CHAPTER 2

CONCEPTUAL BACKGROUND AND ANALYTICAL FRAMEWORK

In this chapter, it is intended to provide an understanding of technology transfers. It begins with definitions of technology transfers based on a lot of literatures. Then, intra- and inter-firm technology transfers, channels, processes, barriers and solutions, and bilateral and multilateral relationships in technology transfers will be the focus. At the end of this chapter, factors facilitating technology transfers will be presented.

2.1 Definitions of Technology Transfer

It is very difficult to clearly define the definition of "technology transfer" because it is defined differently by various groups of gurus. It is very important to understand the meaning of "technology" first. The term 'technology' is derived from the Greek word *techne* and *logos* (An ESCAP Training Manual, 1992). *Techne* means the skill or craft needed to make something; *Logos* means discussion (knowledge of something). So, technology can be defined as an accumulation of knowledge related to activities such as the manufacturing and marketing process (Stewart, 1979 and Dodgson, 2000).

However, technology can be defined more broadly. It is not only defined as an accumulation of knowledge in manufacturing, but it also includes physical evidence such as machinery in that process (Charles and Howells, 1992). In addition, technology can be defined as techniques involved in the product design, production, and managerial system (Baranson, 1978 and Jeremy, 1991).

Tuma (1980), technology should be considered as an operation within an "open system." It can be considered as the process between transferee and transferor. Thus, technology transfer can be defined as the acquisition and adoption of a technique and technological knowledge from one country or industry to another in the production process.

So, technology can be defined into two major types (Dosi, 1985; Kogut and Zander; 1992, and Techakanont, 2002), namely, “explicit or hardware” and “implicit or software” technology. Explicit or hardware transfer is broadly defined as the transfer of devices, equipment, parts, information, licenses, manuals, and guidelines for uses. Implicit or software transfer is defined as the competence to plan, manage, and evaluate applications, skills, and know-how. However, most scholars have suggested that tacit or knowledge transfer is much more important than explicit or hardware transfers (Dosi, 1985; Kogut and Zander; 1992, and Techakanont, 2002) because knowledge transfer is very difficult to be codified, and it takes time in the learning process. Besides, it contributes to long-run economic development and the design of new products.

So, in this study, technology transfer or knowledge transfer is the main focus, and it can be used interchangeably.

2.2 Difference between Intra- and Inter-firm Technology Transfers

Technology can be transferred in two major forms, namely intra- and inter-firm technology transfers. From previous studies (Cohen and Levinthal, 1990; and Techakanont and Terdudomtham, 2004), technology transfer is recognized as being complete only if a transferee is able to understand, operate, and make effective use of technologies that have been transferred. However, how fast and successful a transferee is in internalizing transferred technology or knowledge and making it his own (absorptive capacity) depends on prior relevant knowledge (Cohen and Levinthal, 1990).

Theoretically, intra- and inter-firm technology transfers can be distinguished by two significant attributes, which are equity relationships, and forms of return from transferring technologies. According to Techakanont (2002), he defines intra- and inter-firm technology transfers as follows. An intra-firm technology transfer is defined as a situation in which technology is intentionally transferred by the technology source, a foreign-parent company, to its foreign affiliates. The transferor of technology is paid a monetary benefit from transferring technology as profit or dividends.

