ACQUISITION AND MANAGEMENT OF TECHNOLOGY IN MALAYSIAN COMPANIES

MD. HAMZAH MD. KASSIM
Doctor of Philosophy

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SUMMARY

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This thesis is about the acquisition and diffusion of imported technology. Writers in the field of technology development in developing countries have always recognised that technical progress depends on the diffusion of imported technology and its applications to the provision of products and processes (Rosenberg, 1982). Despite the massive importation of technology by Malaysian companies, little effort has been made to study and understand the diffusion system in local companies. This study analyses: The problems associated with the acquisition of technology, highlighting the technology strategies adopted by the suppliers of technology; the diffusion pattern and key characteristics of the diffusion process; and major factors affecting the diffusion of technology. The policy implications are examined and the framework to manage the diffusion process within the enterprises is suggested. The findings indicated that the diffusion process is not one of passive acceptance but involves systematic efforts to acquire and diffuse the imported technology. A strong system of diffusion in companies had enabled a rapid diffusion of imported technology resulting in higher levels of technical capability. On the other hand, weakness in the company's diffusion system led to limited diffusion and slow technical progress. Characteristics of diffusion system are analysed and discussed extensively. The thesis attempts to develop the idea of "in-house system of diffusion" associated with the acquisition and development of imported technology. It argues for the development of a stronger theoretical framework on the diffusion and development of technology particularly in countries like Malaysia which relies extensively on the importation of foreign technology.

Acquisition; diffusion; management; transfer technology

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CHAPTER I

INTRODUCTION

1.1 INTRODUCTORY REMARKS

The main purpose of this study is to seek answers to the following vital questions concerning the acquisition and diffusion of technology in Malaysian companies.

(i) What are the costs and benefits of technology acquisition to Malaysian companies?

(ii) Is there a degree of association or relationship with regard to the level of technological capability in companies and their organizational and technology transfer characteristics?

(iii) What are the critical factors limiting and facilitating the diffusion of imported technology?

It is an attempt to substantiate generalisations about acquisition and diffusion of imported technology in Malaysian companies with a view of contributing to the development of a theoretical framework.

For many developing countries, including Malaysia, the issues of technological development are beginning to assume important dimensions. Nearly all developing countries are engaged in programmes of industrialisation of one kind or another. A high rate of industrialisation implies a need for technology. These developing countries are attempting to industrialise without the benefit of the long, more or less evolutionary process of technical change characteristic of mature industrial nations. The process of industrialisation depends critically on the success of acquiring the necessary technological capabilities.

The process of national industrial development can be reasonably identified with the process by which the nation keeps on accumulating technological capabilities. For instance, when a country creates a modern petroleum refinery, it is absorbing technology to operate the refinery. When the growth of this refinery motivates other industrialists to create power plants so that they can sell electricity to the refinery, the nation now adds to the technology needed to produce electricity to its national assets. The industrial development of a nation is a continual process. The direction and the speed of such development are influenced by the direction and the speed of a nation's endeavours to accumulate technological capability. Economic development means not so much the accumulation of foods and services as the basic capability to produce goods and services. Technology provides essentially that capability. In recent years there has been increasing concern about technology transfer. The Fifth Malaysian Plan Report which incorporates national development strategies has noted some of the issues relating to the development of technological capability viz:

> "The development of indigenous technological capability depends on the transfer of technology from abroad which are often imported at very high costs. Few of these technologies have been assimilated and improved upon because of the lack of technical expertise in this country to undertake such processes. In view of this, the Government will institute mechanisms necessary for the selection of technologies for industrial development, appropriate for the exploitation of the comparative advantage of the country. The Government will also consider the establishment of regulatory, administrative and technical instruments for effective

technology transfer and absorption while giving special emphasis towards the commercial exploitation of locally-generated technologies."

Developing indigenous technological capability has now been perceived as an important national objective so as to maximise the benefit of the transfer of technology. It has been recognised by various writers on technology transfer that one of the most important factors which has determined the success of the transfer of technology has been early emergence of an indigenous technological capability. As pointed out by Rosenberg (1982), in the absence of such capability, foreign technology has not usually flourished. Countries with successful experience in technology acquisition have come to realise that a minimum level of technological skill is required, not only to modify and adapt the foreign technology to local needs once it has been imported, but also to provide the basis of an intelligent selection of the wide range of potential suppliers. Intelligent choice of the alternative technologies available abroad presupposes a considerable amount of technical knowledge. Such knowledge is, in turn, difficult to acquire in the absence of any domestic experience. It has generally been acknowledged that creating indigenous technological capability is of vital importance to developing countries as part of the development process. It will accelerate the absorption of imported technology, improve the firms' bargaining power in the import of technology, increase their ability to make independent technological choices, enable them to improve upon chosen techniques and products and eventually generate new technological knowledge. The development of indigenous technological capability will ultimately speed up the absorption and assimilation of technology. For instance, as pointed by Ozawa (1974) the Japanese have continually stressed the growth of their own technological capabilities. Direct investment has been virtually excluded and the acquisition of advanced technology has been achieved through a policy which has relied heavily upon licensing agreements together with larger R & D efforts.

Unless there is concurrent development of indigenous technological skills and scientific capability, the country runs the risk of remaining in a permanent stage of dependence without acquiring its own know-how and skill of managing its own industrial operation. Clearly, the importation of technology from abroad and the building up of an internal technological system must be complementary to one another. An economy which lacks indigenous technological capability is most unlikely to make successful use of innovations developed far away and in response to a very different set of circumstances. Conversely, an economy which possesses or can acquire this capacity is in a position to draw upon more advanced technologies abroad in ways which can yield quite spectacular results.

1.2 THE IMPORTANCE OF THE STUDY

The research reported in this thesis was undertaken to examine this dominant issue and to test a number of premises. First, if a strategy of growth through industrialisation is to be pursued, developing countries like Malaysia must undergo rapid technological transformations which involve more than mere imports of technology. Such a strategy requires the acquired technology to be generalised within the recipient organization, resulting in the development of an indigenous technological base.

Second, the development of organizational capability in local firms is necessary to optimise the transfer process and to enhance the diffusion of technology that will ultimately lead to a higher level of technological development. Such capability enables local firms to plan and implement product process knowledge, undertake maintenance, with the possibility of creation of new technological knowledge.

Third, firms in developing countries need to view technology diffusion as a dynamic process critical for their survival and growth, and must be prepared to respond flexibly and imaginatively to new opportunities.

Despite considerable interest shown towards technological development in developing countries, little effort has been made to identify problems and issues of technology diffusion and development of technological capabilities.

Empirical data for the identification and definition of the exact shape of the problems arising from the transfer of technology are lacking. The failure to understand the major problems of technology transfer in Malaysian manufacturing industries will affect long-term industrial growth. Malaysia is now entering a new phase in economic development with the manufacturing sector earmarked to play a more dynamic role. The government has recognised the need to promote technological capability. As stated in the Fifth Malaysia Plan Report, 1986-1990 (Malaysia 1986):

> "The development of indigenous technological capability will be given high priority during the Fifth Plan period, particularly with regard to increasing the absorptive capabilities of the country. Measures to encourage the development of indigenous technological capability are expected to cover the development of research manpower improved institutional arrangement and incentives for R & D".

The literature on technology transfer abounds with policy-oriented studies which tend to discuss technology transfer issues in relation to industrial strategies, technology policy and planning, and other public policy issues. This project is believed to be the first attempt to study technology diffusion of imported technology at the level of the firm in Malaysia. It's findings will be of interest not only to Malaysia, but other countries which have pursued fairly open technology transfer policy. In Malaysia, such a liberal strategy has been partly influenced by the government's positive attitudes towards foreign investment. The government's role in technology transfer is limited to the approval of technical collaboration. Critical technological decisions are made by the firms with little governmental intervention. In such an environment the nature of the acquisition process, the recipient firms' characteristics are of major consequence to the diffusion and development of technology.

Interest in the field of technology transfer began with the growing role of multinational firms in developing countries. The main focus was the multinational firms: their strategies, motives, behaviour and impact on developing countries have been the subject of several studies (Fayerweather 1978). Growing concern about the role of multinationals and their impact on technological development in developing countries have led to a series of studies which explored in some detail the direct costs and estimated some of the indirect costs of technology transfer arrangements entered into by developing countries. These studies highlighted some of the restrictive clauses and inequities forced upon the recipient firms in many of these agreements (Vaitsos 1971). At the same time, there is also a growing awareness of the impact of multinational firms in the diffusion of technology and the development of indigenous technological capability. For instance, a UNIDO Report (1982) pointed out that the diffusion of technology to the host country was severely limited by the following factors:

(a) The predominance of assembly line type of operations and the lack of complex production processes and local research and development;

(b) The concentration of research and development within the head offices of the transnational corporations, strengthening the external control over the technology used; and

(c) The outward oriented enclave character of an export processing zone which prevents the transfer of technology through the establishment of a commercial relationship between companies in the zone with local firms outside it.

Increasingly, the role of multinational firms has come under close scrutiny and the issue of technology transfer has been related to issues of different dimensions, particularly multinational input on the development process. Another body of literature has addressed the development issues in less developed countries. Of significance is the theory of dependency, first articulated in the late 1950s through the development of the center-periphery model which divided the world into industrialised centers holding the majority of productive capabilities and periphery areas supplying the centers with raw materials. This model viewed growth in the center. This general dependency theory has taken various forms in the work of other economists and theorists. One version of this theory notes that the presence of foreign investment and imported technical skills often causes the local industrial sector to develop a bias against building up local technical capabilities with the result that a natural form of dependence arises. The significance of these theories is that they have altered the way in which foreign investment and importation of technology is viewed by policy makers.

This has led to the natural development of the screening approaches on technology transfer. Various developing countries have set up mechanisms to screen and register technology transfer arrangements. The adoption of screening approaches presupposes the formulation and articulation of national policies on technological and developmental criteria for deciding the type and the conditions under which technology may be imported. One important element of the screening approach is the growing realisation of the importance of the transfer process. Research in the field of technology policy and planning has been generated. Of interest is a study sponsored by the International Development Research Center (IDRC) on Science and Technology Policy Instrument (STPI) in developing countries. The IDRC study (Sagasti, 1978) raised questions on costs, benefits and impacts of various policies adopted by developing countries. The emergence of a new set of studies on the accumulation of technological capability in developing countries has provided new insights into issues related to technical development in developing countries (Dahlman and Westphal 1983, Fransman and King 1984). In following the development of these theories and approaches one notes a progression from highly politicised theory to a more practical approach of explaining technology transfer.

Thus, previous research has tended to focus on policy oriented issues without giving due attention to specific questions about how companies should effectively manage the acquisition of imported technology. The main thrust of this research reported here is to examine major issues that could offer practical suggestions in increasing the ability of companies to promote development of technological capabilities. The focus of the study is the firm. Actions within the firm, its internal characteristics, and strategies can affect the way technology is diffused.

1.3 RELEVANCE OF RESEARCH QUESTIONS:

The question stated above is meant to satisfy particular objectives. As the Malaysian government intensifies its industrial development efforts, the issues confronting the country is whether the massive inflow of technology as a result of rapid is whether the massive inflow of technology as a result of rapid industrialisation programmes has contributed to the countinuing development of a strong technological base in its own local companies. This study is concerned with diffusion and development of technology in firms which had imported technology from foreign technology suppliers. In studying diffusion of technology, one can evaluate at the micro or macro levels. At the micro level it concerns the diffusion of knowledge, skills and know-how among the personnel of the firms which had imported foreign technology. At the macro level it concerns the spread of technology from one firm to another. This is a micro level study of technology diffusion. The term "diffusion of technology" has been chosen instead of "transfer of technology" because it is more appropriate when viewed within the overall context of this research.

The term "transfer of technology" has been an important area debated in the literature. Interpretations differ, nor indeed is there any consensus on exactly what should be the focus of attention. Essentially in the present context one is concerned by which one firm acquires technological capability from another. The word "transfer" in the literature seems to embrace any form of transmittal of technology between institutions. As pointed by Dunning (1982), the term "transfer" suggests that the transferrer loses what is being transferred to the transferee. Dahlman & Westphal consider the term "transfer of technology" misleading to the extent that is suggests that technologies can be transferred wholesale and in working order. Capital goods can be transferred, but capital goods alone do not constitute a technology. They represent only that part of the technology which is embodied in hardware. The remainder comprises disembodied technological knowledge and related social arrangements - and although knowledge can be transferred, the ability to make effective use of it cannot be.

In this case, diffusion may be the more appropriate term as it covers the flow of technological knowledge within organisations which had acquired technology from another source. In defining "diffusion" the dictionary focuses on the 'spread' aspect of the acquisition process. Clearly in this case, the research is concerned with spread of knowledge among personnel of the companies acquiring the technology. Hence imported technoloogy is considered diffused when personnel in the recipient firms have acquired a high degree of technological capability.

The study of the pattern of technology diffusion in the companies is needed in order to achieve an appropriate perspective for the study; such as format will facilitate analysis of the data. Important pattern of technology diffusion based on some common set of criteria would assist evaluation and assessment of the significance variables incorporated in the research design.

The technology acquisition aspects are incorporated to provide an insight into the issues related to the sourcing of technology by firms in Malaysia. The data on these will describe, in part at least some of the dimensions of the technology acquisition process. These are set forth here in order to probe the extent, peculiarities and qualitative nature of problems encountered by Malaysian companies in the first stage of the technology development process.

The companies' technological, managerial and organizational characteristics are incorporated because there are many writers who place considerable emphasis on the internal characteristics of system of the firm as factors influencing the diffusion of technology. (Zaltman et al 1973, Hall, 1975).

The design of the research is based on the following approach:-

First, major issues relating to the acquisition of technology are examined. Since this study focusses on the diffusion of imported technology, an understanding of issues related to technology acquisition is necessary. The acquisition phase is crucial because it has long-term implications for the technical system of the firms. The presentation of the issues relating to technology acquisition is based both on a literature review and on the perceptions of executives interviewed in a sample of firms. Since the suppliers of technology are mostly multinational firms, it was necessary to locate the study within the context of a broad framework of multinational firms' influence.

The study of diffusion can be complicated because of inter-organisational relationships between firms of different nationalities, background, investment and technology strategies. Since many of the firms studied are joint venture companies, the strategy the foreign partners adopt towards overseas operations and the control they exert have wide implications on the development of the firm. Hence a major part of this and subsequent sections will trace how behaviour of foreign technology suppliers affects the diffusion of technology.

Second, having identified and discussed the major issues relating to technology acquisition, the relationship between selected variables and the pattern of diffusion is analysed. The variables are:-

(a) Ownership structure;
(b) Management control;
(c) Age of firm;
(d) Nationality of foreign partners in joint venture companies;
(e) Method of initial technological input;
(f) Structure of technical staffing; and
(g) types of technical collaboration.

Statistical analysis together with cross tabulation is employed to determine the relationship between these variables and the pattern of technology diffusion. Understanding how these variables interact with the diffusion pattern would enable firms to opt for alternative strategies to achieve the desired pattern of technology diffusion. National strategies to promote diffusion of technology also need to consider the impacts of the variables on the diffusion of technology. The methodology of establishing the pattern of diffusion will be explained in Chapter III on research methodology.

The third approach in this study examines management-related issues on technology diffusion. This is based on the perceptions of executives in the firms about the management issues that limit and promote the diffusion of technology. Issues pertaining to corporate strategy, top management planning and organisational capability may have significant influence on technology diffusion. The findings also provide practical suggestions about the management of technology transfer.

This study takes a holistic approach by linking technological organisational and managerial issues at firm level. This should provide an integrated and focussed policy viewpoint on emerging issues of technological development in a developing economy.

The end result is the development of a conceptual framework for analysing the diffusion of technology, and the identification and partial testing of a set of hypotheses that should be tested further in future research.

As mentioned at the beginning of this Chapter, the objective of the study is to undertake an overall assessment on the acquisition and diffusion of technology in Malaysian companies with a view of contributing to the development of a theoretical framework on technology development.

To realise the objectives, the study had to:-

(a) Examine major issues faced by Malaysian firms in successfully acquiring technology;

(b) Study the nature of diffusion of imported technology and identify critical factors affecting the development of technological capability;

(c) Examine issues related to the management of the firm which could facilitate or limit the diffusion of technology;

(d) Explore how the findings bear upon the role of national policies to promote the diffusion of technology; and

(e) Derive from the examination, a more effective approach to managing technological development at firm level.

1.4 STRUCTURE OF THE REPORT

This research is divided into 10 major sections:

Chapter 2 reviews the literature on the development and transfer of technology with particular reference to developing countries. It sets the variable perspectives for the empirical study. Chapter 3 describes the research methodology, and is dedicated to formal presentation of the hypothesis and framework to the empirical study. Chapter 4 reports the research findings. Chapter 6, 7 and 8 attempt to analyse and interpret the research findings in terms of the implications. Chapter 8 offers a number of recommendations in the way of policies and actions for those who seek to promote higher levels of technology diffusion. Chapters 9 suggest the framework for managing technology development at the firm level. The last chapter provides a summary of the study and present conclusions.

CHAPTER II

LITERATURE REVIEW

The purpose of this Chapter is to develop an operational definition technology; obtain a clear understanding of the significance of acquisition and development of technology; review the literature of theories of technology development; and to set down the theoretical basis for the empirical study on acquisition and management of technology.

One of the major sources of confusion regarding technology transfer comes from the wide spectrum of the meaning of the term "technology". According to UNCTAD (1972), the technology associated with industrial projects broadly consists of technology needed to appraise, design and construct the project; technology needed to operate the project and to market its output; and technology needed to keep the project from becoming obsolete because of world wide technical progress. More specifically, industrial projects need some or all of the following elements of technology:

(a) Feasibility studies, market surveys and other pre-investment services;

(b) Determination of the range of technologies and the choice of technology;

(c) Industrial processes;

(d) Engineering design and detailed engineering;

(e) Plant construction and installation;

(f) Training of technical and managerial personnel;

(g) Management and operation of production facilities;

(h) Marketing information;

(i) Improvements to processes and product designs.

As an essential factor of production, technology may be transferred in the following forms: "embodied" form in other factors of production, such as capital goods (machinery and equipment), skilled human labour (technicians, scientists, engineers, and managers and "disembodied" form as in information such as industrial property (patents and trademarks), unpatented trade secrets and know-how.

More specifically, UNIDO (1981) typified all technologies as follows:

(a) Equipment-based technology. The technology required to operate the plant is implicit in the equipment and is acquired with it. The raw material suppliers provide whatever additional technical information is required.

(b) Product-based technology. The key aspect of the technology is in the chemical composition or physical structure of the final product and not in the manufacturing process. Typically, a technician with experience in the industry in question, and with access to product technology and patent can design an adequate manufacturing process.

(c) Process-based technology. The final product and the equipment are well known and the proprietary value lies in the details of the process, such as materials balance, energy balance or a flow-sheet.

(d) Operations-based technology. Typically, these are the oldest and most developed technologies and represent a mixture of the other types of technology. As equipment-based technologies become more developed and generate a larger volume, they merge into operations-based technology.

Some authors have attempted to make distinctions between the various types of technology. Hall and Johnson (1978) stressed the distinction between "general technology", "system specific technology" and "firm specific" technology. General technology refers to information common to one industry and possessed by all firms in the industry; system specific technology is when a firm manufacturing an item acquires information that is peculiar to the item; firm specific technology is knowledge or skill which is unequal for any particular firm. Quinn (1968) distinguished between "proprietory" technology i.e. technology which is owned or controlled specifically by a particular institution and "non- proprietory" technology, which includes not only the results of new knowledge contained in the technical literature but also direct purchases of hardware services, technical service activities backing up these sales, demonstrations of modern management technologies and technical assistance to suppliers and customers, and observation and imitation of proprietory technologies.

A technology may be defined as a collection of physical processes which transforms input into outputs together with the social arrangement which structure the activities involved in carrying out these transformations (Brooks 1980). Thus technology may be thought of as the translation into practice of technological knowledge (Salter 1960). The exploitation of technological knowledge is central to the development process. Less developed countries like Malaysia typically obtain this knowledge from more advanced ones rather than creating it themselves. The international transfer of technology takes place when three conditions occur. First, decision makers in one country wish to use a certain technology; secondly, that technology is not available locally; thirdly, they believe it is cheaper for them to transfer the technology than to reproduce it locally. These three conditions explain the quite substantial amount of technology transfer between developed countries (Posner 1970).

For the purpose of this research the broadest possible definition has been adopted. In the context of this research technology encompasses all the activities related to the management of industrial operation ranging from feasibility studies, selection of technology, plant construction to the implementation of innovative efforts.

Technologies are made available to developing countries in a number of ways. Understanding the various channels of technologies acquisition will enable us to have a better appreciation of the transfer process. It is difficult to categories the mechanism by which technology is acquired because any transactions may involve many combinations of technological elements. Generally, technology can be acquired by firms in developing countries from various sources as follows:

(a) Books, journals and other published information;

(b) Movement of personnel from country to country;

(c) Education and training;

(d) Exchange of information and personnel through technical cooperation;

(e) Employment of foreign experts and consultancy arrangements;

(f) Import of equipment and machinery and related literature;

(g) Licence agreement for production process, use of trade marks and patents; and

(h) Direct foreign investment.

According to UNCTAD (1975), various elements of technology are being bought and sold in world markets in one or other of the above forms including machinery, equipment and intermediate goods; patents, inventor's certificates utility models, industrial designs and trade marks; know-how in the form of plans, design, models, instructions; and technical, managerial and marketing expertise.

Cooper and Hoffman (1978) classified the transfer mechanism into three broad categories:

(a) Simple direct-outright sales of embodied (machinery) or disembodied (specific consulting services);

(b) Processed-packaged sales of technology where a complete industrial process or plant is supplied together with various types of studies and design, commissioning, supervision and training services by machinery manufacturers, independent engineering firms or final manufacturers of products; and

(c) Project-packaged sales of technology where the technology is accompanied by other requirements for the commercial operation of a project such as management, capital, brand names and some element of control by the seller through licensing contract, joint ventures and wholly-owned foreign subsidiary.

It is important to recognise that at present, the main suppliers of technology to developing countries are the multinational corporations. According to Helleiner (1975):

> "..... multinational firms which are the major suppliers of technology, apart from direct investment in wholly owned subsidiary may enter into a joint venture, licence, sell input of equipment, negotiate management or marketing contract, erect plant on turnkey basis, provide training or various combination of all these".

International firms as argued by Baranson (1970) would prefer direct foreign investment to licensing if they have the resources and desires to control present and future market development particularly with products and techniques with longer life cycle. Multinational firms would opt for direct foreign investment if they feel that by giving away valuable information, their market position will be threatened. Another major reason stated by Baranson is the recipient firm lacks industrial experience and the transfer requires a prolonged and sustained relationship. Transfer of technology by foreign enterprise is also motivated by the need to protect export markets which are threatened by increasing trade barriers. Caves (1982) has argued that direct investment is often preferred because know-how cannot be always transferred independently of the firm and its management. Magee (1960) has also stressed the fact that firms opt for direct investments over other forms of gaining rent for their knowledge, skills or information, thereby ensuring full "appropriatability" of their investments in the production of technology. Though the literature on the subject is not lacking in arguments pointing out the indispensability of foreign direct investment in the transfer process, attention is increasingly being turned to possible alternative arrangements.

Recent literature on multinational corporations have also incorporated several location specific variables of the host country in an attempt to explain internationalisation of a firm (Dunning 1979). These are considered as "pull" factors which may attract foreign firms to a country; these factors may include trade barriers, low labour costs, availability of raw materials, market size and growth rate and host government policies. In the case of Japanese foreign investments, Ozawa (1982) has suggested that Japanese overseas investors were mainly small firms that were producing standardized products. Their primary motive was to gain access to relatively cheap labour and raw materials. On the basis of extensive research among Japanese international business firms, Yoshino (1977) reported a quite different pattern of motivations for Japanese foreign investments. He observed that whereas U.S. MNCs had been heavily concentrated in high technology industries and motor vehicles, much of Japanese investment had been in basic commodities, for example, nearly a quarter in textiles. The main impetus for the investment came from import substitution policies in LDCs, notably in Southeast Asia which threatened Japan's large export trade based on large-scale production and low costs. This pattern was dominant among the major Japanese trading companies which accounted for a considerable portion of foreign investment. Their strategy was to defend particular export markets and to become the major suppliers of intermediate materials or components, machinery, and equipment for the new plants overseas. Since the primary objective was simply to establish captive export customers, the trading companies had little interest in control and held less than 25 percent equity in two-thirds of their affiliates.

National governments are guided primarily by their own objectives and interests and their attitudes towards the same factors affecting the flow of technology vary from country to country. Policies on direct investment vary from country to country. There are "open door" policies where foreign investments are invited without due consideration of the consequences of technology transfer on development of local technological capability. Some countries have pursued a rather restrictive policy towards foreign investment where foreign investors are permitted in some and excluded in certain industries. Japan is an example of a country where technology is the most important consideration in approving foreign investment. such policies require detailed technological evaluation of investment proposal. The main objective is to minimize external technological dependence and develop local capability. Similar policies are followed in varying degrees in India and Korea. Some countries may have limited policy options due to circumstances beyond their control. For example, where the domestic market is small and growth is slow, the only way to get access to foreign technology is to encourage foreign investment through concessional terms. The structure of local industry and the availability of local technological capability are other critical considerations in determining policies towards foreign investment. There are certain industrial sectors where it is impossible to develop local production without accepting foreign investors. This could be due to the lack of local capability and the monopolistic nature of the technology.

