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**"The Success Factors of Technology Transfer
in Indonesian Manufacturing Industry"**

by

Lasdini Purwanti, B.Sc.

**A Thesis submitted to
The Faculty of Graduate Studies and Research
in partial fulfilment of the requirements for the degree of
Master of Management Studies**

**School of Business
Carleton University
Ottawa, Ontario
December 12, 1994**

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submitted by Lasdini Purwanti, B.Sc.
in partial fulfilment of the requirements
for the degree of Master of Management Studies

Thesis Supervisor

Director, School of Business

School of Business
Carleton University
December 19, 1994

ABSTRACT

This study is conducted to understand to what extent the internal and external factors of the recipient firm, the nature of technology, and the mechanism of technology transfer influence the success of technology transfer in the Indonesian manufacturing industry. The technique of multiple regression is employed to study the relative importance of those independent variables to the success.

The sample consists of 42 Indonesian firms of garments, textiles, electronics, and footwear industries, which had a technology transfer project and an export-orientation. The responses consist of 23 personal interviews and 15 telephones interviews with senior executives of 38 companies who were knowledgeable about the technology transfer project. In addition, all 42 firms provided information through a structured questionnaire.

The study results indicate differences between the success factors of technology transfer in Indonesian firms and the factors suggested in the literature. Results also indicate that firms perceived the success of the transfer according to the achievement of the firms' technological capability. The regression functions show that selected independent variables are better in explaining the variability of the firms' technological capability than the firms' economic performance. Finally, the measure of the technology transfer project success is a determinant consideration in identifying the factors leading to the project success.

There are 4 variables (good management as a combination of planning, control, and top management support, training, government role, and mechanism of technology transfer) which contribute significantly to predicting the achievement of firms' technological capability, 3 variables (export, government role, and the age of technology) to predicting the change of the firms' profitability growth rate, and 4 variables (the

industrial experience of recipient firm, planning, the complexity of technology, and mechanism of technology transfer) to predicting the firms' satisfaction.

Furthermore, in order to develop the Indonesian manufacturing industry, a study of success factors for integrating both the firms' successes of technology and economic is suggested.

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CHAPTER 1

INTRODUCTION

It is recognized that some developing countries achieve their economic advancement due to their ability to develop their technological capability beyond the absorption of the initially imported technology. However, "science and technology policy in most developing countries has been misplaced" by overlooking the role of firms in accumulating technology (Bell and Pavitt 1993, p. 262). These authors argue that "most technological learning takes place in firms" by learning from developing and operating specific production systems (p. 270). Considering the important role of foreign firms as channels for technology, the nature of the relationship between the transfer of foreign technologies and domestic technological achievement needs to be developed.

Empirical studies reveal that the extent of technological achievement varies by firms. Research on the technology transfer process suggests that receiving firms should have an adequately skilled workforce, adequate effort, and sufficient investment while acquiring foreign technology, because technological knowledge is a tacit knowledge which cannot be imitated by itself (Lall 1992). An investigation of the factors affecting the success of technology transfer at the firm level can help firms to reduce their time and their dependency on foreign firms in developing their technology.

However, finding the general factors of the success of technology transfer is not

easy. The interpretation is usually influenced by the level of technological development and the differences in the actors' objectives (Derakhshani 1984). According to Wallender (1979), there are four factors which are involved in the technology-transfer-transaction: the technology supplier, the environment of the supplier, the technology recipient or user, and the environment of the recipient or user. Furthermore, the nature of technology and the mechanisms of technology transfer are other factors which also should be considered (Madu 1989).

In a country like Indonesia - where the industrial base is still weak and highly concentrated in consumable-goods industries -the presence of foreign firms in industries which need technological change is crucial (Hill 1993). Nowadays, the Indonesian manufacturing sector - which hardly existed two decades ago - has become the largest segment of the economy and is growing by nearly 10% annually (National Development Information Office Republic of Indonesia, Sept. 1993). Foreign firms provide an enormous investment in infrastructure and in private production facilities, and also provide technology to increase the productivity of local economies and of local technological capabilities (Dorodjatun Kuntjoro-Jakti *et al.* 1989). Given this situation, a study on technology transfer in Indonesian manufacturing firms may result in different characteristics than those found by other researchers of the success factors of international technology transfer (ITT).

This study is conducted in order to find out to what extent the internal and

external factors of the recipient firm, the nature of technology, and the mechanism of technology transfer influence the success of technology transfer in the Indonesian manufacturing industry. The firm's internal factors examined include the availability of engineers and technical personnel, the industrial experience of the recipient firm, training, top management support, planning, control, export-orientation, and the research and development. The main external factor is the role of the government in foreign direct investment (FDI) regulations. The nature of technology includes the age of technology and the complexity of technology. The mechanisms of technology transfer considered are turnkey operations, licensing, and joint ventures. Success of technology transfer is defined by the degree of the firms' mastery the technology, the degree of firms' satisfaction to the success, and the economic performance of the firms.

The thesis consists of six chapters. The first chapter introduces the study. Then, a literature review which is relevant to technology transfer is presented in the second chapter. The theoretical framework and methodology of this study are described in the third and fourth chapters respectively. Chapter five provides the results of this study and an analysis of the results. Finally, in the sixth chapter, conclusions and limitations of the study are presented along with recommendations for the Indonesian government, industry and future research.

CHAPTER 2

LITERATURE REVIEW

This chapter reviews the literature on international technology transfer (ITT) and provides a rationale for this study. First, definitions of technology, international technology transfer, the technology transfer process, and the success of technology transfer are reviewed. Second, factors affecting the success of technology transfer are examined and appropriate ones are chosen for this study.

2.1 Definitions

2.1.1 Technology

Various researchers in the field of technology offer varying definitions of technology. The following definitions (Table 1) have been chosen to illustrate the range of approaches to technology. For example, technology is defined as the knowledge which consists of entrepreneurial expertise and managerial know-how in running the firm (Santikarn 1981), while Kuuya (1978) classifies technology in three broad categories: technical and commercial information, highly trained workforce, and embodied technology or physical assets. Technical and commercial information consist of methods used in production processes, marketing skills, and purchasing of technologies and their products. A highly trained workforce can consist of engineers, designers, and managers, who have the capability, in terms of design, to develop and carry out research on technology, and to choose the most appropriate technology for their project. Finally, embodied technology

Table 1**Definitions of Technology**

Barquin (1981): "Technology is a set of disciplines, methods, techniques and supported instruments which is needed to elaborate the process of a tangible or intangible product."

Cantwell (1989): "Technology is partially tacit; (it) is differentiated by firm, location, learning process, and skill with which the technology has been created or adapted."

Kuuya (1978): Technology is categorized in three classifications: technical and commercial information, highly trained workforce, and embodied technology or physical assets.

Meissner (1988): "Technology is a quantum of knowledge, which is mostly tacit, retained by individual teams or specialized personnel in terms of design, production, and investment activities."

Santikarn (1981 p.4): "Technology, as a limited element in the industrialization process, is defined as the knowledge or methods that are necessary to carry on or to improve the existing production and distribution of goods and services."

Wallender (1979): Technology is defined in terms of industrial or business activity, that is, process (engineering), management, marketing, and production know-how.

Christensen (1992): Technology is a process, technique, or methodology - embodied in a product design or in a manufacturing or service process - which transforms inputs of labour, capital, information, material, and energy into outputs of greater value.

or physical assets consist of machinery.

In summary, technology is embodied in many forms: in human expertise, in capital, in physical capital, and in recorded information. For this study, using the definitions by Santikarn and Kuuya, technology is defined as knowledge and methods, which include technical and commercial information, highly trained workforces, and physical assets.

2.1.2 Technology Transfer

Technology transfer has been defined by Barquin (1981 p.103) as "the process by which a technology is transplanted or diffused from one locality to another, vertical and horizontal." Vertical transfer is much more the transfer of technical information within the firm; on the other hand, horizontal transfer is more related to the transfer from one project to another or inter-firm.

Horizontal transfer can be distinguished through three phases: materials transfer, design transfer, and capacity transfer (Teece 1976 p.7). First, material transfer is defined by the recipient's direct use of imported new products or materials. Second, design transfer will involve an adaptation process in accordance with domestic technical processes and local skills. Third, capacity transfer will involve scientific knowledge and the capability to develop new technology or to modify imported technology. This means that technology transfer is not only the application of technology to a different purpose

or user, but also an increase in the existing technology utilization (Gee 1981).

Table 2 presents various definitions of technology transfer from several researchers. The adaptation and improvement of imported technology are considered as important processes in the full utilization of the transferred technology. For this study, using the definitions by Derakhshani and Santikarn, technology transfer is defined as the acquisition, development, and utilization of imported technology knowledge, which did not previously exist in the local environment, by the local work force.

2.1.3 The Technology Transfer Process

Technology transfer is a process of varying degrees of review and evaluation. The process of technology transfer begins with identifying the active participants in decision-making and needs recognition. These steps are followed by an evaluation of the existing technology and its limitations to achieve the transfer result, the selection of the technology which is to be transferred, the definition of standards to measure the success or failure of the transfer process, the adoption and the implementation of the technology selected, and the establishment of a mechanism to evaluate the transfer process (Madu 1989). Madu has proposed this process for the ministry or department of planning and development in less-developed countries (LDCs). Unfortunately, Madu offers no explanation of the definition of success except that long-term economic growth will be achieved through the ability to maintain and to fully utilize the appropriate technology.

Table 2
Definitions of Technology Transfer

Derakhshani (1984 p. 27): International technology transfer is the "acquisition, development, and utilization of technology knowledge by a country other than that in which knowledge originated."

Kuuya (1978): Technology transfer exists when the adaptation or the improvement of technology fits into the local resource base and requirements.

Mogavero and Shane (1982): Technology transfer occurs when "the technical knowledge has been put to use" without regard to the users' expectation.

Santikarn (1981 p. 7): Technology transfer is "the fostering of technology which did not previously exist in the local environment in such a way that the local work force can independently exploit and improve the imported technology."

Teece (1976) : The technology transfer is achieved when the design or the expected productivity level has been reached.

Holliday (1979), who examined the experiences of western industrial and developing countries in importing foreign technologies, divides the technology transfer process into two phases: (1) the initial planning and purchase of technology, and (2) the absorption of technology. Table 3 shows such a process. Holliday's definition of these stages is based on the recipient's standpoint and on the fact that the absorptive level of imported technologies of a given country depends on indigenous technology capability.

Table 3. The Technology Transfer Process

I. Initial Planning and Purchase of Technology	Choice of technology
	Selection of transfer mechanism
	Negotiation of contract
	financing
II. Absorption	Design and adaptation
	Construction and installation
	Training
	Operation of plants, machinery
	Domestic diffusion

Source: George D. Holliday, Technology Transfer to the USSR, 1928-1937 and 1966-1975: The role of Western Technology in Soviet Economic Development, Westview Press, Boulder, Colorado, 1979, p. 24.

According to Teece (1976), the signing of the contract identifies the beginning of the technology transfer program, although some technical knowledge may have been transferred during technical consultation in previous steps. Teece (1976 p. 29) divides the

absorption-of-technology phase into four major stages. The first stage is identified by the transfer of key elements of the process or of the product design. If the recipient firm has been familiar with the technology, the information which relates to this technology may not be required. The second phase involves activities such as engineering design and production planning. The third phase is identified by the construction, tooling and installation of the manufacturing facilities. Finally, the fourth phase is characterised by "the manufacturing start-up or bringing the plant on stream," which is measured according to the design or expected productivity level. This stage can involve activities which relate to human and machinery considerations. These activities will appear in the training of operatives and/or the alteration, adjustment, dismantling and replacement of unsatisfactory equipment.

In summary, the technology transfer process starts with the firm's needs for technology and ends with the execution of selected technology. For this study, Holliday's and Teece's models have been adopted, i.e., the technology transfer starts from the signing of the contract and continue with the absorption stage. This stage includes design and adaptation, training, operation of plants and machinery, and activities to generate new technological knowledge.

2.1.4 Success of International Technology Transfer

There are various ways to determine the success of international technology transfer (ITT). Derakhshani (1984) points out that the measurement of the success of

technology transfer is influenced by the diversity of the objectives and the perspectives of the actors in the transfer transactions. Wallender (1979) identifies the four major actors in the technology transfer process as follows: (1) the technology supplier, (2) the environment of the supplier, (3) the technology recipient or user, and (4) the environment of the recipient or user. In this study, the success of technology transfer is reviewed from the recipient's side.

Derakhshani (1984) measures the success of technology transfer activities at the operational level and the second-order consequences. The operational level relates to the performance of firms in areas such as Return On Investment (ROI), growth of sales and value added, and factors related to production efficiency. The second-order consequences include activities related to international competitiveness, indigenization, and ability of a firm to modify and to develop the initial imported technology.

Yin (1992) uses the economic performance and technological competence of the recipient firms to evaluate the success of ITT; economic performance is defined as the marginal change of sales growth and of profitability, and technological competence as the level of absorption and of diffusion of the transferred technology.

Mytelka (1985 p. 177) suggests that "an effective technology transfer ... is essentially a process of building indigenous technological capabilities" through the accumulation of the learning experiences within firms. Wallender (1979 p. 27) claims that

successful technology transfer occurs "when technology is transmitted, received, and applied."

Hayashi, as quoted in Komoda (1986 p.407), assesses the success of technology transfer by the development of local technological mastery, using the following five measurements: "(1) the mastering of machine-operating techniques; (2) the acquiring of maintenance capabilities; (3) the mastering of repairing technique, including making minor improvement; (4) attainment of the ability to undertake unaided technological design; and (5) the beginning of autonomous home production and development of new technology."

Santikarn's study (1981) uses the concept of local participation to evaluate the success of technology transfer. This measurement is indicated by the ability of the local work force to take charge and efficiently utilize the imported technology, to adapt the imported technology to the specific needs of the local environment, or to modify it for various purposes (Santikarn 1981, p. 6). The concept of local participation in technology transfer is also examined in Rafii's study (1978). Rafii measures the performance of technology transfer through joint ventures by two achievements: the extent of domestic value added and the degree of manpower indigenization.

In summary, the definition of success of technology transfer ranges from technological acquisition to economic achievement; the former is difficult to quantify. In this study, success of technology transfer is defined as the firm's achievement in terms

of technological mastery by the local workforces and/or the economic performance of the recipient firm. The achievement of technological mastery by the local workforces leads to the development of transferred technology; this development is necessary for a firm's long-term survival in the marketplace. On the other hand, a firm that focuses on economic performance will capture the benefit of technology for a reasonable return on its investment.

A comparison of these approaches, technological mastery versus economic return, is conducted. The resulting data is analyzed to examine any possible relationship between technological mastery and economic performance. Hayashi's measures of technology mastery (1986) and Yin's measures of economic performance (1992) are used in this study.

2.2 Factors Affecting The Success of Technology Transfer

The literature shows that the success of technology transfer is determined by a combination of factors. Basically, factors affecting the success of technology transfer can be categorized in "the environmental characteristics of the recipient and the supplier, the mechanism for technology transfer, and the nature of technology itself" (Yin 1992; Madu 1989; Derakhshani 1984, p. 30; Wallender 1979). Table 4 summarizes a number of previous research studies of technology transfer and Table 5 lists the ITT success factors which are identified in those studies. The following are some variables which seem to be the determinants of technology transfer success. The numerical in parenthesis refers to the

number of studies that have identified this factor to be relevant to the success of technology transfer: absorptive capabilities of the recipient (11), the industrial experience of recipient firm (5), availability of engineers and technical personnel (14), training (5), characteristics of structural organization (5), management capabilities (6), the activity of management (6), the location of control (5), the level of personal interaction (5), the stability of the relationship between the recipient and the supplier (6), government role (18), the complexity of technology (9), and the mechanism of technology transfer (9). In the following section, some of these studies are described.