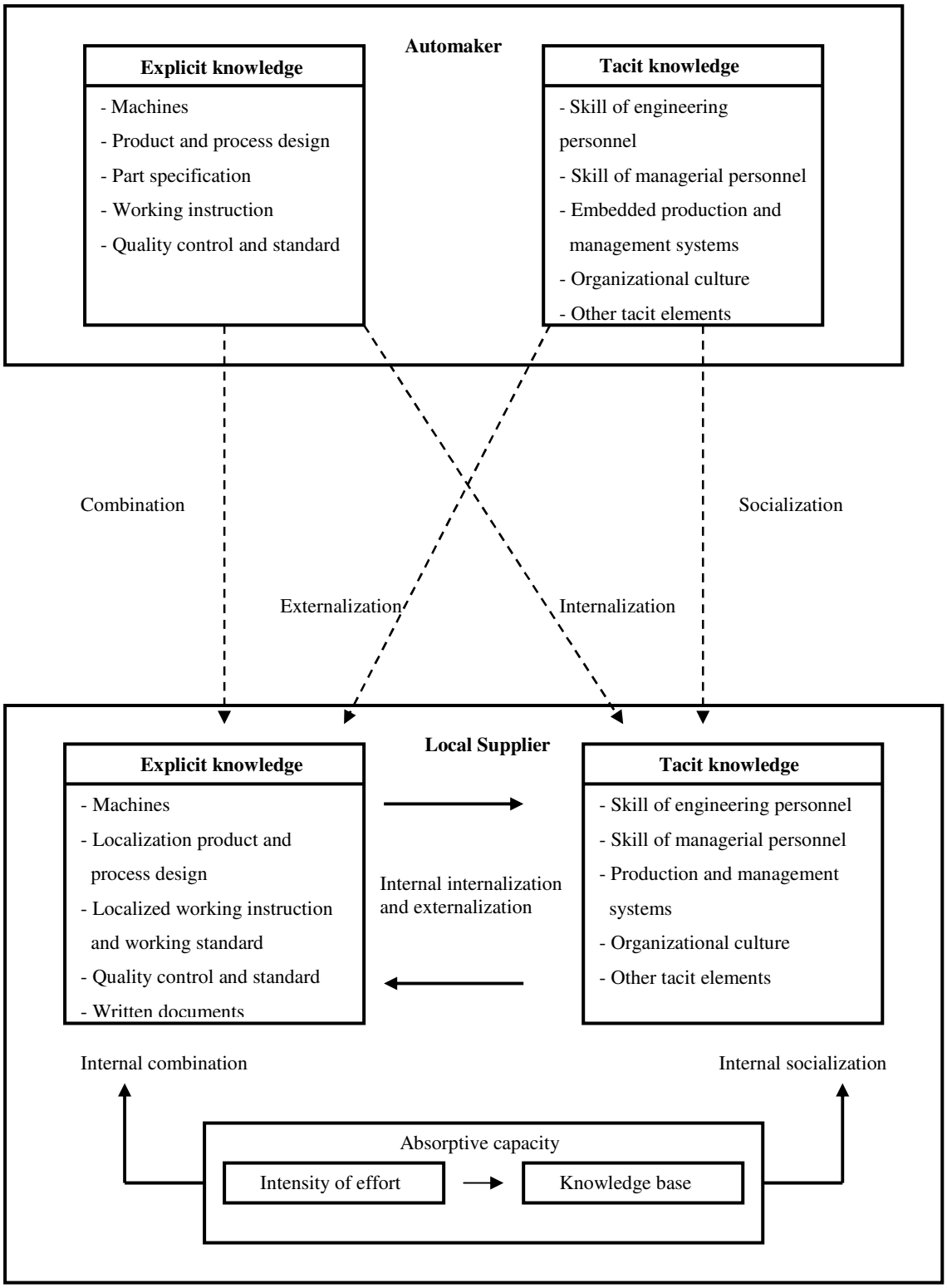
On the other hand, inter-firm technology transfer is defined as the relationship between an input buyer and an input supplier in which both parties have no equity relationship. A special characteristic of inter-firm technology transfer is that the transferor receives productivity or cost-reduction by suppliers instead of monetary benefit (Techakanont, 2002).

In the Thai automotive industry, at the intra-firm level, a Japanese automaker in the homeland is a transferor of technology, and the transferee is its affiliate in Thailand. At the inter-firm level, a Japanese automaker in Thailand is a transferor, and the transferee is its local parts suppliers (Techakanont, 2007). However, an intra-firm technology transfer is less focused than inter-firm technology transfer because Japanese automakers in Thailand will receive full support from their parent companies. In contrast, at the inter-firm level it is much more complicated than that.

Technology transfers in both intra- and inter-firm can be classified into four types, which are socialization, combination, externalization, and internalization (Nonaka and Takeuchi, 1995; Kim, 1997; Ernts and Kim, 2002; and Techakanont, 2007). Socialization refers to the transfer from tacit to tacit that occurs when an individual's tacit knowledge is transferred to another through interactions. Combination refers to the transfer from explicit to explicit that occurs when an individual's explicit knowledge (easily codified) is transferred to another and to be created into new whole explicit knowledge. Externalization refers to the transfer of an individual's tacit knowledge to another in an explicit format. Internalization refers to the transfer from explicit to tacit knowledge that occurs when explicit format is internalized, and shared throughout a firm, and individuals utilize and broaden their own tacit knowledge.