The flow of technology from developed to developing countries has been a subject of intense discussion. Several writers have criticised the transfer of technology through direct foreign investment. Investment in the form of wholly-owned subsidiary will lead to the whole transfer being dominated by the parent company and the situation where choice of technologies, machine suppliers, plant contractors are decided by the parent company. Wionczek (1981) a well known authority on technology transfer in Latin American countries commented that multinational corporations usually insisted that all the subsequent stages in establishing a wholly-owned subsidiary whether in manufacturing or in other sectors must be tightly controlled by the parent because of the complexity in a developing country. Foreign direct investment constitutes an important method of technology transfer. Developing countries are beginning to face situation in which foreign control in their manufacturing sector is uniformly high. The impact of foreign ownership on diffusion has been widely discussed. Some critics argued this involved a heavy social cost because of the expatriation of profits. Writers like Francis Stewart (1981) pointed out that the packaging of technology restricts opportunities for local learning by doing. on the basis of extensive research, chiefly in the North Atlantic area Behrman presented an analysis of the sources of tensions between MNCs and host governments of industrialized nations. He dealt with two major sources of tension; those derived from MNC actions and those attributable to the home government. On the first he observed that the host government was caught in a 'love-hate' syndrome. It wanted the contributions to wealth and economic growth that the multinational enterprise could provide because they added to its power within the country, as well as internationally. At the same time it disliked and feared the resulting incursions on national sovereignty and technological dependence.

The key tensions stemming from MNC operations fall into three groups-industrial dominance, technological dependence, and disturbance of economic plans. The fear of industrial dominance by MNCs stemmed in part from the size of U.S. enterprises and their affiliates, in part from their concentration in a few key industry sectors, and in part from their aggressive behaviour. According to Behrman, the concern was that vital sectors of the economy would be dominated by MNCs responsive to interests other than those of the host nation. The second source of tension identified by Behrman, fear of technological dependence, is an extension of the fear of MNC dominance into an area of special national interest because of the great importance of technology for economic and security goals. Although host countries want the advanced technologies that come with direct investment by multinational enterprise, they do not always like the time and form of the transfers or the fact that the decision is up to the enterprise. They fear that their companies and economies will become dependent on the United States because of its control over the new technological advances. The third element, disturbance to economic plans, describes concerns of host governments in a broader context. Governments are assuming more responsibilities for the achievement of economic growth and social goals; and many of them consider that without planning, these goals cannot be realized. Consequently, the role accorded to private enterprise is changing, and acceptance by business of expanded responsibility on the part of the government is alterning the government business relationship. The entrance of the multinational enterprise has made it more difficult for host governments to work out this new relationship. These same responsibilities have made governments more nationalistic, for the national economy is all that they are able to control. The host country emphasis was on technology, skills, and ownership. While most often ownership goals were sought by requiring local equity participation, Robinson (1976) observed that if a government could induce a foreign firm to transfer the great part of its skills and technology, it might then weaken external control, thereby facilitating equity spin off and a more favorable division of equity. He concluded that several countries were pushing fairly rapidly toward effective control of the direct foreign investor, notably the Philippines, Malaysia, and Brazil, precisely because they seemed to be giving priority to skill and technology transfer and were willing to waive local ownership requirements if the technology transfer was sufficiently great.

In view of the problems associated with foreign direct investment via wholly-owned subsidiary, some developing countries are looking at alternative methods of technology acquisition such as licensing, turnkey plants and direct purchase of equipment which limits foreign ownership. Technical collaboration agreements encompasses a wide variety of contractual agreements between a foreign firm and a local firm. Technical collaboration agreements, which are devoid of foreign capital ownership and have the virtue of an apparent absence of control over operations, have held a great appeal in this respect.

Licensing is a contractual arrangement under which the licencee is granted certain rights to manufacture and sell products utilising inventions, process techniques and other industrial property rights of the licensor. Some agreements give the licensor equity in the joint venture with the licensee while others do not involve ownership. Equity participation may sometimes be given in payment for the technology, often in addition to royalties. In other cases, the licensor buys the equity in a separate transaction. Licence agreements may vary in the elements of technical knowledge they cover. Generally, know-how which is also known as unpatented proprietory knowledge or other forms of assistance may be provided to the licensees in the form of models, documented information and computer programmes. As pointed out by Farouk Contractor (1981) licensing to developing countries would include know-how and other form of technical assistance as these countries lack technological capabilities and industrial experience. According to him, know-how is often considered far more crucial a contribution than mere patent rights since the objective is to equip the licencee firm with the complete technological capabilities of the licensor. Two principal aspects are normally involved in a technological agreement, namely the payment formula for the licence, and the contents of the agreement which specify the obligations and the constraints on both parties. The coverage of the agreement may reflect the availability of technological and managerial skill in the recipient firm. The nature of technological collaboration may have strong influence on the pattern of technology diffusion.

Mytelka (1978) in a study based on an interview with 90 managers of firms in the metal working and chemical industries in Peru, Equador and Columbia found that licensing tended to inhibit technological self-reliance. Mytelka also found that firms with licensing arrangements also tended to purchase their machinery from the parent company or licensor and followed the recommendations of their licensor. In doing so they have given up the opportunity to select new machinery to be purchased which would have enabled them to know more about the technology and to select machinery more suitable to their environment.

As pointed by Stewart the mechanism of transfer in a particular case depends on the outcome of the willingness of the supplier of technology to supply the technology in a particular form and the desire and ability of the recipient to acquire in a particular form. Country variations in technology mechanism is partly a matter of national policy towards technology transfer and private overseas investment and partly of managerial and technological sophistication. Secondly the absorptive capacity of recipient firms is equally important.

Cooper and Sercovitch (1971) expressed the view that developing countries will depend on the indirect mechanism of technology transfer as long as they do not have the capacity to use technical knowledge. Thirdly national policies relating to industrial development can influence the nature of technology acquisition. A study by Mariluz Cortes (1978) on the transfer of petrochemical technology to less developed countries concluded that host country policies concerning foreign investment and transfer of technology are more important than product characteristics such as maturity and type of product in determining who supplies the technology and through which type of contractual agreement. He further stated that in the absence of foreign investment and technological constraints, local manufacturers usually sought equity participation with the suppliers of process know-how. In such an arrangements the returns to the foreign firm consist of both an agreed royalty payment and profits on their share of the equity. It is conceivable that the technical involvement of the foreign firms is relatively higher when they have a stake in the profitability of the operations.

Importance of developing technological capability

Most issues on technology transfer tend to address the problem of technology acquisition and it is only recently that the focus has changed to the development of technological capability. There is not a single focus, but rather a new set of directions. In general the new perspectives are concerned with the technology in a dynamic setting, with attention on how technological capability develop over time, whereas previously the major concern was the static question of cost and terms of technology transfer. The rapid industrial development achieved by new industrialising economies like Korea, Taiwan has generated much interest in the field of technological changes in developing economies. Increasing technological capability has been perceived as an important national objectives as to the transfer of technology. The concept of indigenous technological capability has important theoretical and practical implications.

Absorption of technology requires extensive indigenous technological effort, especially product and process adaptation. Indigenous effort of this nature has been found to facilitate the development of local mastery over imported technology (Rosenberg 1982). This process in which local staff participate in varying degrees may continue for some time after completion of the original transfer. In developing countries, technological innovation is viewed as an important learning process of gaining mastery over imported technology. It is also recognised that the viability of an economy and its capacity to respond to changing market circumstances will partly depend on the presence of a strong innovative skill in the economy. For a country with a strong export strategy, such as capacity plays a much more pervasive role in determining the success or failure of economic performance than many other factors.

During the past two hundred years technological innovations have been dominated by a handful of countries. A study by O.E.C.D. (1970) identified 110 significant innovations in the twentieth century. All emanated from developed countries with the U.S. responsible for 60%, the U.K. 14% and German firms 11%. As these figures indicate innovations are not evenly spread among developed countries, but largely concentrated on a very few countries. Only the U.S. and the U.K. are net creditors in terms of royalty payments. The U.S. accounted for nearly two thirds of the gross receipts of royalty payments among the major recipients in 1977; the main European countries accounted for nearly 30%, and Japan for 3%. These reflect the past history of technological domination by a few developed countries. But much of this domination remains. The developed countries are responsible for 97% of world research and development expenditure. (Annerstadt 1978) 6 nations employ nearly 70% of the world's research and development manpower and spend nearly 85% of R & D funds; only 6% of an estimated 3 1/2 million patents issued in 1972 were granted by developing countries, and less than one sixth of those issued by developing countries were owned by developing country nationals. (UNCTAD 1956b) with the exception of Brazil and India, developing countries import a high proportion of their capital goods (Stewart 1977); over 90% of LDC plant and machinery imports come from developed countries.

In recent years there has been some increase in the technological capacity of developing countries - an increase which, as is to be expected, has been unevenly spread among developing countries. This is indicated by rising expenditure on research and development and, by some evidence of incipient exports of technology by some countries (Lall, 1978). But while these developments are potentially significant, particularly in relation to policy, they are of relative insignificance in the general picture. The developed countries retain a massive preponderance in technological innovation which is a fundamental fact which must underly any discussion of technology transfer: it is this preponderance that is sometimes described as technological dependence.

The ability to make independent technological choices, to adapt and improve upon chosen techniques and products, and eventually to generate new technology endogenously are essential aspects of the process of development. The process may be described as the accumulation of technological capacity; it is at least as important to economic development as the accumulation of capital.

The accumulation of technological capacity is the outcome of a complex series of forces. One significant element is 'learning by doing'; another is an educational, infrastructural and institutional setting which both permits and encourages the learning process. Both aspects are crucial, although in the past policy has tended to overemphasize the institutional side, which is most obviously amenable to government policy, and underestimate the 'learning by doing' side. Weak links between an elaborate institutional structure and industrial and learning by doing activities have tended to 'marginalize' the activities of the scientific institutions. (Herrera 1976), Sagasti 1978).

According to Steward (1979) accumulation of technological capacity is not a simple, easily described activity. It cannot be measured in a straight forward way at either macro or micro levels. At a macro-level, redidual methods of measuring technical change, suggest the substantial significance of increases in productivity which are not explained by increases in inputs.

The relationship between technological transfer and creation of technological capability is rather complex and little is known about the process of accumulation of technological capability. Empirical study in this area is very limited although the world Bank is now carrying out some depth studies in several newly industrialised countries. However literature dealing with technological development in developing countries has generally acknowledged that creating indigenous technological capability is of vital importance to developing countries as part of the development process. (Dahlman and Westphal 1983, Rosemberg 1982). This will improve the developing countries' bargaining power in relation to the technology, increase their ability to make independent technological choices, enable them to improve on chosen techniques and products and eventually generate new technological knowledge. The development of indigenous technological capability will ultimately speed up the absorption and assimilation of technology. For instance, Ozawa (1974) pointed out the Japanese have continually stressed the growth of their own technological capabilities. Direct investment has been virtually excluded and the acquisition of advanced technology has been achieved through a policy which has relied heavily on licensing agreement together with a large R & D. According to Ozawa that Japan's remarkable success story seems to have been a result of the government strategy for introducing foreign technologies in ways that have emphasised their local linkages.

One of the objectives of promoting diffusion of imported technology in the firms is to increase the indigenous technological capacity at the enterprise level. The idea is to provide the enterprises with the necessary capacity to better understand the principle of the technology they are using to master its application, and to introduce modifications to make it more suitable for their specific operating conditions. Through the effective diffusion of the technology by enterprises, pressure can put on technology suppliers to force them to continuously improve their technology and quality of the services they provide. Further, the absorption of imported technology by enterprise requires the initiation of a learning process and this in turn means that technology will not be imported subsequently in an identical form when additional technology is acquired for further expansion. As a result, technology transfer will become more of a dynamic process as the capability gained in absorbing one technology enables greater involvement in subsequent transfers of relating technology. Therefore, the firm will be in position to reduce its payments for technology, to widen its sources, to make better choices, and to source for local suppliers for certain technological components.

As pointed earlier little empiricalworks have been conducted on issues relating to the development of technological capability. However various writers have advanced some broad concepts explaining the phenomena of technology development in developing countries.

Writers like Rosenberg (1982) have pointed out that the successful transplantation of technology involves the domestic capacity to alter, modify and adapt in a number of way, evident only to person with considerable technical expertise. A review of the recent growing literature on technical change and innovation in developing countries points to the fact that the emphasis is not so much on the type of innovation that is generated but on learning by doing experience and accumulating technological capability as a result of such effort. Innovation however, minor it seems to be, is perceived as an important element in the accumulation of technological capability. A study by Teitel (1977) on technical development in Latin American countries has identified several minor innovations such as stretching the capacity of existing plants through various adaptations, breaking bottlenecks in particular process within existing plants, improving the use of by-products, extending the life of equipment, adjusting to changes in raw materials and alterning the product mix. All these activities constitute technical problem-solving efforts that make use of technological knowledge of adapted technology. One important piece of empirical work lends support to the view that in developing countries formal and non formal R & D are increasingly important for minor improvement which can enhance the firm technological base. This is the work of Katz (1978) in Argentina. He set out to measure the contribution of technical progress to the growth of a large number of enterprises in several branches of the Argentine economy. From his preliminary interview, he has ascertained that many Argentine firms, whilst not making original radical innovations themselves nevertheless made many adaptions and improvements to the processes and products which they had acquired either from foreign parent companies or by imitation or licencing. His results showed conclusively that:

(a) the growth of enterprises was closely related to their technical progress; and

(b) their technical progress was strongly associated with performance of adaptive R & D and of specialised technical services.

According to Dahlman and Westphal, (1977) local technological efforts of this nature may lead to higher technological mastery. The researcher hopes to confirm through extensive case analysis whether such efforts facilitate the diffusion of technology. It is important to investigate whether capability gained in assimilating one technology enables greater indigenous participation in subsequent transfer of related technologies, thereby increasing the effectiveness with which they are assimilated including replication or adoption of foreign technologies as well as creation of technologies.

According to Lall (1982) developing countries normally experience three stages in their development of technological capability. When a new technology is imported two sorts of learning take place. These are simple learning by doing whereby workers become more efficient simply through experience and learning by adaptation. The next stage of learning occurs when some of the machinery is manufactured within the country. Lall distinguishes between learning by imitation where local engineers simply replicated foreign designs and blue-prints and learning by design where they progressed to understanding the underlying engineering and scientific principles. The final stage of learning of a technology is to graduate from the capability to produce a particular machine to being able to reproduce the whole technology. Dahlman's (1984) study on the Usiminas steel in Brazil suggests that successful local technological development depends on a relatively long-term strategy of building systematically on experience as it is acquired. One of the elements that stands out in this case study is the tremendous amount of learning that took place. Such learning included much more than cost reduction efforts. It also extended to the the selection, and evaluation of technology.

In spite of the massive flow of foreign technology, must developing countries have yet to develop a strong indigenous technological system. One of the major issues raised by several writers has been the lack of indigenous technological efforts to absorb the imported technology. The absence of local indigenous innovation as occurred in the developing countries is attributed to several factors. The multinationals have dominated the economics of developing countries but they usually performed their research in the advanced countries Ronstadt's (1977) research shows that foreign firms initially used technology transfer units to assist new production units in adapting to parent methods, but for latter ventures in LDC these units were unnecessary because the process technologies had been so standardised that new operations could be aided adequately by teams of experts undertaking existing operations in other countries.

Some authors argue that local firms function under monopolistic conditions and therefore in the absence of competition, are not motivated to carry out research to improve their products. The early production technology strategies of many foreign firms especially in developing countries as observed by Skinner (1968) were notably loose. A general tendency to transfer parent methods with little consideration of the nature of the foreign environment has led to lower productivity and higher costs than would have resulted from a careful consideration of alternative approaches. The general low standards of local production and high protection from external competition provided by governments anxious to develop local manufacturing have made it possible for firms to function profitably despite the inefficiency of inadequately planned technology strategies. Other critics claim that local firms are run by managers who lack scientific knowledge or expertise and therefore are not capable of utilizing it effectively in their operations.

Baranson's (1967) case analysis of the Cummins Engine Company which was involved in a joint venture operation with an Indian company is an example of the many problems associated with the transfer of technology. In his analysis, Baranson described in detail the problems of inadequate supplies, lack of technical skills, deficiencies of Indian management, the inefficiencies of small-scale operations, and the difficulties created by government planning. Kapoor (1966) made an intensive study on the experience of 53 Indian companies and 26 US and European firms with licensing collaboration. Kapoor concluded that although foreign collaboration had done much to help Indian Industrial development, the foreign firms had not contributed as much as they might have. The notable shortcoming was the lack of sufficient competence in the Indian firms to effectively absorb and adapt the technology made available. While Kapoor found that many firms criticsed the technicians, he also observed that those companies not technically qualified to make evaluations were the ones who were critizing. Those that were technically qualified to evaluate were generally satisfied.

Kidron (1965) in his study in India cites many cases where critical elements of knowledge and know-how were withheld in the interest of protecting the firm's bargaining assets and world market positions. Kidron concluded that the technical staffing policy pursued by many multinational firms is a key method of controlling dissemination of technology. He notes that most foreign firms have insisted on staffing certain key major technical posts with their own country personnel. Yoshino also (1971) noted that an increasing number of Japanese enterprises consider control so critical that in those cases where they cannot obtain at least majority ownership, they have insisted on an explicit agreement with the partner over certain key management decisions from the outset.

One of the major constraints to the transfer process is related to the control mechanism exercised by foreign technology suppliers. For example, Friedman and Kalmanoff (1961) observed that the interests of foreign collaborators were adequately protected even where the foreign holder has a minority stake in the equity structure of the joint venture, since the control over technical operations and financial assistance other than equity investment ensured that the venture is run to the satisfaction of the foreign partners without their exercising actual formal control. Multinational firms have begun to shift their strategy from "control by ownership" to "control without ownership". The willingness of foreign entities to forgo control depends mainly on their objectives in entering into technical collaboration agreements. If the financial returns accruing from the sale of knowledge are their only objective, they may not worry too much about control. But when their objective, include market protection, forestalling a rival, transfer pricing, and preventing leakage of their technologies, their desire to retain control may be important. The desire for control may also depend on the nature of the business. It would be higher in relatively technologically intensive industries.

Dilution of foreign ownership pursued by governments in developing countries has meant that the multinational firm has to consider other options of ensuring their control over foreign operations. The foreign firm may also be able to exercise control by restricting the actions of the local firms various studies on technology transfer agreements have noted the explicit restriction clauses that foreign firms stipulate under the agreements and their possible effects on the development of the local firms. Available evidence shows that other forms of restriction are also imposed on recipient firm which affects the growth and development of the firm. Most technical collaboration contracts are associated with several kinds of restrictive clauses particularly, those pertaining to the exports of the local firm, sources of components and materials, and production procedures. A study of the Andean Pact countries experience showed that of contracts examined 77% in Bolivia, 77% in Colombia, 75% in Equador and 89% in Peru restrictive clauses on export (Vaitsos 1971). Tied source of inputs was common among several firms covered in this study. Under this arrangement, the recipient firm was required to source its spare parts, components and raw materials from the technology supplier, giving rise to transfer pricing. If the technology imported under the agreement is vital to the firm's future operations, the control exercised by the foreign firm over the duration of the agreement may be deemed as a necessary short-term price that has to be paid. But more important are the possible long-term effects of such control. If the restrictions exercised by the foreign firms under the agreements perpetuate the local firms' dependence on them for supplies, limit their export market, and hinder the development of technological capability, they may prove detrimental to the long-run interests of the local firms.

The development of technological capability is slow if recipient firm do not formulate long range plan pertaining to the technical development of the firm. Croobell (1973) made a study in Canada and found that Canadian-owned firms tended to operate through the distortion of transitory arm's length relationships with foreign licensors and to overlook the development of in-house adaptive skills. It appeared that the firm remained dependent on the licensor for even minor changes in technology. Often the licensor would send skilled technicians to the Canadian firms to iron out problems. The development of in-house technological capability was slow in these circumstances. Managers had so little control over the speed and direction of the licensor's research that they were generally unable to formulate integrated long-range plans. The lack of technological efforts, poor management expertise low technical competency and inadequate planned technology strategy and strategic behaviour of multinational firms appears to be some of the important limitations to the rapid diffusion of technology.

The growing concern with the development of local technological capability, foreign domination of the economy, and cost and terms of technology transfer has led several developing countries to introduce regulations controlling the inflow of technology. Several factors influence the way foreign technology flows into the country. One of the most important is governmental policy towards foreign investment. In most developing countries, there already exist legal and policy framework concerning foreign investment viz:

(a) The registration and approval of foreign investment proposals;

(b) Legislation relating to ownership;

(c) Repatriation of profits and remittances of foreign currency;

(d) Fiscal and tariff treatment accorded to foreign investors; and

(e) Guarantees of various kinds that may be given to foreign investors.

The major reasons for refusal were deviations, as measured in international comparative terms, between the cost of the acquired technology and its market value, clauses for arbitration in foreign courts excessive duration of contractors and restrictive clauses in contracts with regard to exports, production, use of complementary technologies, purchase of raw materials and similar restrictive business practices. An analysis of the contracts which were rejected by the authorities shown evidence of the abuses that are rampant in technological agreements, especially the inclusion of the various restrictions as discussed above.

Government intervention in the transfer of technology has not been without problems. Balasubramanyam (1973) commented that in India the regulatory system has come under criticism for the delay involved in the processing of technical collaboration arrangements. The greatest delay occurs in reaching a decision on the royalty rates and technical fees to be paid. In Mexico, most of the rejected contracts were renegotiated and resubmitted for approval. Very few cases are known in which legislation caused the suspension of technology flows. More will be discussed on this matter in later chapters when we examine factors facilitating and constraining technological development are examined.

Despite the problems discussed above, technology transfer will continue between developing and industrialised countries. Some countries will regulate the inflow of technology preferring one mechanism over another in order to reduce foreign control over the economy and promote development of technological capability. Japan has often been quoted as a country that has successfully pursued a deliberate policy of regulating and controlling the inflow of technology to foster local technological capability. Korea has relied heavily on capital inflow in the form of debt not equity, and technology has been acquired largely through means other than foreign direct investment namely through arm's length transactions (Dhalman and Westphal 1983). On the technology supplier side, the decision to either select foreign direct investment or licensing is not only based on investives and regulations but several other factors such as the complexity of the product and the production techniques, the absorptive capacity of the recipient firm, resources and philosophy of the supplier firm.

CONCLUSION

Little theoretical work has been done on the diffusion and development of technology in developing countries; especially notable is the lack of theoretical contribution from technology policy researchers. This is a curious situation and merits some explanations. One explanation can be that researchers in developing countries did very little theoretical work on anything at all and innovation theories in the industrialised countries may not give much priority to this problem. The second explanation may be that many Governments assume that merely by promoting industrial development it would automatically give enough stimulus for diffusion and development of technology. The third possible explanation is the absence of adequate systems for evaluating technology development in national enterprises. The fourth explanation is perhaps that the economic and industrial strategies of some of these countries preclude more active analytical work on this problem. These or a combination of these factors may be contributory to the theoretical desert in this area of inquiry by researchers in the field of diffusion and development of imported technology.

Yet, many writers have acknowledge the very important role that transfer and development of technology has to play in the development of the industries. The role of the diffusion and development of technology in the process of economic growth can be conceived as that of a carrier or an agent of innovation and modernisation. Technology development is a strategic factor but it is only recently that results are beginning to emerge on the role of technology development in enhancing the industrial base of the developing country. Because of the forces involved, as discussed in the literature, which are not only economic but also social and even political, the Government has a major role to perform in fostering the growth of indigenous technological capability. While much has been done by the Malaysian Government to attract foreign investment into the country, the same cannot be said about the efforts to nurture and foster indigenous technology development. It is noteworthy as highlighted in the literature that while the impact of state intervention can be positive towards the development of indigenous capability, the forces of foreign investment on domestic industry seems to pull in a diametrical opposite direction. The major issue, therefore, is to what extent indigenous firms can survive in the face of multinational strategies and competition.

Studies on international transfer of technology have attracted interest from academic as well as international agencies for more than a decade. Particular attention has been given to issues related to the appropriateness of technology transfer, its cost and conditions and the impact of alternative arrangements. A fairly significant part of the literature on technology transfer deals with definition and is characterised by the proliferation of special terms which attempt to conceptualise and illuminate the process of technology transfer.

Writers have attempted to identify more specifically the "what" or "how" of technology or to classify the types of technology. Nowhere does the literature tackle directly the phenomenon of diffusion and development of imported technology at the micro level. This fact explains why the previous research are especially sparse with regard to the analysis of the nature of technology diffusion.

Indirectly, however, it is possible to find cues on technology development from the studies relating to international technology transfer and technology development. But they answer the question, "what is technology development?" rather than "why is there rapid technology development in one company as compared to another?" The literature is more helpful in explaining the process of technology transfer than the phenomenon of a firm's level diffusion and development of imported technology. Hence this research has stressed, on what are the factors determining the development of technological capabilities of companies acquiring foreign technology.

It was only recently that studies had been conducted to examine technology development in developing countries. Empirical studies at micro level is lacking. It is the intention of the study to examine some of the basic issues with regard to the technology development process in developing countries like Malaysia. The approach of the study group is to examine those issues relating to technology acquisition which can be considered as the first process of technology development.