Madu (1989) proposes a framework to determine the type and the mechanism of technology transfer at either the national or the firm level. There are eight major factors which are thought to contribute to the success of technology transfer. These factors are objectives, capabilities, education and training, research and design, societies' cultural value systems, identification and implementation of appropriate technology, managerial effectiveness, and stable government and political systems. However, the relative importance of each factor, which Madu proposes to use in determining the success of technology transfer, still needs to be explored, due to the characteristic differences among the actors in the technology transfer process.

Yin conducts an empirical study to examine the effects of indigenous technology capabilities (ITCs) and five variables which are considered to have effects on the success of technology transfer (Yin 1992). Yin defines an organization's technological capability

Table 4: Summary of Articles on International Technology Transfer

Author and Year of Publication	Industry Studied	Sample size & Analysis	Country
Baranson (1970)	Not stated	Conceptual	Developing
Balasubramanyam (1973)	Manufacturing	20 +	India
Rafii (1978)	Manufacturing	35 *	Iran
Holliday (1979)	Automotive	3 +	USSR
Wallender (1979)	Manufact., service.	67 +	Peru, Korea, Kenya Brazil, Tanzania
Killing (1980)	Not stated	102 +	Canada
Aydin & Terpstra (1981)	Consumer and industrial	28 +	Turkey
Mason (1981)	Not stated	7 +	Asia and Pacific
Santikarn (1981)	Textile	70 *	Thailand
Smith (1981)	Not stated	294 +	Brazil
Derakhshani (1984)	Manufacturing	50 *	Iran
Davidson & McFetridge (1985)	Manufacturing	1,226 **	US
Mytelka (1985)	Textile	26 +	Kenya and The Ivory Coast
Pavitt (1985)	Not stated	Conceptual	OECD countries
Hattori (1986)	Not stated	Conceptual	Japan
Ito (1986)	Manufacturing	13 +	India
Komoda (1986)	Not stated	Conceptual	Japan
Robinson (1988)	Not stated	Conceptual	---
Madu (1989)	Not stated	Conceptual	LDCs
Thee Kian Wie (1990)	Manufacturing	12 +	Indonesia
Janaro & Bommer(1991)	Manufacturing	Conceptual	LDCs
Shaiken (1991)	Automobile	1 +	Mexico
Lall (1992)	Not stated	Conceptual	NICs countries
Yin (1992)	Manufacturing	116 *	China

Statistical technique used : * regression ** logit + descriptive statistics.

Table 5
Summary of Success Factors from Previous
Research Findings in the Field of Technology Transfer

Success Variables	Research Study (see key on the next page)
Internal Factors	
Absorptive capabilities of the recipient	3,5,7,8,9,11,12 14,18,24,25
The industrial experience of the firm	2,5,6,9,21
The firm's history of technology acquisition	3,9
The ability of clients to perceive the value of technology	3,5
Availability of engineers and technical personnel	3,7,10,19,20,21, 22,24,25,26,27, 28,31,32
Training	19,21,28,31,32,33
R&D Facilities	1,20,31
Characteristics of structural organization	3,9,22,24,26
The relationships between division of labour and cooperation	21,23
The relationships between the upper and lower stream of the production process	21,23
Employee depth on the corporate team	21,24,28
The breadth of workplace for engineer and skilled worker.	21,24
Management capabilities	3,10,22,23,26,31
The activity of management	2,3,4,23,32,33
The availability of management resources	2,3,4,5
Charismatic leadership	3
Foreign ownership	3,4,13,15,25
The location of control	2,4,5,25,26
The level of personal interaction	2,21,22,23,26
The stability of the relationship between the recipient and the supplier	2,12,16,26,28, 30
Effective communication	18,22,24
The size of firm	9,13
Financial resources	3,7,10,26,29
The corporation's objectives	17,21,31,33
The purpose of transfer	17,21,31

continued

External Factors	
Government role	1,2,3,4,5,6,10, 13,19,22,25, 27,31,33
Market characteristics	6,17,26,27
Geographic Proximity	6
The size of firm's market share	1,6
The intensity of the market competition	1,3,21,32
The rivalry among suppliers	1
The level of initial supplier involvement	2,26
The process of consultation	3
Local technological infrastructure	3,22,27,29,31
The cost and appropriateness of the technology	3,9
Financial interest	9,25
Willingness and ability to transfer technical knowledge and skills from the supplier	12,25
Socio-cultural system	31
The Nature of Technology	
The age of technology	6,9,24
The complexity of technology	2,5,10,12,13,18, 24,28,33
The number of firms utilizing similar and competitive technology	9
The degree of diversification	30
The Mechanism of Technology Transfer	
	12,14,16,17,20, 24,25,29,30,33

Key

1. Yin 1992	11. Mason 1981	20. Killing 1977
2. Derakhshani 1984	12. Baranson 1970	21. Ezzat <i>et al.</i> 1989
3. Wallender 1979	13. Robinson 1988	22. Kiggundu 1989
4. Rafii 1978	14. Frame 1983	23. Komoda 1986
5. Santikarn 1981	15. Aydin and
Terspstra 1981	24. Hattori 1986
6. Davidson and
McFetridge 1985	16. Perlmutter and
Sagafi-nejad 1981	25. Balasubramanyam
1973
7. Lall 1992	17. Janaro and
Bommer 1991	26. Schechter 1982
8. Pavitt 1985	18. Shahrokhi 1987	27. Smith 1981
9. Teece 1976	19. Stewart and
Nihei 1987	28. Shaiken 1991
10. Holliday 1979		29. Hawthorne 1971
		30. Killing 1980
		31. Madu 1989
		32. Ito 1986
		33. Thee Kian Wie 1990

as the effort of an organization on Research and Development (R&D) and learning by doing (LbD); and the variables are the form of transfer, the size of the recipient's firm, the assistance from government, the intensity of market competition, and the rivalry among suppliers. Based on 116 transfer projects in China from 4 industries (machine building, electronics and computers, textiles, and consumers appliances), Yin concludes that there is a significant relationship between the success of ITT projects and the firms' technological capability. Furthermore, Yin finds that government assistance contributes significantly to the development of a firm's technological competence. The intensity of the market competition between firms has a more positive impact on firm's economic performance than on its technological competence. Moreover, Yin distinguishes technology transfer in embodied forms, such as direct purchase of equipment and turnkey plant transactions, from disembodied forms, such as licensing of process/product design and know-how. Yin finds that economic performance is associated more with embodied technology, whereas technological performance is associated with disembodied technology.

A study conducted by Wallender (1979), in 5 selected countries (Peru, Brazil, Korea, Tanzania, and Kenya) with 67 projects, examines the impact of internal factors, external factors, and the process of consultation on the individual firm's ability to receive and to utilize technology. The firms' internal factors are defined as structural characteristics and management capabilities; the external factors are defined as local environment and type of technology; and the process of consultation is defined as the

diagnosis of technology-need and the consultation program. This study reveals that 3 of 31 factors are found to be the most important factors affecting the success of technology transfer. These factors are the ability of clients to perceive the value of technology, the activity of management, and the availability of management resources.

The need for management resources in order to achieve a firm's efficiency is also pointed out by Santikarn (1981), who conducts a study of Thailand's textile industries. To measure a firm's efficiency, Santikarn uses adjusted value added per-worker and net return on primary factors. The results of regression analysis indicate that foreign management and the experience of the recipient firm have positive effects on labour productivity and on the net return on primary factors. Furthermore, Santikarn finds that technology transfer at the entrepreneurial level occurs more often when the local partners have an industrial background or education. Santikarn also finds that R&D is more influenced by the nature of technology, the environment in which these mechanisms operate, and the absorptive capacity of the recipient economies, than it is by the mechanism of technology transfer.

Davidson and McFetridge (1985) test the relationship between internal technology transfer and the characteristics of the technology of 1,226 technology transactions from 32 U.S.- based multinational enterprises. The characteristics of the technology are defined by the age of technology and the previous transfer of technology. The age of technology is measured by the duration between the time the technology is introduced in the US and

the time of the transfer. They find that the age of technology, the previous transfer of technology, and the intensity of the recipient's R&D have a positive relationship with the probability of internal transfer.

Above are the variables on which most of the researchers agree. However, there are a number of variables on which researchers have diverse opinions. The first area of disagreement is *size of recipient firms*. Santikarn (1981) and Yin (1992) find that the size of the recipient firm is not significantly relevant to the success of technology transfer. However, Teece (1976) finds that there is a positive relationship between the firm size and the degree of technology transfer achievement. Furthermore, Robinson (1988) argues that firm size is related to the availability of a firm's resources, such as finances and personnel. Adequate human resources will allow a firm to shift the employee from one assignment to another without materially reducing efficiency.

The second area is *the mechanism of technology transfer*¹. Balasubramanyam's study of international technology transfer in India (1973) reveals that the mechanism of technology transfer relates to the extent of technology transferred. Balasubramanyam (1973) points out that technical agreements are relatively limited in technology

¹ Frame (1983) mentions the most frequent ways of transfer mechanism such as licensing, turnkey operation, joint venture, the technological enclave, patents, in-house transfer to foreign subsidiary, purchase of technological services, education abroad, site visits and on the job training abroad, international cooperative research, published literature, and seminars.

transmission, compared to foreign direct investment or joint venture. Technical agreement is more appropriate for embodied knowledge, such as machinery, blueprint, and design, than for complicated technology.

However, Ito (1986), who conducts a case study of 12 manufacturing firms in India, finds that the imported technology modification is dependent more on the competency of local staff than on the mechanism of technology transfer. Similarly, based on an empirical study on 8 technology groups in Iran, Derakhshani (1984) claims that the success of transfer technology is not affected by the mechanisms of technology transfer.

The third area of disagreement is *competitive forces in the marketplace*. Smith (1981) finds that serving the needs of local markets is a success factor of Japanese technology transfer to Brazil. This finding contradicts Santikarn's study in Thailand (1981) which reveals that there is a positive relationship between export-oriented firms and the success of technology transfer.

Finally, *the industrial experience of the recipient firm* is another area of disagreement. Davidson and McFetridge (1985) define the industrial experience of the recipient firm as one which has a line of business in the same three digit Standard Industrial Classification (SIC) class as the supplier firm. Some research studies reveal that there is a positive relationship between the industrial experience of the recipient firm and the success of the technology transfer (Teece 1976; Santikarn 1981; Derakhshani 1984;

Davidson and McFetridge 1985; and Ezzat *et al.* 1989). However, Shaiken (1991) finds that a young and inexperienced firm in Mexico's automobile industry can successfully manage the advanced manufacturing technology. This success in the transfer of technology can be attributed to the fact that the designed product and a production process are focused on simplicity and reliability. However, this finding should be examined further since Shaiken's case study had insufficient sample size.

Several factors may cause these disagreements. First, the precise definition of technology transfer success seems to present a fundamental difficulty in research in this area. For example, some studies use the local technological mastery to measure success without clearly articulating the measure of this technological mastery. They merely state that the recipient firms should catch imported technology beyond the original technology transferred (Mytelka 1985, Derakhshani 1984, Wallender 1979). To cite another example, several studies measure the success by the firms' achievement in economic performance. So far, it seems that just Yin (1992) tries to measure success with economic performance in terms of a change of annual sales growth rate and of annual profitability growth rate.

Second, another variation is in the methods of data collection and analysis. The concepts of technology and technology transfer themselves are rarely defined clearly (see Table 1 and 2); this lack of clarity leads to implications for the measurement and interpretation of technology indicators in data collection. For example, Westphal *et al.* (1985) classify technological capabilities into three broad areas: production, investment,

and innovation, while Stewart (1984) defines indigenous technological capability (ITC) as the capability of an organization to search for, to adapt, to modify, and to create technology. Subsequently, Yin (1992) uses a nominal definition to measure ITC, which is indicated by R&D spending and number of personnel, the duration of on-the-job training and number of innovative activities. These distinctions lead to different analyses - purely descriptive and quantitative - and different perceptions of the studies' results; these differing perceptions reveal the relative importance of the success factor for technology transfer.

Finally, another source of contention lies in the fact that the respondents of the studies come from various professional specialties, management levels, and countries; in addition, they are using various types of technology transferred, and mechanisms of transfer. For example, Hattori (1986) claims that the success of Japanese technology transfer relates to a typical Japanese corporation management system which is characterized by employee job security, free interaction between highly skilled workers and engineers, and loosely defined job descriptions. These characteristics of the Japanese management system may not be desirable for other countries because of cultural differences, for example.

In summary, although there are several variables which most researchers agree are success factors of technology transfer, there is still contradiction concerning the precise set of variables. The contradiction of results may be related to success definitions, method

of data collection and analysis variations, and the respondents. However, the existence of contradiction on these success variables demands a further study.

2.3 Indonesia's Manufacturing Industry

Since 1973, the growth of the Indonesian industrial performance has been very impressive. According to the World Bank's World Development Report 1985, as quoted in Hill (1990 p.80), "manufacturing output growth (in Indonesia) is the highest of all middle income countries, exceeding that of well known success stories such as Korea, Thailand, and Singapore." Subsequently, the manufacturing sector - which hardly existed two decades ago - has become the largest segment of the economy and is growing by nearly 10% annually (National Development Information Office Republic of Indonesia, Sept. 1993). Hill also points out that there is a transformation of the manufacturing sector due to the following changes: the emergence of the dynamic sector, the introduction of new products and technologies, and export oriented industrial development. Furthermore, it is apparent that foreign firms play a significant role in a wider range of industries where the need of technology is crucial. In this section, the relationship between foreign companies and the Indonesian manufacturing industry is delineated briefly in terms of technology transfer.

First of all, the contributions of foreign firms to Indonesian skill formation is still questionable (Hill 1991). Balasubramanyam's study (1984) indicates that foreign owned firms in the Indonesian manufacturing sectors have higher productive efficiency than

locally owned firms. Balasubramanyam finds that the managerial and labour skills of foreign owned firms are determinants of their productive efficiency. However, Hill (1991) points out that the benefits from the multinational enterprise (MNE) presence in skilled-workers' development seems limited due to the inability of Indonesian skilled workers to interact efficiently with their foreign counterparts. This reason needs to be examined further since Tsurumi (1980), as quoted in Hill (1991 p.43), cites management reports which find that Indonesian workers, after 12 to 18 months of work experience and supervised training, achieved 80-90 per cent of the productivity level of Korean or Japanese workers. Prior to this training, some workers performed at only 50-60 per cent level.

Second, Thee Kian Wie (1990) finds that the degree of local technological capabilities is determined by the type of arrangement, ownership, and managerial strategies. The technological capabilities are classified according to the extent of mastery in production engineering, project execution, capital goods manufacture, and R&D. These findings are based on a study of 12 companies in the Indonesian food products, pharmaceutical, chemical and automotive industries. In particular, Thee Kian Wie claims that the acquisition of technological mastery in national companies through licensing is greater than in joint ventures between transnational corporations (TNCs) and national private or state-owned companies, especially when the TNCs have major equity.

In conclusion, although Indonesia has developed its industries, it seems Indonesia still depends greatly on foreign firms to acquire technology. Inadequately skilled workers, management support, and government regulations on the workforce are some of the inhibiting factors which prevent Indonesia from building its local technological capability. In view of the above, a further study of the process of technology transfer is needed to obtain a more comprehensive perception of the success factors of technology transfer.