Figure 2.1

Inter-firm Technology Transfer and Local Capability Formation



Source: Techakanont (2007)

2.3 Local Sourcing as a Channel of Technology Transfer to Local Suppliers

Entries of MNEs in host countries, there are three channels for strategic options available to obtain inputs, which are imports, in-house production, and local sourcing. However, only local sourcing can be used as a channel of inter-firm technology transfers to local suppliers. (Capanelli; 1997, United Nations Economic Commission for Europe, 2001; and Brooks and Hill, 2004) (see figure 2.2).

Based on previous studies (Markusen and Venables, 1998; Hill and Athukorala, 2001; and Belderbos et. al. 2001), local sourcing creates backward linkages[1], which are powerful channels for diffusing knowledge and skills between MNEs and local suppliers. Besides, strong backward linkages, specifically under a competitive environment can promote production efficiency, productivity growth, and technological and managerial capabilities to local suppliers. The strengthening of local suppliers can in turn lead to technological spillovers for the rest of the host countries.

In addition, technology transfers through local sourcing provide varieties of assistances to local suppliers as follows (United Nations Economic Commission for Europe; 2001):

2.3.1 Transfers of product designs and technical modification: MNEs transfer technologies in product designs and technological specification to local suppliers because MNEs expect them to be able to supply inputs meeting their specific requirements.

2.3.2 Technical advices to local suppliers in using new technologies: In order to transfer new technologies to local suppliers, the problem may arise because they may never use new technologies. So, technical advices are needed to help them in learning and using new technologies.

[1] To remind the meaning of backward linkages, they occur when MNEs acquire goods or services from local suppliers.

2.3.3 Collaboration in R&D: Relationships between MNEs and local suppliers typically require collaborations in research capability in the host countries. Sometime local universities or research institutes are employed in R&D collaboration.

2.3.4 Provision of hardware to local suppliers: MNEs sometimes transfer machinery equipment to local suppliers. Such equipment may be related to the manufacturing process or testing for quality. Besides, MNEs may also advise local suppliers on the selection of equipment.

2.3.5 Technical support on production planning, quality management, inspection and testing: MNEs provide assistances to local suppliers in improving their manufacturing processes, quality control, and testing methods because they expect low cost and high quality inputs from local suppliers.

2.3.6 Training visit to local supplier for improving operations and quality: Visiting suppliers' plants by MNEs can provide advice on factory layout and machinery, production planning, and quality control. Besides, training visit to local suppliers allow MNEs to solve their problem on a case by case basis. In general, relying on training visit to local suppliers, MNEs have to do it periodically.

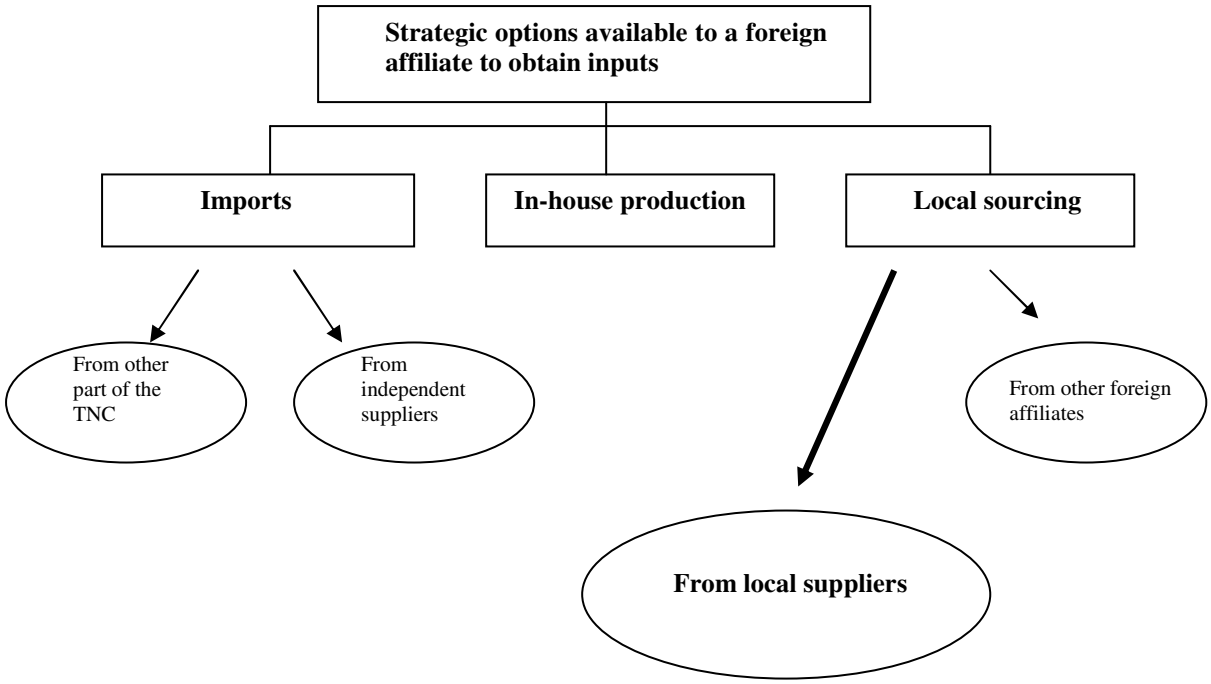
2.3.7 Formation of "co-operation clubs" for interacting with or among suppliers on technical issues: Co-operation clubs are particularly common in Japanese MNEs and sometimes arrange for activities such as quality improvement, cost effectiveness, collaborations in problem solving, technical guidance, and training.