The literature has discussed on the cost and terms of the various types of technology acquisition methods. However, much is needed to investigate some of the intricacies governing the relationship of recipient and supplying firms as a result of the acquisition process. On the determinance of technology diffusion at micro level, the literature has not provided much evidence on the subject.

The international findings by the World Bank Study Group, however, indicate the importance of technological efforts. Learning by doing is one of the few determinants of development of technological capability in developing countries. The importance of this research is to identify critical factors which will contribute more significantly as to the many factors which would act as a major determinant of technology development. In many developing countries, programmes are apparently needed to accelerate the diffusion of imported technology and to increase access to other sources of technology. Another single factor approach to indigenous technology development in a newly industrialised country is, however, likely to be ineffective. An integrated programme that works on a careful combination of factors simultaneously is much more likely to prove worthwhile; not better access to technology, not just restructuring ownership, not nationalisation but a carefully worked out strategy which is imaginatively executed. Hence the importance of understanding the various determinants of technology diffusion which is crucial in formulating a broad strategy for technology development. In this sense, the literature has yet to provide a broad framework explaining the various determinants of technology development in developing countries. The purpose of this study is to develop a theoritical framework that could explain the success or lack of success of Malaysian companies with regard to the diffusion and development of technology.

In order to appreciate the complex dimensions of the problems involved in technology development, the researcher has developed a simple model in Chapter III which explains the primary factors and variables which affect the diffusion and acquisition of technology in Malaysian companies. The model also emphasises the need to continuously effect the numerous variables indicated so as to be able to comprehend and understand the major forces, as they affect the supply, acquisition and development of technology.

SUMMARY

In this Chapter, the researcher has developed operational definition of technology with regard to significance of technology development generally as well as with specific reference to Malaysian, and review the literature on theories of technology development. It is observed, as studied in the Chapter, that generally speaking, recent theories on technology development appear to provide grounds for considerable optimism regarding the possibility of increasing the high level of technology development in developing countries.

CHAPTER III

RESEARCH METHODOLOGY

3.1 FRAMEWORK OF THE STUDY AND HYPOTHESIS

The problem of diffusion and development of imported technology is investigated by examining the issues related to acquisition and development of technological capability in Malaysian enterprises. As explained in the previous chapters Malaysian companies set up their manufacturing facilities by importing foreign technology. The process of developing a firm's industrial and technological system can be reasonably identified with the process by which a firm keeps on accumulating technological capability. Unless there is concurrent development of indigenous technological skills and capability, the firm runs the risk of remaining in a permanent state of dependence without acquiring its own know-how and skills of managing its own industrial operations. Hence, importation of technology from abroad and the building up of an internal technological system must be complementary with one another.

3.1.1 *Acquisition of technology*

The first aspect of the study incorporates the areas of technology acquisition. There are various sources from which companies can acquire foreign technology ranging from multinational companies to consultants who have no interest in directly owning and running manufacturing enterprises and smaller firms which may license the technology. Understanding technology acquisition is crucial in building a proper framework of technology development at the enterprise level. The researcher is of the view that a simple evaluation and assessment of the issues relating to technology acquisition is beneficial because it helps to focus on the problems which are in essence internal and in large measure within the control of the firm. Of course, failure and lack of success in acquiring technology may be attributed to external factors such as the technology market over which the individual firm may have little control. The peculiarities of the technology market are not subject to the control of the individual firms. These peculiarities of the technology market derive from the fact that it deals with knowledge, which once produced, costs little at the margin to sell, yet can be very expensive to produce and commercialise, and mostly because of this, it is extremely concentrated in its ownership.

In this study, the researcher will be looking at some of the contributions made by the technology suppliers in building the manufacturing base of Malaysian companies. To obtain an initial clue the researcher sought the views of the senior technical executives regarding the benefits and costs associated with acquiring foreign technologies. The respondents were asked to give an overall evaluation of their experiences regarding technology acquisition.

The executives were asked to rank the importance of five kinds of contributions made by their technology suppliers. Each factor was ranked on a descending scale from 6 (extremely important) to 0 (not important at all). Similarly, the executives were asked to rank the relative importance of the four possible areas of conflict. Initial pilot studies conducted on selected companies had enabled the researcher to identity the general assessments of executives on contributions by technology suppliers and the main areas of conflicts encountered in the acquisition process. In a developing country, the foreign companies play a major role in providing advanced managerial and organizational skills as well as a high level of production and technical skills. There are several benefits of sourcing technology through foreign direct investment. The benefits arise from the fact that multinationals are the main producers and in many cases, the suppliers of technology to developing countries. Direct investment may prove the best and most efficient way of getting access to the latest technology as in such cases, the manufacturers are able to provide a whole package successful commercial application of technology. They would be able to transfer the most advanced techniques from the developing countries, including high level managers from abroad, and would even be able to attract the best talents locally by offering relatively high salaries. Their technological and engineering capabilities, together with highly developed skills would give local joint venture companies a marked edge in industries requiring such skills. In Malaysia, their managerial advantage shows up in terms of better remuneration for high level executives and better pay for their employees in general. These are the areas that the researcher sought to investigate with regard to the contribution of technology suppliers in the manufacturing industries in Malaysia. Yoshino (1976) demonstrated the types of contributions of local partners associated with joint venture companies as listed below:

General knowledge of local environment;
Government relations;
General management;
Labour relations; and
Access to local market.

However in the study the researcher will be assessing the contributions of foreign technology suppliers as perceived by local partners and executives. While the foreign technology suppliers have played a major role in providing managerial and technological input, they also pose serious problems to the development of local expertise. One major concern about through foreign direct investment continues to be the effect that it may have on the development of local technological capabilities. Even if it is admitted that foreign technology suppliers transfer the best production technology, they do not transfer the capability to generate new technology to companies in the Third World. According to Lall (1981) foreign firms transfer know-how (production engineering) and not know-why (basic design, research and development). Local firms cannot rely on a continuous flow of basic design knowledge from a foreign parent company. The comparative advantage of being transnational rests to a large extent on centralising activities like R & D which enjoy tremendous economies of scale and which have vital linkages with sophisticated scientific infrastructure of the developed countries. Thus there is a strong possibility that foreign firms would source their technical resources from their foreign parent company. Thus, a conscious strategy by local firms to develop technological autonomy over time may conflict with the R & D strategy adopted by foreign firms. There are various areas of conflict encountered by local firms with their foreign counterparts among them issues related to transfer pricing and technical collaboration. According to Yoshino (1977) there are various areas of conflicts associated with technology acquisition in to joint venture companies. He listed the main areas of conflicts as follows:

<u>Areas of conflicts</u>

Transfer price

Disposition of earnings

Marketing

Selection of products

Quality of products

Pricing of outputs.

Lall and Streeten's (1977) comments on transfer pricing are relevance, "There are external factors which may cause a firm to use transfer prices to move profits out of the host country. Actual transfer pricing policies may be effected not only by those, but also by constraints which are set by external (Tax and Customs Authorities) and internal (the need to monitor and control such factors). Firms made a great deal of the fact that because of external checks, they are unable to manipulate transfer prices and this is certainly true with growing awareness of the problems. Several Governments have tightened regulations for regulating intra-firm transactions. Transfer pricing has been one of the most sensitive areas and will continue to be so as long as firms' specific products are traded across the country. Many of the commodities exchanged in intra-firm trade are mostly goods which are specific to the firm. Hence the prices charged for those products do not have market prices. In most cases, conflicts arise between local partners and foreign partners as to what should be the fair price for those products transacted on an intra-firm basis. Another area of conflict is includes the conditions attached to the technology transfer arrangement. Some of these conditions may restrict the freedom of the recipient firms to buy and sell commodities related to the technology transfer, and may sometimes stipulate how the benefits of future technological advances by the licencee are to be exploited, how contracts are to be terminated and where the disputes are to be arbitrated. A study of the Andean Pact countries' experiences showed that of the contracts examined, 77% in Bolivia, in Colombia, 75% in Equador and 89% in Peru, restrictive clauses on export are generally common (Vaitsos, 1971). Different sources of input were common among several firms covered in the study. Under this arrangement, the recipient firm was required to source its spare parts, components and raw materials from the technology suppliers giving rise to transfer price. Similar restrictions are also common in contractual arrangements in Malaysia. It is posited that many of the problems have important implications with regard to acquisition of technology. It is true that some of these problems are also caused by the lack of understanding by local firms with regard to the intricacies of technology transactions. According to UNCTAD (1972) local companies in developing countries failed to understand the complexities of technology transactions, thus leading to poor management of the transfer process.

3.1.2 *Development of technological capability*

Another major component of the study is to examine the development of technological capability. The study attempts to test the determinants of technological capability in Malaysian companies as measured by the degree of indigenous capabilities developed among local personnel. The dependent variable in this analysis is the extent of indigenous technological capability classified into three broad components which will be discussed in 3.1.5.

It is commonly felt that technology capability can be gained through the effective diffusion of imported technology. The effective diffusion will ultimately speed up the development of technology in local companies. For example, Japan's technological achievements seem to have been the result of the Government's success in introducing the strategy of acquiring foreign technologies in ways which emphasise their effective diffusion, that is, through policies which rely heavily on licensing agreements usually coupled with large investments in R & D (Ozawa 1974). During the diffusion stage, firms will provide training programmes and utilise other formal and informal methods to transplant some technical capability into the work force. The development of technological capability will enable the recipient companies to make independent technological choices to adopt and improve upon chosen techniques and products, and eventually, to generate new technologies endogenously. The purpose of this part of the study is to identify factors that may have an important influence on the development of technological capability. As will be discussed later, technological capability refers to the ability to search, implement product process knowledge, undertake product process motivation and plant construction and develop new technological knowledge. Hence, imported technology is considered diffused when it has been implemented in the recipient work force in such a way that the work force can tentatively undertake all the activities related to industrial operations on its own.

Studies on the determinants of technological capability are still in the infancy stage. In his study on technological capability in India, Lall (1985) examines seven broad variables related to technological efforts, foreign ownership, skills, product differentiation, scale of economies, capital intensity and profitability. For the purpose of this study, the researcher has selected seven key variables which may influence the development of indigenous technological capability. The variables are related to company and technology transfer characteristics. The variables are selected on the basis of the limited studies carried out in related areas of technology transfer and multinational business. Given the lack of knowledge on the precise relationship between technological capability and other variables relating to organizational and transfer characteristics it would be worthwhile to undertake such an attempt on a limited scale.

3.1.2.1 *Variables*

3.1.2.1.1 *Ownership*

One major question in this research is whether ownership has any influence on the development of technology capability. A study by Lall (1985) in India indicates that ownership has a weak link with development of technological capability in Indian firms. Another study by Langdon (1984) on the development of textile and wood product companies in Kenya suggests that ownership has a strong influence on the development of technological capability. Evidence is mixed with regard to the role of ownership in the development of technological capability in developing countries. It should be pointed out that ownership has been selected as a variable for the study because of the importance of foreign ownership in developing countries. One major question is whether foreign ownership would be an effective vehicle for inculcating interest in promoting a higher level of technological capability. It has been pointed out by Yoshiro (1977) that the main strategy of most foreign partners, particularly in joint venture companies, is to promote the investments of their parent companies. Therefore, it is likely that foreign firms would maximise the purchase of raw materials, components and technology from their parent companies. Ownership control, therefore, is important for companies which have integrated their operation with those of their parent companies. In these instances, they would depend highly on the technological resources of their foreign parent companies. Foreign-owned firms would not want to see new local competitors created and therefore would be very much protective with regard to the leakage of their technology. Hence they would prefer to undertake most of the technological efforts in their foreign parent company. According to Yoshiro (1977) the protection of technology is one of the reasons why Japanese firms prefer to have ownership control in joint venture companies. With regard to wholly-owned local companies it is suggested that local entrepreneurs would have stronger personal motivation to promote technology development in their companies. Since many of them had sourced technology through technology trade or contractual arrangements they would have to develop their own internal capability to implement the technological efforts. Unlike mixed ownership companies which could rely on their foreign partners for technological input wholly owned local companies would have to undertake much stronger initiatives in developing their own internal expertise. The presumption is that as local firms, they would be more susceptible to Government influence than mixed ownership companies in promoting indigenous technological development. It is posited that ownership would be a strong influence on the development of technological capability.

3.1.2.1.2 *Management control*

Control refers to the power of determining the broad policies governing the operation. This power is exercised at two levels, strategic and operational. Strategic control involves decision over diversification, mergers and general objectives aimed at coping with environmental constraints. Strategic control must take these constraints into account and also attempt to alter them to enhance the position of the enterprise within the environment. The operational sphere involves activities to implement corporate strategies and operational control involving budgeting, choices of technology, selection of equipment suppliers and types of personnel to be recruited. In this study, the nationality of the Chief Executive had been noted to determine whether the company was under foreign or local management control. Being head of the organization, the Chief Executive determines the strategic direction of the company and he also controls the day-to-day operations. It is felt that foreign management control would focus on major decisions on finance, product lines and other matters in which there are advantages in building through their central corporate views and capacity of pooling together matters acceptable to unified global strategies. Foreign-managed companies with their strong linkages to their corporate headquarters are likely to have greater interest in meeting important investment strategies of their parent companies. Shearer (1960) has noted in his landmark study that the reason most often cited for foreign firms' preference to employ their own staff in key positions lay in the possible conflicts of loyalties that would develop when the interests of the firm and host country differ. Specifically, he noted that in most companies, the foremost rationalisations for oppposition to appoint local Chief Executives were related to:-

(1) National conflicts of loyalties to country and company; and
(2) Nationals not being "company" men.

How does management control affect the development of technological capability? According to Peno (1977) it is generally postulated that management control is desired in the interest of protecting the firm's security motives which are related to its market and technology competency. Such security serves as a base from which high rates of growth in domestic and international markets may be pursued.

Foreign management controlled firms, as indicated earlier, place high priority on the investment strategies of their foreign parent companies.

In his study of Japanese multinational enterprises Yoshino (1977) identified several reasons for Japanese firms desiring control of their subsidiaries. Reasons for desiring control by Japanese firms include wanting to :

Maintain quality standard
Protect company brand names
Protect the company's technology
Coordinate export
Control dividend policy.

Historically, foreign firms have pursued a strategy based on the notion that control is augmented when their own "company men" act as Chief Executives. If nationals held key positions, there are inevitable conflicts of loyalties when the interests of the company and the host country are opposed. The evidence of historical political conflicts between firms and Governments in developing countries and the manpower policy pursued by those firms is quite evident in existing literature. In the present analysis, the researcher is concerned with regard to management control and its impact on the development of technological capability. It is felt that companies with local management control would have higher levels of technological capability because of the strong desire of local Chief Executives to rise within the ranks of the industry within his own country. Hence by developing the local expertise, he could fulfill his growth motivation. It is, therefore, reasonable to speculate that such firms would have a high level of technological development.

3.1.2.1.3 *Methods of technology acquisition*

Much technology is acquired by developing countries through foreign direct investment, contractual arrangements and technology trade. The determination of the appropriate choice of mechanism to acquire technology is the outcome of the willingness of the supplier to supply the technology in a particular form and the desire and ability of the recipient to acquire it in a particular form. The nature of the methods of technology acquisition adopted varies with the industries. The more technologically sophisticated, the more difficult it is for companies to rely on direct mechanisms like technology trade. Writers like Francis Stewart (1981) have pointed out that direct foreign investments restrict opportunities for local learning-by-doing. In this method of technology acquisition, the whole process will be dominated by the parent company and the situation would result where choice of technologies, machine suppliers, plant contractors are decided by the parent company. Wionczek (1981), a well-known authority on technology transfer in a Latin American company, has commented that multinational corporations usually insist that all the subsequent stages in establishing a wholly-owned subsidiary, whether in manufacturing or in other sectors, must be tightly controlled by the parent because of the complexities in the developing country. In view of the high degree of involvement of foreign firms in this method of technology acquisition, critics have argued that local development of technological capability would be retarded. In most cases, there would be little linkages to local technical systems. It is, therefore, argued that other modes of technology acquisition like technology trade should be promoted, Mytelka's (1978) research into the Andean Pact experience indicates that development of local capability to choose and generate technology requires unpackaged modes of technology acquisition such as technology trade. Because of the negative impact of foreign direct investment which has been strongly argued by several writers, it is possible that other modes of technology acquisition, particularly contractual arrangement which would allow greater participation of local personnel, would contribute to rapid development of technological capability. Therefore, it is posited that direct technology trade and contractual arrangements which the exclude foreign equity element would have a more positive impact on the development of local capability.

3.1.2.1.4 *Nationality of partners*

Since joint ventures are so prevalent among Malaysian companies it is noteworthy to investigate the influence of foreign firm's management strategies on diffusion pattern according to their nationalities. For example, the study by Sim (1977) on the pattern and degree of decentralization of Malaysian subsidiaries of British, Japanese and U.S. firms would be of interest to this research. The industries covered were products, pharmaceuticals, chemicals, transportation, electronics, electrical goods and textiles. There were 7 British, 6 Japanese and 7 U.S. subsidiaries. Decentralisation was found to be the highest in marketing, personnel and organization, and production; and least in finance, ownership and R & D. The American subsidiaries' planning and budgeting involved greater head office involvement and tended to be a top-down process. There was less involvement by head office in the British subsidiaries and the process tended to be bottom-up where the process depends on the subsidiaries and works its way up to the head office. In the Japanese firms, there was a great deal of interaction between subsidiaries and parent companies and also planning and decision-making tended to be confined to Japanese executives. On the other hand, the American subsidiaries encouraged their employees to participate in planning. The British subsidiaries tended to confine their participation and information access to their top management personnel. The use of expatriates in the subsidiaries vary in nationality with the highest number in Japanese subsidiaries while the American and British had about the same number of expatriates. Sim speculates that Japanese companies are rather less decentralised as compared to British and American companies for two main reasons. A Japanese firm tended to use operational and managerial control rather than equity ownership to control their subsidiaries. Secondly, the Japanese managers of the subsidiaries tended to be autocractic in their management and did not delegate their authority to the extent of that of the American and British subsidiaries. Since Japanese are the largest foreign investors in Malaysia the research focuses on the impact of Japanese and non-Japanese corporate strategies on the development of technology capability. Yoshiro's study (1976) also indicates the tendency of Japanese companies exercising stronger control in the operation of their operation as compared to other multinationals. It is possible that companies with Japanese partners would have lower diffusion of technology. Thus the researcher expects that the nationality of foreign partners would have a strong influence on technological capability.

3.1.2.1.5 *Age of firm*

Age is another variable that could have an influence on the development of technological capability. It was assumed that the operating life of the firms would have a positive impact on the development of technological capability. Industrialization is fairly new to the country because systematic efforts to industrialise started only in the early 1960s. It was assumed that learning could be an automatic process and a function of time. As the company develops and matures it would be able to acquire the necessary expertise to further enhance its technical capability. However evidence on the impact of operating life on the development of indigenous technological capability is mixed. Some study shows that the operating life of a firm does not necessarily guarantee that it may acquire a high level of technical capability. For example, the study by Bell Scott-Kemmis (1982), on a plant in Thailand indicates that learning did not take place. Their study examined production of galvanised sheet steel in three lines in the firm in the firm in Thailand. One of the lines was imported from Japan in 1961 and the other two were locally built the in 1964 and 1968. Between 1968 and 1973, there was no improvement in performance in the 3 lines and in some cases, productivity declined. Over a period of at least about 9 years, this company did not improve its production efficiency. The study indicates that learning is not automatic, not simply a function of time, or use of a particular technique; other factors are also necessary. However, the findings are only tentative and the researcher emphasises the need for more empirical research in order to identify those conditions in which technological capability is likely to occur. However, studies by Dahlman (1984) indicate that a firm could develop its capability over time. They cited the example of an integrated steel mill in Brazil where the plant's capacity was effectively doubled over 7 years with very little additional investment and no increase in the work force. The studies indicate the ability of firms to accumulate experience over time and develop their own capability. In this research, the operating life of each of the firms is being identified as a variable. It is posited that age would have a positive relationship with the development of the technological capability of Malaysian companies. The researcher was of the view that the firms will be able to acquire technological capability, given their experience in building up their production capacity and also the involvement of personnel in running the companies. It was felt that the findings by Bell may not be widely applicable and the learning stories of Dahlman and Westphal are more typical of Malaysian companies.

3.1.2.1.6 *Nature of technical collaboration*

Malaysian companies acquire technologies from a variety of sources. One major source is formal technical collaboration which refers to a broad range of technical services in the form of technical assistance agreements, management contracts, technical know-how agreements and a combination of various types of arrangements. Such arrangements were common among joint venture companies and also some local companies where foreign technology suppliers provided those technical resources through formal arrangement on a long-term basis. Another major source is the less formal and short-term arrangement where companies source technical assistance on specific areas such as training, trouble-shooting or product process know-how. This can be either formal or informal arrangements with technology suppliers. Generally such technical assistance is provided on a short term basis to solve immediate technical problems. For example, a study by Westphal, Rhee and Pursell, (1982) indicates that although Korea has relied rather heavily on the inflows of investment resources, the inflows overwhelmingly been in the form of debts and not equity. Except for industries established during the colonial period, technology has been acquired from abroad, largely through means other than direct foreign investment. The purchase of technology through licensing has been of modest importance at the initial source of process technology; machinery imports and turnkey plant construction were found to be of much greater consequence in the transfer of technology and a tremendous amount of know-how has entered with Koreans returning from studies or work abroad. It was also pointed out that Korea's strategy to gain industrial competence has just relied heavily on indigenous effort from various forms of learning by doing, and emphasised transactions at arm's length in the use of foreign resources. Since the study focuses on mature and less sophisticated industries, technology can easily be acquired from less formal sources other than formal technical assistance and technical collaboration arrangement. It is the view of the researcher that sourcing technology on a short term basis for specific efforts could generate greater learning by doing to enhance the technical development of Malaysian companies. Therefore, there will be more positive development in these companies, particularly those mature industries which are able to acquire technology from sources which will also enable them to develop it further. Companies which rely on a long term arrangement, particularly through technical assistance or other formal mechanism will not progress because of their dependence on foreign sources and other restrictions imposed on those arrangements. The study of technology resources in South Korea as discussed earlier also found that formal mechanisms of transfer such as licences and technical agreements with foreign technology suppliers accounted for only a small proportion of the total. Formal mechanisms from foreign suppliers are of great significance in the modern sector, accounting for 21% of all imported technology resources. This is a small proportion and other sources of foreign technology include technology embodied in Korean labour and management, foreign suppliers of equipment or raw materials and foreign buyers. It is pointed out that there has been over-emphasis on the role of formal mechanisms in technology transfer. There is also a growing recognition of the importance of acquiring technology, from other means particularly from information exchange, training of local personnel and informal linkages developed between friendly companies in various parts of the world. On this basis, it is felt that companies which acquire technology on short term and less informal arrangements will have greater flexibility of sourcing technology from various sources and are likely to undertake a higher level of in-house technological efforts to increase their technical capability. On the other hand, companies which rely on long-term formal mechanisms will not be able to achieve a high level of technological capability in view of their greater reliance on the expertise of foreign technology suppliers.

3.1.2.1.7 *Technical staffing structure:*

Little empirical work is available on the relationship of technical staffing structure and the development of technological capability in Malaysian companies. However, earlier works on manpower policies in multinational firms could provide a clue as to the influence of the staffing policy on technology development. Evidence on the relationship between manpower policy and control of technology is found in Kidron's work (1965) on early British and American direct investments in India. Kidron notes with specific reference to manpower tactics/practices:

> "Although not always distinguishable from fundamental research and development, the application of results or operational know-how is less a

natural monopoly. In a sense, it can be detached and used independently, either because the basic knowledge is almost entirely embodied in fixed equipment as in some chemical industries, or because it is easily assimilated without expensive apparatus as in advertising, a booming industry peopled almost entirely by ex-employees of foreign agencies. Partly in order to prevent this ..... foreign firms have proved reluctant to impart much of their know-how and skills to local personnel."

Kidron (1965) cites many cases where critical elements of knowledge and know-how were withheld in the interest of protecting the firm's bargaining assets in the world market positions.

Another study was carried out by Peno (1977) on multinational corporate behaviour with regard to staffing of expatriates in key positions. According to Peno, the know-how accumulated in a firm is mainly invested in the persons employed by the firm. He postulated that the firm considered it less of a risk to its firm-specific knowledge to have sourced personnel in positions of trust where such knowledge is vested. Again, employment of a host-country national with host-country loyalties in such positions and vested with such knowledge could place the firm's long-run market security in jeopardy. Such knowledge would be diffused through such persons moving to other firms.

However, Peno (1977) noted that the relationship between high level manpower and the desire of firms to protect their proprietary knowledge is a complex issue. He hypothesised that by controlling the transmission of knowledge through the use of foreign personnel in the engineering and technical positions, the multinational firm protects its market position from erosion by existing and rival firms.

Unfortunately, hard empirical evidence on the technological strategies of a foreign firm with regard to multinational firms is in very short supply, particularly relating to development of technological capability in joint venture operations. In this study, it is postulated that companies with expatriate staff in high-level positions will have lower diffusion of knowledge in view of their desire to protect their market positions while local companies which had not employed foreign expatriates would have higher levels of technological capability. It should be noted that short-term experts hired by local firms would not be considered as expatriate staff for the purpose of this study. Hiring of consultants and short-term foreign experts to provide specific know-how is common among Malaysian companies to develop their own internal capability. It is felt that companies which have no long term expatriate staff would achieve higher levels of technological capability. Such companies would also promote a high degree of internal expertise through manpower development programmes and hiring of short-term experts to upgrade expertise of technical personnel.