2.4. Summary

The success of technology transfer can be defined and measured in many ways; these definitions are influenced by the needs and the objectives of the participants in the technology transfer transactions. The concepts of technological competence and economic performance to measure the success of technology transfer from the recipient's standpoints are used by several researchers (Yin 1992, Santikarn 1981, and Wallender 1979). As a result, they have determined different sets of variable combinations to reveal the success factors of the technology transfer project, depending on the measure of the success.

Local technological capability is considered to be the most determinant factor affecting the success of technology transfer according to most studies (Yin 1992, Ito 1986, Santikarn 1981, and Wallender 1979). Government assistance also has a positive relationship with the increase of firms' technological capability (Yin 1992, Santikarn 1981, Wallender 1979). However, the mechanisms of technology transfer, for example,

reveal contradicting results with the success of the transfer. Several researchers claim that the success of technology transfer is not affected by the mechanisms of technology transfer (Derakhshani 1984, Santikarn 1981, Ito 1986), while others (Thee Kian Wie 1990, Hattori 1986, and Balasubramanyam 1973) disagree. They point out that the mechanism of technology transfer determines the degree of technology transferred.

Nowadays, Indonesian industry is still dependent on foreign firms to accumulate technology, but very little work has been done to study the success factors in acquiring foreign technology. Thee Kian Wie (1990) indicates that the mechanism of technology transfer affects the degree of local technological development. Furthermore, Hill (1991) points out that Indonesia's shortage of skilled workers and the restriction of local staff to be senior management level in such foreign firms are inhibiting factors in transferring the skills from foreign firms to Indonesian personnel. Nevertheless, there are several factors which may have contributed to the success of technology transfer, but which remain under-researched.

As mentioned above, it is clear that there is no precise set of success factors of technology transfer which can be generalised. Furthermore, most studies do not reveal the relative importance of each success factor. Consequently, it is necessary to find more insight in the success factors of technology transfer for Indonesian firms. This therefore, became the main topic of this thesis.

The case studies and environmental analyses show that success of technology transfer is usually influenced by the participants in the technology transfer transaction, the nature of technology and the mechanisms of technology transfer. Thus, the examination of those factors from the recipient's side are useful when examining success of technology transfer in particular environment, Indonesia firms, which is the main focus of this thesis.

CHAPTER 3

THEORETICAL FRAMEWORK

The literature review leads to a conceptual model shown in figure 1. This model represents the theoretical framework for this study. The dependent variable is the degree of the success of technology transfer. This is the variable of primary interest, the variance in which is attempted to be explained by the number of independent variables. These independent variables are categorised as internal and external factors of the firm, the nature of technology, and the mechanism of technology transfer. These dependent and independent variables are explained below in detail.

3.1 Measuring The Success of Technology Transfer

The degree of the success of technology transfer in this study is defined by the degree to which recipient firms can enhance their local technological mastery and/or their economic performance by the transfer of imported technology. The measures to be used are derived from the previous studies. In addition, the success is also assessed by the respondents' perception regarding to whether the firms were satisfied with the performance of technology transferred.

Technological capability

The development of technological capability is a process of accumulating

technical knowledge or of organizational learning (Rosenberg *et al.* 1985). In conjunction with local technological achievement, these processes are assessed with respect to the level of technological absorption in the following aspects: (1) mastering of operation; (2) mastering of maintenance; (3) mastering of repair; (4) accumulation of modification know-how; and (5) creation of new design (Komoda 1986). In this study, mastering the area of maintaining product quality is added to assess the level of technological mastery by recipient firms.

Economic performance

Technological change is one of the determinant factors in the increase of a firm's productivity, because technological change leads to a more effective use of labour, capital, and raw materials. This higher efficiency allows the firm to have lower unit production costs and to increase market competitiveness (Gee 1981, Mytelka 1985). This change in the firm's performance, due to technology improvement, can be captured through a measurement of the change of the annual sales growth rate and the change of the annual profitability growth rate (Yin 1992).

3.2 Internal Factors

Availability of engineers and technical personnel

This variable refers to the total number of engineers and technical personnel as a percentage of the total number of employees in the recipient firm (Rafii 1978, Santikarn

1981). In this study, this percentage for the number of Indonesian engineers and technical personnel in recipient firm was calculated before technology transfer took place.

Ito (1986) states that the competency of local staffs enhances the acquiring of the imported technology due to their ability in modifying and improving the technology in accordance with local needs. Furthermore, Santikarn (1981) and Wallender (1979) point out that local technological capabilities are the most determinant factor in enhancing the success of technology transfer. In this case, one of the local technological capabilities can be identified as the availability of human resources.

The industrial experience of the firm

The research findings reveal that there is a positive relationship between the industrial experience of the recipient firm and the success of the technology transfer (Teece 1976; Santikarn 1981; Derakhshani 1984; Davidson and McFetridge 1985; Ezzat *et al.* 1989; and Lall 1992). Lall (1992) claims that the industrial experience of the recipient firm gives the firm the understanding of basic manufacturer's principles which can enhance the ability of the firm to adapt and develop the technology.

The industrial experience of the recipient firm refers to the number of years that the recipient firm has been in the same field of business as the technology supplier. Davidson and McFetridge (1985) classify the field of business according to the same three

digit SIC (Standard Industrial Classification) class. However, SIC class is not used in classifying the field of business for this study, considering that the three digit SIC may not be the same in both countries. As a result, the name of the field of business, i.e. garments, is used to determine whether the recipient and supplier firms have the same of field business.

Training

This variable refers to the level of on-the-job training, which relates to technology transfer implementation, in recipient firms. Thee Kian Wie (1990) finds that training is an effective way to enhance technological mastery in a company since training provides the participants with the transfer of skills and technical knowledge which is necessary for their qualifications to do the job. The level of on-the-job training is measured in terms of the average duration of the training program per employee before the transfer took place (Yin 1992).

Top management support

This variable refers to the involvement of top management of recipient firms during the implementation of technology transfer. Thee Kian Wie (1990) indicates that management involvement plays an important role in achieving success in technology transfer in Indonesian national companies. Top management involvement is measured in terms of personnel encouragement in cooperation and participation in the technology

transfer project, and providing sufficient resources for it. Madu (1989) writes that the participation of the firm's personnel can reduce the personnel's resistance to change due to technological progress, which creates the obstacles of technology progress.

Planning

This variable refers to the planning exerted by the recipient firm during the implementation of technology transfer. Madu (1989) points out that a formal plan can enhance the success of technology transfer in LDCs (Less Developed Countries) and MNCs (Multi National Companies). Effective planning enhances the management's ability to deal with change due to technological progress. This variable is measured by a set of questions adopted from Madu (1989) and Wallender (1979). The focus of the questions is a systematic and detailed planning exerted by the firm in terms of technology acquisition, standards to measure the success, an awareness program of technological changes, and an environment preparation for technology transfer implementation.

Control

This variable refers to the control exerted by a recipient firm during the implementation of technology transfer to ensure that the transfer process progresses well. This variable is measured in the degree of technological progress being reported in terms of its progress and its unfavourable trends. This control management enables firms to measure the technological progress and detect the source of failure in achieving the target.

Export orientation

This variable refers to the firm's orientation to the export market. Santikarn (1981) argues that export-orientation, on the part of the firm, increases the success of ITT since firms must produce effectively to survive in the international market. This variable is measured by the average of total exports as a percentage of annual total sales of the firm before the transfer took place.

Research and Development (R & D)

This variable refers to the efforts of the firm in managing technological change. Madu (1989) points out that R&D plays an important role in the success of technology transfer since R&D provides a greater access to experience and expertise in international market, which then enhances the rate of technological diffusion. This variable is measured by R&D spending as a percentage of annual sales in the year before the transfer took place (Yin 1992).

3.3 External Factors

Government role

Milman (see Madu 1989) states that the technology transfer is viewed as part of the government policy of foreign issues. In this case, government policy "can have a significant impact on promoting and hindering the transfer process" (Madu 1989, p.121). However, the importance of the government interventions in the technology transfer

process has been mentioned by several authors (Yin 1992, Derakhshani 1984, Santikarn 1981, and Wallender 1979).

In this study, the government intervention variable refers to government policies on foreign direct investment (FDI). This variable is assessed by respondent perception of investment regulation in terms of the relaxation of foreign ownership equity, the maximisation of the proportion of Indonesian managers in foreign companies, and the allowing more investors to enter certain businesses. The detailed explanation of this regulation is given in Appendix A.

3.4 The Nature of Technology

The age of technology

This variable refers to the number of years from the time that technology is first applied in commercial areas to the time that it is transferred to recipient firms (Teece 1976; Davidson *et al.* 1985). The potential of technology transfer is greater when the age of technology increases, because the transfer process is less dependent on certain key people. When the technology becomes more mature, more individuals become familiarised with that technology and that situation can enhance the potential to assist the transfer (Teece 1976). However, Teece also points out that the condition may reverse if technology is becoming obsolete. In this study, the variable is measured by the recipient firm's estimation of the age of technology transferred.

The complexity of technology

This variable refers to the recipient firm's perception of the technology, which is coloured by the recipient's experience and the level of their technology (Derakhshani 1984). Lall (1992) argues that the complexity of technology is one of determinant factors in identifying the ability of firms to acquire the technology.

Teitel (1984) measures complexity by the need of new technical knowledge. Rogers (1983) defines complexity as the degree to which a technology is perceived as difficult to understand and use. Teitel's and Rogers' definitions are adopted to measure the complexity of technology. The variable is assessed in terms of the easiness and the knowledge required to master the technology.

3.5 The Mechanism of Technology Transfer

This variable refers to the collaboration agreement between the recipient and the supplier of the technology. Several studies reveal that the degree of technology transferred relates to the mechanism of technology transfer which is identified by the restriction in the contract agreement (Thee Kian Wie 1990, Hattori 1986, and Balasubramanyam 1973). For example, Yin (1992) finds that economic performance is associated more with the turnkey plant transaction or direct purchased equipment, whereas technological performance is associated with licensing of process/product design. In addition, Thee Kian Wie (1990) states that the technology transfer process seems to be more successful in

Indonesian national companies than in joint ventures, particularly with majority foreign equity.

In this study, the type of mechanisms considered are the turnkey operation, licensing, and the joint venture. The turnkey operation is characterized by supplier firms constructing a production facility, i.e. a fully functioning plant (Yin 1992). Licensing is characterized by an agreement which permits the recipient firm to use the technology of the supplier firm such as technical assistance, process/product design, and process/product know-how (Frame 1983). A joint venture is characterized by shared equity between two or more parties, where each party holds at least five per cent of the equity (Beamish 1988, p. 3).

Figure 1. A Conceptual Model for Successful Technology Transfer

CHAPTER 4

METHODOLOGY

This chapter describes the methodology employed in this study. First, the framework of sampling design is defined in terms of population, sampling frame, and sampling size and selection. Second, the description of research design is given. Third, the method of data collection is explained. Finally, the procedures for conducting data analysis are given.

4.1 Sampling Design

Population

The population studied was manufacturing companies in garment, textile, electronic, and footwear industries in Indonesia which received technology from other countries and had an export-orientation. Table 6 shows the total number of manufacturing firms in Jakarta, West Java, and Indonesia for these 4 types of industries which are classified according to the definition of Indonesian Central Bureau of Statistics.

The respondent units were senior executives of the company such as the general manager, director, and production manager who were involved in the technology transfer project. The unit of analysis was the technology transfer project implemented in the sample firms.

Garments, textiles, electronics, and footwear were chosen due to their contribution to exports. According to the Indonesian Trade Department report 1993 (Komoas July 21, 1994), the 5 most export-oriented commodities were: wood products 18.94%; garments 12.93%; textile products 9.74%; footwear 6.13%; and fish 5.23%. In this study, electronics was chosen based on the consideration that electronics will play an important role in the future if Indonesia wants to develop its economy. Wood was not chosen considering wood products provoke environmental issues. These issues may lead

Table 6: The Number of Manufacturing Firms in Jakarta, West Java, and Indonesia

Industry	Jakarta	West Java	Indonesia
Garments	719	406	1773
Textile	22	392	609
Electronics	26	51	104
Footwear	84	99	240

Source: Centre of Data Processing, Ministry of Indonesian Industry, 1994.

- Garments : manufacture of wearing apparel made of textile
- Textile : weaving mills except gunny and other sacks
- Electronic: manufacture of radio, television, and consumer electronic; battery, and household electronic appliances
- Footwear : sport-shoes.

Indonesia to look for alternative commodities to be exported. Finally, fish was not chosen due to the constraints of time and the financial limitations of this project.

The export-orientation parameter was chosen since a large number of companies were available for study from this group. The number of firms with export-orientation has increased since the Indonesian government introduced a number of regulations which facilitated exportation. These include duty exemption and drawback² of imported raw-material that is used for exported products. These policies relate to the efforts of the Indonesian government to boost non-oil industrial exports, in order to reduce dependency on oil-revenue.

Sampling Frame

The preliminary sampling frame population was derived from reports³ containing lists of manufacturing companies in Indonesia. These reports covered 3,200 companies which received export assistance from the Indonesian government and had a collaboration with foreign companies. Out of these, 1062 companies deal in garments, textile, footwear, and electronics.

² Refund of import duties and surcharges if those goods and materials are incorporated into products and subsequently exported

³ Board of Export Facilities (BAPEKSTA), Ministry of Finance, 1994.

Sampling Size and Selection

For this study, cities of Jakarta and West Java were chosen since these locations are the major industrial regions of Indonesia (Hill 1990). 435 out of 1062 companies were in these cities. The selection was based on the company's performance in terms of i) having a good administration according to BAPEKSTA evaluation and ii) having exports exceeding 65% of sales. There were only 95 companies which were satisfied these criteria. These 95 companies formed the sample for this study.

4.2 Research Design

Personal and telephone interviews were the main methods used to gather data in order to meet the research objective. Respondents also filled out a structured questionnaire. The questionnaire included close-ended and open-ended questions. The close-ended questions related to the degree of firm mastering the technology, planning and control exerted by management to implement the technology, top management support, government role, the complexity of technology, and mechanism of technology transfer. The open-ended questions were used to cover the respondent's expression to enrich information gathered from close-ended questions. These questions were primarily to explore information related to success of the technology transfer project, relationship between recipient and supplier firms after signing the contract, and the process of technology transfer.

The questionnaire was written first in English, then translated into Indonesian by three persons. To check and enhance the accuracy of the translation, the questionnaire was then translated back into English. The differences between both translations had been checked to reduce inaccuracy of the translation (Brislin 1970). The questionnaires were distributed in both languages to give respondents the option of using either language. The questionnaires in English and Indonesian can be seen in Appendices C and D respectively.

4.3 Data Collection

Pretesting of the questionnaire was done in 3 companies to improve the clarity of the questions. The revised questionnaires were then sent by mail or by facsimile to 95 selected companies. All these companies were then contacted by telephone to explain the objective of the study and to clarify, if necessary, some terms in the questionnaire. The terms needed clarifications include: technology transfer project, mechanism of technology transfer, and the success measurement. Follow up on the telephone was also done in order to improve the response rate.

The responses were obtained as follow : 45 out of 95 firms agreed to participate in this study. The reasons for not participating are shown in Table 7. As can be seen almost 16% of the companies declined to participate because they were afraid of some retaliation from the government inspite of the fact that full confidentiality was assured. Out of the participating firms, all 45 companies filled out the questionnaires. 23 of them

agreed to have personal interviews and 15 to have telephone interviews.