2.3.8 Assistance with inventory management and the use of just-in-time and other systems: Those assistances are very important in input supplies because late deliveries by local suppliers cause delays in MNEs' production process. So, organizing production schedules for local suppliers is needed.

2.3.9 Assistance in implementing quality assurance systems (including ISO certification): MNEs provide support to local suppliers in managing and implementing quality assurance systems or total quality control systems. The aim of assistance is to assure quality of product manufactured by local suppliers.

FIGURE 2.2

Strategic Options for MNEs with Regard to Obtaining Inputs



Source: United Nations Economic Commission for Europe (2001)

2.4 Technology Transfer Processes

It is very important to understand the process of technology transfers because it constructs a systematic framework in facilitating the transfer of technology from a transferor to a transferee. There are ten steps in the technology transfer process (see figure 2.3) (Li-Hua, 2004). It begins with the step of identification of need. It refers to the kind of technology needed by an organization. It is realized that the manufacturing and marketing process will be enhanced by new technologies.

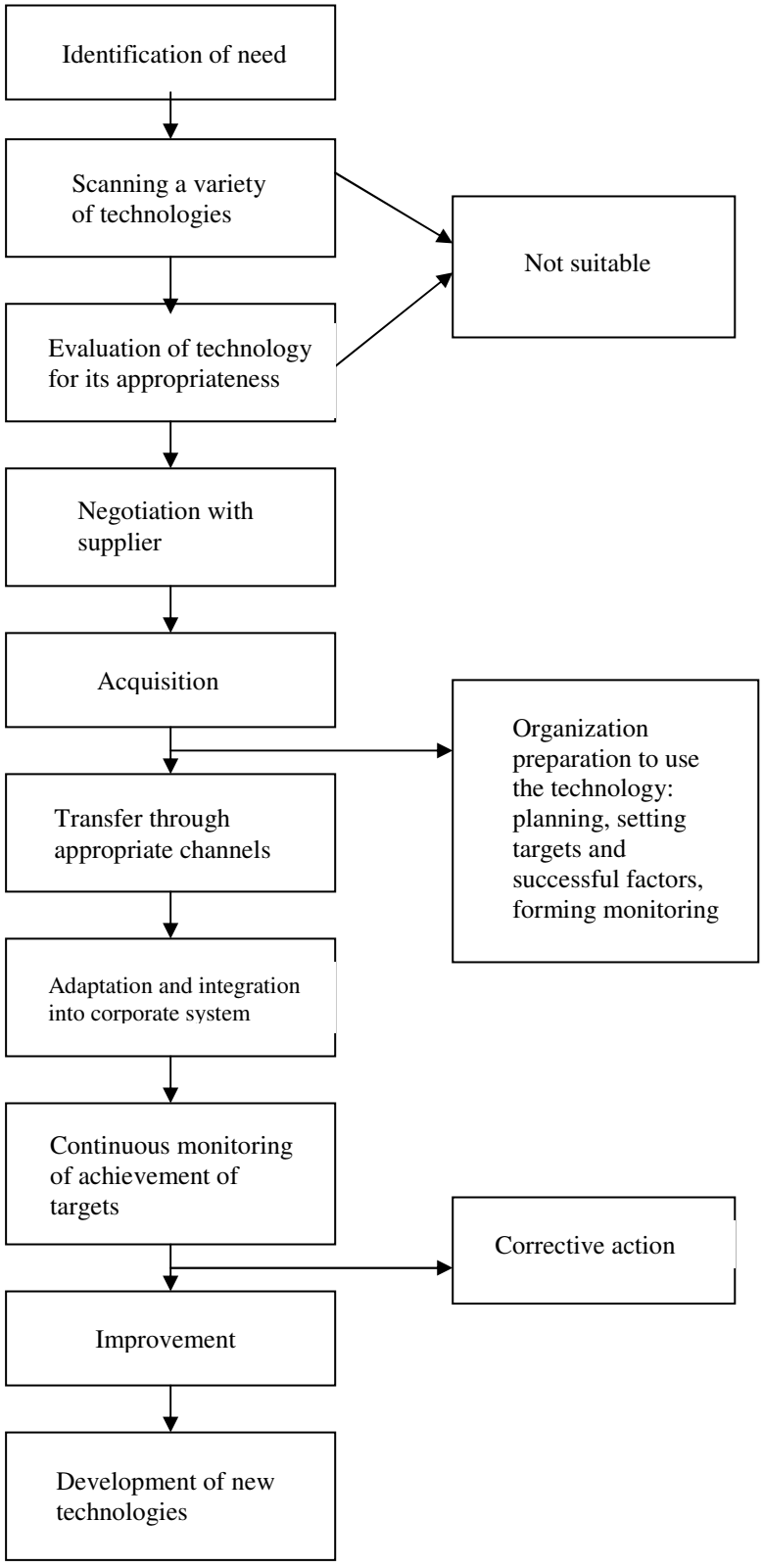
The second step is the scanning of a variety of technologies. It refers to searching for the new technologies which are needed. There is no consideration as to which technology is appropriate for the organization in this step. Next, is an evaluation of the technology for its appropriateness. It refers to choosing the most appropriate technology. All inappropriate technologies are ignored.