3.1.3.2 *Hypotheses*

The outcome of the foregoing theoretical review led the researcher to the decision that the study on the development of technological capability would be guided by the following hypotheses:-

<u>Research hypotheses:</u>

(a) There is a degree of association with regard to ownership structure and developments of technological capability;

(b) There is a degree of association with regard to management control and the development of technological capability;

(c) There is a degree of association with regard to methods of technology acquisition and the development of technological capability;

(d) There is a degree of association with regard to technical staffing structure and the development of technological capability;

(e) There is a degree of association with regard to nationality of foreign partners and the development of technological capability;

(f) There is a degree of association with regard to sources of technology and the development of technological capability;

(g) There is a degree of association with regard to age of the firm and the development of technological capability.

3.1.3 *Management related factors*

The third component of the study examines closely how management oriented factors such as the role of top management and its strategies have constrained and/or shaped the diffusion process. What factors facilitate or inhibit the development of technology? Williams (1967) has provided an overview of the factors that affect technology development although he was primarily concerned with the situations in which rapid innovation is likely. Williams first noted that before there is innovation, there must be opportunities to innovate. Opportunities to innovate arise from innovations which can be copied or bought from other organisations. Many inter-organisational relationships are designed to permit organisations to share innovative ideas. In the field of technology transfer, technology exchange networks among recipient firms create free flow of information among firms attempting to master the imported technology. Technology development is also affected by characteristics of an organisation such as the distribution of decision-making power and the rigidity of the organisation's operations (Hage and Aiken, 1970; Zaltman et al, 1973). Top management plays a major role in influencing the innovative capacities of the firm. Mansfield (1968) also pointed out that decisions in regard to technological investments are linked to the nature of competitors, suppliers and consumers, to market structures to legal constraints, and to attitudes towards change on the part of managers. Zaltman et al's (1973) work also contributes to an understanding of the importance of technological efforts; they noted that the adoption of one innovation fosters additional actions. Organisations that get into the habit of planning technology development are likely to continue to do so through their R & D efforts. Dahlman's (1982) study on Usiminas Steel Mills suggests that successful local technological development depends on a relatively long term strategy of building systematically on experiences it acquired. Drawing on the study, Dahlman concluded that a successful transfer of technology involves much more than the exact replication of the original technology. It also involves technological efforts on the part of the recipient to learn to operate, and to assimilate the transferred technology, and to be able to adapt it to changing circumstances.

Zaltman et al's work shows that not just any technology development will develop in just any organization. Some characteristics of organizations and their members can block technological development. Hall (1975) has pointed out that resistance by managers and works can contribute to decisions not to develop a higher level of technological capabilities. The components of decision-making are complex. They include the goals that an organisation is pursuing. The decisions are based around the acquisition and utilization of resources (White, 1974), as well as around external politics (Allison, 1971) and internal politics (Pfeffer and Salancik, 1974). Organizational decision making occurs in the context of both an internal political economy and an external political economy. The effective management of technology is crucial in developing technological capability. If it is the desire of the firm to acquire the project execution and investment capability, it must develop adequate plans that will ensure participation of local personnel in all activities of the project relating to the investment phase. Unless carried out with the explicit objective of doing so, technology transfer associated with project execution does not necessarily provide the experience which is critical to the development of such capability. Fostering technological development by management is also crucial in strengthening the technological base. For example, the implementation of R & D activities relating to project process development, plant optimisation, and new product development have strong links to the manufacturing activities undertaken by the firm. Such an effort will enhance the learning process of local personnel in the various activities relating to industrial operations. For example, in Japan, the Government has strongly encouraged technology development by Japanese companies. The Japanese strategy of moving up the scale steadily may be the most appropriate, and the distinctive feature of the Japanese success has been the way in which Government policies have underpinned the efforts of management at enterprise level (Allen, 1987 and Peck and Wilson, 1982). The failure of management to promote technology development activities at enterprise level can lead to technical stagnation with little absorption of imported technology. As pointed out by Freeman, (1982) "simply to assimilate any sophisticated technology today and operate it efficiently, require some independent capacity or R & D even if it is mainly adaptive R & D." Freeman in his discussion on the characteristics successful innovating firms identified several of these characteristics which are relevant to this study such as in-house R & D, readiness to take risks, good communication with the outside scientific world and entrepreneurship strong enough effectively to coordinate R & D. Summing up the decision on factors affecting diffusion of imported technology one might conclude that among the critical factors considered are those related to the acquisition and management of technical resources.

The researcher sought the views of technical executives regarding the factors limiting and facilitating the diffusion of imported technology.The respondents were asked to give an overall evaluation of the experiences regarding management related factors affecting technology diffusion. The executives were asked to rank the limiting and facilitating factors. Each factor was ranked in a descending scale from 6 (extremely important) to 0 (not important at all). The factors were identified on the basis of the literature review and the pilot studies.

3.1.5 *Measuring technological capability*

As noted in UNCTAD (1972), the transfer of technology in industrial operations involved the transfer of the following elements of technology:

(a) Feasibility studies, market surveys and other pre-investment services;

(b) Determination of the range of technologies and the choice of technology;

(c) Industrial processes;

(d) Engineering design and detailed engineering;

(e) Plant construction and installation;

(f) Training of technical and managerial personnel;

(g) Management and operation of production facilities;

(h) Market information; and

(i) Improvements to processes and product designs.

In study on the acquisition of technological capability in India, Mexico, Korea and Brazil, sponsored by the World Bank, Dalhman and Westphal (1982) broadly classified four areas of technological capability: Project execution, production management, capital goods and plant construction. Kenneth King (1983) in his article on science and indigenous skills highlighted pre-investment, search, negotiation and skills related to production engineering. Stewart (1979) in a comprehensive literature review on technology transfer classified local technological capacity as having three stages: Independent search, technological change and development of new technology. Taking into consideration the level of industrial development in Malaysia and on the basis of pilot study, the researcher decided to classify technology diffusion into three components: investment and project execution capability, production capability and innovation capability.

3.1.3.2 *Investment and project execution*

The investment and project acquisition constitute a critical phase in the development of industrial projects. Major decisions have to be made regarding the feasibility of the projects, the choices of technology, selection of technology suppliers, coordination and supervision of the plant construction, plant commissioning and other engineering services. Generally, a firm would seek assistance from consultant or engineering firms to assist in the implementation of this phase. Major decisions on those activities that have to be implemented in the investment and project acquisition phase would have to be made by the firm. Activities involved in the planning and implementation of industrial activities involved a series of procedures which can be divided in the following broad stages:

(a) Feasibility studies;
(b) Project and engineering design;
(c) Negotiations and contracting;
(d) Construction;
(e) Training; and
(f) Plant commissioning

The preparation of project and engineering designs includes time-scheduling, size prospecting and probing, preparation of blueprint and plant designs, detailed plant engineering and a final selection of technology and equipment. Negotiations and contracting define the legal obligations in respect to project financing, acquisition of technology, construction of buildings and services, and supply of machinery and equipment for the operational phase. It covers the signing of contracts between the investor on the one hand and the financial institutions, consultants, architects, contractors, equipment suppliers, patent holders and licensors, and collaborators and suppliers of input materials and utilities on the other. This stage involves a host of procedures that often present serious problems for developing countries. Negotiations and contracting take place at all stages of the investment phase. Pre-investment studies provide the basis for the activities of the investment phase. The decisions at the investment phase, however, do not necessarily follow the recommendations of the pre-investment studies. Direct negotiations and contracting would often reveal the need for modifications and provide new ideas for project improvement that often lead to unforeseen increases in investment costs.

The construction stage involves site preparation, construction of buildings and other civil works together with the erection and installation of equipment in accordance with proper programming and scheduling.

The training stage, which should proceed simultaneously with the construction stage, may prove very relevant to the rapid growth of productivity and efficiency in plant operations.

The plant commissioning or start-up (delivery stage) is normally a brief but technically critical span in project development. It links the preceding phase and the following operational phase. The success achieved at this point demonstrates the effectiveness of the planning and execution of the project and is a portent of the future performance of the programme.

The investment phase involves heavy financial commitments and major modifications of the project could have serious financial implications. Bad scheduling, delays in construction and delivery, start-up, etc. would inevitably result in an increase of investment costs and affect the viability of the project. In the pre-investment phase, the quality and dependability of the project are more important than the time factor but in the investment phase, the time factor is critical.

In determining the diffusion of technology with regards to the investment and project acquisition firms will be asked to indicate the degree of indigenous capabilities related to those activities carried out during this phase. The degree of indigenous capability will reflect the extent of technology diffusion in the firm.

3.1.3.3. *Production capability*

The second component of technological capability involves the diffusion of production capability. A firm depends upon the products it makes although companies differ in how much they produce internally or buy from outside. Production management describes the tasks concerned with managing those resources of an enterprise which are required to produce the goods. The production management function task is concerned with the transformation process which takes inputs and converts them into output, together with the support functions required. The integration of schedules, buying of parts, quality assurance, capacity planning, operation planning and control, and material control are among the many tasks of production management. Production function is then a function of considerable diversity and importance.

3.1.3.4 *Innovation capability*

The third component is the diffusion of innovation capability. The extent of innovation capability is evaluated on the basis of the firm's efforts relating to product process development, minor modification, plant optimization and other cost cutting efforts. Innovation capability covers everything from invention to innovation and includes improvements in existing technology. As pointed by Teitel (1979) most innovation activity in developing countries involves modification or improvements of existing technology which is a more narrowly focused applied R

& D task as well as trial and error experimentation. Imported technology has to be adapted to local materials and equipment. In a number of cases, the technology has to be scaled down to the size of the local market and adapted to available local skills. Adaptation is also the means of linking imported technology to local innovative efforts. In practice innovation efforts in any firm consist of the modification of a process or product introduced by a firm irrespective of whether it is new in itself. This kind of innovative efforts goes on all the time and inevitably puts the emphasis on adaptation of imported technology. It puts the whole problem of what is involved in the increasing technological capability into perspective, particularly from the point of view of a developing country.

3.2 RESEARCH APPROACH

The research approach was based on interviews and case analyses. Considering the nature of the subject, mailed questionnaires were not deemed to be a good strategy because they would not have permitted the researcher to collect as much useful information as possible, since the studies involved several key issues which were a source of conflicts between foreign companies and Governments in many developing countries. Contentious issues such as transfer pricing, restricted clauses, employment of foreign expatriates, investment strategies and restricted flow of information were included in the interview guidelines. Foreign companies, particularly joint venture firms thus were reluctant to discuss these issues unless the researcher could establish some degree of rapport with them. Therefore mailed questionnaires were ruled out as being unsuitable due to the nature of the subject.

Another alternative would be a single firm case study. For example, the Dahlman (1969) study on technological change was based on the study of one steel plant in Brazil. Such a study has yielded many positive results and has been consistent with the researcher's results. In this approach rather detailed case studies on technological development were exploited. However, one drawback of a single firm study is that the conclusion tends to be unique to the case recorded and the results were difficult to generalise.

This led to the choice of an interview study of all the sample firms, followed by indepth interviews with a shortlisted number of firms. The interview study allowed the researcher to seek as much useful information as possible while permitting the researcher the opportunity to explain and clarify certain major issues affecting technology transfer in Malaysia as well as solicit responses which were recorded with the questionnaire guidelines. It is also the intention of the researcher to write brief case studies of all 31 firms followed by detailed case studies of eight firms shortlisted.

3.2.1 *Research population*

The researcher decided to concentrate on a study with a fair sized sample drawn from established import substitution industries. A sample firm was drawn from various product group sectors such as glass and glass products, iron and steel, cable and wires and other product groups as shown in Table 3.1. The aim of the study is to cut across the various product groups so as to identify general problems affecting the overall industries in Malaysia.

The researcher is aware that in certain industries the problems could be industry or product specific. However, the purpose of the study is to examine critical issues that cut across the various industrial sectors relating to diffusion and development of technology. Since the study focuses on Malaysian companies, the sample is confined to mixed and wholly-owned local companies. As indicated earlier, the purpose of the study is to assist in the formulation of appropriate strategies and policies to accelerate the diffusion and development of technology in Malaysian-based firms. Wholly-owned multinational firms are excluded from this sample because the study is confined to the import substitution industry which is the target group of national development strategies. The sample is made up of both joint venture and wholly-owned local companies. These companies were drawn from the product groups comprising both joint venture and wholly-owned local companies. In all, the researcher completed 90 interviews successfully 70 were with local Chief Executive officers and technical executives, and 20 with foreign expatriate staff.

A total of 35 companies was selected for this study. Thirty-five was thought to be a fair-sized sample because of the need to conduct interviews and write a brief case study of all the samples. The researcher selected fifteen product groups which were considered the main stay of Malaysian imports substifution industries listed in the Malaysian Manufacturing Directory. Seventy companies representing the fifteen product groups were contacted. Only twenty companies replied indicating their interest to participate in the study. Subsequently the researcher sought the assistance of his employer to pursuade fifteen other companies to cooperate seeking their participation in this study. Secondly, the researcher would need to devote more time in writing the detailed studies of selected companies. The purpose of writing out brief case studies of the companies studied was done with the view of generating considerable insights into the diffusion process, in trying to explain why some companies develop higher levels of technological capability and others do not, and the fundamental and underlying explanation often seems to lie in the development of the firm. Hence, a major element in understanding indigenous technological development should be to trace how the company developed its technological base, how the interests and rewards of the decision-makers relate to local and foreign sources of technology. It is much easier to explain the dynamism of some companies on these terms than with reference to the effects of particular strategies. Emerging empirical studies on technology development in developing countries tend to adopt detailed case studies especially at micro level, for example, Maxwell's (1977) study on technology development in a steel firm in Argentina shows how particular events led to particular innovations. Hence in this study, the researcher decided to write a brief case study of all the companies studied which would provide considerable insights into some of the strategies adopted by Malaysian firms with regard to diffusion and development of technology. The researcher selected the companies representing the various product group sectors. However, only 31 companies were included in the analysis because 4 other companies were not able to provide sufficient information for the study. Most of these companies are medium and large companies employing between 200 and 2,000 workers. Of the 31 firms, 20 are mixed ownership companies. A description of the 31 companies is given in Table 3.2. In terms of nationality of foreign partners, nine are Japanese, three Australian, three British and two Indian. Table 3.3 gives a detailed breakdown of foreign firms according to nationality. The eight companies selected for indepth interviews were Tasek Cement, Soong Seng Asbestos, Amalgated Steel Mills, Pernas NEC, H & R Johnson, Malaysian Sheet Glass, Petronas Refinery and Aluminum Company of Malaysia. Tasek Cement, Soong Seng Industries, Amalgated Steel Mills and Petronas Refinery are wholly-owned local companies while the other four are joint-venture companies. The eight companies were selected because they had implemented major expansion projects recently and were able to provide significant input on the technology transfer process. Most importantly, they were willing to participate in the indepth interviews. Most of these firms are leaders in their own field. These companies serve as a focus for the more rigorous and detailed investigation that would eventually translate general ideas into concrete form. Each case study starts with a brief background of the company which includes information on the type of industry, product, and the role of the owners in establishing the initial manufacturing operations. This is followed by a description of the technology acquisition process adopted by the company. The case study traces the principal sources of technology and know-how. It examines the historical development of the firm with regard to the technology acquisition process, in particular the linkages and the nature of technical collaboration entered between the supplier and the recipient firm. it focusses on the links and the relationships established by the firms with other key actors or companies for the purpose of acquiring technologies. The case study then examines the development of the technological capability within the company and provides illustrations of how the company evolves its technological capability. The analysis also contains information on the degree of capability that has been developed within the company. In total, these cases are built on several interviews and direct involvement and observation as well as reviews of published material. While the breadth of view, including statistical associations is important to show that the findings relate to Malaysian companies more generally, the depth of focus on the selected eight companies enabled the researcher to learn in detail what exactly and how the companies manage their acquisition and diffusion processes. Since the spread or diffusion of technology in the firm is the theme, the researcher needed to capture a more qualitative aspect of firms' experiences rather than snap-shots and so related more of the findings in terms of the internal management issues and conflicts than in terms of statistical associations although the studies elicited both. This enabled the researcher to understand in detail exactly why some companies were more successful in building indigenous technological capability and diffusing the imported technology than others. What emerged from these case studies was a set of conclusions about the conditions supporting and hindering development of technological capability in Malaysian companies.

Table 3.1 Branch of industrial activities

Industrial activity	No. of firms
Glass and glass products	3
Structural clay products	5
Cement	2
Concrete and cement	3
Iron and steel	2
Communication equipment	1
Fabricated metal products	3
Motor vehicle parts	1
Wire and wire products	1
Petroleum refineries	1
Dry cells and storage batteries	2
Cables and wires	2
Electrical industrial machinery	2
Metal and wood working	1
Metal basic industries	2

Table 3.2 Brief outline of companies in the sample

	Name of Company	Ownership	Branch of Industrial Activity	Nationality of Foreign Partners	Date Established
1.	Alcom	Mixed	Fabricated Metal Products	Canadian	1966
2.	Hume Industries (Asbetos Cement Plusion)	Mixed	Concrete and cement products	Denmark	1967
3.	Kuala Lumpur Glass	Mixed	Glass and glass products	Australian	1967
4.	Malex Asbestos	Mixed	Concrete and cement products	Japan	1961
5.	Berjaya Kawat	Mixed	Wire and wire products	Australian	1968
6.	Federal Power and Telecom	Mixed	Cables and wires	Japan	1974
7.	Industrial Boilers and Allied Equipment	Local	Industrial machinery and equipment	-	1971
8.	Malaysian Gauge and Tool	Mixed	Metal and woodworking machinery	India	1958
9.	Associated Pan Malaysian Cement (Railway Plant)	Mixed	Cement	British	1953
10.	Federal Aluminium	Mixed	Fabricated Metal Products	Australian	1970
11.	Malaysian Sheet Glass	Mixed	Glass and glass products	Japan	1975
12.	Soon Seng Industries	Local	Cement and concrete products	-	1977
13.	Malayan Mosaic	Local	Structural clay products	-	1964
14.	Tasek Cement	Local	Cement	-	1964
15.	Malayawata Steel	Mixed	Iron and Steel	Japan	1968

Table 3.2 **Brief outline of companies in the sample (contd.)**

	Name of Company	Ownership	Branch of Industrial Activity	Nationality of Foreign Partners	Date Established
16.	Indo Malaysian Engineering	Mixed	Structural Industrial Machinery	India	1971
17.	General Ceramic	Local	Structural clay products	-	1969
18.	Associated Tiles Industry	Local	Structural clay products	-	1966
19.	H & R Johnson	Mixed	Structural clay products	British	1977
20.	MCIS Safety Glass	Mixed	Glass and glass products	Japan	1978
21.	Federal Iron	Mixed	Fabricated metal products	Japan and Singapore	1960
22.	Associated Ceramics Works	Local	Structural clay products	-	1981
23.	Antara Steel Mills	Mixed	Iron and steel	Germany	1981
24.	PERSTIMA	Mixed	Metal	Japan	1979
25.	BRIMAL	Local	Motor vehicle parts	-	1978
26.	PERNAS NEC	Mixed	Communication equipment	Japan	1972
27.	Federal Cables, Wires and Metal Manufacturing	Mixed	Cables and wires	Japan	1966
28.	Century Batteries (Australian partner recently sold its interest to a local company)	Local	Dry cells and storage	-	1966
29.	Chloride Batteries	Mixed	Dry cells storage batteries	British	1967
30.	Amalgamated Steel Mills	Local	Iron and steel	-	1974
31.	Petronas Refinery	Local	Petroleum refineries	-	1983

Table 3.3 Nationalities of foreign partners

Nationalities of foreign partners	No of firms
Japanese	9
Australian	3
British	3
Canadian	1
Indian	2
Danish	1
German	1

3.2.2 *Questionnaire*

The questionnaire utilized for the study is a composite borrowed and adapted from selected works including those being undertaken by international agencies such as the World Bank and OECD on development of technological capabilities and supplemented by items representing the author's research concerns and Malaysian content. The rationale for basing the questionnaire on these studies is that these organizations have developed some items which have been shown demonstrated to be reliable and valid for measuring certain variables that the author is directly concerned with. The questionnaire is designed to elicit basically two different types of information. First, descriptive data such as types of manufacturing activities, main products, number of personnel, sources of technology; second, data in subjective values and perceptions which, of course, are not readily apparent and therefore must be elicited in a different way.

In order to organize the variable to be studied into a coherent framework and establish a logical and sequential flow of attention, the writer structured the items into 5 sections:-

(i) Background information of the firm;

(ii) Sources of technology;

(iii) Benefits and costs of technology acquisition;

(iv) Development of technological capability; and

(v) Management related factors affecting technology diffusion.

As can be seen in Appendix II and the questionnaire has used both closed and open-ended questions. In the case of closed questions, a multiple choice format was followed so that ambiguity was minimized. The major advantage of the closed or structured responses is that the questions are easier to answer, easier to code and analyse, require less skill and effort on the part of the interviewer, shorten the interview and make it easier to comment on sensitive subjects. The researcher found that the greatest advantage of the coded responses is that answer are comparable from executives to executives. This comparability factor is critical in the empirical enquiry. However, the researcher did use the open-ended format for probes of a more qualitative nature to gather information on the relative degree of technology diffusion.

In using the open-ended format the researcher was interested in obtaining, if possible, as much as useful information as possible. However, the researcher limited the use of this format to what was considered to be an 'optimum' level because of the awareness of the tremendous work and the problems involved in the analysis phase of the work if used too extensively.

A two-stage interview process was followed. First, a one-day interview was conducted with Chief Executive Officers and technical managers. In joint venture companies the researcher requested that foreign expatriate staff participate in the interviews of all the 31 firms. Later, indepth interviews conducted over three to four full days were carried out on eight firms. These indepth interviews were supplemented with intermittent but continuous contacts with personnel of the various technical divisions of the respective companies. The manner of conducting the interview and choice and sequence of the interview was similar throughout the course of the research. A pilot study of the questions was tested among five firms. Relevant theoretical work plus long conversations with a small group of people in the pilot study were used to build up a very open and flexible set of themes and questions. These themes and questions provided the basic background for the second round of interviews involving the 8 firms. Over the period of the research, 90 people were interviewed from subsidiary companies and corporate headquarters of the firms under study. An introductory letter with the interview guidelines was sent to the 31 firms which had agreed to participate in the study. The letter, as shown in Appendix A, provided a detailed objective of the study as well as a request to participate in the study.

3.2.3 *The variables for determinants opf technological capability*

According to Isaac and Michael, (1972) in social science research, there are 3 categories of variables : independent, control and dependent. They assert that independent variables are also known as input, manipulated, treatment or stinulus variables; the control variables are also known as background, classificatory orghanismic variables; and the dependent variables are known as outcome or response variables.

In this inquiry, the main dependent variables are the development of indigenous technological capability among local personnel, measured according to the 3 components relating to investment and project execution, production capability and innovative capability. The independent variables include a set of transfer and organizational characteristics (management control, methods of technology, classification etc.). The control variables include items such as age of the company, type of manufacturing organisations, ownership, etc. It is the relationship of the independent as well as some of the control variables, to the dependent variables which constitutes the main focus of the empirical studies.

3.3 CONCEPTUAL MODEL

In order to facilitate clearer thinking on the issues affecting diffusion and development of technology, the researcher has created a simple model which would enable one to see the problems in a clearer perspective. As can be seen in Figure 3.1 it is possible conceptually to visualise some of the factors affecting the diffusion of imported technology and the dimensions of the phenomena involved. For example, the technology acquisition process adopted by companies would have an impact on the diffusion process as measured by the capability developed by local personnel. The acquisition process which would be influenced by the role of technology suppliers, the nature of the technical collaboration and other issues relating to the acquisition process would also have a direct effect on the extent of knowledge diffusion within a particular firm. Transfer characteristics related to ownership pattern, management control, nationalities of foreign partners and also the type of technical collaboration would have a direct impact on the extent of technologies diffused to the companies. One contribution of this model is that the development of technological capability depends on the interaction of a number of group of factors. Environmental factors have an important role in creating a conducive environment on the diffusion and development of technology. It influences the diffusion process through deliberate government policies such as industrial strategies and regulatory mechanisms, particularly the screening of technical collaboration. Policies regarding ownership have been incorporated in foreign investment regulations and also influence the technology diffusion processes. Hence the conceptual model enables one to realise that the development of technological capability requires both actions and policies at micro and macro level. The model attempts to emphasise the complexities of managing technology development, particularly for those countries which rely extensively on imported technology. Unfortunately, very little empirical work has been carried out to examine as to what degree Government policies affected the choice of technology and the degree of technology diffusion at the firm's level. It has also been recognised that the success of the transfer of technology from foreign countries to developing countries not only depended on public policies but also on the actions of individual firms which acquire those technologies. The ideal type of situation is where policies are formulated with awareness about the impact it has on the technology strategy of the recipient firms. In the past, policies tend to address the role of multinational firms, and the cost and terms of transfer of technology and had not looked into some of the problems faced by recipient firms. The outcome of the empirical and theoretical review of the literature and conceptual integration given in last few sections form the basis of this study.