Table 7: The Reasons for Not Participating in This Study

Reason	Number of companies
1. Afraid that this study will affect company's profile with the government	15
2. Not enough time to handle the broad scope of the questionnaire	16
3. Interviewer shortage of time since the companies agreed to participate only if they can meet face to face with the interviewer	6
4. Companies had not been involved in technology transfer	8
5. The top managers were not available	5

Once a company agreed for personal interview, interview time was set-up. 17 personal interviews were conducted with a director or a manager who was involved in the technology transfer project while 6 interviews were conducted with a team of managers since the management thought that the questions were in diverse area and could not be answered by a single person. 4 companies not only participated in personal interviews but also enthusiastically took the interviewer for a plant visit.

As stated earlier, 15 interviews were conducted on telephone due to time limitations of the respondents. Unfortunately, of all efforts, 3 of 45 questionnaires could not be used in the final analysis due to incomplete data.

4.4 Data Analysis

Both quantitative and qualitative data from the research were analyzed. Quantitative data analysis focused on determining the relative importance among the variables under study as listed in the objectives. A standard multiple regression was employed using the SPSS[®] program to examine the effect of each variable on the ITT performance. Prior to analysis, the data distribution was examined to meet the assumptions of multivariate analysis as follow: number of sample; normality, linearity, and homoscedasticity of residual; outliers; and multicollinearity and singularity (Tabachnick *et al.* 1990).

The data analysis was employed in the following way. First, Cronbach's alpha coefficient was used in assessing the reliability of measurements. Second, in accordance with the research objective, which is to examine the effect of internal and external factors of the recipient firm, the nature of technology, and the mechanisms of technology transfer on the success of ITT, the correlations among these variables were analyzed. The Pearson correlation coefficient was used to determine the strength of association between the variables. Furthermore, the correlations among the dependent variables was used to

determine if there is any possible relationship between the firms' economic performance, the technological mastery, and the satisfaction with the achievement of technology transferred.

Third, for regression analysis the equation related to each of the four dependent variables could be written in the following way:

$$Y = A + B_i X_i \quad i = 1, \dots, 12$$

where Y = dependent variables,

X_i = independent variables.

The variables, both dependent and independent, are listed in Table 8.

The regression coefficients of each independent variable (B_i 's) in all four equations were estimated by regression analysis to predict the proportion of variance in the dependent variables, and the relative importance of the various independent variables to the success of technology transfer project.

Fourth, the stepwise method was employed to obtain a better model in predicting the success of technology transfer. Then, Stein's formula (Stevens 1992) was used to measure the effectiveness of the regression function (ρ_c^2) in predicting other samples. Meanwhile, R^2_{adj} (the corrected multiple coefficient of determination of the population) estimates the amount of shrinkage found in R^2 where "in applications, the population

regression function can never be known" according to Herzberg (Stevens p. 99). The Stein's formula for estimating ρ_c^2 under the correlation model is given below:

$$\rho_c^2 = 1 - \left(\frac{n-1}{n-k-1} \right) \left(\frac{n-2}{n-k-2} \right) \left(\frac{n+1}{n} \right) (1-R^2)$$

where n is sample size and k is the number of predictors (independent variables).

Qualitative data, gathered through interviews including the respondents' comments, were used to support the statistical results. The information was also used to explain variable, if any, which influenced the success of technology transfer projects.

**Table 8: List of Variables Relating to
the Question# in the Questionnaire.**

Variable	Description of the variable and its measurement	Question #
Dependent variables		
<u>Technological capability</u>		
TCAP	The level of mastering of the technology transferred, in multi-item scale. The rate of scale (5 - very high, to 1 - very low)	18-23
<u>Economic performance</u>		
ECPSAL	The change of firm's annual sales growth rate, (%)	24
ECPPRO	The change of firm's annual profitability growth rate, (%)	25
<u>Satisfaction</u>		
SATFIC	The level of firm's satisfaction from the achievement of technology transferred, in rating scale (5 - completely satisfied, to 1 - not satisfied at all)	17

continued

Variable	Description of the variable and its measurement	Question #
Independent variables		
<u>Internal factors</u>		
<i>Availability of engineers and technical personnel</i>		
EGTECH	The total number of engineers and technical personnel employed by recipient firm as a percentage of the total number of employees in the firm (before the transfer took place), (%)	30-35 11
<i>The industrial experience of the firm</i>		
EXPCF	The number of years that recipient firm has been in the same field of business as the technology supplier, (years)	4b
<i>Training</i>		
TRAIN	The average duration of formal training per employee in the year before the transfer took place, (days)	37
<i>Top management support</i>		
TOPMS	The level of top management involvement during the implementation of the transfer project, in multi-item scale. The rate of scale (5 - very strong, to 1 - very weak)	47-50
<i>Planning</i>		
PLANN	The level of planning done by the firm to implement the technology transferred, in multi-item scale. The rate of scale (5 - very detail, to 1 - very general)	39-42

continued

Variable	Description of the variable and its measurement	Question #
<i>Control</i>		
CONTROL	The activities of control done by the recipient firm to implement the technology transferred, in multi-item scale. The rate of scale (5 - very detail, to 1 - very general)	43-46
<i>Export orientation</i>		
EXPORT	The average of total export as percentage of annual total sales of the firm, before the transfer took place,(%)	13
<i>Research and Development</i>		
RDSPEN	R&D spending as percentage of firm's annual sales, before the transfer took place, (%)	15
<u>External factors</u>		
<i>Government role</i>		
GOVRL	The level of government intervention on achieving the success of technology transfer to the firm, in multi-item scale. The rate of scale (5 - very high, to 1 - very low)	51-53

continued

Variable	Description of the variable and its measurement	Question #
<u>The nature of technology</u>		
<i>The age of technology</i>		
AGETC	The number of years between the time that technology was first applied commercially to the time that it is transferred to the recipient firm, (years)	54
<i>The complexity of technology</i>		
COMPTCH	The degree of technology complexity perceived by the recipient firm, in multi-item scale. The rate of scale (5 - strongly agree, to 1 - strongly disagree)	56-57
<u>The mechanism of technology transfer</u>		
MECH	The means of technology delivered from the technology supplier to the firm, D1 = turnkey, D2 = licensing, D3 = joint ventures	10

Note:

Question# 1-4a; 6a; 7-9; 11-12; 14; 16; and 38 were used for qualitative analysis.

CHAPTER 5

RESULTS

This chapter presents the results of this study. First, a general profile of participating companies is described. Then, the results of quantitative data are examined. Finally, factors affecting the success of technology transfer, based on the quantitative and qualitative results, are explained and then compared to the literature's findings.

5.1 Firm Profiles

As discussed in section 4.3, 95 firms were targeted. Responses were obtained from 45 of them. All 45 companies filled out the questionnaire. However, 3 of the 45 questionnaires could not be used due to incomplete data. Characteristics of the 42 firms by industries are shown in Table 9.

5.1.1 Firms' Demographic Profile

As shown in Table 9, 8 firms have foreign ownership equity, 7 of them owning the majority share. This ownership is by supplier partner. The percentage of engineer and technical personnel to the total employees in the recipient firm ranges from 0.0% to 26.01%, with an average of 4.58%. The number of employees ranges from 97 to 6,000, with an average of 2,031. The annual sales when the technology transfer project was signed ranges from US\$ 0.430 million to US\$ 750.300 million, with an average of US\$

Table 9: Respondent Firm Profiles

Characteristics	Industrial category				
	Garments	Textile	Electronic	Footwear	all
Firm's Samples	15	6	8	13	42
Firm's location					
- Jakarta	8	1	4	2	15
- West Java	7	5	4	11	27
Foreign ownership equity					
< 50%	-	-	-	-	-
50 %	-	1	-	-	1
> 50 %	1	-	1	5	7
Average percent. of engineer and technical personnel to total employees in the recipient firm	.86	6.27	10.12	3.98	4.58
Average number of employees	2,034	1,861	529	3,163	2,031
Average annual sales (in million) US\$	10.637	41.689	106.637	27.232	38.31
Average percent. R%D spending to total annual sales	.28	.26	.33	.19	.23
Average percent. export to total annual sales	85.64	58.33	55.62	94.62	74.38

38.31 million. The annual sales were calculated without considering the fluctuation of the exchange rates. The percentage of R&D spending to total annual sales ranges from 0.0% to 3.0%, with an average of 0.28%. The percentage of export to total annual sales ranges from 20% to 100%, with an average of 74.38%.

5.1.2 Some Characteristics of the Technology Transferred

Table 10 presents some characteristics of the technology transferred. Among the sample firms, licensing is the most popular type of technology transfer mechanism. The age of technology transferred ranges from 1 year (in an electronic firm) to 21 years (in a textile firm), with an average of 7.36 years. The industrial experience of the recipient firm ranges from no experience at all to 20 years, with an average of 5 years. On the other hand, the industrial experience of the supplier's firm ranges from 2 years to 100 years, with an average of 20.5 years. The duration of training per employee before technology transfer took place ranges from none at all to 90 days, with an average of 26 days.

Table 10: Some Characteristics of the Technology Transferred

Characteristics	Industrial category				
	Garments	Textile	Electronic	Footwear	all
<u>Mechanism of transfer</u>					
- Turnkey operations	6	4	1	3	14
- Licensing	8	2	6	7	23
- Joint venture	1	-	1	3	5
Average age of technology transferred (years)					
	6.69	8.0	9.25	6.92	7.36
Average industrial experience of technology recipient firm (years)					
	2.07	13.17	6.0	1.31	4.52
Average industrial experience of technology supplier firm (years)					
	14.58	33.33	19.5	21.61	20.50
Average duration of training per employee (days)					
	18	35	27	33	26

5.1.3 Home Country of the Technology Supplier

South Korea, Taiwan, and Japan dominate the firms' sample as a source of technology (Table 11). These results are in accordance with data from Badan Koordinasi Penanaman Modal (Board of Investment) which has shown that the Newly Industrial Countries (NICs) are the biggest investors in Indonesia (Table 22).

Table 11: Home Country of the Technology Supplier

Country	Garments	Textile	Electr.	Footwear	all
South Korea	3	-	-	10	13
Taiwan	5	-	3	2	10
Japan	2	4	4	-	10
USA	2	-	-	1	3
Germany	1	2	-	-	3
Hongkong	2	-	1	-	3

5.2 Results of Quantitative Analysis

5.2.1 Reliability

Cronbach's alpha coefficient is used to assess the internal reliability of measurements in this study. These measurements are as follows: technological capability, top management support, planning, control, government role, and complexity of technology. A high alpha coefficient indicating a high reliability is desirable. However,

there is no fixed numerical value as a criterion in determining the reliability of measurement. For this study, the Cronbach's alpha coefficients for these measurements are exceeding 0.70 (see Table 12) which can be considered as satisfactory according to Gay *et al.* (1992).

Table 12: Cronbach's Alpha Coefficient

Measurement		Alpha
Technological capability	TCAP	.8053
Top management support	TOPMS	.8676
Planning	PLANN	.8323
Control	CONTROL	.8471
Government role	GOVRL	.7567
Complexity of technology	COMPTCH	.8767

5.2.2 Regression

Examination of data for univariate outliers shows 2 cases in TCAP, 3 cases in ECPSAL (the change of firm's annual sales growth rate), 1 case in ECPPRO (the change of firm's annual profitability growth rate), 4 cases in EGTECH (availability of engineers and technical personnel), 1 case in PLANN, 1 case in RDSPEN (R&D spending), 1 case in AGETC (the age of technology), and 1 case in GOVRL. These outliers are replaced by the closest score before the outliers score. The data is not deleted considering the sample size is small for multiple regression analysis. Furthermore, results of data analysis

using the SPSS* FREQUENCIES program lead to transformation of the variables to reduce skewness in their distributions, eliminate the number of outliers, and improve the normality, linearity and homoscedasticity of residuals. Square root transformations are used on 7 variables: ECPSAL, ECPPRO, EGTECH, EXPCF (the industrial experience of recipient firm), TRAIN (training), RDSPEN, and AGETC. Also, logarithmic transformation is used on the EXPORT (export orientation) variable. For other variables, transformations are not done since the results of transformations are worse than the original variable data distribution. Furthermore, there is no multivariate outliers among the cases with using $p < .001$ criterion for Mahalanobis distance.

In the following section, the results of data analysis are examined in terms of correlations among the variables and the regression functions. First, the correlations between variables are examined in terms of correlations between the independent variables, correlations between the dependent variables, and correlations between the dependent variables and the independent variables. Finally, the regression functions are examined.

5.2.2.1 The Correlation Coefficient

- Correlation between the independent variables

To meet multivariate assumptions in terms of singularity and multicollinearity, a bivariate correlation of 1.00 is used as the criterion for defining singularity and .70 or

more is used for defining multicollinearity (Tabachnick *et al.* 1990). Table 13 displays the Pearson correlations between the independent variables. The results shows that no singularity is found but 2 correlations are significant. First, the correlation between planning done by the firm (PLANN) to implement the technology transfer project and the activities to control the project (CONTROL) is .7631 at $p < .01$. Second, the correlation between the firm's export-orientation (EXPORT) and the industrial experience (EXPCF) is .5234 at $p < .01$.

Table 13 : Correlation Matrix Among Independent Variables

Independent variables	Independent variables				
	EGTECH	EXPCF	TRAIN	TOPMS	PLANN
EGTECH					
EXPCF	-.0440				
TRAIN	-.0160	.2017			
TOPMS	.1645	.2142	.2779*		
PLANN	.1902*	-.0541	.1945	.4310***	
CONTROL	.1004	.0799	.2592	.4607***	.7631***
EXPORT	.2576	.5234***	.0759	.0673	.0671
RDSPEN	-.0451	.5097***	.2530	.3265**	-.0308
GOVRL	.0152	.2610*	.3135**	.4182***	.1815
AGETC	.0531	.1225	.0356	-.0597	-.2439
COMPTCH	.0196	-.0162	-.2708*	-.0499	-.0248

*** $p < .01$; ** $p < .05$; * $p < .10$ (2-tailed)

continued

Independent variables	Independent variables				
	CONTROL	EXPORT	RDSPEN	GOVRL	AGETC
CONTROL					
EXPORT	-.0191				
RDSPEN	.0544	.1725			
GOVRL	.2507	.2389	.1786		
AGETC	-.3442**	.1641	.2764	-.0281	
COMPTCH	.0527	.0462	-.0254	.1410	-.1840

** $p < .05$ (2-tailed)

That PLANN and CONTROL are highly correlated is not surprising since control activities are considered a means to achieve the planning targets. However, in an attempt to build a model in predicting success factors of technology transfer, both variables were kept for regression analysis.

The result that EXPORT and EXPCF have a strong and positive correlation indicates that the more experienced firms tend to have a high percentage of export in relation to the firm's total annual sales. It implies that the industrial experience of firms enhances the firms' capability of competing in the international market. However, caution should be used when assessing this indication since these phenomena may be due to Indonesian government assistance in the form of drawback and exemption duty facilities for imported-raw-material which is used for exported products. In this study, these two variables are retained for regression analysis to find their role to the success of technology transfer.

Moreover, there are 4 moderate correlations between the variables. First, the moderate correlation between EXPCF and RDSPEN, which is .5097 at $p < .01$, indicates that the less experienced firms tend to have spend less on R&D. This indication may be due to the fact that 55% of the sample firms, which do not have industrial experience, part of industrial relocation from NICs (Newly Industrial Countries) and, in that case, all R&D activities are being conducted in their partners' country. For this study, both

variables are not excluded from regression analysis because it is still important to predict their contribution to the success of ITT.