After that, negotiations with the supplier will take place. The organization can obtain technology from other organizations through suppliers. Then, comes the acquisition step. The organization possessing an appropriate technology will be contacted. Afterwards, technology will be transferred through an appropriate channel. Remarkably, an inappropriate channel may cause less efficiency in obtaining new technologies. There could be some adaptation and integration into the corporate system. Some technology will work efficiently if there is some adaptation to local conditions.

Next, is the real implementation. The continuous monitoring of the achievement of each target is needed. This to make sure that the technology acquired does perform efficiently. However, if it does not work, it is an important to task improvement this step. It is involved in the corrective action. Finally, the last step, is the development of new technologies. Experts may be needed to develop the new technologies.

Figure 2.3

Technology Transfer Processes



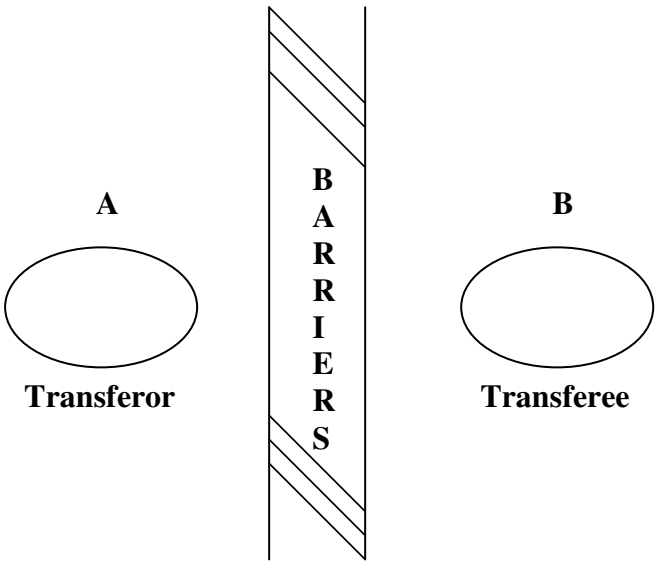
Source: Technology and knowledge transfer in China by Li-Hua (2004)

2.5 Barriers of Technology Transfer

In this section, it is intended to provide an analysis of barriers and solutions in the technology transfer. Figure 2.4 shows the model of the technology transfer barrier, which blocks the flows of technology from a transferor and transferee. Most of barriers that are frequently found in technology transfers; there are the mismatches, the need for product modifications, investors' concerns over short-run profits, lack of financial resources, cultural difference, and political risk.