3.4 RATING SCALE AND INDICES CONSTRUCTION

The instrument utilized allows a comparison of relative patterns of internal diffusion of technology as measured by the development of technological capability among local personnel. The factors selected scale rating including subjectively perceived degree of costs and benefits of technology acquisition, extent of technological capability and subjective perception of the importance of factors facilitating and limiting diffusion. Statistical analyses utilized enabled the researcher to ensure the extent the associationship in the cross tabulation. A large portion of the analysis used simple cross tabulation and simple descriptive statistics such as percentages. The mean, and percentile were computed in specific variables. When testing to specific hypotheses, the basic statistical technique used was the spearman. All critical ratios were tested for significance at .05 level of confidence. The non para metric statistical method is used for this project as it is more appropriate for ordinally measured data. The order of the numbers as used in the survey reflects a low, medium or high rating of the particular subject asked.

Thus to test the correlation between two variables, Spearman rank correlation coefficient is used.

The standard package for social sciences computer program (SPSS) was used to make all the computations in this study. The researcher utilized the HP 3000 computer located at SIRIM to process the data.

TECHNOLOGY ACQUISITION PROCESS

Nature of Technology Transactions
Strategy of Multinationals Enterprise
Internal Resource Development
Project Planning and Management

ENVIRONMENTAL FACTORS

Industrial Policy
Technology Policy
Technology Transfer control System

Results of diffusion as measured by the development of technological capability

TRANSFER CHARACTERISTICS

* Ownership
* Management Control
* Age of Firm
* Nationalities of Foreign Partners
* Methods of Technology Acquisition
* Technical Staffing Structure
* Nature of Technical Collaboration

MANAGEMENT RELATED FACTORS

Management of the Transfer Process
Role of Top Management
Technology Strategy of the Firm
Supplier recipient Relationship

Figure 3.1 Conceptual model in the factors affecting development and diffusion of technology

The pilot study

The instrument was initially pretested in a pilot study on a small group of respondents of five firms. The focus of the pretesting included the technical details of the items in the questionnaire and the applicability of the rating scale technique to be utilized in the actual study. The writer were also interested in observing whether some of the more sensitive items would cause any problem to the respondents. The comments of the respondents and interviewer regarding problems of understanding the question, prognosis or possible reactions to the questions, and other suggestions for improvement were integrated into the instrument finally utilized in the inquiry. The pretest showed that it was generally easy to use the questionnaire correctly. The length of the questionnaire did not prove to be a problem with the respondents.

Assumptions

It is assumed that the questionnaire used is a valid and reliable instrument for the measurement of the values and attitudes that the researcher is interested in. It is also assumed that the interview questions were answered with honesty and candour. The assumption is, therefore, that the data collected are valid and, if properly interpreted, reflect the true problems confronted by the firms involved.

3.5 SCOPE AND DELIMITATIONS OF STUDY

The empirical part of the study is essentially an exploratory one. The unit of analysis is the individual companies. Their effort is mainly concerned with the micro problem of diffusion and development of imported technology. The main objective is to attempt to analyse the company's problem so as to better understand issues relating to diffusion and the development of technology and thereby help contribute towards development of more effective policies and programmes to assist and stimulate technology development in so far as it affects the problems so identified. The methodology used, however, also enables one to examine technology, strategies, corporate problems relating to acquisition and development of technology and the relationship between foreign and local technology suppliers. On the time dimension, it is noteworthy that the empirical study undertaken is cross-sectional rather than longitudinal and that the data collected are mainly limited to a single point in time, that is, they represent snapshort views. On these partial dimension, the empirical research is confined to companies involved in imports substitution industries. The study findings are not necessarily representative of the situation in every part of Malaysia nor can they be entirely accurate for even the import substitution industries. Based as they are on interviews, the findings must necessarily reflect a strong subjective element. Nevertheless, in so far as there is convincing correlation with the findings of other studies elsewhere, the researcher is convinced that some of the conclusions set forth in this report are true, at least for Malaysia. Still other problems may, however, be so specialised that they may defy the study.

SUMMARY

This chapter has been elaborated on the theory specified the framework of the study, research. hyphotheses and outlined the methodology used in the study. It described the sample, the variables studied, the data gathering procedure, and the data processing procedure. The results of the analysis will be presented in Chapter V.

CHAPTER IV

PRESENTATION OF RESEARCH FINDINGS

4.1 INTRODUCTION

Analysis of the data gathered in the questionnaires are presented in this chapter where the researcher shall present a brief descriptive analysis of the data collected on the 31 firms. First an analysis of the profile of the companies such as ownership structure, management and operating life shall be presented. Then the researcher would present the data on executives' assessment on the issues relating to technology acquisition. This will be followed by the analysis on the diffusion pattern of the companies which will also examine the data on the relationship between diffusion patterns and the selected variables. Having presented the data the researcher would present the findings on executives' assessment on management related factors limiting and facilitating the diffusion of technology. Finally the summary of the research findings and analysis will be presented.

4.2 PROFILE OF COMPANIES STUDIED

Table 4.1 Ownership structure of sample firms

Ownership control	No. of firms	%
Mixed ownership	20	64
Wholly owned local companies	11	36
	31	100

As shown in Table 4.1 the sample comprised 20 mixed ownership companies and 11 wholly owned local companies. Mixed ownership companies are basically joint venture companies established between foreign firms and local companies.

Table 4.2 Method of acquiring initial technological input

Method of technology acquisition	No. of firms	%
Foreign direct investment	25	80
Contractual arrangements	6	20
	31	100

In terms of initial technological input, 25 of the companies were established as a result of foreign direct investment. Only six companies acquired their initial technological input through contractual arrangement namely turnkey contracts.

Table 4.3 Nationality of foreign partners in mixed ownership firms

Nationality of foreign partners	No. of firms	%
Japanese	9	43
Australia	4	19
British	4	19
Others	4	19
Total	21	100

Out of the 21 mixed ownership companies, nine were companies established with Japanese foreign partners. Japanese joint venture companies comprised 43% of the joint venture companies studied. It should be noted that Japan constitutes one of the largest foreign investors in Malaysia.

Table 4.4 Analysis of the age of the firms

Length of operation	No. of firms	%
Less than 5 years	4	12.9
6 to 10 years	5	16.1
10 to 15 years	7	22.6
15 to 20 years	7	22.6
Over 20 years	8	25.8

As shown in Table 4.4 there is a fairly wide distribution of firms among the various age groups. Eight of the companies studied had been in operation for over 20 years. The eight firms were among the first to be established when Malaysia launched the development of imports substitution industry. Among these companies were Federal Iron, Malex Asbestos and Associated Pam Malaysian Cement. The four firms established within the last five years were companies such as Petronas and Perstima electrolytic tinning plant. As indicated in the Table 4.4, 70% of the companies studied had been in operation for over 10 years.

Table 4.5 Analysis of Management Control

Management control	No. of firms	%
Foreign	7	22
Local	24	78
Total	31	100

In this study the nationality of the chief executive had been noted to determine whether the company was under foreign or local management control. Being head of the organization the chief executive determined the strategic direction of the company and controlled the day-to-day direction of the company. Twenty-four of the companies or 78% of the sample had local management control.

Table 4.6 Placement of expatriate according to department

Department	No. of firms	%
General management	5	22
Finance	1	5
Production/technical department	16	73
Total	22	100

Twenty two of the companies had employed expatriate staff in their management team. Sixteen of the companies had expatriate staff in their technical production department. Most of them were assigned to key technical positions particularly as technical managers.

Table 4.7 Technical collaborations entered into by sample firms

Type of technical collaboration	No. of firms	%
Technical Assistance	20	95
Licensing	-	-
Management Contract	1	5
Total	21	100

Twenty-one of the companies studied had entered into some form of technical collaboration with foreign technology suppliers. Technical assistance agreement comprised 95 % of the main type of collaborative arrangement.

4.3 ISSUES RELATING TO TECHNOLOGY ACQUISITION

Table 4.8 Executives' assessment on the importance of contribution made by technology suppliers

Areas of contributions	Mean values
Supplying of technical know-how	3.83
Training of local personnel	3.77
Providing management expertise	2.64
Sourcing of raw material and component	2.48

In the acquisition of technology both recipient and supplying firms are confronted with critical issues relating to the process of technology transfer. Companies had been asked to rank the contributions made by technology suppliers. Similarly they had also been asked to indicate in order of importance the main areas of conflicts encountered in the technology acquisition process. The scale of the ranking is from 6 (extremely important) to 0 (not at all). The mean values of the each of the factor are calculated to derive the ranking order. As indicated in Table 4.8 the provision of technical know-how had been one of the most important contributions made by foreign technology suppliers technical know-how. Once a manufacturing plant is established the firm becomes dependent on a continuous flow of technical know-how. The firms for example need to develop the ability to maintain the plant in top operating condition or to alter product mix such as product volume, quality range and price as market conditions change. Training was ranked by companies as the second most important contribution made by technology suppliers. Technology acquisition had always been accompanied by massive training programmes in both joint venture and wholly owned local companies. In Chapter V the researcher will provide a detailed analysis on the role of technology suppliers in the technology acquisition process.

Table 4.9 Contributions made by technology suppliers: By management control

Control / Importance of contribution	Foreign management control	Local management control
Supplying of technical know-how	3.71	3.86
Training of local personnel	3.43	3.86
Selection and evaluation of technology	3.57	3.54
Providing management expertise	3.00	2.54
Sourcing of raw material and component	2.71	2.46

Executives in foreign managed firms tended to value the role of foreign technology suppliers much higher with regard to the provision of management expertise, selection and evaluation of technology, and sourcing of raw materials and component than those in locally managed firms. For executives in company with local management control the supply of technical know-how and training was perceived of greater importance than any other contributions.

Table 4.10 Contributions made by technology suppliers: Age of firm

Age of firm / Importance of contribution	< 5 Years (4)	6-10 Years (5)	10-15 Years (7)	15-20 Years (7)	Over 20 Years (8)
Supplying of technical know-how	4.25	5.25	3.57	3.71	3.75
Training of local personnel	4.75	5.25	3.57	3.71	3.75
Selection and evaluation of technology	4.25	3.40	3.14	3.57	3.38
Providing management expertise	2.75	3.40	2.71	2.57	2.63
Sourcing of raw material and component	3.00	2.40	2.57	2.29	2.36

As indicated in Table 4.10 companies which had operated within 6 to 10 years tended to rank highly the contributions of technology suppliers with regard to training and transfer of technical know-how than those in the other age of group. The support by foreign firms on selection and evaluation of technology was perceived as an important contribution by newly established firms particularly those which had been in operation for less than five years.

Table 4.11 Importance of contributions made by technology suppliers: By ownership structure

Ownership / Importance of contribution	Wholly-owned local company (11)	Mixed ownership (20)
Supplying of technical know how	3.73	3.90
Training of local personnel	3.64	3.85
Selection and evaluation of technology	3.27	3.80
Providing management expertise	2.18	2.90
Sourcing of raw material and component	2.09	2.60

Table 4.11 shows the assessment according to ownership structure. As shown in the table executives in mixed ownership companies tended to give higher ratings on the contributions of technology suppliers than executives in wholly owned local companies.

Table 4.12 Executives assessment of the conflicts associated with technology acquisition with technology suppliers

Areas of conflict	Mean values
Development of local expertise	3.39
Project planning and management	3.00
Transfer pricing	2.84
Control of technological resources	2.71
Implementation of technological collaboration	2.32

In the acquisition of technology both recipient andsupplying firms are confronted with critical issues relating to the process of technology transfer. Companies had been asked to rank the major areas of difficulties encountered with technology suppliers in order of importance. As shown in Table 4.12 development of local expertise had been ranked as the most important areas of conflict followed by project planning and implementation. Development of expertise involves issues such as manpower development, employment of expatriates and nature of technical resources that needed to be developed internally. The next most important area of conflict is project planning and implementation. In project planning and implementation recipient and supplying firms tended to have disagreements on issues such as the sourcing of technology and components and determining the level of local personnel involvement in the project. Transfer pricing has been identified as the third most important areas of conflict. Transfer pricing is a common practice among joint venture companies. In view of certain reasons such as taxation and investment strategies foreign firms are known to implement wide-ranging practices with regard to inter company pricing. It is a common practice for joint venture companies to source components from their foreign parent companies.

Table 4.13 Source of conflicts with technology suppliers by method of technology acquisition

Method of acquiring technology	Foreign direct investment	Contractual arrangement
Development of local expertise	3.43	2.13
Project planning and implementation	2.95	3.10
Transfer pricing	2.86	2.80
Control of technological resources	2.76	2.10
Implementation of technological collaboration	2.33	2.30

As shown in Table 4.13 companies that had sourced technology through contractual arrangement tended to view project planning and implementation as a major source of conflict. In contractual arrangement such as turnkey contract the foreign technology suppliers play a dominant role in project planning and implementation. The ability of local personnel to participate actively in the project planning phase is generally a matter of negotiation between the two parties. With regard to companies that acquired technology through foreign direct investment the major area of conflict tended to be in the development of local expertise.

Table 4.14 Source of conflicts with technology suppliers: By location of expatriates

Project planning and management / Source of conflicts	2 General Management (5)	3 Finance (1)	4 Production/ Technical Debt (16)	6 Non (9)
Development of local expertise	3.40	2.00	4.25	2.56
Project planning and implementations	2.40	5.00	3.19	2.78
Transfer pricing	2.00	4.00	3.19	2.56
Control of technological resources	2.40	4.00	3.88	2.44
Implementation of technological collaboration	2.00	4.00	2.44	2.11

Development of expertise tended to be an important area of conflict in companies where expatriate staff were located in the production/technical department. As indicated earlier in Table 4.6. 16 out of the 22 companies that employed foreign expatriate staff had assigned them in the product/technical department. Table 4.14 also suggests that conflicts tended to be lower in companies where expatriate staff were located in general management positions in areas relating to development of local expertise. Personnel departments however do exercise strong influence in the area of training and development of local expertise.

Table 4.15 Major source of conflicts with technology suppliers by nationality of foreign partners

Nationalities / Source of conflicts	1 Japanese	2 Australia	3 British	5 Others
Development of local expertise	4.67	2.50	3.00	3.25
Project planning and implementations	3.44	2.25	2.25	3.25
Transfer pricing	3.44	2.25	2.75	2.75
Control of technological resources	3.33	2.75	2.50	3.50
Implementation of technological collaboration	2.56	2.00	2.00	2.50

Table 4.15 shows the areas of conflicts by nationalities of foreign partners. As indicated in the Table conflicts are more apparent in firms with Japanese technology suppliers.

Table 4.16 Source of conflicts with technology suppliers: By management control

Management control / Source of conflicts	Foreign (7)	Local (24)
Development of local expertise	3.86	2.13
Project planning and implementation	3.14	2.96
Transfer pricing	3.14	2.75
Control of technological resources	3.14	2.58
Implementation technological collaboration	2.86	2.17

As suggested by Table 4.16, 17 executives in foreign managed companies tended to show higher ratings on conflicts with foreign technology suppliers as compared to those in local managed companies. This suggests that conflicts are more intense in companies under foreign management control.

Table 4.17 Source of conflicts with technology suppliers: by nationalities

Nationalities / Source of conflicts	1 Japanese	2 Australia	3 British	5 Others
Development of local expertise	4.67	2.50	3.00	3.25
Project planning and implementations	3.44	2.25	2.25	3.25
Transfer pricing	3.44	2.25	2.75	2.75
Control of technological resources	3.33	2.75	2.50	3.50
Implementation of technological collaboration	2.56	2.00	2.00	2.50

Conflicts were more apparent in Japanese joint venture companies than in joint ventures of other nationalities. As will be explained in Chapter V Japanese companies tended to rely to a greater extent on their expatriate staff with little involvement of local personnel involvement in key aspects of companies operation. As a result of this practice, conflicts tended to spread to other areas such as project planning and implementation.

Table 4.18 Areas of conflicts with technology suppliers by ownership structure

Ownership	Wholly-owned local company	Mixed ownership
Development of local expertise	2.36	3.7
Project planning and implementation	3.0	3.0
Transfer pricing	2.73	2.9
Control of technological resources	2.18	3.0
Implementation technological collaboration	2.27	2.35

Table 4.18 suggests that conflict is more intense in mixed ownership companies with regard to development of local expertise and control of technological resources than in wholly owned local companies.

4.4 DEVELOPMENT OF TECHNOLOGICAL CAPABILITIES

In establishing diffusion pattern, firms had been asked to rank the diffusion of the three components of technological capabilities which are as follows (a) investment and project execution, (b) production capability, (c) innovation capability. A detailed explanation of the elements of each individual component had been given to the respondents. The method of obtaining the diffusion pattern will consist of evaluating the degree of technological capabilities acquired by local personnel. Each component was ranked in descending scale from 6 (extremely developed) to 0 (not at all). The firm will register one of the three diffusion patterns in each component of technology capability; high, medium and low. A scale of 5 to 6 is considered high; 3 to 4 medium, and a figure below two is considered low. The researcher will attempt to find some association between the diffusion patterns and some specific variables selected in this study such as ownership structure and management control.

Table 4.19 Analysis showing the diffusion of investment and project execution capability

Degree of diffusion	No. of firms	%
High	7	32.2
Medium	14	45.2
Low	10	32.3
	31	100

Table 4.19 indicates that investment and project execution capability has not been highly diffused with 77% of the firms showing medium to low pattern if diffusion. The elements involved in assessing the development of investment and project execution capability are feasibility studies, project and engineering design determining the choice of technology, negotiation and contracting, plant construction, training and plant commissioning.

Table 4.20 Analysis showing the diffusion of production capability

Degree of diffusion	No. of firms	%
High	15	48.4
Medium	14	45.2
Low	2	6.5
Total	31	100

Table 4.1 reveals that production capability is widely diffused among the firms studied. Over 48.4% of the firms had acquired a high degree of production capability with 45.2% in the medium pattern. The elements of production capability include quality control, production planning and scheduling, maintenance, material handling and other related tasks. The production function task is concerned with the transformation process which takes inputs and converts them into output, together with the support functions.

Table 4.21 Patterns of innovative capability

Degree of diffusion	No. of firms	%
High	2	6.5
Medium	21	67.7
Low	8	25.8

The third component in the diffusion pattern is the development of innovative capability. As shown in Table 4.21 innovative capability was the least developed among the three components of technological capability investigated. Only two firms - 6.5% of the firms studied - had achieved a high degree of technological capability. The extent of innovative capability is evaluated on the basis of the firm's efforts relating to product process development, minor modification, plant optimization and other cost cutting efforts. As suggested by the Table, 67.7% of the sample had developed some degree of innovative capability.

Table 4.22 Diffusion of investment and project execution capability by ownership structure

Type of ownership	Low		Medium		High		No. of firms
	No.	%	No.	%	No.	%	
Mixed ownership companies	8	40	11	55	1	5	20
Wholly owned local companies	2	18	3	27	6	55	11
Total	10		14		7		31

Table 4.23 Diffusion of production capability by ownership structure

Type of ownership	Low		Medium		High		No. of firms
	No.	%	No.	%	No.	%	
Mixed ownership companies	2	10	10	50	8	40	20
Wholly owned local companies	0	0	4	36	7	64	11
Total	2		14		15		31

Table 4.24 Diffusion of innovative capability by ownership structure

Type of ownership	Low		Medium		High		No. of firms
	No.	%	No.	%	No.	%	
Mixed ownership companies	7	35	13	65	0		20
Wholly owned local companies	1	9	8	73	2	18	11
Total	8		21		2		31

Table 4.25 **Ownership structure and diffusion**

Types of diffusion	Coefficient correlation
Investment and project executives capability	- 0.159879
Production capability	0.018548
Innovation capability	- 0.097077

4.4.1 *Ownership*

There are two categories of ownership structure: wholly-owned local companies where the equity holdings are fully owned by Malaysian investors, and mixed-ownership companies where the equity is jointly owned by local and foreign firms. Among the 31 companies studied, 20 are mixed-ownership companies and 11 are wholly-owned local companies. With regard to the development of investment and project execution capability Table 4.22 shows that only 5% of mixed-ownership companies had acquired a high degree of investment capability, with 27% in the medium pattern and 40% in low pattern of development capability. Around 55% of the wholly-owned local companies had achieved a high degree of technological capability with regard to investment and project execution. Table 4.23 suggests that the development of production capability seems to develop much higher than investment capability in both wholly-owned and mixed-ownership companies. It shows 64% of wholly-owned local companies had acquired a high degree of production capability. At the same time 40% of the mixed-ownership companies achieved a high degree of production capability. As shown in Table 4.24 almost all the mixed and wholly-owned companies are within the medium-to-low pattern of development with regard to innovative capability. Only 13% of wholly-owned local companies had achieved a high degree of innovative capability with 73% in the medium pattern. Innovative capability is much weaker in mixed membership companies with 65% in the medium pattern and 35% in the low pattern. The statistical analysis as shown in Table 4.25 indicates a weak relationship between ownership and development of technological capability.

4.4.2 *Management Control:*

Management control refers to the power of determining the broad policies guiding the operation. This power is exercised at two levels - strategic and operational. Strategic control involves decision and other diversification of mergers and general objectives aimed at coping with environmental constraints. The operational sphere involves activities to implement group strategies and operational control such as choice of technology, selection of equipment and suppliers and the type of personnel to be recruited. In this study, the nationality of the Chief Executive had been noted to determine whether the company was under foreign or local management control. As shown in Table 4.26 only 18% of the firms under local management control had attained a high degree of capability in investment and project execution with 52% in the medium pattern. About 83% of the firms under foreign management control had weak investment and project execution capability. As shown in Table 4.27 firms under local management control had attained higher development of technological capability with regard to production capability as compared to firms under foreign management control. About 56% of firms under local management control had attained a high degree of technological capability. On the other hand, only 17% of the firms under foreign management control had acquired a high degree of development in production capability. In the case of innovative capability, Table 4.28 indicates that the two firms that had acquired a high degree of capability were both firms under local management control. Statistical analysis as shown in table 4.29 indicates that management control had a strong relationship with development of technological capability.

Table 4.26 Diffusion of investment and project executive capability by management control

Management Control	Low		Medium		High		Total
	No.	%	No.	%	No.	%	
Foreign	5	83	1	17	-	0	6
Local	5	20	13	52	7	18	25
Total	10		14		7		31

Table 4.27 Diffusion of production capability by management control

Management Control	Low		Medium		High		Total
	No.	%	No.	%	No.	%	
Foreign	1	17	4	66	1	17	6
Local	1	4	10	40	14	56	25
Total	2		14		15		31

Table 4.28 Diffusion of innovation capability by management control

Management Control	Low		Medium		High		Total
	No.	%	No.	%	No.	%	
Foreign	4	66	2	34	-		6
Local	4	16	19	76	2	18	25
Total	8		21		2		31

Table 4.29 Management control and diffusion; statistical analysis

Types of diffusion	Coefficient correlation
Investment and project executives capability	0.627621
Production capability	0.477923
Innovation capability	0.546673

4.4.3 *Technology Acquisition:*

As shown in Table 4.30, companies which had acquired technology through purchase of turnkey plants had acquired a high degree of project execution capability. The table shows that 60% of the firms which received the technological input through contractual arrangement such as the purchase of turnkey plants had achieved a high degree of capability in respect of investment and project execution while only 5% of the firm which started as a result of foreign direct investment had been able to develop a high degree of technological capability in this area. With regard to production capability Table 4.31 indicates that 70% of the firms which received technological input from contractual arrangement such as the purchase of turnkey plants, had achieved a high degree of technological capability. About 52% of the companies which started as a result of foreign direct investment was able to achieve a high degree of production capability. With regard to innovative capability, Table 4.32 indicates that 70% of the firms which started with the purchase of turnkey plants had achieved within medium-to-high pattern of innovative capability. With regard to foreign direct investment 67% acquired some innovative capability with 33% of firms indicating low innovative capability. Statistical analysis as shown in Table 4.33 indicates a strong relationship exists between methods of technology acquisition and patterns of technological capability. It should be noted that almost all the firms studied started by acquiring technology through two major types of technology acquisition, namely, foreign direct investment and purchase of turnkey projects.

Table 4.30 Diffusion of investment and project execution capability by methods of technology acquisition

Method of technology acquisition	Low		Medium		High		No. of firms
	No.	%	No.	%	No.	%	
Foreign direct investment	8	38	12	57	1	5	21
Contractual arrangement	2	20	2	20	6	60	10
Total							31

Table 4.31 Diffusion of capability by methods of technology acquisition production

Method of technology acquisition	Low		Medium		High		No. of firms
	No.	%	No.	%	No.	%	
Foreign direct investment	2	10	11	52	8	38	21
Contractual arrangement	-		3	30	7	70	10
Total							31

Table 4.32 Diffusion of innovative capability by methods of technology acquisition

Method of technology acquisition	Low		Medium		High		No. of firms
	No.	%	No.	%	No.	%	
Foreign direct investment	7	33	14	67	-		21
Contractual arrangement	1	10	7	70	2	20	10
Total							31

Table 4.33 Methods of technology acquisition and diffusion; statistical analysis

Types of diffusion	Coefficient correlation
Investment and project executives capability	0.508871
Production capability	0.477923
Innovation capability	0.527923

4.4.4 *Length of operation*

As shown in this Table 4.34 there is a fairly wide distribution of firms among the various age groups and levels of diffusion. Of the 4 firms that started operation within the last 5 years, 25% had acquired a high degree of investment capability. Among the firms which operated for over 20 years, 25% had achieved a high degree of technological capability in the same area. With regard to production capability Table 4.35 shows that 60% of the firm that had been operating from 6 to 10 years had achieved a high degree of technological capability. However only 28% of the firms that had been operating 11 to 15 years had achieved a high degree of production capability. Among the firms which had been operating for over 20 years, 63% had achieved a high degree of production capability. With regard to the development of innovative capabilities, Table 4.36 suggests that almost all the companies operating for more than 16 years developed some degree of innovative capability. Only 2 firms had achieved a high degree of technological capability: one has been in operation between 6-10 years and the other, over 20 years. From the three tables, it appears that length of operation of the firm had very little influence on the diffusion of 'technological capability. The statistical analysis as shown in Table 4.37 suggest weak relationship between length of operation and pattern of technology diffusion.