Second, the correlation between TOPMS and CONTROL is .4607 at $p < .01$. Third, the correlation between TOPMS and PLANN is .4310 at $p < .01$. The results that TOPMS, PLANN, and CONTROL tend to be positively and significantly correlated are consistent with Wallender's Study (1979). The involvement of top management (TOPMS) during the implementation of technology transfer is a series of management activity with planning and control being necessary elements in achieving the success of the project. However, in order to detect the contribution of each variable in the success of technology transfer, no variable is excluded for regression analysis.

Fourth, the positive correlation between GOVRL and TOPMS, which is .4182 at $p < .01$, indicates that the attempts of government (GOVRL) to attract the foreign investors and maximizing the proportion of Indonesian managers lead the firms' management to increase their support of technology transfer. For example, most Korean firms started delegating the management tasks to Indonesian personnel in order to encourage employee participation, which in turn causes the government regulation on Indonesianisation of management levels, to take effect. However, in terms of regression analysis, the moderate correlation between these two variables weakens the analysis. But, for this study, both variables are retained for analysis due to their role in the success of ITT as discovered

in earlier research findings (see Table 5).

In addition, 3 more coefficients are positive at $p < .05$. The correlation between TRAIN and GOVRL is .3135; and between TOPMS and RDSPEN is .3265. Meanwhile, there is negative correlation between CONTROL and AGETC (-.3442 at $p < .05$). For the regression analysis, none of these variables are excluded since the literature's findings support their role in achieving the success of technology transfer project.

The result that TRAIN and GOVRL tend to have a positive significant correlation may be due to the fact that the government intervention in investment regulation has increased the amount of foreign investments in Indonesia. In this case, these new investments called for the need of skilled workers which could be obtained through training provided by companies.

A positive correlation between TOPMS and RDSPEN may be due to the degree of management awareness of the important role of R&D in developing the firm's technology. The following examples support this suggestion. First, the director of one sport shoe company said that by having its own R&D, the company can immediately meet buyers' requests regarding modifications of shoe design. These capabilities lead the firm to access buyers directly. Developing networks with international buyers is essential for the company, especially since the international market of shoe products are dominated by

certain foreign agencies.

In another example, the management of an electronic company stressed that having its own R&D was important since technology in electronic products changes very quickly. As a result, this company was able to reduce the process of power supply production from 6 stages to 3 stages. Additionally, the company modified the amount of raw material which can be recycled. Consequently, not only did this company reduce its dependence on its licensee, but it started exchanging its technology with its licensee.

The fact that CONTROL and AGETC have a negative and significant correlation indicates that management tends to have detailed control reports if the technology is new. Since detailed information has been available for older technology, management did not need detailed control reports. Similarly, a number of respondents commented that they did not use detailed formal reports when they employed basic technology. This result supports Teece's arguments (1976).

In summary, all independent variables are retained for the regression analysis, even though intercorrelation among independent variables can weaken the analysis. Using all these variables in the regression analysis could prompt further research into their contribution to the success.

- Correlations between the dependent variables

The correlations between the four dependent variables are positive with varying degree associations (Table 14). The firms' annual sales growth rate (ECPSAL) and the firms' annual profitability growth rate (ECPPRO) - which are used to measure the firms' economic performance - show a strong correlation (.7997 at $p < .01$). Similarly, the achievement of technological capability of the firms' (TCAP) and the firms' satisfaction with the success of the technology transfer project (SATFIC) show a rather strong association (.6583 at $p < .01$). Furthermore, TCAP has a moderate association with ECPSAL and ECPPRO (.4116 at $p < .01$ and .3825 at $p < .05$) respectively, while SATFIC is significantly correlated with ECPPRO at $p < .1$, and insignificantly correlated with ECPSAL. The interpretation of these correlations is discussed in Section 5.3.

Table 14: Correlation Matrix Among Dependent Variables

Dependent variables	Dependent variables		
	TCAP	ECPSAL	ECPPRO
TCAP			
ECPSAL	.4116***		
ECPPRO	.3825**	.7997***	
SATFIC	.6583***	.2160	.2727*

*** $p < .01$; ** $p < .05$; * $p < .1$ (2-tailed)

- The correlation between the dependent variables and independent variables

The Pearson correlations amongst the four dependent variables and the twelve independent variables can be seen in Table 15. PLANN and CONTROL variables have rather strong correlations with TCAP and SATFIC variables at $p < .01$; and they have insignificant correlations with ECPSAL and ECPPRO. Subsequently, the GOVRL variable has negative and significant associations with ECPPRO at $p < .01$; it has a negative and significant correlation with ECPSAL at $p < .10$; and it has a negative and insignificant association with TCAP and SATFIC.

Other independent variables which have a significant correlation with the dependent variables at $p < .05$ are EXPCF and EXPORT. Then, at $p < .10$, TOPMS, GOVRL, COMPTCH, and AGETC variables have significant correlations with varying degree from $-.2909$ to $.2877$. The detailed interpretations of these relationships are explained further in section 5.3.

Table 15 : Correlation Matrix of Dependent Variables and Independent Variables

Dependent variables	Independent variables					
	EGTECH	EXPCF	TRAIN	TOPMS	PLANN	CONTROL
TCAP	.0805	-.1622	-.1426	.2776*	.5309***	.5124***
ECPSAL	-.0282	-.1598	-.1225	-.1117	.0420	.0429
ECPPRO	-.1630	-.3396**	-.1972	-.1335	-.0341	-.0225
SATFIC	.1939	-.2096	-.0911	.2979*	.5521***	.4275***

***p < .01; **p < .05; *p < .10 (2-tailed)

continued

Dependent variables	Independent variables				
	EXPORT	RDSPEN	GOVRL	AGETC	COMPTCH
TCAP	-.1673	-.0305	-.1598	-.2456	.1203
ECPSAL	-.2280	-.0572	-.2909*	-.1695	.1789
ECPPRO	-.3682**	-.1624	-.4026***	-.2877*	.1403
SATFIC	-.0405	-.1074	-.0563	-.2103	.2049*

***p < .01; **p < .05; *p < .10 (2-tailed)

In summary, most independent variables represent a low correlation coefficient, which in turn indicates a weak relationship with the dependent variables. Only 2 independent variables (PLANN and CONTROL) represent correlation coefficients of more than .5 at $p < .01$. These weak relationships lead to the independent variables (IVs) having a little contribution in explaining the variability of dependent variables (DVs). However,

since this study is designed to identify the influence of the IVs to the success of technology transfer (DVs), no IVs are excluded from regression analysis.

5.2.2.2 The Regression Coefficient

- Standard Regression

In accordance with the low numerical value of the correlation coefficients between the DVs and the IVs (Table 15) and intercorrelation amongst the IVs (Table 13), it is found that only few IVs make a significant contribution to predicting the variability of the DV in each equation. The results of the regression beta coefficient estimated for four DVs can be seen in Table 16.

In an equation with TCAP as DV, PLANN and turnkey operation (D1) contribute significantly at $p < .10$ to the achievement of the firms' technological capability (TCAP). The 12 IVs in combination explain 56% (36% adjusted) of the variability in the firms' technological capability. However, based on Stein's formula, this regression equation is not good in predicting other samples from the same population since the amount of shrinkage to predict the TCAP is great, about 94.97%.

In equation SATFIC as DV, 3 of 12 IVs contribute significantly to the regression. PLANN and COMPTCH contribute positively and significantly to the regression at $p < .1$. Meanwhile, joint ventures (D3) contribute negatively and significantly to regression

Table 16: Regression Beta Coefficients

TCAP = - .0046 (EGTECH) -.1078 (EXPCF) -.2242 (TRAIN)
 +.2136 (TOPMS) +.4023* (PLANN) +.2292 (CONTROL)
 +.0361 (RDSPEN) -.1873 (EXPORT) -.2457 (GOVRL)
 +.0089 (AGETC) +.0853 (COMPTCH) -.2365 (D3)
 -.2583* (D1)

(N = 42, C= 1.7851, MR= .7500, R^2 = .5625, R^2_{adj} = .3594
 ρ_c^2 = .0283, F = 2.7692, p < .01)

ECPSAL = -.0303 (EGTECH) +.0223 (EXPCF) -.0231 (TRAIN)
 +.0186 (TOPMS) +.2180 (PLANN) -.1223 (CONTROL)
 -.0106 (RDSPEN) -.2368 (EXPORT) -.2533 (GOVRL)
 -.1269 (AGETC) -.0256 (COMPTCH) +.2820 (D2)
 +.1271 (D3)

(N = 42, C= 6.8889, MR= .4851, R^2 = .2353,
 R^2_{adj} = -.1197, ρ_c^2 = -.6984, F = .6629 p < .7804)

ECPPRO = -.1512 (EGTECH) -.1965 (EXPCF) -.0287 (TRAIN)
 +.1288 (TOPMS) +.0609 (PLANN) -.0943 (CONTROL)
 -.0329 (RDSPEN) -.1848 (EXPORT) -.3567* (GOVRL)
 -.2313 (AGETC) +.1553 (COMPTCH) -.1902 (D1)
 -.0978 (D3)

(N = 42, C= 6.6964 MR= .6276, R^2 = .3938, R^2_{adj} = .1124,
 ρ_c^2 = -.3463, F = 1.3994, p < .25)

SATFIC = .1229 (EGTECH) -.2877 (EXPCF) -.0373 (TRAIN)
 +.1700 (TOPMS) +.4169* (PLANN) +.1351 (CONTROL)
 +.0016 (RDSPEN) -.0588 (EXPORT) -.2095 (GOVRL)
 +.1162 (AGETC) +.2310* (COMPTCH) -.4307*** (D3)
 -.0426 (D1)

(N = 42, C= 1.9527, MR= .7588, R^2 = .5758,
 R^2_{adj} = .3789, ρ_c^2 = .0581, F = 2.9242, p < .01)

*** p < .01 , * p < .10

at $p < .01$. The 12 IVs in combination explain 57% (38% adjusted) of the variability in the degree of the firm's satisfaction regarding the success of the technology transfer project. However, using Stein's formula to predict the cross validity power of this equation, the amount of shrinkage to predict the SATFIC is great, about 89.91 %.

In the equation ECPSAL as DV, no variable contributes to the regression with any significance. The 12 IVs in combination explain 23% (- 12% adjusted) of the variability in the change of the firm's annual sales growth rate.

In the equation ECPPRO as DV, GOVRL contributes negatively and significantly to the regression at $p < .1$. The 12 IVs in combination explain 39% (11% adjusted) of the variability in the change of the firms' annual profitability growth rate. Furthermore, Stein's formula indicates that this regression equation is not good in predicting other samples from the same population.

In summary, these regression results indicate that the independent variables are better in explaining the variability of the achievement of firms' technological capability and the degree of the firms' satisfaction regarding the success than the variability of the firms' economic performance. This is evident in the value of the multiple coefficient of determination (R^2). In this case, the IVs can explain 56% (36% adjusted) of the variability of TCAP and 57% (38% adjusted) of the variability of SATFIC. However, the population

cross validity, ρ_c^2 , indicates that these regression functions are not good enough to predict the other samples from the same population since the estimated amount of shrinkage is great. A good model will be obtained if the ratio between the sample size and the predictors is 15 (Stevens 1992 p. 100); whereas in this study the ratio between sample size and independent variables is 3.2. Nevertheless, these results need to be researched further.

- Stepwise regression

In an attempt to get a better prediction, the stepwise method is executed and the results are displayed in Table 17.

Table 17: Regression Beta Coefficients Using Stepwise Method

$$\text{TCAP} = -.2292^+ (\text{TRAIN}) + .3274^+ (\text{PLANN}) + .3830^+ (\text{CONTROL}) \\ - .2433^+ (\text{GOVRL})$$

$$(N = 42, C = 17.83681, MR = .6645, R^2 = .4416, R^2_{\text{adj}} = .3812 \\ \rho_c^2 = .2961, F = 7.3151, p < .001)$$

$$\text{ECPSAL} = - .2909^+ (\text{GOVRL})$$

$$(N = 42, C = 4.8548, MR = .2909, R^2 = .0846, R^2_{\text{adj}} = .0617, \\ \rho_c^2 = -.0105, F = 3.6986, p < .1)$$

$$\text{ECPPRO} = -.2417^+ (\text{EXPORT}) -.3520^* (\text{GOVRL}) -.2579^+ (\text{AGETC})$$

$$(N = 42, C = 8.3429, MR = .5522, R^2 = .3049, R^2_{\text{adj}} = .2500, \\ \rho_c^2 = .1699, F = 5.5569, p < .01)$$

$$\text{SATFIC} = -.2915^* (\text{EXPCF}) + .5332^{***} (\text{PLANN}) \\ + .2093^+ (\text{COMPTCH}) -.3521^{**} (\text{D3})$$

$$(N = 42, C = 1.8339, MR = .7031, R^2 = .4944, R^2_{\text{adj}} = .4397, \\ \rho_c^2 = .3627, F = 9.0438, p < .001)$$

$$***p < .001; **p < .01; *p < .05; ^+p < .10$$

In the TCAP equation, 4 variables contribute significantly to the regression at $p < .1$. Subsequently, 4 variables make a significant contribution to predicting SATFIC. Meanwhile 3 variables contribute negatively and significantly to predicting ECPPRO. Moreover, the numerical value of Stein's formula indicate that these regression equations give better results in predicting the other samples for the same population than the previous regression functions. However, there is no better model revealed for the ECPSAL function. In this case, only the GOVRL variable contributes significantly to the regression and the amount of shrinkage to predict the ECPSAL is still great ($p_c^2 = -.0105$). As a result, ECPSAL, which is initially used as one of the measures of the success of technology transfer, is not being analyzed further in this study.

5.3 Explanation of Variables

The following section explains in detail the relationships amongst the dependent variables and the relationships between the independent variables and the dependent variables. The explanations focus on the plausible causality of the relationship between each dependent variable and independent variable based on information provided by respondents.

- Success of technology transfer

The correlation results (see Table 14) suggest that the firms credited their technological capability (TCAP) for the success of the technology transfer project. Then,

the correlation results imply that the firms' technological capability could improve the firms' economic performance. Furthermore, the regression functions indicate that there are different combinations of independent variables which contribute significantly to predicting different success criteria.

First, good management is an important factor in achieving the firms' technological capability. This indication is supported by the stepwise regression results when PLANN, CONTROL, and TOPMS variables are combined. Moreover, this regression function is more effective in predicting the TCAP than the previous function. The amount of shrinkage to predict the TCAP is relatively good, about 28% from 33%. The regression function can be seen in below.

$$\text{TCAP} = .7269^{***} (\text{MNG}) + .2813^+ (\text{D2}) - .2421^+ (\text{GOVRL}) \\ - .2732^* (\text{TRAIN})$$

(N = 42, C= 21.6127, $R^2 = .5437$, $R^2 \text{ adj} = .4803$,

$\rho_c^2 = .3919$, $F = 8.5792$, $p < .001$)

***p < .001; *p < .05 ; +p < .10

Furthermore, it is found that the mechanisms of technology transfer affect the achievement of firms' technological capability. In this case, licensing agreements (D2) have a greater contribution than joint ventures or turnkey operations in achieving the firms' technological capability. However, GOVRL and TRAIN tend to have negative

impacts on TCAP. The description of these indications are given below in the sections Government role and Training.

Second, GOVRL, EXPORT, and AGETC variables contribute negatively and significantly to predicting the change of the firms' annual profitability growth rate (ECPPRO). This particular interest in predicting the ECPPRO may be due to the fact that the profit of most firms tended to be determined by foreign agencies. According to the executives of 5 companies, many firms - especially garments and footwear firms - produced exported goods based on job-orders from foreign agencies. These foreign agencies also supplied the raw materials and did production cost calculations of the recipient firms. Evidently these firms had little mark up. This same phenomenon might be occurring in some of the firms participating in this study since 65% of the sample firms manufactured based on job-orders.