Figure 2.4

Technology Transfer Barriers (by the author)



2.5.1 The Mismatches

It is usually found that the objectives of a technology transfer between a transferor and transferee do not match each other. As a result, technologies that are transferred to the transferee cannot be used to solve relevant problems.

The mismatches between the transferor and the transferee may take place in the case of a transferee in a developing country needing only simple technologies to improve production processes serving local demands. However, the transferor may expect more capabilities from the transferee. Improving quality and cost-effectiveness of inputs meeting international standards are required by the MNE transferor. Thus,

more advanced technologies are transferred to local firm transferees. As a result, the local firm cannot use the technologies efficiently.

The solution for mismatches is for a consulting firm to be hired to study the situation before the transfer takes place (Reddy, 1996). The study will result in appropriate kinds of technology being transferred to the transferee. It will be able to guarantee that the transferee can use new technologies efficiently. Furthermore, it reduces costs in cases of obtaining new technologies but the transferee does not know how to use them.

In addition, another problem of the mismatches is the lack of communication between the transferor and the transferee. Ineffective communication gives rise to misunderstandings (Etgar, 1979). Thus, communication between the transferor and transferee should be improved.

2.5.2 Difference in Technological Capability

There is a problem in difference in technological capability between the transferor and transferee. Thus, technology modification from the transferor is needed in this sense. However, the modification requires efforts from the transferor in order to modify the technologies to fit the transferee. Notably, technology modifications and costs go hand in hand.

In addition, the technology modification requires some effort from the transferor's R&D department, which may not favor it since the organization possesses more advanced technologies. Therefore, to persuade the R&D staff to work on the process of "reverse engineering" might be unpopular with top management.

The solution of the need for technology modification is hiring a consulting firm or an educational institute to carry out the study (Reddy, 1996). Its benefit is that the transferor would be able to know the kinds of modification needed. In addition, the transferee can gain specialized technologies that can be used efficiently.

2.5.3 Investors' Concern over Short-run Profits

In general, improving the production process and generating profits in the short-run are expected from a transferee when new technologies are transferred. But it seems hardly possible because the transferee in a developing country lacks knowledge

and experience in using the new technologies. It may take time to absorb new technologies.

In addition, infrastructures in developing countries such as financial services, transportations, and communications are inferior to those in developed countries. Thus, technology modifications are needed and they take time in generating profits for the transferor. As a result, short-run profit expectations inhibit the technology transfer.

The technology modifications could take time in developing countries because of low illiteracy and poor communication. As a consequence, the transferor is reluctant to wait for long adoption periods. A project having no immediate cash return is rejected. Thus, the transferor must be patient and allow the transferee time in adapting the new technologies (Reddy, 1996).

2.5.4 Lack of Financial Resources

Major problem in getting new technologies is the lack of financial resources of a transferee. High initial fees and royalty payments are the main barriers of the transferee in less developed countries. As a matter of fact, advanced technologies and the high price of technology acquisitions go hand in hand. The transferees have to put more efforts into new installations, maintenances, and services. Thus, the lack of financial resources by the transferee inhibits the technology transfer.

The solution for a lack of financial resources by the transferee is the direct involvement of the transferor. General speaking, it is involving the transferor in the transferee's operations, for instance giving the transferor an equity relationship in the transferee's organization. As a consequence, the transferor can make capital and equipment investments in the transferee's operations (Dyer and Ouchi, 1993 and Monczka et al., 1993). For example, manufacturers such as Toyota and Nissan typically have a 20-50% equity relationship with their suppliers (Dyer, 1996).

2.5.5 Cultural Differentiation

Mainly, it refers to communication difficulties due to different languages. The languages are determinants facilitating the success of technology transfers because

they enable a transferee to understand messages from a transferor. The English language is the international language in communications.

However, lack of English skills can be found broadly in groups of transferees in many countries. As a result, the technology cannot be transferred efficiently. For instance, sending workers from the transferee company to the mother company in abroad with the aim of learning new technologies, being unskilled at English is the main barrier in this case.

Kitsopoulos (1994) found that executives from North America who are assigned to work in overseas, will take courses in local languages for four weeks. The aim is to make them better at business negotiation and be able to understand new perspectives from local workers. So, improving communication skill will help solve cultural differentiation problems.