Table 4.34 Diffusion of investment and project execution by years of operation

Years of operation	Low		Medium		High		No. of firms
	No.	%	No.	%	No.	%	
Less than 5 years	1	25	2	50	1	25	4
6 to 10 years	1	10	2	40	2	40	5
11 to 15 years	4	57	2	28	1	15	7
16 to 20 years	2	20	4	57	1	15	7
Over 20 years	2	25	4	50	2	25	8
Total							31

Table 4.35 Diffusion of production capabilities by years of operation

Years of operation	Low		Medium		High		No. of firms
	No.	%	No.	%	No.	%	
Less than 5 years	-		3	75	1	25	4
6 to 10 years	-		2	40	3	60	5
11 to 15 years	1	15	4	57	2	28	7
16 to 20 years	-		3	43	4	57	7
Over 20 years	1	12	2	25	5	63	8
Total							31

Table 4.36 Diffusion innovative capabilities by years of operation

Years of operation	Low		Medium		High		No. of firms
	No.	%	No.	%	No.	%	
Less than 5 years	2	50	2	50	-		4
6 to 10 years	1	20	3	60	1	20	5
11 to 15 years	3	43	4	57	-		7
16 to 20 years	1	15	6	85	-		7
Over 20 years	1	12	6	16	1	12	8
Total							31

Table 4.37 Years of operation and diffusion; statistical analysis

Types of diffusion	Coefficient correlation
Investment and project execution capability	0.041129
Production capability	0.314314
Innovation capability	0.298589

4.4.5 *Nationality of foreign partners:*

For the purpose of this analysis, the nationalities were grouped into two categories, Japanese and non-Japanese joint ventures. As shown in Table 4.38, there were 9 Japanese, and 12 non Japanese firms. Japanese joint ventures constituted the largest number in the sample. In terms of investment and project execution capabilities, only 12% of the Japanese firms achieved a high degree of technological capability with 66% of the Japanese companies fall within the low pattern. On the other hand about 88% of the non Japanese joint venture companies had developed some degree of investment and project execution capability. With regard to production capabilities, Table 4.39 shows that none of the Japanese joint venture companies had acquired a high degree of production capability while 67% of the 12 non-Japanese companies had achieved a high degree of capability. Table 4.40 shows that 91% of non-Japanese companies are in the medium pattern of innovative capabilities while only 34% of the Japanese companies are in similar pattern of innovative capabilities. It should be noted that 66% of the Japanese joint venture companies had low innovative capability. As shown in the three tables non Japanese companies tended to show higher level of technological capability. Table 4.41 indicates a strong relationship exists between development of technological capability and nationality of foreign partners.

Table 4.38 Diffusion of investment and project execution capability by nationality of foreign partners

	Low		Medium		High		No. of firms
	No.	%	No.	%	No.	%	
Japanese	6	66	2	22	1	12	9
Non Japanese	2	17	10	83	0	0	12
Total	1	25	3		-		

Table 4.39 Diffusion production capability by nationality of foreign partners

	Low		Medium		High		No. of firms
	No.	%	No.	%	No.	%	
Japanese	3	34	6	66	0	0	9
Non Japanese	0	0	4	33	8	67	12
Total	3		10		8		1

Table 4.40 Diffusion of innovative capability by nationality of foreign partners

	Low		Medium		High		No. of firms
	No.	%	No.	%	No.	%	
Japanese	6	66	3	34	1		9
Non Japanese	1	9	11	11	-		12
Total	7		14		-		12

Table 4.41 Nationality of foreign partner and diffusion; statistical analysis

Types of technology diffusion	Coefficient correlation
Investment and project execution capability	0.470514
Production management capability	0.464919
Innovation capability	0.568952

4.4.6 *Nature of technical staffing:*

A large number of Malaysian companies had employed expatriates in various stages of their development. There are 2 categories of expatriate staff. For the purpose of this research, companies with short tenure experts were not considered as those employing foreign expatriates. Long-term tenure experts are those serving with the company for a period of over one year. Table 4.42 shows that five out of the nine firms or 55% that did not employ foreign expatriates had achieved a high degree of investment and project execution capability while only 10% of the firms that employed expatriates had acquired a high degree of capability in the same area. Similarly, with regard to production capability Table 4.43 shows 88% of the firms that did not employ expatriates had achieved a high degree of technological capability while 31% of the firms that employed expatriates had achieved a high degree of capability. In terms of innovative capability, Table 4.44 indicates that 77% of the firms that did not employ expatriate staff had achieved within the moderate pattern with 23% acquiring high degree of innovative capability. As shown in Table 4.44, 37% of the firms which had expatriates did not develop innovative capability while the remainder had achieved medium pattern of technological capability. The statistical analysis as shown in Table 4.45 indicates that a strong relationship exists between technical staffing structure and technological development capability.

Table 4.42 Diffusion of investment and project execution capability by technical staffing

	Low		Medium		High		No. of firms
	No.	%	No.	%	No.	%	
Expatriate	10	45	10	45	2	10	22
Non-expatriate	-		4	45	5	55	9
Total	10		14		7		31

Table 4.43 Diffusion of production capability by technical staffing

	Low		Medium		High		No. of firms
	No.	%	No.	%	No.	%	
Expatriate	2	14	13	55	7	31	22
Non-expatriate	-		1	12	8	88	9
Total	2		14		15		31

Table 4.44 Diffusion of innovation capability by technical staffing

	Low		Medium		High		No. of firms
	No.	%	No.	%	No.	%	
Expatriate	8	57	14	63	-		22
Non-expatriate	-		7	77	2	23	9
Total	8		21		2		31

Table 4.45 Technical staffing and diffusion; statistical analysis

Types of diffusion	Coefficient correlation
Investment and project execution capability	0.583770
Production capability	0.440524
Innovation capability	0.424698

4.4.7 *Nature of technical collaboration:*

For the purpose of this research, technical collaboration has been classified into 2 categories, short-term and long term. Technical collaborations with a period of less than one year are considered short-term while those exceeding one year are considered long-term. Among the 31 firms, 10 firms had no long-term technical collaboration arrangements. From Table 4.46, it appears that 60% of the firms with short-term technical collaboration arrangements had been able to achieve a higher pattern of project execution capability. On the hand those with long term technical technical collaboration had yet to develop strong investment and project execution capability with 42% of the companies indicating low capability. Table 4.47 shows that 70% of the firms which had short term technical collaboration had acquired a high degree of production capability while 38% of the companies with long term technical collaboration had attained high capability. As shown in Table 4.48, the majority of the firms with short-term and long-term technical collaboration, had acquired some degree of innovation capability. The statistical analysis in Table 4.49 indicates that there is some degree of association between the nature of technical collaboration and development of the technological capability.

Table 4.46 Diffusion of investment and project-execution by technical collaboration

	Low		Medium		High		No. of firms
	No.	%	No.	%	No.	%	
Long term	9	42	11	52	1	6	21
Short term	1	10	3	30	6	60	10

Table 4.47 Diffusion of production capability by technical collaboration

	Low		Medium		High		No. of firms
	No.	%	No.	%	No.	%	
Long term	2	20	11	52	8	38	21
Short term	-		3	30	7	70	10

Table 4.48 Diffusion of innovating capability by technical collaboration

	Low		Medium		High		No. of firms
	No.	%	No.	%	No.	%	
Long term	7	34	14	66	-		21
Short term	1	10	7	70	2	20	10

Table 4.49 **Technological collaboration and diffusion; statistical analysis**

Types of technology diffusion	Coefficient correlation
Investment and project execution capability	0.601008
Production capability	0.501411
Innovation capability	0.596573

4.5 FACTORS FACILITATING AND LIMITING DIFFUSION

Apart from investigating the degree of association between diffusion pattern and selected variableshe researcher will examine the influence ofmanagement related factors on diffusion. Executives interviewed haden asked to rank the main factors limiting and facilitating the diffusion of technology. The scale of the ranking is from 6 (extremely important) to 0 (not important at all). The mean values of each factor are calculated to arrive at the ranking order. As indicated in Table 4.50 the most important factor limiting diffusion is poor management of technology. For example the lack of local personnel involvement in project execution was attributed to inadequate understanding by management of recipient firms of the transfer process. The objectives with regard to the acquisition of technology were narrowly confined to building up production capability. Further analysis of the factor is provided according to ownership structure and management control. As shown in Table 4.51 and Table 4.52 foreign managed firms and mixed ownership firms tended to place slightly greater significance on poor management of technology acquisition. Table 4.53 indicates that Japanese joint venture companies had given a higher rating to poor management of technology as compared to those companies of other nationalities.

Table 4.50 Executives' assessment on the factors limiting the diffusion of technology

Factors limiting diffusion	Mean valves
Poor management of technology acquisition	4.87
Lack of management efforts to foster technological development	4.51
Lack of well defined technology transfer programme	4.25
Strategy of technology supplying firm	3.8

Table 4.51 Factors limiting diffusion by ownership structure

Ownership / Limiting factors	Wholly-owned local company	Mixed ownership
Poor management of technology acquisition	4.36	5.00
Lack of well defined technology transfer programme	4.73	4.30
Lack of management efforts to factor technological development	4.82	4.60
Strategy of technology supplying firm	4.00	3.80

As shown from Table 4.55 both wholly owned and mixed ownership companies, gave different rankings on factors facilitating diffusion. Wholly owned local companies ranked the lack of management efforts as the most important factor limiting diffusion of technology. Mixed ownership companies however gave higher assessment on poor management of technology. For wholly owned local companies the next important factor is the lack of a well defined technology transfer programme while for mixed ownership companies lack of management support appears to be the second most important factor.

Table 4.52 Factors limiting diffusion by management control

Management control / Limiting factors	Foreign (7)	Local (24)
Poor management of technology acquisition.	5.14	4.79
Lack of well defined technology transfer programme.	4.14	4.54
Strategy of technology supplying firm	3.75	3.75
Lack of management efforts to foster technological development	4.71	4.46

Table 4.53 Factors limiting diffusion by nationalities

Nationalities / Limiting factors	1 Japanese	2 Australia	3 British	5 Others
Poor management of technology acquisition	5.89	4.50	5.00	4.25
Lack of well defined technology transfer programme	4.22	4.25	4.25	4.50
Lack of management efforts to foster technological development	4.44	5.00	4.00	3.75
Strategy of technology supplying firm	3.78	4.00	3.25	4.00

According to Table 4.53 executives in Japanese joint venture companies, had expressed strongly on poor management of technology acquisition when compared to joint venture for other nationalities.

On factors facilitating diffusion, Table 4.54 shows the ranking order given by the companies. Development of internal resources is the most important factors facilitating the diffusion of technology.

Table 4.54 Executive's assessment on the factors facilitating the diffusion of technology

Facilitating factors	Mean value
Development of technological resources	5.48
In house technological efforts	4.80
Top management support	4.35
Strong linkages to alternative sources of technology	4.09
Selection of appropriate transfer mechanism	3.48

Table 4.55 Factors facilitating the diffusion of technological resources by ownership

Ownership / Facilitating factors	Wholly-owned local company	Mixed ownership
Development of technological resources	5.64	5.40
In house technological efforts	5.09	4.80
Top management support	4.64	4.20
Strong linkages to alternative sources of technology	3.36	3.55
Selection of appropriate transfer mechanism	3.73	4.30

As shown in Table 4.55 both wholly owned and mixed ownership companies felt strongly about the development of technological resources. It is also interesting to note that the average rating in wholly owned company is much higher in all the first three facilitating factors relating to development of technological resources, in-house technological efforts and top management support. It is noteworthy to observe that a higher importance is attached to strong linkages and selection of appropriate transfer mechanism by mixed ownership when compared to wholly owned local companies.

Table 4.56 indicates mean values by management control. According to this table executives in foreign managed companies tended to attach greater importance to development of internal technological resources than locally managed companies.

Table 4.56 Factors facilitating the diffusion of technological resources: by management control

Management Control / Facilitating factors	Foreign (7)	Local (24)
Development of internal technological resources	5.86	5.38
In-house technological efforts	5.29	4.79
Top management support	4.29	4.38
Strong linkages to alternative sources of technology	3.71	3.42
Selection of appropriate transfer mechanism	4.14	4.00

4.6 SUMMARY OF FINDINGS

This study focuses on the analysis of diffusion of imported technology in Malaysian industries. The approach to this study is based on the simple three-stage process of technological development model of a firm: acquisition, diffusion and development of technological capability. One important aim of the study was to identify the nature of technology acquisition. It was felt that the study of diffusion of imported technology should start with some understanding of the acquisition process. The second aim of the study was to identify the characteristics and factors affecting the diffusion of technology. The study was to analyse the differences in respect to the diffusion pattern among firms. The findings showed a distinct pattern of diffusion. Among firms with different types of technology acquisitions, management control and technical collaborations. The results of the analysis are summarised below in broad outline.

The researcher hopes the findings will make a real contribution to the important factors influencing diffusion of imported technology in Malaysian industries and to the development of more effective technological policies. The following summary highlights the overall findings.

4.6.1 *Acquisition of technology*

Almost all the companies studied relied extensively on the acquisition of foreign technology through direct foreign investment, contractual arrangement and, to a lesser degree, direct purchase of equipment. The most dominant method of technology acquisition is foreign direct investment, particularly joint venture operations. 70 % of the companies studied were established through joint venture operations. Firms which had no previous experience in industrial operation preferred joint venture operations because of the fast and efficient development of operating capability. They perceived the technical assistance accompanying the joint venture arrangement as an effective way of developing a long-term technological relationship with foreign suppliers of technology.

Joint venture firms when importing technology relied heavily on parent and affiliated firms. Local R & D is substituted by importing product and process technology. Design and construction of plant and equipment were contracted to foreign engineering firms which were sometimes affiliated to the parent companies. Subsequent expansion and modification of plant were also implemented through parent or affiliated firms, with little involvement of local personnel.

65% of the firms studied continued to be dependent on a continued flow of technical services and knowledge from suppliers of technology through technical assistance agreement. Because of the easy access to foreign technical assistance agreement, most Malaysian companies did not devote much of their resources to the development of the local technical expertise. However, there was a growing awareness among several joint venture firms of the need to wean themselves from the dependence on foreign technology suppliers.

These firms have emphasised development of internal expertise, particularly in the employment of professional staff and the strengthening of their technical department. The study found that the development of local expertise was a major source of friction between local and foreign partners in joint venture operations.

Local companies which had a strong desire to retain ownership and control over their operations tended to opt for the purchase of turnkey plants as a means of acquiring technology. These firms acquired technology from a number of external sources and were not tied to any one single source. They established formal and non-formal linkages with independent technology suppliers, trade associations and machine suppliers. Hence, they enjoyed greater flexibility in sourcing technology and were able to switch from one source to another in establishing additional production facilities.

The study found that locally owned firms tended to devote greater resources in the selection and evaluation of technology. Extensive search efforts were expended to identify suitable technology suppliers. In firms where investment activities was more or less continuous, there was a growing ability to undertake a range of tasks requiring a high level of technological skills in investment and project acquisition. The study also found that companies which acquired technology through turnkey transactions tended to develop a high level of skills in project planning and implementation.

4.6.2 *Determinants of technology diffusion*

Production capability was widely diffused among the firms studied. Most firms considered the diffusion of production capability essential to the commercial viability of the project. That the firm considered production capability important in the diffusion process is shown by the fact that over 50% of the firms had achieved a high degree of diffusion. Both wholly owned and joint venture operations had devoted their resources in the development of production capability. Massive training programmes had been implemented with the view to developing skills related to production capability among the various levels of staff. In joint venture operations, however, foreign partners exerted greater control over the diffusion of production capability. Foreign expatriate staff continued to play a key role in the implementation of production activities. This had to a large extent affected their ability to increase their competence in the areas relating to production function. As a result, over 50% of the firms had not been able to acquire a high degree of diffusion because of the reliance on foreign expertise and technology suppliers.

Investment and project capability was not as widely diffused as production capability. Only 22% of the firms studied had achieved a high degree of diffusion in investment and project acquisition capability. The study found that firms did not perceive the acquisition and investment of project acquisition as essential to the long-term development of the firm. It was felt that such skills could be acquired easily from technology suppliers which provided a comprehensive package relating to investment and project acquisition capabilities. In joint venture firms local partners tended to rely on parent companies to supply the necessary skills related to investment and project acquisition. There was a tendency among firms to view such skills as not necessary because they did not implement modification and expansion regularly.

Investment and project acquisition capability was highly diffused among firms which acquired technology through turnkey transactions. The high degree of involvement of local personnel in the planning and implementation of turnkey project led to the wide diffusion of investment and project acquisition capability. The case analysis shows that firms which had developed a high degree of investment and project acquisition skills tend to switch to alternative methods of technology acquisition in subsequent projects. The study also shows that in firms where investment activities was more or less continuous, investment and project acquisition capability was diffused more widely.

Innovation capability was the least developed among the three components of technology investigated in this study. Only 6.5% of the firms had achieved a high degree of diffusion with over 90% of the companies studied registering a moderate to low diffusion pattern. In most firms, local R & D was substituted by importation of product and process technology through technical assistance arrangements. In fact, all the skills involved in innovation had been acquired in one way or another from outside the country. The study found that innovation capability was developed through external technological efforts. Companies which had developed a high degree of innovation capability were those that implemented efforts to solve technical problems relating to faulty designs supplied by technology suppliers. Such efforts generally propelled the firms to a higher level of innovation capability. This served confirm the importance of learning by doing in promoting innovation capability.

Diffusion of technology tended to evolve in stages. Production capability tended to emerge early followed by investment and project execution capability. Increasing participation in project planning and implementation opened up new opportunities for learning by doing. Such efforts generally increased the role of local personnel in undertaking plant modernization adaption thus building up innovative capability.

4.6.3 *Factors influencing diffusion of technology*

4.6.3.1 *Ownership*

Ownership structure did not have much influence over the diffusion of technology. It was hypothesised that ownership would have a strong influence over diffusion. However, this hypothesis had to be rejected as the analysis did not support the statement that ownership had an influence over the diffusion of technology. In many locally owned firms, foreign technology suppliers continued to exert influence over technical operations. There was also a lack of management efforts to systematically promote the diffusion of technology. Only in a few selected firms were there any serious efforts to enhance diffusion of technology. These were owner-managed business enterprises. The high quality of entrepreneurs and strong management expertise had facilitated the diffusion of technology in these firms. Ownership control therefore was not sufficient to ensure the diffusion of technology.

4.6.3.2 *Management control*

Management control tended to have a stronger influence on technology diffusion. Firms under local management control tended to have greater autonomy in determining the long-term development of the firm. In many of these companies, locally appointed chief executives had sought to source local technical resources and develop strong inhouse expertise in order to reduce the cost of technology acquisition. A significant proportion of local personnel in key management positions in these firms had opened up more opportunities for local staff to be actually involved in critical production areas and in the process of project planning and acquisition, thereby enhancing the diffusion process. By contrast, a relative lack of local management in key positions in firms with foreign management control seemed to restraint the diffusion of technology.

4.6.3.3 *Methods of technology acquisition*

Malaysian companies generally acquired technology through foreign direct investment, contractual arrangement and direct sourcing. The analysis suggests that there is a strong relationship between technology acquisition and diffusion. Firms which acquired technology through foreign direct investment, particularly joint venture arrangements, tended to achieve lower degrees of diffusion. The study suggests that the less significant the components of foreign interests in the technology transactions in terms of equity participation and operation responsibility, the higher the diffusion pattern. Contractual transactions where the recipient firm assumed operating responsibility after the plant had been commissioned was a better vehicle of acquiring technology particularly for those firms which had a strong desire to develop a high degree of industrial expertise.

4.6.3.4 *Operating life of the firm*

The age or the operating life of the firm had little influence on the diffusion of technology. The statistical analysis and the cross tabulation did not support the hypothesis that the operating life of the firm had a major influence over the diffusion of technology. It was generally assumed that firms with a longer operating life would benefit from the learning experience and thereby accumulate a higher degree of industrial expertise. In such firms technology should be widely diffused as a result of experience in production and other technical activities implemented throughout the years of operation. However, the findings seem to indicate that many firms which had operated for over 20 years had not attained a high degree of diffusion. Many of these firms had remained stagnant and the technology diffused was only confined to basic operating skills. The study suggests that diffusion did not depend on the operating life of the firm but on the nature of technical efforts, investment activities and systematical management efforts to enhance the diffusion. A number of firms which had only started operation during the last five years had achieved a high degree of diffusion because of intense technological efforts and investment activities in terms of plant expansion and modification which led to greater diffusion of technology.

4.6.3.5 *Nationality of foreign investment*

The study suggests that multinational strategy had important implications on the diffusion of technology. A strong relationship existed between nationality and the pattern of diffusion. The statistical analysis supports the hypothesis that nationality of foreign partners had an influence over the diffusion of technology. In this study, it was found that multinational firms of Japanese origin tended to exert tighter control over the technology diffusion than multinational firms of other nationalities such as British or Australian firms. Japanese multinational firms tended to pursue a strategy which maximised the sale of components expertise, technical services and raw materials from their parent companies. They exerted greater control over the operation of the subsidiary companies than other foreign multinationals. The study suggests that such a strategy could limit the diffusion of technology because these firms tended to exclude local personnel from key decision making processes. A lack of local personnel involvement would restrict the diffusion of technology.

4.6.3.6 *Technical staffing structure*

Expatriate staffing had been employed in key roles in most of the companies. However the type of service, the nature of their jobs and the terms of employment differed from firm to firm. The findings indicate a strong relationship between technical staffing structure and diffusion. Firms which employed foreign expatriates tended to have a lower degree of diffusion than firms which did not have expatriates. Although many of these firms employed expatriates in the initial stage of operation, these expatriates had been replaced by own local personnel. In such cases, the local personnel had assumed full responsibility for the overall development of the firm. In firms which employed foreign expatriates on a long-term basis, local personnel had little opportunity to implement product process knowhow. As a result, very little learning had been accumulated and technology was not widely diffused.

4.6.3.7 *Technical collaboration*

Most of the companies tended to rely on formal technical collaboration, particularly through technical assistance agreements, to source specialised technical information and services. The study suggests that the technical collaboration has an influence over the diffusion of technology. Firms with technical collaboration tends to have a lower diffusion pattern. It should be noted that most of these firms had entered into technical collaboration arrangements since they started operation and had continued to source the necessary expertise through these formal arrangements with foreign technology suppliers. In firms which had no technical collaboration, technology tended to be diffused more widely. These firms had on their own, originated a major portion of essential technical knowledge for their own development, had no long term reliance on foreign technology sources, were quite capable of undertaking new product process initiatives and were able to originate the technological knowledge for such initiatives. Firms which had technical collaboration arrangements and which tended to rely on foreign technology input for their development continued to rely on institutional links with foreign technology suppliers.

These firms felt product and process initiative could only be undertaken by such foreign technology suppliers.

The case analysis indicates that technology diffusion tended to depend to a significant degree on the extent and nature of top management involvement and their awareness and commitment to the firm's technical progress. Technology was widely diffused in companies where the top management were involved in the planning and implementation of the transfer prices. In these firms systematic efforts were undertaken to foster technical development and develop linkages with other technology suppliers.

The study shows that many Malaysian firms rarely formulated specific plans or objectives to promote technical development. Often they had allowed the technology suppliers to determine the nature and extent of technology to be diffused. Technology transfer was often emphasised in the initial stage but the lack of policy and planning meant that the development of internal capability had not been managed effectively. The analysis has provided strong evidence that the choices of technology transfer made during the early development of the firm had long-term implications over the diffusion of technology. Most of the companies studied had delegated these choices to foreign firms. They had not given much attention or sought technical expertise or evaluated the implication of these choices. As a result technological decisions were made without examining the long-term development of the firm. In cases where the technological decisions had been left to foreign firms, interests of the subsidiary companies or local firms had not been protected. Efforts to review or make subsequent changes to technological arrangements had led to friction between the local and foreign firms.

There is strong evidence in the study to indicate that the foreign firms' corporate strategies were aimed to closely control the related technological activities. Joint venture firms and foreign partners tended to exert strong control over the diffusion of technology. Control became necessary so as to ensure that the foreign partners' interests and bargaining strength were safeguarded. The foreign firms' technology strategies must be viewed within the context of strategic control process. Control was also necessary in joint venture firms because of the desire of foreign partners to maintain some degree of flexibility in determining the transfer prices of parts and components shipped to local subsidiaries.

The findings also indicate that in-house technological efforts tend to lead to rapid diffusion of technology as such efforts not only accelerated the information flow but also subsequently generated new technical information which contributed to greater understanding of the principles underlying the imported technology. Efforts of local firms to break through technical problems when successful, often propelled the firm to a high level of technical capability. This confirmed the importance of the learning process. The study shows that in wholly-owned local firms where investment activities were more or less continuous, there was a growing ability to undertake a range of tasks requiring a high level of technological skills. In these firms local personnel participated actively in project planning and implementation and subsequently assumed an expanding role in implementing creation of new production facilities. A high degree of investment capability had permitted these firms to switch to direct purchase of equipment in their subsequent plant expansion and modification.