Finally, the firms' satisfaction can be predicted significantly by PLANN, COMPTCH, EXPCF, and the mechanisms of technology transfer. In particular, the firms' satisfaction is lower in joint venture agreements (D3) than in licensing or turnkey operation agreements. Then, the experienced firms tend to be less satisfied with the result of the technology transfer project.

The firms' perceived success of the technology transfer project can be further

delineated by reviewing the respondents' criteria in measuring the success. There are a number of measures which participating companies used for the success of technology transfer. Table 18 displays the summary of such success criteria. Companies used several items to measure the success in terms of the technology transfer project. In relating to these success criteria, six points are worth mentioning.

Table 18: Success Perceived by Firm's Executives

Success Measurement	Frequency Mentioned
Product quality	16
Production output	15
Optimize the production capacity	9
Sales performance	7
Mastering the technology	7
Productivity	6
Market share	4
Increase the number of labour	2
Material efficiency	2
Product price	1
Increase the number of machines	1
Time delivery	1
Reduction in usage of spare parts	1
Less repair and maintenance	1
Continuity of transfer of new technology from supplier	1

First, product quality criterion was used by firms which wanted to increase their value added. For example, one garment company just bought new machines in order to improve their product quality rather than to increase its production capacity.

Second, production output as criterion for success was used by firms which had a product's license without any concern about marketing the product. These respondents preferred to use the production output term rather than the sales performance term since they thought that firms' target was to produce goods in order to achieve their quota; marketing was the licensee's responsibility.

Third, optimizing the production capacity was used as a success criterion by firms which have concern about productivity and product quality. For instance, a large shoe company had a policy to optimize the production capacity rather than to maximize it. The management thought that maximising the production capacity could create problems in the areas of control of product quality, management of the workers, and acquiring the raw material. Therefore, sometimes this company refuses the extra order from buyers.

Fourth, the majority of companies which used sales performance as a success criterion were joint venture firms. For these companies, sales performance is important since the parent company can directly access the international market.

Fifth, only a few companies used mastering the technology as success criterion. These companies usually had top managers who were concerned about up-dating the technology.

Finally, productivity as a success criterion was used by companies which had a foreigner as a production manager. For example, managers of one garment company and two shoe companies mentioned that the management was of the opinion that Indonesian productivity was still lower than that of Korean workers. Furthermore, managers of 8 companies were questioning the apparent tendency that Indonesian workers work more productively if they are supervised by foreigners. This is an interesting case to be studied further.

In conclusion, the firms seem to perceive the success of the technology transfer project as being from the achievement of the firms' technological capability. This indication is in accordance with the fact that product quality is the most popular criterion for success. This indication is also supported by the regression results. The results show that plan done by firms to implement the technology transfer make a significant contribution to predicting SATFIC and TCAP. As a result, profitability could be an indirect result of technology development.

- Availability of engineers and technical personnel (EGTECH)

Based on correlation coefficients, the availability of engineers and technical personnel is not significantly relevant to the firms' mastery of technology, satisfaction, and the change of the profitability growth rate. However, perhaps these results, which contradict the findings in the literature, occur because of the sample used for this study.

Several authors cited EGTECH as one of the success factors for technology transfer (see Table 5).

The contradictory result may be due to the differences in defining engineers and technical personnel, the level of technology, and the data limitations. First, in this study, "technical personnel" is defined as one who performs a function of intermediate grade between scientist or engineer and skilled worker or operator (Training of Technicians for the Mechatronics Age 1988). "Engineer" is defined as one who holds a degree of engineering.

Based on the above definition, firms which had joint ventures with South Korean firms did not consider a degree, i.e., an engineer, as the most important criterion to successfully perform the job (5 companies). They were more appreciative of the personnel who have ability, responsibility, leadership, diligence, and intelligence in doing the job. To enhance employee knowledge, the Koreans trained Indonesian employees by on-the-job training or sent them to the parents' plant.

Second, the executives of 8 firms thought that they employed a simple technology. To acquire this technology, the availability of engineers and technical personnel was not an important factor.

Third, there is an indication that firms did not give real data on the number of foreign engineers and technical personnel. This suspicion emerges since a lot of companies complained that the government regulation on limiting foreign employees inhibits their production. This indication implies that the number of foreign engineers or technical personnel employed by recipient firms may be higher than the given data.

- The industrial experience of the firm (EXPCF)

The correlation coefficient (Table 15) shows that EXPCF is negatively and significantly related with the change of the firms' annual profitability growth rate (ECPPRO) at $p < .05$ and has an insignificant correlation with the achievement of the firms' technological capability (TCAP). This indication is interesting since there are disagreements among authors about the contribution of EXPCF to the success of the technology transfer (see p. 21).

In this study, the fact that EXPCF contributes negatively to enhancing the firms' mastery of the technology may be due to the majority of sample firms employing a simple technology. In term of the firms' profitability, it seems that the export-market circumstances contribute to this phenomenon. However, further study is needed to elaborate on these circumstances.

Furthermore, the regression shows that EXPCF contributes negatively and

significantly to predicting the variability of the SATFIC at $p < .05$. This result implies that experienced firms are not satisfied with the result of the technology transfer. The reasons for this indication may be due to the lower of the firms' achievement in mastering of the technology and the lower of the firms' profitability.

- Training (TRAIN)

The correlation coefficient shows that the duration of training per employee before the technology transfer took place tends to be negatively associated with the firms' mastery of technology, profitability growth rate, and satisfaction. These results are contradictory to Yin's findings (1992). The plausible explanation is that training requires capital and time, which may in turn reduce the firms' profitability. Then, these phenomena lead to the firms' lower satisfaction. Yet these study results should be interpreted with caution since the correlations are insignificant.

However, the regression result that TRAIN contributes negatively and significantly to predicting TCAP at $p < .1$ is interesting. This result may be due to the level of technology transferring by sample firms. It is perhaps simple compared to the firm's existing technology; this consideration is based on the small duration of training provided by companies. This study reveals that the average duration of training provided by companies for each employee ranged from 18 days to 35 days (Table 10). An employee needs two years of training, in total, to operate a modern sewing machines or to produce

high-fashion products according to 3 supervisors (garments and footwear firms). This claim is also supported by personnel progress reports.

As another example, in two companies, it took only two weeks to train the personnel in operating marker computerisation for garment design. The speed of this transfer was such because the employee had enough knowledge to learn it.

Subsequently, the qualitative results also indicate that firms had no formal training to implement the technology transferred if they could operate the technology with their existing capabilities (Table 19). As a result, the need for training in the mastery of the technology may relate to the level of firms' technological capability.

Table 19: The Reasons for Not Having Formal Training

Reasons	Frequency Mentioned
Firm had enough skilled-workers	7
Firm recruited workers who had enough skill in production	5
The workers did not need specific skill to operate the technology	3
Training was done through on-the-job training which is provided by government	1

- Top management support (TOPMS)

The results indicate that TOPMS is positively and significantly related to the TCAP and SATFIC at $p < .1$. Meanwhile, it has a negative and insignificant association with the ECPPRO. The indication that management support can enhance the achievement of the firms' technological capability is in accordance with the earlier research findings (see Table 5). However, that the management support may not enhance the firms' profitability should be interpreted with caution. Yin (1992) claims that technological improvement usually has no impact on economic performance in the short-term. Further investigation is needed to delineate these phenomena.

- Planning (PLANN)

The indication that planning contributes positively and significantly to predicting the firms' mastery of the technology transferred is consistent with literature (Wallender 1979, Santikarn 1981, and Madu 1989). This finding suggests that Indonesian firms had done proper planning for the technology transfer project.

- Control

This study finds that control activities are positively associated with the firms' mastery of technology and the firms' satisfaction of the technology transfer project. This result supports Wallender's findings (1979). Apparently, as a series of management activities, control cannot be separated from the role of management in achieving the

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PM-1 3½"x4" PHOTOGRAPHIC MICROCOPY TARGET
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success of the project.

However, the CONTROL variable has a negative correlation with the change of the firms' annual profitability growth rate. This result may be due to the cost of foreign personnel. This study finds that the control activities of most firms were employed by the licensee's firm personnel or the buyers. For example, in a large garment company, where the company could meet the licensee's product standard, it still permanently employed several personnel of the licensee's firm to supervise the production process. In another example buyers controlled the product quality actively through inspecting the process production (3 sample plants). This suggests that Indonesian firms still lack the ability to exert management control. For Indonesian firms to acquire this knowledge is a challenge.

- Export Orientation (EXPORT)

The results indicate that the firms' export-orientation tends to have negative correlations with the TCAP and SATFIC, and it has a negative and significant correlation with ECPPRO at $p < .05$. These results contradict Santikarn's findings (1981). In this case, the contradictory result may be due to the characteristics of the export products and market.

First, most sample firms export basic products which require little technical knowledge. Other factors are that the export orientation is limited in quota products, and

the export-orientation is concentrated in the US market (7 companies). In this case, there is an agreed limit for the growth of the export rate for certain product categories within garments and textiles. This agreement exists for markets in the US, Canada, the European Economic Community, and Norway (MKE, Vol. 3, 1993). In the long-term, the limitation of Indonesian exported products in countries which employ a quota system is very dangerous. This situation leads Indonesian firms to rely on the policies of buyer countries which can change unpredictably. Furthermore, it seems to reduce the incentive of the firms in acquiring technology.

The above results are interesting since the Indonesian government promotes export-orientation to boost the economy. The findings suggest that the policies on duty exemption for export-products tend to have a negative impact on the firms' mastery of technology and the firms' profitability. Therefore, these policies should be reassessed.

- Spending on Research and Development (RDSPEN)

The results show that firms' spending on R&D as percentage of sales has negative and insignificant correlations with the firms' mastery of the technology, profitability, and satisfaction. These results contradict the literature's findings. The results are not significant and therefore should be interpreted with caution.

Based on interview results, it can be interpreted that R&D actually can enhance

the achievement of the firms' technological capability. This indication can be seen from the way technology was acquired. Most R&D activities were being conducted in the parent plants, the results of which were transferred to Indonesian firms through regular visits of foreign firm personnel. This suggests that firms can acquire the technology without doing their own R&D.

On the other hand, 10 out of 42 companies were performing research and development although there was no formal R&D set up in their companies. Based on the companies interviewed, these R&D activities were focused on transforming the licensee's product design to manufacturing while optimizing the production time and the use of raw materials. These activities included developing the production techniques to obtain material efficiency, looking for a better raw material, or finding ways to improve the production process suggested by the licensee. Furthermore, it was found that firms did not get to the stage of developing new product designs at their own. Nevertheless, results suggest that a large sample is needed to evaluate the role of R&D in achieving the technology capability.

- Government Role

The regression results indicate that government policies on investment regulations contribute negatively and significantly to predicting TCAP and ECPPRO. These results imply that regulations seem to be unsuccessful in enhancing the firms' mastery of the

technology and the firms' profitability. In particular, the regulations relate to the relaxation of foreign ownership equity, maximisation of Indonesianisation on the management levels, and allowing more investors to enter certain businesses.

Based on interview results, there are two factors, which provide the rationale of government policy failure: lack of integrated planning and inconsistency in law enforcement. For example, the lack of integrated planning is evident when the NICs companies have relocated their plants, which did not make much improvement in the technological capability of Indonesian firms due to technology being simple and outdated (3 directors of 2 textile companies and one shoe company). The case may differ if the government not only allows more foreign investors to enter certain business but also determines some criteria for foreign investors in relocating their plant regarding the type and the level of technology.

To cite another example, the regulation on the relaxation of foreign ownership equity in firms, which produce goods for export is not followed by the availability of supporting industry in order to provide the raw materials. The lack of supporting industries is used as a rationale by Indonesian firms to rely on imported raw material, which in turn demotivates the firms in improving their technological capability (7 companies). For example, the Indonesian textile industry still relies on imported cotton to meet the raw material requirement instead of taking advantage of the fact that

Indonesia has a lot of a vacant land which could be used to cultivate cotton (3 companies). Similarly, the shoe industry has to import a high quality rubber thread even though Indonesia has a lot of natural rubber (2 companies). Then, some electronic firms still prefer imported products - capacitor, resistance, and mould - due to the lower cost and faster delivery (2 companies).

Second, inconsistency in law enforcement is wide spread. For example, many companies are still employing foreign personnel since the sanction was conducted. This can be seen through the large number of foreign personnel in management levels in the sample firms which employed joint venture agreements. This will be elaborated in the Section on Mechanism of Technology Transfer.

In summary, the government policies on investment regulation seems to be unsuccessful in achieving the firms' technological capability and the firms' profitability. However, the qualitative results suggest that the government role is still important in enhancing the firms' technological capability and their profitability if the policy is planned wisely in terms of integrated planning, evaluation activities, and consistency in law enforcement.

- The age of technology

The regression shows that the age of technology contributes negatively and

significantly to predicting the firms' profitability. Furthermore, the correlation coefficients indicate that the age of the technology has a negative and insignificant association with the firms' mastery of the technology and satisfaction. These findings imply that with the aging of technology, there is not much improvement in the firms' technological capability and profitability. This indication suggests that the age of technology should be considered in order to gain a good profit.

- The complexity of technology

The correlation coefficients show that the complexity of technology (COMPTCH) is positively and insignificantly associated with TCAP, ECPPRO, and SATFIC. Furthermore, the regression indicate that the complexity of technology contributes significantly to predicting the firms' satisfaction at $p < .1$. These findings imply that with the growing complexity of technology, the level of the firms' mastery the technology is low. This result is consistent with Teitel's statement (1984). Teitel suggests that technological developments frequently pass through several stages, from basic technical knowledge to more technical complexity.

However, the fact that Indonesian export-products are still dominated by simple manufactured goods indicate that the technological capabilities of Indonesian firms are still low. This phenomena should be taken into account when attempting to develop Indonesian technological capabilities.

- Mechanisms of Technology Transfer

The regression results imply that licensing agreements tend to be more successful than turnkey operation or joint venture agreements in enhancing the firms' technological capability. Subsequently, firms tend to be less satisfied with the success of technology transfer in joint venture agreements than in turnkey operation or licensing agreements. These results suggest that mechanism of technology transfer affects the achievement of the firms' technological capability and their satisfaction. This finding is consistent with earlier research results (Thee Kian Wie 1990 and Balasubramanyam 1973).

The result that licensing agreements have a positive impact on improving the firms' technological capability may be due to the fact that these agreements allow more communication between personnel as well as introducing trouble shooting into the production process (3 production managers). In the following section, several operating characteristics of the mechanism of technology transfer agreements are given. The explanations focus on the relationship between the recipient and the supplier of technology after signing of the contract, and the technology transfer process.

- The relationship between the recipient and the supplier of technology

- *Turnkey operations*

It is found that most textile sample companies used turnkey agreements to buy new machines in order to meet the growing market demand. The suppliers were consulted

when there was a problem with the machine. A manager of a textile company said that the Indonesian companies still have a great dependency on foreign countries in catching-up with the technological advances. He also said that, so far, most Indonesian textile industries still use old technology. Furthermore, this weakness is exacerbated since Indonesian textile industries are relying on imported raw material, such as cotton, textile yarn, and dye stuff.

In garment companies, turnkey operations took the form of computerisation of design markers. Based on the licensee's design, the company made the marker with computers. The supplier trained the recipient firm's personnel to operate this machine.