2.5.6 Political Risk

Political instabilities can mostly be found in the third world and developing countries. It deteriorates investor confidence from developed countries. Most investors rely heavily on democracy and political stability because they expect money return from continuous investment policies. Political instability often mean changes in a country's policy.

More importantly, entries of MNEs require a lot of money in building factories and setting up machinery. In other words, there are sunken costs for them. Thus, any perception of political instability by investors leads to the abandon their investments in a host country. As a result, financial inflows and new technologies will not go into the host country.

The way investors may protect themselves from political instabilities is by purchasing insurance from government sources and private insurance firms (Reddy, 1996).

2.6 Analysis of Bilateral and Multilateral Knowledge Sharing

The business environment today requires firms to effectively use all available resources to retain their competitiveness. Quality improvement and cost effectiveness of a product or service are the main goals that they need to achieve. To retain their

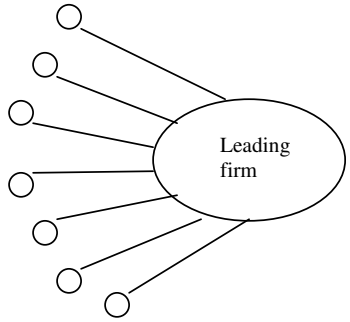
competitiveness, they have been increasingly relying on their local suppliers to get involved in production (Modi and Mabert, 2006; Mcgovern and Hicks, 2006; and Li et al., 2006). However, the capabilities of local suppliers are considerably low, specifically in less developed countries. As a result, inter-firm knowledge sharing with their local suppliers is essential, specifically in a global production network (Dyer and Nobeoka, 2000; Liker and Wu, 2000; and Takayasu and Mori, 2004).

According to previous studies (Dyer and Nobeoka, 2000; Ernts, 2004; and Techakanont, 2007), knowledge sharing in the form of 'network' is much more effective than an individual firm i.e. members in the network can access a variety of knowledge rather than specific knowledge generated by an individual firm. In the early stages of network formation, there are weak ties among members in the network and knowledge is solely transferred by the leading firm. However, over the time is through, every member in the network is encouraged by the leading firm to share knowledge with other members. The relationship among members in the network is called "multilateral relationships." The key characteristics of multilateral relationships are strong ties in nested networks and with the leading firm, few structural holes, explicit and tacit knowledge shared, and effectiveness in the learning process (Dyer and Nobeoka, 2000). On the other hand, if knowledge is only transferred by the leading firm, and there is no knowledge sharing among its members, it is called "bilateral relationship." Under the bilateral relationship, the relationships among members are weak, and only explicit knowledge is shared.

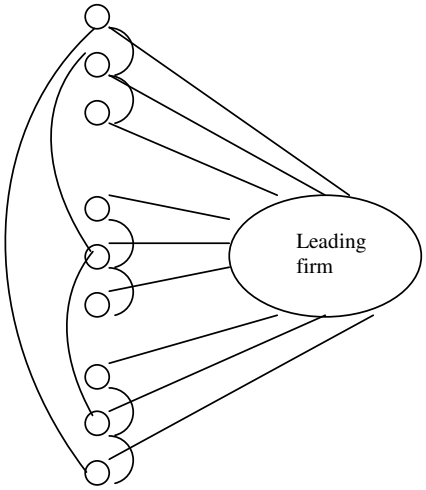
Figure 2.5

Patterns of Knowledge Sharing

Bilateral relationships



Multilateral relationship



Dimensions	**Bilateral relationship**		**Multilateral relationship**
Network structure:	- One large network with leading firm	→	- Large network plus multiple nested networks
	- Bilateral relationship with leading firm	→	- Multilateral relationships
	- Weak ties among most members	→	- Strong/embedded ties in nested networks and with leading firm
	- Numerous structural holes	→	- Few structural holes
Type of knowledge:	- Explicit knowledge	→	- Both explicit and tacit knowledge
Member motivation: **(to participate)**	- Demonstrate commitment to leading firm	→	- Learn faster than competitors

Note: Explicit knowledge refers to information, market trends, and production policies. In contrast, tacit knowledge refers to know-how, production process, and management proprietary.

Source: (Dyer and Nobeoka, 2000)

Previous studies provide three dilemmas contributing to the success of knowledge sharing in a network. The first dilemma is how to motivate members to participate in the network and to openly share knowledge with other members (Wood and Gray, 1991; and Dyer and Nobeoka, 2000). In general, most firms tend to keep their knowledge inside and they share it reluctantly with others. However, previous studies (Kogut and Zander, 1992; and Dyer and Nobeoka, 2000) suggest that firms, which openly share knowledge with others gain a competitive advantage over competitors in the long-run.