Wholly-owned local firms acquired their technological knowledge through the development of an information network to gain greater access to technical or strategic information. It shows that easy access to information is essential to accelerate the diffusion process. While joint venture firms were able to tap their multinational networks, wholly-owned local firms had to make major efforts to seek and acquire information. To sum up the analysis, the case studies tended to confirm that diffusion of technology depended to a significant degree on the extent and nature of top management involvement, their awareness and commitment to technical processes, the degree and nature of technical activities, technology strategies of foreign firms and accessibility to technological information.

The interpretation of the findings as well as the descriptive analysis will be given in the following chapters.

CHAPTER V

ACQUISITION OF TECHNOLOGY

5.1 INTRODUCTION

Developing countries on the threshold of industrial development will seek to import technology from abroad. Local companies and public enterprises seeking to venture into the manufacturing industry will acquire the necessary organizational and technological skills from foreign suppliers of technology. The purpose of this chapter is to identify the main methods of technology acquisition and to examine the experiences of Malaysian companies with regard to the acquisition of technology and draw conclusions. For many of the companies studied, the acquisition of industrial know-how is an integral part of the local enterprises. This research has shown that technologies are acquired by Malaysian companies in a number of ways, namely, foreign direct investment, contractual arrangement and technology trade. The process of acquiring technology can be complex or straightforward, depending on the nature of the technology to be imported. If the firm is engaged in industrial activities new to the country, the acquisition can be complex, involving massive transfer of resources from the supplier firms including the transfer of organizational capability. In the study, the researcher came across several cases in the areas of steel-making, petroleum-refining and cement-manufacturing where foreign technology suppliers have been given the task of transferring not only technological know-how but also organizational capability. This is illustrated in the case of Malayawata Steel, Petronas Refinery and Malaysian Sheet Glass where there were extensive infusions of foreign expertise and organizational know-how over a period of time. Such an effort entailed the foreign firms providing not only the hardware and the process equipment but also the infusion of a wide range of managerial knowledge relating to finance, marketing and human resource management. In analysing the issue of technology acquisition it is important to make the distinction between the three main types of technology transactions.

5.2 METHODS OF TECHNOLOGY ACQUISITION

Like many other developing countries Malaysia has to encourage the inflow of foreign technology, capital and management to develop its manufacturing base. Technology is acquired by Malaysian companies in a number of ways namely, foreign direct investment, contractual arrangement and technology trade. In foreign direct investment the sale of technology is accompanied by other requirements for the commercial operation of a project such as management, capital, brand names and some element of control by the seller through licensing, joint ventures and wholly owned subsidiaries. Contractual arrangement involves licensing agreements, technical assistance agreements, management contracts and turnkey projects. Technology trade is simply the import of machinery and equipment. Table 4.1 shows the methods of acquiring the initial technological input of the companies studied.

5.2.1 *Foreign direct investment*

Foreign firms have played a major role as investors and technology suppliers to developing countries. Apart from direct investment in wholly-owned subsidiaries, foreign firms may enter joint ventures, offer licences, sell inputs of equipment, negotiate management contracts, erect plants to provide training, or a combination of all these. As in most developing countries, foreign companies have played an important role in the development of manufacturing industries. In Malaysia, 25 of the 31 firms in the study had acquired their initial technology input through foreign direct investment. Many of them were set up in the sixties during the initial phase of the import-substitution programme.

The initial phase of industrialisation saw a massive inflow of foreign direct investment via wholly owned subsidiaries of multinationals and joint venture operations. Almost 80 per cent of the firms surveyed started their initial operations through foreign direct investment where the parent company undertook all aspects of the planning and implementation of the manufacturing operations. This method of technology acquisition had continued to be the most important channel of technology acquisition. The launching of the New Economic Policy in the seventies led to the active involvement of public enterprise in the manufacturing sector. This brought about a new surge of foreign direct investment on a joint venture basis. The lack of experience in industrial operations led many of these companies to engage in joint venture operations where the necessary technological financial and management input were provided by the foreign firms.

5.2.2 *Contractual arrangement*

Contractual arrangement encompasses a wide variety of contractual devices available for effecting transfer of technical know-how on an enterprise-to-enterprise basis. Contractual arrangement includes know-how agreement, licencing, engineering service and sale of turnkey plants. Technical assistance agreement and sale of turnkey plants are the two most common types of contractual arrangements adopted by the companies studied.

5.2.2.1 *Technical assistance agreement*

Technical assistance agreement is a major type of contractual arrangement found in Malaysian companies. Specialised technical information and services are required in the manufacture of products. The term technical assistance covers only that component of technical information and services. For many of the firms interviewed, technical assistance agreements provided an important mechanism to acquire information on plant layout, lists and specification of equipment, product literature and managerial expertise. J.N. Behrman (1970) defines a technical assistance agreement as:

> "A tool to transfer specification, production layouts, product mixes, formulae, trade secrets, advertising copy, manuals, selling techniques. Generally included also is provision for the training of foreign technicians in the supplier's plant and for a certain number of visits by the technology suppliers to help get production under way and remove any snags which may arise later".

5.2.2.2 *Turnkey plant*

Apart from technical assistance, turnkey transaction is the second type of contractual arrangement commonly adopted by the companies studied. Turnkey transactions are more complex because they require some degree of managerial and engineering skills in the recipient firms. There are various degrees of process packaging, from fully integrated turnkey plant to packaging sub-process. One of the earliest local firms to acquire technology through process packaging is Tasek Cement. Established in the sixties, Tasek Cement was then one of the largest local integrated cement plants in the country. According to the plant's Chief Engineer, it was a tremendous achievement for a local company to start a cement plant because at that time, cement manufacturing was very much considered as an industry of foreign dominance. The other cement plant at that time was operated and managed by Blue Circle of UK. Tasek Cement's ability to select process packaging was due to the fact that it had nine key personnel who had worked in another small cement plant in Batu Caves, Selangor. The turnkey contractor was a German machine manufacturer who had been supplying equipment to this small cement plant.

Table 5.1 shows the six companies that started their operation through the purchase of turnkey plants.

Table 5.1 Companies that started operation through the purchase of turnkey plants

Name of Companies	Products
Amalgated Steel Mills	Steel
Petronas Refinery	Petroleum
Associated Tiles Industries	Tiles
Associated Ceramic Works	Tiles
Seong Seng Asbestos	Asbestos products
Tasek Cement	Cement

Here, the plant contractors supply "packages" of fully integrated plants on production lines - put together from bits which they have subcontracted from component suppliers. This kind of package differs from direct foreign investment because it covers only the technical process and does not involve control over the implementation of the project. Such firms are not interested in controlling the production of the recipient firms. Process package is possible when there are machine suppliers (turnkey contractors) whose primary interest is not to sell the end product but to design and construct the plant. Their main objective is to minimise control by carrying out or subcontracting the main activities involved in a project. Consequently, some of the basic and intermediate product manufacturing plants in Malaysia are locally owned as in the cases of Tasek Cement, Amalgated Steel Mill and Petronas Refinery. However, technology suppliers will accept equity participation if they are allowed to do so, as in the case of Malayawata Steel and several other projects. Turnkey transactions are common among capital intensive industries such as steel, non-ferrous metal, power generation, oil and petrochemicals. Local firms like Tasek Cement, Amalgated Steel Mill and Petronas did not have the necessary industry experience in the early part of their operations and relied on outside help with some accumulated experience to provide the necessary organisational and engineering skills. The performance of the consulting function in a turnkey project can either be undertaken by the turnkey contractor or an independent engineering firm.

Since local enterprises do not have the necessary experience, the turnkey contractor had to assume the major role in the planning and implementation of the transfer process. The scope of the project undertaken by turnkey contractors however differs from project to project. Turnkey contractors may be appointed to undertake all the phases of the project from the planning stage to commissioning of the plant. In some cases the contractor may be asked to deliver an operating plant. In large complex projects, as in the cases of Petronas Refinery and ASM, the companies had been responsible for setting up their own project teams to work closely with various consultants to initiate the feasibility studies.

Turnkey contractors perform various functions as found in the companies studied. If the project is viable, and approved by the relevant authority, the company will proceed with basic engineering which will include the core technology in terms of process flows, plant layout and specification of principal equipment and machinery. This will also be followed by the detailed engineering aspect which will show the complete specifications of equipment and materials, detailed architectural and civil engineering plants, construction specifications and installation specifications for all equipment. Before a decision is made on the awarding of the contract, the company has to evaluate the various offers and negotiate other terms and conditions. In large and integrated projects, the recipient company may set up a task force or project management team and hire independent consulting firms to monitor and supervise the implementation of the project by the turnkey contractor.

For example, when Petronas decided to set up its own refinery in 1979 it engaged an American firm Bechtel as its own technical advisor to develop the basic design of the refinery. One of the major tasks of Bechtel was to prepare the "invitation to bid" document. Petronas assigned three of its staff to work closely with the consultant while the basic design was being prepared. Earlier Petronas had also appointed an expatriate as manager of the Refinery Project Department which came under the Processing and Manufacturing (P & M) Division of Petronas. This department was responsible for the front end planning and continuing project administration. The Engineering Procurement and Construction (EPC) lump sum contract was subsequently awarded to JGC-C-ITOH, the turnkey contractor for the construction of the refinery. Bechtel then ceased to provide further technical service as its scope of work was limited to the preparation of the "invitation to bid" document and evaluation of the bidders. To supervise the implementation of the project, Petronas formed a Project Management Team comprising 15 local personnel and technical assistants. The project team was headed by another expatriate who was provided under arrangement between Petronas and Amoco Far East Oil Company.

5.2.3 *Technology trade*

The alternative to turnkey plant, not so much perhaps for the initial project but for subsequent expansion is to acquire technology through technology trade. In this type of transaction, the technology buyers must have the technical capability to put processes together through direct dealings with the machine manufacturer. There is no packaging and the price of each component is known directly. However, this requires the recipient to develop a high degree of project planning and engineering design. Out of the 31 firms surveyed, only three firms have subsequently sourced technology through simple direct transaction. All these three firms have, over a period of time, developed in-house project management capability that permitted them to opt for technology trade. It should be noted that the three companies acquired their initial technological input from contractual arrangement.

In direct purchase of equipment, the recipient firm sometimes assumes the role of a turnkey contractor. Take for example ASM Cement. Its first and second technology acquisitions were through turnkey projects but it subsequently switched to direct purchase when it implemented its expansion project. The company's engineering staff with some external assistance carried out the feasibility studies, specification preparation, project planning, tender formulations, bidding scrutinisation and technical negotiations. After various plants and equipment had been selected, and contracts awarded, the company's engineers were responsible for the follow-up action on the detailed plant layout and arrangement with manufacturers. In direct purchase, the company will know the exact price of each component. ASM selected four different machine suppliers from Italy, Germany, Switzerland and France to establish the second rolling mills.

Direct purchase of equipment is not well developed as a form of technology acquisition among large and medium sized companies. Many companies reported that they lacked information and the market intelligence to check on the validity, completeness and quality of whatever was available. Apart from companies like ASM, Tasek Cement and Malayawata Steel, most companies had limited ability to break down technology, not simply because of the lack of knowledge but also because of limited capability for design and engineering of technologies associated with the more complex technologies imported. Therefore companies tended to purchase on a packaged basis through turnkey transactions. Chapter VIII on policy implication discuss some of the issues related to the lack of design and engineering capability in Malaysian companies.

5.3 CONTRIBUTION MADE BY TECHNOLOGY SUPPLIERS

Technology suppliers played a dominant role in building up the manufacturing base of Malaysian companies, namely through the creation of joint venture operations. In the course of this study companies were asked to indicate in order of importance the contributions made by foreign technology suppliers. Table 4.9 shows the mean values of the contributions made by technology suppliers. As pointed out in Chapter IV the supply of technical know-how was perceived as the most important contribution followed by training selection and evaluation of technology. In this chapter the researcher would provide detailed analysis supported by relevant case analysis.

5.3.1 *Supply of technical know-how*

The supply of technical know-how was been ranked as the most important contribution made by technology suppliers. Most of the companies felt that the infusion of product process know-how through technical assistance agreements had contributed to the commercial viability of their projects. Almost all the joint venture firms interviewed had technical assistance from their foreign partners. Many of the executives felt that they could not afford to have teething problems which might later affect the commercial viability of the project. Moreover, many of them did not have sufficient industrial expertise and such an arrangement required comprehensive development of technological resources.

Executives were also aware of competitors who had attempted to be self-reliant and as a result suffered serious setbacks due to severe technical problems. In fact, in the sample firms studied, there were three firms which started through the purchase of turnkey transactions without any technical assistance arrangement.

The discussion on two companies, H & R Johnson and Associated Ceramic Works (ACW) illustrates the role of technical collaboration in technology acquisition. H & R Johnson is a joint venture between local interests and H & R Johnson of UK. The company has been manufacturing wall tiles for the past 10 years. Recently, the company expanded into the manufacturing of floor tiles. It has a technical assistance agreement with H & R Johnson of UK. As part of this arrangement, the foreign partner seconded one of its staff as a technical advisor. During the initial expansion project, the company was guided by the UK company on choice of technology, evaluation of technology suppliers, training of manpower and product process formulation. Key executives of H & R Johnson (Malaysia) attributed the smooth operation of the company to the technical support from its UK partner. Because of its long experience in tile manufacturing, the UK company was able to accumulate and contribute vast resources of know-how, assistance and expertise.

The case of Associated Cement Works (ACW) provides a contrasting experience. This company is a subsidiary of a large wholly owned local company with diverse interests in manufacturing, finance and property development. ACW started its floor tiles operation through the purchase of turnkey plant from a machine supplier. There was no technical assistance arrangement as the company felt it could tap the expertise of its associate companies involved in the manufacturing of building products. When the new plant become operational, the company encountered several technical problems which could not be remedied by the machine suppliers. In the course of the interviews with the executives of ACW, it was found that the company had underestimated the complexity of introducing a new process equipment which required a different type of product process know-how. It was also pointed out that the equipment supplier had little manufacturing experience and was unable to provide useful assistance. It took the company several months before it could solve the problem with assistance from another established manufacturer in Indonesia. For many new firms, the acquisition of machinery plant and equipment is not sufficient to ensure a viable operation.

From the interviews it is obvious that foreign firms, particularly technology suppliers, had contributed to the development of manufacturing base through the provision of product process know-how. In various industrial sectors such contributions have been recognised by companies. Once a manufacturing plant is established and performs to the suppliers' warranties, the firm becomes dependent on a continous flow of assistance so that it absorbs the technology and competes in the market place. The firms for example need to develop the ability to maintain the plant in top operating condition or to alter the product mix such as product volume, quality range and price as market conditions change. The value of the contributions lies in ensuring the commercial operation of the new plant.

5.3.2 *Training of local personnel*

Training was ranked by companies as the second most important contribution made by technology suppliers.

Several executives interviewed pointed out the significant contributions made by foreign partners in developing skills of local personnel. Detailed training programmes were generally discussed and agreed upon by both parties during the initial stage of negotiation. Local personnel were then placed in the foreign partners parent's company to undergo on-the-job training. Almost all the firms studied had sought assistance from their technology suppliers to train local personnel in the respective areas.

In terms of enhancing technology diffusion nothing is more important than systematic efforts in the development of human resources as shown in the case of ASM, Petronas and Tasek Cement. Technology acquisition had always been accompanied by massive training programmes in both joint venture and local enterprises. During the initial phase of operation, training assumes an important role in developing basic operating skills. Once a manufacturing plant is established, the new firm becomes dependent on a continuous flow of assistance, particularly skilled manpower to maintain the plant in top operating condition or to alter product mix. Training however, becomes more crucial if the firm is engaging in an activity which is new to the country and whose skills are not widely available in the economy. In large and highly complex plants such as petrochemicals and steel, the availability of a comprehensive training facility will determine the pace of technology diffusion. The role of training in accelerating technology diffusion is also clearly illustrated in the cases of ASM and Tasek Cement. All these three companies had implemented systematic programmes to build up skilled personnel in various fields. For example ASM launched a massive training programme during the initial start up of its steel operation. Almost all its executives and supervisory personnel were trained in other steel companies like China Steel of Taiwan. In addition the company brought in short term experts in various fields such as furnace technology to impart specialised skills to local personnel. In selecting the choice of technology suppliers, staff were encouraged to make plant visits to steel companies in various parts of the world for the purpose of evaluating the performance of the technology suppliers. In the second year of its operation ASM had phased out all foreign expatriates except one. Similarly Tasek recruited 20 Taiwanese technical personnel in the early sixties to train local personnel during the initial phase of operation. Young Malaysian graduates were recruited from foreign universities to work as local counterparts to Taiwanese expatriate staff. The training programme was very successful and from 1967 to 1973 the company's engineering personnel was able to design and engineer several facilities such as a high output limestone crushing plant, electrostatic precipitators and an automatic conveyer system. Petronas' four-year operating contract with Caltex facilities not only involved enterprise-to-enterprise transfer of technology but also the implementation of counterpart training schemes. Because of its intensive search efforts and networking formation, the company was able to send its staff to numerous plants in several countries. According to the Personnel Director the company had invested heavily in manpower development. Among its personnel almost all supervisors and executives had been sent for overseas training.

Training is important not only during the initial stage of operation but also in subsequent plant expansion or introduction of new products. Training was therefore perceived by many firms as critical to the development of their operation and foreign firms had contributed immensely in this area. As shown in Table 4.11 companies which had operated within six to 10 years had given a higher rating on training, suggesting the need to continue training support from foreign technology suppliers after the initial years of operation.

5.3.3 *Selection and evaluation of technology*

Selection of technology has been ranked as one of the most important contributions by technology suppliers. As indicated in Table 4.19 10 out of the 31 companies have low investment capability and generally lacked the ability to decide what to produce and the capacity to prepare a project properly from the preliminary study to the commercial and technological feasibility studies and then to the engineering study which is related to investment capability. During the initial establishment of the firm, company personnel generally do not have the expertise and knowledge in starting a manufacturing operation. Thus the services of technology suppliers in implementing the planning stage are crucial because the selection of technology can determine the viability of the project. Table 4.11 suggests that role of technology suppliers in selecting and evaluating technology is critical in the early years of operation.

Selection of technology starts with the feasibility study. The feasibility study will define the technology required for a particular project, and this will be used to evaluate and select the most appropriate technology in terms of optimum combination or project components. The various implications of acquisition of such technology have to be assessed. When the project is complex, consultants are recruited as in the cases of Petronas Refinery and ASM where both companies hired consultants to assist in the selection of technology. The selection of technology has thus to be dovetailed with the selection of machinery and equipment as this often bears a close relation to the production technique chosen.

The selection of equipment and technology are interdependent. In certain projects, such as cement plants, production and operational technology are part and parcel of the supply of equipment and no separate arrangement for technology acquisition is necessary. Foreign partners and technology suppliers had contributed immensely in the initial stages of development of several companies. Foreign firms with long experience in a particular industry have developed good knowledge of the market for technology. They had assisted in the identification of machinery and equipment on the basis of plant capacity and the selected production technology. The equipment choices for the manufacturing industry are much wider as different machines can perform similiar functions with varying degrees of accuracy. In certain cases where the company has acquired some degree of expertise, local personnel have participated in the process. Companies felt that the contribution of technology suppliers is necessary even though they had developed a high degree of internal expertise. There are cases where technology suppliers had to rely on local personnel to assist them in the selection of technology. This generally occurred during the preliminary stage of the project. Once viability was established, the company would embark on a more detailed study using specific engineering data obtained from potential technology suppliers leading to tentative choices among the alternatives considered earlier. A sound knowledge of the local technological environment is essential to establish a suitable parameter because of the country's specific factor. The size of the domestic market may dictate the scale of the plant and the researcher was informed by several companies that most of the plants have to be scaled down or tailor-made to meet the country's needs. For example Pristima's tin plating plant was tailor-made by the Japanese technology suppliers.

Local companies also worked closely with technology suppliers on the planning of new projects. When Alcom was planning its MR60 million continuous rolling mill, the local manager was sent abroad to the foreign partner's office to obtain advice on the selection of technology. Technology suppliers with wide experience in the manufacturing of a particular product normally acquire a high degree of technical know-how on the manufacturing of a particular product. The selection of technology becomes critical particularly when the equipment will have to be sourced from an independent supplier who may not have the necessary manufacturing expertise. In many cases, the technology has to be adapted in order to be suitable for the local market. This is necessary when local raw materials are used and certain allocations are required to ensure that the plant may be able to manufacture the products. It is important to know that raw materials often differ from those used previously and because the processes may require changes, the end products often differ considerably from those manufactured elsewhere. It is therefore necessary to evaluate how far it is suitable for the local market. Technology suppliers had assisted firms in carrying out this investigation. For example when H & R Johnson started their tile manufacturing plant, the foreign partner had assisted in the investigation of using raw materials for manufacturing the products. The prototype was manufactured in their plant and also sent to other plants where similar equipment were being used. This was to ensure that the equipment to be purchased was suitable for the production. In cases where companies did not have technical assistance, they had to rely on the machine management systems reflected the organisational culture of the parent companies of their partners. In cases where the transaction does not include the provision of management expertise, the recipient firms will have to develop their own management systems.

However, most of the companies studied had to rely on foreign sources to set up the whole organisational system. Executives felt that one of the main advantages of joint venture operations was the ability to acquire advanced management practices from foreign partners. This has been one of the competitive strengths of joint venture companies which are able to establish commercial operations quickly while wholly owned local companies take some time to evolve their own management practices and system. It is important to recognise that the rationale for the transferability of advanced management know-how and practices rests on the premise that such know-how and practices augment and hasten the industrial development processes in the developing countries. In the course of the study, the researcher found all the firms in the joint-venture companies felt strongly that they had benefited from the advanced management practices pertaining to employee training, employee relations, purchasing, cost and budgetary control, quality control maintenance of equipment and setting work standards for blue collar, supervisory, clerical and managerial personnel.

According to Peter Gabriel (1967) the acquisition of specialised management skills and knowledge is crucial but more important is the development of attitudes, assumptions and values in line with the new industrial life. The infusion of corporate skills and capability transcends the supply of product or process centered information. It includes the latter but more importantly it involves the building of a whole new organisation. It requires not only the transplantation of personal abilities but also the infusion of institutional skill and values; not only the transmission of techniques but also change in basic attitudes of the recipient; not suppliers to ensure that those products would be manufactured according to specifications. This could create problems because machine suppliers are not manufacturers and may not have the expertise to assist the local company. For example, the problems encountered by SSA and ACW, elaborated on in various parts of the study, could have been avoided if the two firms had secured assistance from established manufacturers to help them in the selection of technology. It is for this reason that many companies find that technology suppliers' assistance in the selection of technology ensures the viability of their projects.

5.3.4 *Providing management expertise*

A typical manufacturing organisation involves a whole range of activities like production, marketing, research and development, personnel and finance. Each functional grouping requires special capabilities on the part of its manager. As shown in Table 4.10 executives in most foreign managed firms acknowledged the role of foreign partners in establishing a comprehensive management system. They felt that the development of management resources was essential to the successful operation of the company. Most of them attributed the smooth operation of the plant to the comprehensive package provided by the foreign partners. In the study the writer found that firms initiated their management process by acquiring the foreign firm's management practices around which they developed their organising and controlling activities. In foreign direct investment, the technology suppliers were involved in setting up the personnel system, financial and accounting system, marketing and sales support services and the overall production system. These systems were developed and evolved within the organisational system of the foreign firm.

Several executives in joint venture companies, particularly Japanese joint venture companies like Peristima, Pernas NEC, Malex and MSG, pointed out that their only development of the ability to follow instructions but also the ability to make decisions. It is for this reason that many Malaysian companies insisted that local personnel be trained in the plant of the foreign partner in order to acquire greater exposure to industrial practices and ethics of the industrialised countries.

5.3.5 *Sourcing components raw material and strategic information*

Several companies depended on their foreign partners to source basic inputs of plant components during the initial set up of the plants. Apart from basic raw materials and inputs, these new manufacturing companies required various auxiliary materials and factory supplies. It was not always easy to source these inputs locally. Many companies started their operations on assembly basis sourcing all the major components externally. The sources and the constant availability of basic production materials are crucial to the determination of the technical and economic viability. Several executives pointed out that the selection of technology process equipment and the product mix depend largely on the specifications of basic materials. Foreign technology suppliers had made possible the availability of components, intermediate goods and raw materials by sourcing from their own supplier companies within their own multinational network. As shown in Table 4.11 the support of technology suppliers is crucial in the initial years since local companies have not developed their relationship with the component suppliers.

Market information is important to firms seeking to export their product to other parts of the world. In view of the small domestic market in Malaysia many firms have sought the assistance of technology suppliers to gain access to the world market. Foreign partners in joint venture companies have used their international network to export products of local subsidiaries to regions where they have no production facilities. For example KL Glass through its foreign partner Australia Consolidated Industries exported its glass products to the Middle East. Several wholly owned firms which had technical collaboration arrangements with independent suppliers tended to seek information on potential markets. Linkages with established manufacturers would allow the firms to sell back a portion of their production.