- Licensing

Licensing agreements in this study can be grouped into technical assistance, process/product design, and process/product know-how (Table 20). It was found that process/product design was the most popular kind of licensing agreement used by the sample firms. It is also evident that a firm can have more than one type of licensing agreement such as product/process know-how combined with product/process design (2 firms) or can have all three of them (4 firms).

Product licensing agreements are found to be the most popular in garment and footwear firms. Here, the licensee controlled the production process in terms of product

quality, raw material, product design, and market. Under this term, most sample firms appear as a manufacturing division of MNCs (Multinational Companies). Only one garment company out of the sample firms obtained an agreement for marketing the products by itself.

Table 20: The Types of Licensing Agreements

Types of agreements	Garment	Text.	Electr.	Footw.	Tot
Technical assistance	1	–	3	3	7
Process/product design	6	2	4	6	18
Process/product know-how	1	–	3	3	7

- A joint venture

A sample firm which had a majority of foreign ownership equity was more like a manufacturing division of its parent company. The organization was almost dominated by personnel from the parent company such as the president, production director, production manager, production supervisors, mechanical supervisors, quality control supervisors, and financial manager. The Indonesian firm was only responsible for making the products in accordance with the policies of its parent.

- Technology transfer process

Generally, a process of technology transfer in firms is carried out through

personnel contacts. The transfer process takes place by giving the tasks gradually to Indonesia personnel (3 companies). Knowledge is also transferred through regular meetings (4 companies), monthly production meetings (5 companies), and visiting the licensee plant (5 companies).

5.4 Factors Inhibiting the Transfer of Technology

The executives of the participating firms cited 3 factors as inhibiting the technology transfer process. The factors are language, culture, and exported products. First, language inhibits communication between the Korean and Indonesian workers according to the managers in 4 companies. The problem is worse if the technology is complex as the Director of a garment company.

Second, culture differences lead to some misunderstanding in perceiving the objectives of each participant. These differences took the form of punctuality, adherence to deadlines, discipline, and manner of speaking (3 companies).

Finally, the exported products which required a little knowledge lead to a reduction of the firms' efforts in enhancing their technology capability. It was found that most firms have no tendency to diversify their products which will call for technological change. They were satisfied with their existing performance even though the experiences of one garment and one shoe company showed that their product diversifications have

opened a new export-market and improved their profitability.

5.5 Summary

The study suggests that the firms perceived the success of technology transfer from the achievement of the firms' technological capability. The study also implies that the firms' technological capability could improve the firms' profitability. Furthermore, it indicates that there are different combinations of independent variables which contribute significantly to predicting different success criteria.

First, in predicting the firms' achievement of technological capability, a good management in terms of planning, controlling, and management support in implementing the technology transfer is an important factor to be considered. Similarly, licensing agreements are more beneficial for the firms than joint ventures or turnkey operations in mastering the technology. However, government intervention on investment regulations and training provided by companies have a negative correlation with the success in achieving the firms' technological capability.

Second, government intervention on investment regulations, the firms' export orientation, and the age of technology can be used to predict the change of firms' profitability growth rate. Finally, the firms' satisfaction is influenced by the plan performed by firms in implementing the technology transfer, the complexity of

technology, the industrial experienced of recipient firms, and the mechanisms of technology transfer.

CHAPTER 6

CONCLUSION

The conclusion of this study is presented in this chapter. Then, it is followed by an explanation of the limitations of this study. Finally, recommendations to the Indonesian government, companies, and future researchers are given.

6.1 Conclusion

Literature reviews indicate that various combinations of variables should be taken into account for a successful technology transfer project. Based on a sample of 42 Indonesian manufacturing companies, this study finds that the success factors of technology transfer in Indonesian manufacturing firms do not entirely follow the literature-suggested factors. The results also indicate that the conceptual model for successful technology transfer employed in this study is more relevant to achieve the firms' technological capability than the firms' economic performance. However, caution should be used in generalising these results.

The study also finds that the measure of the technology transfer project success is a determinant consideration in identifying the factors leading to the project success. The stepwise multiple regression technique identifies 4 variables⁴ which contribute

⁴ MNG (PLANN + CONTROL + TOPMS), GOVRL, TRAIN and MECH

significantly to predicting the achievement of firms' technological capability, 3 variables⁵ to predicting the change of the firms' profitability growth rate, and 4 variables⁶ to predicting the firms' satisfaction. Thus, a firm need to clearly define the objectives of its technology transfer project in order to identify the factors affecting the project success.

6.2 Limitations of The Study

Two limitations are apparent in this study even though efforts were made to lessen their effect. These should be noted in interpreting the study results. The first limitation lies in the independent variables selection. Due to time constraints, it was difficult to take into account all potential factors which may contribute to technology transfer project success.

Second limitation is that the study utilizes subjective perception to examine variables, i.e. the achievement of firms' technological capability, the level of government intervention in achieving the success of technology transfer, and the complexity of technology. Many extraneous factors, for example the respondents' experience, can influence respondents' perceptions.

⁵ EXPORT, GOVRL, and AGETC

⁶ EXPCF, PLANN, COMPTCH, and MECH

6.3 Recommendations

Although technology transfer is one of the government objectives in attracting foreign investors to do business in Indonesia, very little research has been conducted on technology transfer in the Indonesian manufacturing industry. The following suggestions would help in improving the success of technology transfer.

Recommendations to the Indonesian Government

- The government could promote the supporting industry for most determinant export products since most firms still rely heavily on raw material imports. By building the supporting industries, it would not only reduce the import of raw materials but also enhance the firms' technological capability. This is due to the fact that modification and adaptation in production processes will be required in order to utilize the local raw materials.

- The government should reassess its policies on duty exemption and the drawback system. Our study showed that government assistance did not enhance the profitability of those firms which produce goods based on job orders. In these firms, the cost reduction is calculated by the foreign agencies or international buyers which in turn factored in determining the profitability of the Indonesian firms.

- In order to enhance the firms' economic performance, the active role of government in the international market is suggested due to the fact that most firms have little direct

access to the international buyers. In this case, government could negotiate to relax the quota policies of those countries which employ quota restriction for Indonesian products.

Recommendations to Industry

- The Indonesian firms should start diversifying their exported products, which are still dominated by basic products. In producing diverse products not only will increase the firms technological capability due to the requirement of technological change, but also improve the firms' economic performance due to the acquisition of a new export-market. The experiences of one garment company and one shoe company has proved the usefulness of this strategy. In particular, the development of products which require more complex technology is important for the Indonesian firms since some new comers, i.e. Bangladesh, Vietnam, and the Republic of China, are active in basic product categories within garment and sport-shoe industries and have advantages in their cheap labour.
- The Indonesian firms should acquire marketing expertise in terms of negotiation skills and building the marketing network. Presently most firms rely heavily on foreign agencies for accessing the international market.
- The Indonesian firms should develop their ability in management control since most firms still employ foreign personnel to manage their operations.
- The age of technology should be taken into account in considering the technology

transfer project. Our study showed that with the aging technology, the firms' technological capability and profitability were not much improved.

- Firms should develop more long-term planning in acquiring the technology in order to survive in the international market. Most firms have been found to pay little attention to R&D activities, the level of training, and the need of local engineers and technical personnel in developing the technology. Meanwhile, there is indication that simple and outdated technologies did not improve the Indonesian firms' technological capability much and only gave a low added-value.

Recommendations for Future Research

- In order to find more insight in the success factors of the technology transfer project, the same study could be conducted in other industries which employ medium and/or high technology. It also could be conducted in other developing countries.
- A study of success factors for integrating both the firms' successes of technological capability and economic performance can be conducted, particularly in the context of developing countries. This suggestion is made since in this study, the conceptual model for successful technology transfer has been found to be better in explaining the achievement of the firms' technological capability than the firms' economic performance.
- Future research can focus more in depth on independent variables which contribute

significantly to predicting the success in order to find out the detailed characteristics of each variable. For example, it might be more interesting to find out about planning which is done by firms in implementing the technology in terms of its duration, its contents, or its detailed level.

- Future research can be conducted by using different methodological approaches for variable measurements due to the fact that this study proved that different set of independent variables are relevant for different success criteria. For instance, production growth can be used to measure the success due to the fact that some firms still have difficulties to achieve their production target.

- A study on the role of mechanisms of technology transfer to the success of technology transfer project could be conducted. This suggestion is made since the operating of mechanisms of technology transfer is not entirely follow the written-agreements but the relationship between supplier and recipient, for example, influence the extent of technology transferred.

- Management capabilities and the relationship between supplier and recipient of technology are variables which are suggested to be examined further in achieving the success of technology transfer. This is due to the fact that those variables seem important in achieving the success of technology transfer.

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APPENDIX A

Indonesian Government Regulation on Foreign Direct Investment

In Indonesia, the government still plays a predominant role as both a regulator and a participant in the economy. Recently, the Indonesian government has actively improved previous policies on foreign investment through reform which has been implemented from 1985 to June 1993. This policy is continuously scrutinised since Indonesia still needs foreign investment to help expand its economic base. An expanded economic base should provide many opportunities for investment in manufacturing, consulting, capital equipment and transfer of technology (Davidson 1987). In this section, the recent policies on foreign direct investment (FDI) and investment performance are described briefly.

First, the several recent policies on foreign direct investment (FDI) in Indonesia (National Development Information Office Republic of Indonesia, Sept. 1993) can be summarized as follows:

- (i) allow wider access for foreign investors such as the relaxation of the limit on foreign ownership of projects and the permission of foreign interests to invest in joint ventures for exporting Indonesian products,
- (ii) eliminate obstacles and reduce hidden costs so as to simplify and speed-up investment procedures, including those related to the hiring of expatriate workers, to improve protection of intellectual property rights, and to develop a simple Negative

Investment List, which itemizes sectors that are closed for foreign and domestic investment, and

- (iii) provide investment incentives such as the drawback of import duties and surcharges if those goods and materials are incorporated into products and subsequently exported, exemption of import duty and surcharges on raw materials and intermediate goods utilized in production of the export product.**

In terms of the proportion of Indonesian personnel in foreign companies, Table 21, quoted from Derodjatun Kuntjoro-Jakti *et al.* (1989 p. 49), clarifies these guidelines, which stipulate what percentage of personnel foreign companies must be Indonesian. A time limit is recommended.

In terms of Cooperation Agreements, as quoted from Davidson Paul J (1987), a foreign company, subject to various government approvals, may cooperate with an Indonesian company by way of the following three types of agreement:

- 1. Technical Assistance Agreement: the foreign company's function is limited to providing purely technical assistance to the Indonesian company;**
- 2. Management Agreement: the foreign company's role is to manage the Indonesian company or part thereof;**
- 3. Management Agreement coupled with a Financial Agreement.**

Table 21

**Guidelines for Indonesianisation of the Managerial Personnel
of Foreign Companies Operating in Indonesia**

Type of personnel	The percentage of Indonesian from construction start-up		
	3 years %	5 years %	8 years %
unskilled labour	100	100	100
skilled labour	75	75	100
clerical	75	90	100
technical and supervisory	50	75	85
management, professional	50	75	85

Source: Dorodjatun Kuntjoro-Jakti *et al.*, "Japanese Investment in Indonesia", in Sueo Sekiguchi (eds), Asean Japan Relations Investment, Singapore, Iscas, 1989, p.49.

Second, investment performance in Indonesia is shown in Table 22. According to BKPM (The Investment Coordinating Board), these judicious policy reforms have contributed to the boosting of foreign investment approvals, which increased the value of new annual foreign investment approval by nearly thirteen-fold, from US\$0.8 billion to \$10.3 billion (1986-1992). As a whole, since Indonesia has had a foreign investment law from 1967 to Dec 1, 92, the total value of foreign investment is 37.52% of the total investment (domestic and foreign). However, there is no data for technology mastery development.

Table 22: Investment Performance**The Ten Leading Foreign Investing Countries in Indonesia**

Country	Investment Value (US\$ Mln)	%	Country	Investment Value (US\$ Mln)	%
Japan	13,068.4	20.7	UK	2,453.5	3.9
Hongkong	5,237.8	8.3	Netherland	2,255.7	3.6
Taiwan	3,936.0	6.2	Singapore	2,059.3	3.3
South Korea	2,964.5	4.7	Germany	1,865.3	3.0
USA	2,716.4	4.3	Australia	1,275.0	2.0

Source: BKPM (The Investment Coordinating Board) 1992

In summary, the Indonesian government tries to provide a conducive environment to attract foreign investors while still increasing the local technological capability. However, the effect of government policy in achieving technological mastery remains under-researched.

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May 30, 1994

Dear Sir/Madam

At the School of Business, Carleton University in Ottawa, Canada, one of the chief areas of research is technology management. As part of this research thrust, one of my graduate students, Lasdini Purwanti, is conducting research on success factors of international technology transfer. This project requires investigations of the factors that affect the success of technology transfer in manufacturing firms. The basic research question concerns to what extent the factors influence the success of technology transfer and how manager measures the success. All information obtained will be treated as confidential. Neither the names of those respondents nor the companies they represent will appear in the final document. A copy of the research report will be made available, if desired.

If you would have the time to share your experience in the field with Ms. Lasdini, it would greatly help the project. We at the School encourage our students to relate the knowledge gained in their formal courses to immediate business situations. This, of course, relies on the cooperation of those in the corporate sectors. Thank you in advance for your help.

If you have any questions about this research project or about the School's program, please do not hesitate to get in touch with me. Phone: 1-(613) 788-4463.

Sincerely,

**Uma Kumar, Ph.D.
Director, Research Centre for
Technology Management**

APPENDIX C

The Success Factors of Technology Transfer in Indonesian Manufacturing Industry.

Before you answer this questionnaire, I would like to explain several terms used in this questionnaire.

- 1. Technology** is defined as knowledge and methods, which includes technical and commercial information, highly trained workforces, and physical assets.
- 2. Technology Transfer** is the acquisition, development, and utilization of imported technology - which did not previously exist in your firm - by your firm.
- 3. The mechanism of technology transfer** is how the technology delivered from the technology supplier to your firm.
- 4. Your technology transfer project** is one of your project on a specific recent technology transfer, which has most influenced your production.

Background Company Information

1. Company name: _____
2. Address: _____ City _____
3. Position of interviewee: _____
4. Type of Industry:

- a. What is your field of business?

Please circle the appropriate number.

1. Garment
2. Fabric
3. Other textile
4. Electronic
5. Footwear
6. Other _____

- b. When did your firm begin this business ? _____

Please answer the following questions for a specific recent of your technology transfer project.

5. When did you begin this technology transfer project? (signing of the contract):

6. a. What is your technology supplier's field of business?

Please circle the appropriate number.

1. Garment
2. Fabric
3. Other textile
4. Electronic
5. Footwear
6. Other _____

- b. Since how long has your technology supplier been in this business (estimate)?

_____ years

7. Home country of your technology's supplier. _____
8. How many meeting with the technology supplier did you have after signing the contract
_____ times
9. How long was this regular meeting with your supplier still continued ?
_____ months
10. What type of technology transfer mechanism did your firm have: (Please circle the one which has most influenced your production)
- a. Turnkey operations (the direct purchase of equipment and a fully functioning plant),
 - b. Licensing (technical assistance, process/product design, and process/product know-how), and
 - c. A joint venture (two or more parties share equity where each of which holds at least five per cent of the equity).

Please answer the following questions at time in the year before the technology transfer project took place.