The second dilemma is prevention of the free rider problem. Because knowledge is a proprietary of all members in the network, thus the prevention should be implemented to discourage firms, which have not contributed knowledge to the network. In order to solve the free rider problem, a firm must openly allow other firms to access its proprietary if it wants to enter the network (Dyer and Nobeoka, 2000).

The third dilemma is to effectively share both explicit and tacit knowledge (Dyer and Nobeoka, 2000). For explicit knowledge, it is easily codified and it can be shared with a large group. On the other hand, tacit knowledge needs firms to put in a considerable effort and it requires firms to share knowledge in a small group. So, interconnected pathways in the network can create multilateral ties that can be used to share knowledge more effectively.

According to Dyer and Nobeoka (2000), Toyota operating in the United States gained a competitive advantage over competitors by creating a strong tie network which is facilitated by the main theme of knowledge sharing. The Toyota network is the most powerful network when compared with other automakers because it not only shares knowledge with its suppliers, but it also encourages knowledge sharing among its suppliers. Toyota solves the three dilemmas by contributing to the most effective knowledge sharing as follows: (1) motivates members to participate in the network and to openly share knowledge, (2) prevents the free rider problem, (3) effectively shares both explicit and tacit knowledge.

For the first dilemma, Toyota is willing to give free support to suppliers which want to access Toyota's proprietary in production. Technicians visits from Toyota is also freely provided. However, suppliers are encouraged to share their success in

operations after gaining Toyota's assistance with other members, and they have to view all knowledge as owned by the network, not by the individual.

For the second dilemma, Toyota sets the cost for gaining knowledge in the network by asking a firm which wants to access the network to open its proprietary to other members. Thus, there is no access and no public goods. If any supplier blocks its proprietary from others access, it will not to be given additional production in the future.

For the last dilemma, Toyota strongly creates multilateral interconnected pathways, which allow suppliers to share knowledge in small groups. All relevant explicit and tacit knowledge can be shared more effectively because knowledge is shared within a group whose members have the same interests and backgrounds.

In recent years, knowledge sharing in the form of a network has already taken place in Thai automotive industry. The most prominent example is the Toyota network, which is considered as the strongest tie network.

In conclusion, knowledge sharing as the network is more powerful than a bilateral relationship. From Dyer and Nobeoka (2000), Toyota and its suppliers not only enjoy increases in productivity, but they also enjoy a plentitude and variety of knowledge, and suppliers also learn more quickly in the Toyota network.

2.7 Factors Facilitating the Success of Technology Transfer

There are many factors that facilitate the success of technology transfers. In this section, the factors include communication, joint action, and trust. All details are provided below.

2.7.1 Communication

The role of communication is crucial to the interface between a firm and its suppliers. Poor communication is a cause of supplier development failure because it undermines a firm's efforts to improve supplier performance (Liker and Wu, 2000; Modi and Mabert, 2006). Failure in communication leads to conflict and incorrect strategies (Etgar, 1979). Good communication allows a firm to efficiently share information about cost management and strategic plans.

2.7.2 Joint Action

Joint action refers to in-depth cooperation between a buying firm and its suppliers on activities that are important for improving the performance of both parties (Joshi and Stump, 1999). Joint action has a direct positive impact on operational effectiveness. This results in improvements in product quality and decreases in operating costs (Li et. al., 2006).

From previous studies, for example, Liker and Wu (2000) found that joint action between a Japanese automaker and its suppliers in establishing a just-in-time delivery system led to benefits for both parties in terms of reducing operating costs through holding less inventory. Besides, the joint action can respond quickly to change in customer demands.

2.7.3 Long-term Relationship

A deep long-term relationship between a firm and its supplier is very important to technology transfers because it encourages information sharing between a firm and its suppliers. The more information sharing between firm and its suppliers leads to more efficient quality improvement and cost reduction (Li et. al., 2006).

From previous studies, for example, Lee and Humphreys (2006) found that trust played a crucial role in supplier development in China. A firm having a deep relationship with its suppliers is willing to invest its resources in developing supplier capabilities. In addition, they also found that trust may affect supplier development through outsourcing. An outsourcing represents the purchase of a substantial amount of components and services.