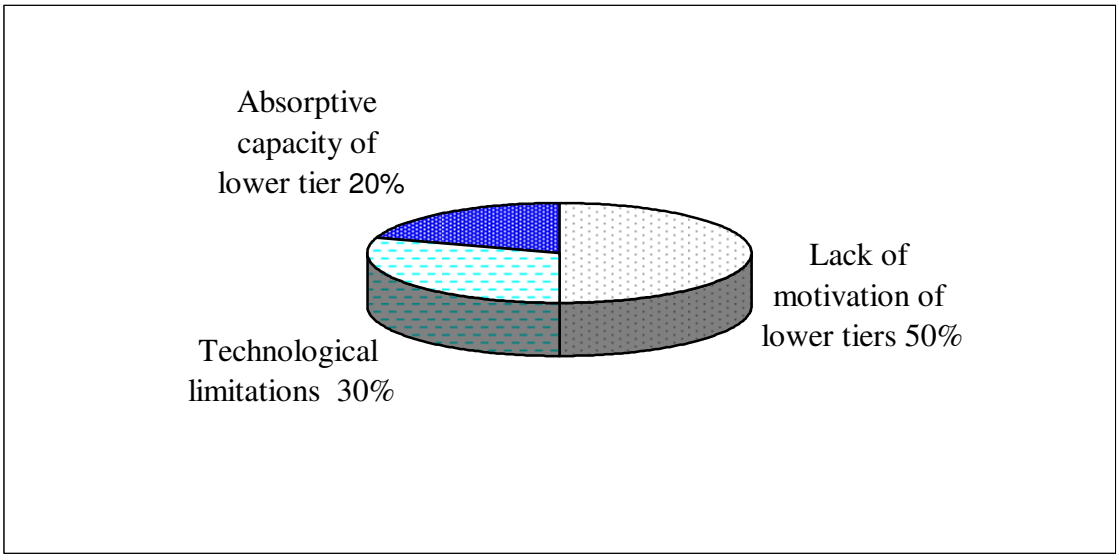
Finally, it is absorptive capacity of lower tier workers. The study finds that workers who work in lower tier plants, they mostly graduate from secondary school which has a little background in mechanics and they have a few working experiences in factories. As a result, they cannot absorb know-how transferred by technicians effectively. For instance, one of firm U's lower tier supplier, there are 547 workers

[9] The study finds that supplier evaluations are used as tools in motivating lower tiers to join the supplier development programs. In appendix C, one of supplier evaluations, namely firm C, is provided as a case.

and more than 70 per cent of workers who work in factories graduate from secondary school. From interview, it is found that the big problem in the learning process is the workers cannot effectively absorb techniques taught by technicians. As a result, the learning process is time consuming and costly to the transferors.

Figure 5.8

Barriers of Technology Transfer between First-tier and Lower Tier Suppliers



Source: From surveys (2007)

5.6 Concluding Remarks

The study shows that a competitive environment and stringent requirements from the automakers e.g. on-time and cost effectiveness, are the main factors influencing technology transfers, specifically tacit knowledge to lower tier suppliers. The case of Toyota in introducing milk runs is evidence.

In addition, types of products manufactured by lower tier suppliers are another factor influencing technology transfers. The study finds that there is only a group of lower tier suppliers, who produce and transform raw materials into simple finished parts used specifically for the automotive industry that will be transferred technologies by first-tier suppliers.

Furthermore, the study finds that technology transfers to lower tier suppliers are knowledge involved in the production stage, which mainly concerns in-house

production and plant management. Besides, technology transfers to lower tier suppliers occur in the form of the bilateral relationship, which knowledge is transferred by first-tier suppliers.

According to a previous study (Dyer and Nobeoka; 2000), there is explicit knowledge that is commonly transferred to suppliers in the bilateral relationship. However, this study finds that, in the bilateral relationships, it includes tacit knowledge. The main reason of tacit knowledge transferred to lower tiers is because of a competitive environment and stringent requirements from automakers.

Besides, the study finds that sending technicians on training visit by first-tiers facilitate tacit knowledge e.g. making mould & die, stamping, casting, organizing delivery schedule (see discussion in section 5.4) to lower tiers because relying on this channel allows the first-tiers' technicians to provide them close supervisions and technical advices (socialization). Furthermore, each lower tier has different technological capability, so relying on this channel allows first-tiers to solve lower tier problems on a case by case basis.

In the last section, the study shows that there are three main barriers of technology transfers to lower tier suppliers, which are lack of motivations in joining supplier development programs of lower tier suppliers, difference in technological capabilities of lower tier suppliers, and absorptive capacity of lower tier workers.

In order to eliminate lack of motivation in joining supplier development program of lower tiers, the study finds that first-tier suppliers eliminate this barrier by having supplier evaluations that lower tier suppliers have to achieve. Supplier evaluations are mostly in the form of giving scores. If any lower tier suppliers fail to achieve minimum scores, they have to improve their performances; otherwise they will not be given new orders.

Finally, in order to eliminate difference in technological capabilities of lower tier suppliers and absorptive capacity of lower tier workers, relying on the push strategy of technology transfers is the solution because it allows first-tier technicians to provide lower tiers close supervision and technical guidance on a case by case basis.