11. Number of employees _____
12. Sales (in million) Rp. _____
13. The average of your total export as a percentage of annual total sales
_____ %
14. a. Does your firm equity consist of foreign ownership?
Yes _____ No _____
If NO go to question no. 15
- b. Foreign ownership equity _____ %

15. R&D spending as percentage of annual sales _____ %

Success of Technology Transfer

16. How did you measure the success of this project ?

17. How satisfied has your firm been with the overall achievement of this project? (circle the appropriate number)

**Completely
Satisfied**

**Not satisfied
at all**

5

4

3

2

1

Please indicate the level which your firm has been mastering this transferred technology. Rate each of the statements on a scale of 5 (very high) to 1 (very low). Circle the appropriate number).

**Very
High**

**Very
Low**

18. Mastering of operating the technology	5	4	3	2	1
19. Mastering of maintaining the technology	5	4	3	2	1
20. Mastering of repairing when breakdown occurs	5	4	3	2	1
21. Mastering of modifying technologies already transferred (e.g. product modification, system adaptation)	5	4	3	2	1

	Very High				Very Low
22. Mastering in maintaining product quality	5	4	3	2	1
23. Mastering of developing of new design (e.g. product, process)	5	4	3	2	1

Economic Performance:

	Technology transfer project	
	Before	After
24. The average annual sales growth rate:	_____ %	_____ %
25. The average annual profitability growth rate:	_____ %	_____ %

How did this transferred technology affect each of the following aspects ? (Circle the appropriate number).

	Improved		No Change	Declined	
26. Labour productivity	5	4	3	2	1
27. Capacity utilization	5	4	3	2	1
28. Product quality	5	4	3	2	1
29. Material efficiency	5	4	3	2	1

Human Resources

Availability of engineers and technical personnel in your firm:

30. The number of foreign engineers from the supplier's firm: _____

31. The number of Indonesian engineers from the supplier's firm: _____

32. The number of Indonesian engineers in your employment: _____
33. The number of foreign technical personnel from the supplier's firm
(excluding engineers): _____
34. The number of Indonesian technical personnel from the supplier's firm
(excluding engineers): _____
35. The number of Indonesian technical personnel in your employment
(excluding engineers): _____

Training

36. Did your firm conduct formal training to implement this project ?

Yes ____ No ____

If you did NOT conduct formal training then please skip question no. 37 and proceed to question number 38.

37. The average duration of the training program per employee before the transfer took place
_____ (days)

(Now skip question no. 38)

38. Your firm did NOT conduct a formal training to implement this project.

Why?

Planning and Control

Please indicate the degree to which your firm planned this project.

39. Firm had a

- a. systematic and detailed plan of technology acquisition
- b. systematic but limited plan of technology acquisition
- c. no formal plan of technology acquisition

Please indicate the extent of your planning of technology acquisition by answering the following statements. (Circle the appropriate number).

	Very Detailed			Very General	
40. Set standards to measure the success of the transfer project	5	4	3	2	1
41. Provided an awareness program of technological change	5	4	3	2	1
42. Prepared environment to implement the technology transferred	5	4	3	2	1

Please indicate the reports of the degree to which progress of the technology transferred was being made.

43. Firm had a

- a. formal report and detailed measures of the progress
- b. formal report but limited measures of the progress
- c. informal reports

Please indicate the extent of your control of technology acquisition by answering the following statements. (circle the appropriate number).

	Very Detailed			Very General	
44. Determined cause of significant deviations from planned performance	5	4	3	2	1
45. Determine the possible ways to act upon significant deviations from planned performance	5	4	3	2	1
46. Taken corrective actions to an unfavourable trend	5	4	3	2	1

Top management support

Please indicate the extent of your top management involvement during the implementation of technology transferred.

	Very Strong			Very Weak	
47. Encouraged cooperation among the various functions involved in the transfer project	5	4	3	2	1
48. Provided sufficient resources (e.g. money, information)	5	4	3	2	1
49. Encouraged employee participation in setting procedures for routine operations	5	4	3	2	1
50. Explained to personnel the benefits of the project in achieving the company's goals	5	4	3	2	1

Government role

Please indicate the extent to which the following aspects played a role in the successful transfer of the technology.

	Very High			Very Low	
51. The government regulation to relax the limit of the foreign equity	5	4	3	2	1
52. The government regulation to maximize the proportion of the number of Indonesian managers	5	4	3	2	1
53. The government regulation on the "Negative List of Investment" for allowing more investors to enter these businesses	5	4	3	2	1

The Nature of Technology

The age of technology

54. How old was the technology when you transferred it ?
(estimate)

_____ years

The complexity of technology

Please indicate your perceptions for the following aspects which relate to implement the technology transferred. Rate each of statement on a scale of 5 (strongly agree) to 1 (strongly disagree) (Please circle the appropriate number)

	Strongly Agree			Strongly Disagree	
55. The technology was very easy to use	5	4	3	2	1

	Strongly Agree			Strongly Disagree	
56. The technology was very easy to understand	5	4	3	2	1
57. Not much new technology knowledge was needed to implement the technology	5	4	3	2	1

Thank you for your cooperation.

APPENDIX D**Faktor-faktor Keberhasilan Alih Teknologi
pada Industri Manufaktur di Indonesia**

Sebelum anda menjawab angket ini, saya ingin menjelaskan beberapa istilah yang digunakan dalam angket ini.

1. **Teknologi** didefinisikan sebagai pengetahuan dan metoda, yang meliputi informasi teknis dan komersial, tenaga ahli, dan aset fisik.
2. **Alih Teknologi** adalah penguasaan, pengembangan, dan pemanfaatan teknologi impor (yang sebelumnya tidak ada di perusahaan anda) oleh perusahaan anda.
3. **Mekanisme Alih Teknologi** adalah bagaimana teknologi dialihkan dari pemasok teknologi ke perusahaan anda.
4. **Proyek Alih Teknologi Anda** adalah salah satu dari proyek- proyek anda tentang alih teknologi yang spesifik, dan paling berpengaruh terhadap produksi perusahaan anda.

Latar Belakang Perusahaan

1. Nama perusahaan : _____
2. Alamat : _____
Kota : _____
3. Jabatan anda : _____
4. Jenis industri :
 - a. Apa bidang usaha perusahaan anda ?
Lingkarilah nomor yang sesuai :
 1. Pakaian jadi
 2. Tekstil
 3. Tekstil lainnya
 4. Elektronik
 5. Sepatu
 6. Lainnya _____
 - b. Kapan perusahaan anda memulai usaha ini ? _____

Jawablah pertanyaan-pertanyaan berikut yang berkaitan dengan proyek alih teknologi anda yang spesifik dan terakhir dilaksanakan.

5. Kapan anda memulai proyek alih teknologi ini (kapan kontrak tersebut ditanda tangani)?

6. a. Apa bidang usaha perusahaan pemasok teknologi anda ?
 1. Pakaian jadi
 2. Tekstil
 3. Tekstil lainnya
 4. Elektronik
 5. Sepatu
 6. Lainnya _____

b. Sudah berapa lama perusahaan pemasok teknologi anda berkecimpung dalam bidang usaha tersebut (taksiran)

_____ tahun

7. Negara asal pemasok teknologi anda ialah _____

8. Berapa kali perusahaan anda dan pemasok teknologi anda mengadakan pertemuan setelah kontrak ditanda tangani

_____ kali

9. Berapa lama pertemuan seperti tersebut di atas tetap berlangsung?

_____ bulan

10. Apa jenis mekanisme alih teknologi yang dimiliki perusahaan anda (lingkari salah satu jawaban di bawah ini yaitu yang paling berpengaruh terhadap produksi perusahaan anda) :

a. Turnkey operations (pembelian langsung alat-alat dan pabrik yang berfungsi penuh),

b. Pemberian Lisensi (bantuan teknis, desain proses/produk, pengetahuan tentang proses/produk), dan

c. Bagi modal/Joint ventures (pembentukan modal oleh dua pihak atau lebih yang masing-masing pihak memegang paling sedikit 5 persen dari modal).

Jawablah pertanyaan-pertanyaan berikut seputar keadaan perusahaan anda pada tahun sebelum proyek alih teknologi tersebut dilaksanakan.

11. Total jumlah pegawai _____

12. Nilai penjualan per-tahun (dalam jutaan) Rp. _____

13. Rata-rata persentase total ekspor terhadap total penjualan tahunan _____ %

14. a. Apakah sebagian saham perusahaan anda dimiliki oleh perusahaan asing ?

Tidak _____

Jika "tidak", langsung ke pertanyaan no. 15

b. Saham perusahaan asing _____ %

15. Persentase pengeluaran untuk Research and Development (LITBANG) terhadap penjualan tahunan _____ %

Keberhasilan Alih Teknologi

16. Bagaimana anda mengukur keberhasilan proyek ini ?

17. Se jauh mana perusahaan anda puas dengan keberhasilan dari proyek ini ? (lingkari nomor yang anda anggap tepat)

**Sangat
Memuaskan**

**Sangat tidak
Memuaskan**

5

4

3

2

1

Tunjukkanlah tingkat penguasaan perusahaan anda terhadap pengalihan teknologi tersebut selama ini. Berilah skala dari 5 (sangat tinggi) sampai 1 (sangat rendah). Lingkari nomor yang sesuai.

**Sangat
Tinggi**

**Sangat
Rendah**

18. Penguasaan dalam pengoperasian teknologi tersebut	5	4	3	2	1
19. Penguasaan dalam perawatan teknologi tersebut	5	4	3	2	1
20. Penguasaan reparasi jika terjadi kerusakan	5	4	3	2	1
21. Penguasaan memodifikasi teknologi yang telah dialihkan (misalnya modifikasi produk, penyesuaian sistem)	5	4	3	2	1

	Sangat Tinggi			Sangat Rendah	
22. Penguasaan menjaga mutu produk	5	4	3	2	1
23. Penguasaan dalam pengembangan desain baru (misalnya produk, proses)	5	4	3	2	1

Kinerja Ekonomi

Proyek Alih Teknologi Sebelum Sesudah

24. Rata-rata tingkat pertumbuhan penjualan pertahun _____ % _____ %

25. Rata-rata tingkat pertumbuhan keuntungan pertahun _____ % _____ %

Bagaimana pengaruh teknologi tersebut terhadap masing-masing aspek berikut ini? (Lingkari nomor yang sesuai).

	Meningkat		Tidak Berubah	Menurun	
26. Produktivitas pekerja	5	4	3	2	1
27. Pendayagunaan kapasitas produksi	5	4	3	2	1
28. Kualitas produk	5	4	3	2	1
29. Efisiensi pemakaian bahan baku	5	4	3	2	1

Sumber daya Manusia

Jumlah insinyur dan teknisi yang bekerja di perusahaan anda (sebelum dan sesudah alih teknologi)

30. Jumlah insinyur asing dari perusahaan pemasok teknologi _____
31. Jumlah insinyur Indonesia dari pemasok teknologi _____
32. Jumlah insinyur Indonesia yang anda pekerjakan _____
33. Jumlah teknisi asing dari perusahaan pemasok teknologi (tidak termasuk insinyur) _____
34. Jumlah teknisi Indonesia dari perusahaan pemasok teknologi (tidak termasuk insinyur) _____
35. Jumlah teknisi Indonesia yang anda pekerjakan (tidak termasuk insinyur) _____

Training

36. Apakah perusahaan anda mengadakan training resmi untuk melaksanakan proyek ini?

Ya _____ Tidak _____

Jika "Tidak", lewati pertanyaan no. 37 dan langsung jawab pertanyaan no. 38

37. Lama rata-rata program training per pekerja sebelum alih teknologi berlangsung _____ (hari)

Lewati pertanyaan nomor 38.

38. Perusahaan anda TIDAK mengadakan training resmi untuk melaksanakan proyek ini. Apa alasannya ?

Perencanaan dan Pengawasan

Tunjukkanlah sejauh mana perusahaan anda merencanakan proyek ini.

39. Perusahaan anda mempunyai suatu :

- a. perencanaan alih teknologi yang sistematis dan terinci
- b. perencanaan alih teknologi yang sistematis tapi tidak terinci
- c. tidak ada perencanaan formal untuk alih teknologi tersebut

Tunjukkanlah sejauh mana tingkat perencanaan anda terhadap pengalihan teknologi tersebut dengan menjawab pertanyaan- pertanyaan berikut ini (lingkari nomor yang sesuai).

	Sangat Terinci			Sangat Umum	
	5	4	3	2	1
40. Menetapkan standar untuk mengukur keberhasilan proyek alih teknologi tersebut					
41. Mengadakan program sadar akan adanya perubahan teknologi					
42. Menciptakan lingkungan untuk melaksanakan alih teknologi tersebut					

Sifat laporan yang dibuat oleh perusahaan anda untuk menunjukkan tingkat kemajuan penguasaan alih teknologi tersebut.

43. Perusahaan mempunyai suatu :

- a. laporan resmi yang terinci untuk mengukur tingkat penguasaan alih teknologi ini
- b. laporan resmi tetapi terbatas untuk mengukur tingkat penguasaan alih teknologi ini
- c. laporan informal

Tunjukkanlah tingkat pengawasan anda terhadap penguasaan alih teknologi ini dengan menjawab pertanyaan berikut ini. (Lingkari nomor yang sesuai).

	Sangat Terinci			Sangat Umum	
	5	4	3	2	1
44. Menentukan penyebab adanya penyimpangan antara hasil yang dicapai dengan yang direncanakan					
45. Menentukan alternatif tindakan untuk mengatasi penyimpangan dari perencanaan					
46. Mengambil tindakan untuk memperbaiki adanya kecenderungan terjadinya penyimpangan antara hasil yang dicapai dengan perencanaan					

Dukungan Manajemen Puncak

Tunjukkanlah tingkat keterlibatan manajemen puncak anda selama pelaksanaan alih teknologi ini.

	Sangat Kuat			Sangat Lemah	
	5	4	3	2	1
47. Mendorong kerja sama antar berbagai fungsi yang terkait dalam proyek alih teknologi ini					
48. Menyediakan sumber daya yang memadai (misalnya, biaya, informasi)					
49. Mendorong partisipasi pekerja dalam menyusun prosedur untuk operasi rutin					
50. Menjelaskan kepada pekerja tentang manfaat dari proyek ini dalam mencapai tujuan perusahaan					

Peran Pemerintah

Tunjukkanlah tingkat peranan aspek-aspek berikut dalam menunjang keberhasilan alih teknologi ini.

	Sangat Tinggi			Sangat Rendah	
	5	4	3	2	1
51. Peraturan pemerintah untuk melonggarkan batas pemilikan modal oleh perusahaan asing	5	4	3	2	1
52. Peraturan pemerintah untuk memaksimalkan proporsi jumlah manajer Indonesia di perusahaan-perusahaan asing	5	4	3	2	1
53. Peraturan Pemerintah untuk melonggarkan bidang usaha yang termasuk "Daftar Investasi Negatif" bagi pengusaha asing	5	4	3	2	1

Sifat Teknologi

Umur Teknologi

54. Berapa umur teknologi tersebut pada saat dialihkan ?
(kira-kira) _____ tahun

Kerumitan Teknologi

Bagaimana persepsi anda terhadap aspek-aspek berikut yang terkait dalam pelaksanaan proyek alih teknologi tersebut ? Beri skala dari 5 (sangat setuju) sampai 1 (sangat tidak setuju).

	Sangat Setuju			Sangat Tidak setuju	
	5	4	3	2	1
55. Teknologi tersebut sangat mudah digunakan	5	4	3	2	1
56. Teknologi tersebut sangat mudah dipahami	5	4	3	2	1
57. Tidak banyak pengetahuan baru yang diperlukan untuk menerapkan teknologi tersebut	5	4	3	2	1

Terima kasih atas kerjasama anda.

END

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