In the case of Hume Industries, a well established local company, the support given by the technology suppliers provided an opportunity to acquire strategic information and to expand into various fields. Most managers indicated that they lacked reliable information on many external phenomena such as population, industry trends, new and emerging technology, and export market opportunities. They lived in a setting characterised by a paucity of data. Short of resources and skilled personnel as they were, the managers felt that they had very limited capability to evaluate and search for external information. The lack of local resources led many firms to rely on foreign sources for critical information particularly market and technical data. Unlike multinational firms, local companies do not enjoy the advantage of international networks to scan the industrial environment and establish overseas market opportunities. Local companies have to rely on foreign firms to identify opportunities for new product development, market opportunities and changing global industrial environment. For example, Blue Circle of UK published several newsletters to inform its associate firms worldwide on technical developments related to the cement industry

5.4 CONFLICTS RELATING TO TECHNOLOGY ACQUISITION

In the acquisition of technology both recipient and supplying firms are confronted with critical issues that affect their long term relationship and also the diffusion of technology. Firms were asked to indicate the major source of conflicts with foreign firms relating to technology acquisition. Table 4.13 shows the mean values of conflicts experienced by firms relating to technology acquisition. The analysis of the findings will be provided in this part of the report.

5.4.1 *Development of local expertise*

Development of expertise has been identified as the most important source of conflict between recipient and supplying firms. From the case analysis there are three major issues relating to the development of expertise. First is the scope of training, second is the nature of internal expertise to be developed, and third is employment of expatriates.

Training has been an important component of technical collaboration between recipient firms and supplying firms. During the initial stage of development, foreign firms generally provide a comprehensive training programme relating to the development of basic operating skills. As company personnel acquire the necessary experience over the years the requirements for training also change. Companies tend to seek training in specialised areas in addition to basic skills that were provided during the early years of cooperation. Foreign firms are reluctant to extend training facilities beyond those that are required for basic operating activities. Several expatriates reported that the scope of the training had been negotiated during the initial stage of establishment of the firm. While a majority of foreign firms were willing to meet the demands of the recipient companies with regards to training requirement, a few recently established joint venture companies were quite rigid in the implementation of training programmes. They did not consider it their responsibility to provide training beyond what was necessary to start the basic operation of the firm. Secondly, they felt that such training was not necessary because the expertise was already available in their parent company. It would not be necessary for the recipient firm to duplicate whatever expertise already existed in the parent company. The reluctance of the foreign partners to entertain additional training requirements tended to create tension between the two partners.

Additional training is also required by recipient firms because of the frequent turnover of the local personnel. There is a tendency of job hopping among Malaysian personnel. A number of these trained staff were taken by other firms because many of them had received training from specific institutes. Many local firms would offer job opportunities to personnel that had received training in foreign countries. Foreign partners generally felt that it was the responsibility of the local partners to ensure that those staff that had received training stayed with the company. There were instances where the local partners would try to acquire additional training facilities from other foreign firms. This was also resisted by foreign firms because they felt that some of these firms could be their potential competitors. Staff that had already been trained in their own firm might reveal some of the management and technical practices adopted in the company.

Another major source of conflict related to development of internal expertise is the nature of technical capability that needs to be developed within the company. Since most of the joint venture firms were perceived as mere production units of the parent company, the foreign partner tended to emphasise on the development of production of management capability. Expertise in the field of production management was to be provided by the parent company. Local partners generally did not agree with this view. They felt that the joint venture firm must develop a wide range of capability encompassing the whole range of industrial operation activities. This should include the feasibility studies, plant construction, production management and the development of R & D capability. However, it is not in the interest of the foreign company to have those activities in the subsidiaries. Many of the foreign companies have pursued the strategy of centralizing their R & D efforts. Moreover they feel that some of the local subsidiaries are too small to justify the establishment of R & D facilities or special project teams. Foreign partners expressed the view that during the initial stage of establishment of the firm, it was agreed by both parties that the primary role was to establish the production activities. Issues relating to R & D capabilities and project management were never discussed. According to expatriate staff it would not be fair to raise those issues at the later stage of development of the firm because the term of the transfer was based on the initial negotiation. Local partners tended to agree that many of these issues were not raised earlier because they felt that they were still new to the industry and had very little experience in the manufacturing operation. However they felt that the foreign partners should be flexible and should adopt different strategies as the company progressed. This would ensure the continued viability of the enterprise.

This leads to another related problem pertaining to the employment of expatriates. Foreign partners employ expatriates particularly for technical positions. As shown in Table 4.14 on development of local expertise, in companies where expatriate staff were employed in production/technical department, employment of expatriates has become a major source of conflict. Local partners have always argued the importance of developing internal expertise in order to replace foreign expatriates. Local partners become quite concerned over the high cost of supporting expatriate staff. Expatriate staff have always been perceived as depriving local personnel of their opportunities for upward mobility. For example, in the case of Malaysian Sheet Glass (MSG), there are at least 10 expatriate staff in various managerial posts while the assistant managerial posts are held by local personnel who have been working for several years. The local personnel felt that there was little opportunity for them to move to managerial positions as long as the expatriate staff were employed by the company. Most local personnel felt that since local investors had ownership control they saw no reason why the managerial or chief executives posts should be held by the expatriate staff. This tended to create tension between local and expatriate staff leading to some degree of mistrust and suspicion. Several of the assistant managers in MSG are professional staff who felt that they should be entrusted with more challenging responsibilities in view of their professional training. They argued that the jobs they were doing were routine and did not demand a high level of technical skills. Key technical decisions were made by expatriates with very little involvement of local personnel. It should be recognised that expatriate staff had served an important role in naturing the development of the companies studied. Very few local employees had the necessary experience and skills to manage complex industrial operation such as steel mills or petrochemical, plant initially. Conflicts relating to the employment of expatriate staff tended to emerge in companies where there is an absence of what is termed as "phase in-phase out" programme. In such a situation there is no specific plan to train local personal to replace foreign expatriate. However in companies where phase inphase out programmes had been implemented the relationship between local personnel and foreign expatriate had been excellent. Trust, goodwill and professional respect seemed to prevail. Technology transfer programmes where expatriate staff were employed to impart specific skills for a specific period had evidently proven to be successful. For example as shown in Table 4.13 companies which sourced technology through contractual arrangement tended to perceive the development of local expertise as a less important area of conflict. In such arrangements foreign expatriate staff has been employed on specific assignment with a views of transferring and training the necessary skills.

5.4.2 *Project planning and implementation*

Another major source of conflict is the implementation of expansion projects. There are two issues related to project planning and implementation. First is the sourcing of technology and second is the involvement of local personnel. In undertaking expansion, it is not uncommon for foreign partners to provide many of the resources needed and at times assert themselves strongly in the planning of the project. Local partners interviewed objected to attempts by foreign partners to exclude them from participating in the planning and implementation of the project. They also objected to attempts by foreign partners to source the technology solely from the foreign partners' parent companies. Local partners felt that such advantages occurred largely to the foreign partner's parent company.

Take the case of a recent project implemented by Alcom. The selection and evaluation of technology were carried out in the foreign partner's head office with some degree of involvement by local personnel. During the implementation the foreign partner seconded eight of its staff from its Indian subsidiary to lead the project management team. Since the technology was acquired on direct purchase involving numerous machine suppliers a strong project management team was required to coordinate the whole project. It was pointed out that only a few local staff were involved in the implementation phase. Nevertheless a high degree of local content was included in the plant because local personnel made serious efforts to subcontract certain components to local engineering firms. According to some personnel, the foreign partner was trying to push some of its secondhand equipment on the project but this was not confirmed. It is important to note that Alcom has over 30 engineers and other professionals in its labour force. As a majority-owned local joint venture, the project was partly financed by local investors. As pointed out by local personnel the staff of the Indian subsidiary benefited immensely from implementing this major project and acquired a high degree of project engineering experience. It should be noted that the Indian subsidiary is wholly owned by the foreign firm. When asked why Indian nationals were brought in to carry out the project, certain key personnel pointed out that local personnel lacked project management skills and secondly most of the technical staff were preoccupied with the day-to-day operation.

The preference for foreign partners to minimise local involvement in the planning and implementation phase is not an accidental phenomenon. First and foremost foreign partners would want to derive some benefits from new projects particularly in the sale of equipment and services. The evidence suggests that Japanese joint venture companies tend to pursue this strategy because of the tie-up of trading companies in the joint venture set up. Interviews with MSG, Malex Asbestos, Peristima, MCIS, Safety Glass and other Japanese joint venture companies tend to confirm this practice. Table 4.15 shows that this area of conflict tended to be more apparent in Japanese companies. As in most cases the trading companies become the exclusive agents during initial set up and subsequent expansion and modification undertaken by the subsidiary company. Whenever local interests are included in the planning stage they tend to reassert themselves by insisting that local components and services should be sourced locally where they could be much cheaper. This becomes a source of conflict between local companies and their foreign partners. Foreign partners in joint venture companies admitted that a large proportion of their raw material or input requirements are not from local sources although some efforts have been made by some of them to increase such purchases. Subcontracting system involving a stable ancillary supplier-purchaser relationship is as yet not well developed. This state of affairs may not be totally their fault because there are a number of inhibiting factors making inter-industry linkages minimal. These factors include:-

(a) The nature of some of the industries represented by the selected companies still require a large proportion of their raw materials and other inputs from overseas as these inputs represent "work in progress" to be further processed (e.g. semiconductor components).

(b) There is a certain amount of tie-up between local subsidiaries and their parent companies or other affiliate companies for the bulk procurement of raw materials and other inputs for reasons of economy of scale.

(c) As far as the companies are concerned, the question of quality and reliability of supply of local raw materials and other inputs always crops up. In many cases, the local operation may have little choice but to obtain their raw material and other inputs from their own sources.

Although local partners accepted the argument that certain components were much cheaper to source abroad there were not convinced as to the seriousness of the foreign partners' efforts to source local inputs and develop local ancillary industries. For example in the case of Pernas NEC, the Telecoms Department which was the sole purchaser of switching equipment had included in its contract that the switching equipment supplied by Pernas NEC should include 70% local inputs. According to Pernas NEC, this condition can be met and so far the company had achieved 40% local inputs. For instance the metal frame for the switching equipment and high grade printed circuit board had been sourced locally. Price comparison is made before the decision to implement local content is taken. In most cases components manufactured by NEC was much cheaper but there were many components which NEC sourced from other Japanese manufacturers which were much more expensive than what could be procured locally. In the case of the switching equipment the metal frame and printed circuit board are a good examples where the products met the stringent quality specifications of NEC and were available at prices much cheaper than those found in Japan.

5.4.3 *Transfer pricing*

Transfer pricing is a common practice among foreign companies. As pointed by Stopford and Wells (1972) inter company transactions among firms within their network is a means of maximising the cash flow. Prices paid for components and other services to their overseas counterparts are above the market prices. Over-charging of components and inputs has become a major source of conflict.

The issue of control is very much related to transfer pricing. Control becomes essential because of the foreign firm's desire to maintain some degree of flexibility in determining the transfer price of parts and components. There are considerable advantages to the company in being able to determine the transfer price at its discretion. Local companies tend to resist when the foreign firms assert control particularly with regard to procurement since they are anxious to obtain the lowest possible price to assure the highest profit to be attained.

For whatever reason the foreign firms are attracted to Malaysia, their primary purpose is to maximise the investment of the parent company. As pointed out by Yoshino (1976), one of the most important objectives of a Japanese joint venture is to maximise exports from Japan to local subsidiaries of items such as intermediate goods, raw materials, and components. Several of the personnel interviewed reported to the writer on large payments of technical fees and higher prices charged by local partners on purchases of raw materials and components. Attempts by local partners to develop alternative suppliers were strongly resisted by foreign partners. For example take the case of Peristima. The company was formed as a result of a joint venture between government-owned companies and Japanese companies. Apart from supplying the technical resources, the foreign partners also supplied the basic raw materials which made up 70% of the production cost. The local chief executive found that he could obtain the raw materials from different sources at more competitive prices. However this was strongly opposed by foreign partners because it would deprive them of the benefits of inter-firm trade. Foreign partners viewed control as necessary to ensure compliance from local partners particularly in areas where there were bound to be disagreement and conflicts. As in other attempts made by local partners to obtain more control over important resources, obtaining better access to information in order to assess the cost of raw material was resisted by foreign partners. Local partners did attempt to affect the conditions in order to create greater likelihood of being able to exert control over their foreign partners. But these attempts more often than not caused strains and interorganisational conflicts. Transfer pricing practices can affect the development of local content programme particularly when sourcing abroad is always beneficial. Companies are required to adhere to certain policies regarding the local content programme imposed by the customer. Implementation of such a programme requires the supplying firm to provide additional information on those components to be manufactured locally. The study shows that there were cases where the supplying firms were not willing to provide the information. Some of the companies found that local content programmes were in conflict with their multinational strategy of supplying components to subsidiary companies. Many of the multinational companies produced components in large volume and supplied these to their various subsidiaries. Local content programmes would not be in their best interest because the cost of manufacturing such components in small volume would not be economical. Moreover there was some element of transfer pricing in supplying components of the parent company. For the local companies, local content programmes provide an opportunity to increase their manufacturing activities. They also help them to develop better linkages with other local companies and to increase the learning opportunities for local personnel. Most important, local companies could demonstrate their commitment to national programmes by promoting the local content programmes. Conflicts between local and foreign firms are due to the different perceptions by both parties of the issue of local content. For the local companies, the technical assistance agreement is a mechanism for acquiring technical resources to meet their specific needs including the implementation of local content programmes. However this may not be accepted by foreign firms which consider the technical assistance agreement as a means of only providing a basic operating knowledge for the local operation. As pointed out by executives interviewed problems of pricing between domestic factories and export divisions of parent companies were of major preoccupation in most firms. However evidence of transfer pricing is difficult to obtain unless one can get access to detailed financial transaction. From the interviews it was revealed that intercompany pricing has always been a controversial issue - some companies like Alcom and Pernas NEC did not agree that transfer pricing is a major issue in their companies. According to these two companies pricing had always been based on ethical business principles consistently applied throughout the enterprise. It was to reflect cost and reasonable assessment of the value of the good service transferred. Prices are not to be influenced by superficial differences in taxation between countries. Transfer pricing involved financial issues and technical related matters such as local content and sourcing. Hence as suggested by Table 4.14 companies with expatriate staff in finance and technical departments gave higher rating on issues related to transfer pricing.

As noted by Stopford and Wells (1972) "the multinational enterprise has a large incentive to remove profits from the joint venture in ways that will eliminate the need to share them with the local partners. Large payment by affiliates for services and higher prices of purchases of materials and components from related enterprises can reduce profits that have to be shared, transferring them to another part of the multinational firm."

5.4.4 *Control of technological resources*

Control of technology resources is a major source of conflict particularly among firms at the advanced stage of development. During the first few years of operation, companies tend to be preoccupied with building up some degree of capability and depended very much upon foreign partners. As technology advances, companies tend to look for other business opportunities particularly due to the increasing demands for their product and also their desire to exploit the technological skills of their staff. This strategy will require development of new products or expansion to new areas of activities. However, in most joint venture companies partners are quite reluctant to invest in new activities they are not familiar with. Many of the foreign firms are single product companies and specialised in the narrow product line. For example there are many medium sized Japanese firms which only specialize in certain products particularly intermediate goods like glass, cement, asbestos and steel. Local partners tend to seek other new technology suppliers to assist in the development of new manufacturing facilities. More often than not this was objected to by foreign partners because they feel that this would conflict with existing joint venture agrements. This therefore created a degree of tension and conflicts between the two parties. Because of the reluctance of foreign partners to participate in this expansion programme, local partners tend to seek greater control over the sourcing of technological resources. Local partners sometimes want to establish separate technical collaboration with other companies that can assist them in these new activities. For example, Pernas NEC, a supplier of telecommunication equipment several times approached their foreign partner to expand the manufacturing operation into several related communication products. The company also tried to seek greater access to technological knowledge with little cooperation from its foreign partner.

Another major source of conflict is the accessibility to technical information. Technical assistance agreements generally provides a formal channel for the local firm to acquire information in broad areas related to the manufacturing activities. Some foreign firms channel the information only through their expatriate staff. As company personnel become more knowledgeable in their operations, their demands for information also increased. Many of them were not happy that the channel of information should be the expatriate staff. They wanted to acquire some of the information direct from the parent company of the foreign firm. For example several Japanese companies like Nippon Glass, a partner to MSG and Nippon Electric Company (NEC), another partner of Pernas NEC, have R & D facilities in their home country. Local personnel had requested that some R & D should be conducted locally to promote greater technological efforts. They also sought greater access to new production process improvement developed by their foreign partner. The reluctance of foreign firms to make such information more accessible created mistrust and tension between the two parties. Foreign firms were not in favour of promoting R & D because they found that certain operations were too small to support R & D activities. It was not in their interest to have R & D activities in a host country because of the possibility of information leakage to competitors. Different perceptions of the role of technological resources was a major issue in technology acquisition. Local partners generally seek greater control of technological resources in view of their need to implement their own programmes. It was therefore necessary to acquire control over resources if their expansion programmes were to materialize. It would also reduce dependence on their foreign partners.

5.4.5 *Implementation of technological collaborative agreement*

Companies enter into technical assistance agreement for the purpose of sourcing product and process know-how, training facilities, management expertise and other assistance from the supplying firms to enhance the capabilities of the recipient companies. The terms of technical assistance agreement are fairly broad in nature. It is perceived as a mechanism to transfer resources to the recipient companies. In consideration of this arrangement, the recipient company is required to pay the cost of technology acquisition. Interpretation of this agreement has become a major source of conflict.

Such clauses are imposed by foreign firms to protect their interests. Examples are clauses restricting the local firms from exporting their products to selected countries. Although most of the firms were set up as a result of the import substitution industry, the need to export becomes quite crucial after the local market has been saturated. Companies find that there is a need for them to look for expanding overseas markets. However, foreign firms are not in favour of this because many of them had established their own subsidiary companies in other countries. Governments generally promote the export of local products as part of their industrialization strategy. Incentives and other benefits are provided by the government to promote export to other countries. Local companies are attracted to such incentives and it is important they should appear to support industrial policies regarding the development of export orientated industries. However it should be noted that the government screening mechanism has to a great extent eliminated restrictive clauses. As shown in the study the issues related to technical agreement have been perceived as the least important areas of conflict.

New demands are established with regard to development of expertise, greater involvement in project planning, elimination of transfer pricing practices and control over technological resources. In the study it was found that these issues often became the major source of tension between the supplier and recipient of technology. The available evidence suggests that while Malaysian companies are dependent on foreign firms for technology, they are seeking new strategies to promote greater technological importance within the enterprise.

Malaysian companies acquired technology through foreign direct investment, contractual arrangements and to a lesser degree direct purchase of equipment. A number of alternative technology transactions such as licensing are available and this raises the concern that for one reason or another, the range of effective options open to Malaysian firms as to the potential alternative sources is not varied.

Thus in terms of sources of technology, the concern is not so much with the measured degree of utilization of imported technology as with the apparent lack of alternative sources of technology. It is therefore important that firms consider alternative methods of technology such as licensing and technology trade rather than foreign direct investment in view of the limitations with regards to the acquisition of technology through joint venture operation. If foreign direct investment particularly joint venture arrangement is preferred Malaysian companies should renew the framework of technical collaboration with some degree of government intervention this would help firms seeking to obtain imports of technology on the best possible terms, to avoid transactions which include components that may hinder the firm's long term growth such as export market restriction, promote the use of local suppliers rather then foreign source; and where technology is imported, ensure that the method of transfer provides for adequate local participation. Some of these provisions are beginning to appear in some recent joint venture arrangements entered into between foreign and local firm. As discussed in Chapter IX on public policy, thegovernment should intervene more strongly to strengthen the existing screening mechanism and impose other measures on local firms to strengthen their management of technology transfer in order to ensure adequate absorption of imported technology. The development of the manufacturing industry must be focussed on the mobilization of indigenous entrepreneurs and technical resources and only within this context is technological capability truly indigenous.

5.5 CONCLUSION

Malaysian companies acquire technologies through three main methods, namely, foreign direct investment, contractual arrangements and, to a lesser degree, technology trade. Most firms tend to view foreign direct investment, particularly joint ventures, as an important vehicle of acquiring technology. Joint venture arrangements appear to be the most common method adopted by Malaysian companies to acquire technology. Foreign firms, particularly foreign joint venture partners, played a dominant role in building up the manufacturing base of Malaysian companies.

One of the main advantages of foreign direct investments, particularly joint venture arrangements, is the ability to acquire technical know-how from established companies. The speed in with many local companies were able to acquire product process know-how from their foreign partners had contributed to the commercial viability of their projects. Many of the foreign partners have several years of experience in manufacturing certain particular products and were able to transfer their industrial expertise to ensure a comprehensive development of the manufacturing enterprises. Apart from providing a comprehensive resource transfer to the local companies, the foreign partners in joint venture arrangements were able to identify and guide local companies in selecting and evaluating the appropriate technology including the training of manpower in establishing the new operations. The experience of joint venture partners had attributed to the smooth operation of many local companies in view of the technical support from their parent companies. The case analyses of HR Johnson, and Alcom, indicate the benefits of joint venture arrangements where local companies were able to tap the vast resources of technical know-how and technical expertise from their foreign partners.

Another major advantage of joint venture arrangements is the ability of local companies to acquire training facilities from their foreign partners. Many of these companies had established operations in various parts of the world. They are able to place local staff in many of their overseas operations to acquire the necessary experience. An example is the case of Malayawata Steel which was the first steel company to be established in Malaysia, which had benefited from the comprehensive training programmes provided to local staff which had little experience in operating steel mills. Continuous upgrading of skills and expertise had also been provided to local companies through long-term technical assistance agreements. In meeting new market demands, several of the foreign partners like Nippon Glass, Alcom and NEC were able to undertake new expansion projects and provide project and management expertise to ensure the successful implementation of new production facilities. None of the joint venture companies studied had serious technical problems in their manufacturing operations in view of their ability to source a wide range of technical expertise from their partners. Most joint venture companies felt that the contributions by their foreign partners in the initial stages of the development of their firms, had contributed to the commercial viability of their projects. In addition to the strong technical support provided by the foreign partners, the joint venture companies were able to source basic inputs of plant components and raw materials from their prospective partners and the constant availability of basic production materials are crucial to the determination of their technical economic viability.

Although foreign direct investment, particularly joint venture arrangements, had been instrumental in providing the initial manufacturing base in Malaysia, there are several disadvantages with regard to these arrangements, particularly relating to long term technological development of the recipient company. The basic motivation among joint venture companies is to take advantage of the import substitution industries promoted by the government. Many of the foreign partners set up joint venture companies in order to operate behind the tariff barriers imposed by the government to promote local industries. Most of these companies were primarily motivated to capture the domestic market because exports from their foreign operations are no more competitive because of high tariff barriers. Almost all the joint venture companies depended heavily on their parent companies for technical support. Local R & D is substituted by importing product and process technology design and construction of plant and equipment has been constricted to foreign engineering firms sometime affiliated to the parent company. To a large extent local personnel had not been able to acquire technological skills related to the various activities on industrial operation.

Another major disadvantage of joint venture companies is their inability to contribute to the development of the inter industry linkages. A large proportion of their raw material or input requirements were sourced abroad. Sub-contracting systems involving a stable ancillary supplier-purchaser relationship did not develop. The nature of joint venture arrangements can be an inhibiting factor making inter industry linkages minimal. In most joint venture companies studied there is a certain amount of tie-up between local subsidiaries and their parent companies or other affiliated industries for the bulk procurement of raw materials and other inputs for reasons of economy and scale. In such cases, they are more motivated to source abroad rather than make serious effort to develop local component industries, and also, the issue of company pricing tended to be a controversial subject. However, the issue of local sourcing can be overcome through contractual arrangements where the foreign partners are required to ensure that a certain percentage of the input that goes to a particular product are sourced locally as illustrated in the case of Pernas NEC, and the Malaysian Telecoms Department which had insisted that the switching equipment manufactured by Pernas NEC should consist of 70% local content. In spite of some of the problems related to joint venture arrangements, this type of technology acquisition continues to be the major form of technology acquisition by Malaysian companies. Complementary contribution of resources made by major parties involved, provides a firm basis for a viable joint venture. The contribution of a foreign company depends on the industry in which it is involved, its product or product lines, its business orientation and many other factors. In many manufacturing operations, the major contribution of a foreign firm comprises manufacturing technology, product know-how, management expertise and technical training. The local partner in a manufacturing joint venture commonly contributes some capital, management, knowledge of the environment of the country and the market, contacts with the Government, financial institutions, local suppliers and some marketing capabilities. Prospective partners should have a clear understanding of one another's goals and objectives in establishing a joint-venture. While different parties will invariably have different objectives, these must not be contradictory. It is important, therefore, that the priority goals of each party be specified and be understood by all parties from the outset. If technological development is considered important for the long term viability of the company, it should be stated in no unclear terms on the expertise to be developed within the company. Major problems can exist in a joint venture with respect to purchase of intermediates, components and other products and the issue of transfer prices. In some cases the foreign firm may be the only readily available source of supply for a joint venture operation, at least during the early years of the operation, or the foreign partner feels he should supply components and intermediates to ensure the required quality for the production of the end product. The local partner, in turn, wants assurance that the prices charged by the foreign partner are arm's length, competitive and fair. Provisions in the joint venture contract with the foreign partner will base prices upon arm's length pricing, cost plus agreed margins, or competitive international prices can help to deal with the problem but they do not guarantee a full resolution. Despite these complexities, a number of foreign companies and national partners have worked out satisfactory ways of dealing with those issues. These arrangements can include not only the contractual provisions mentioned above, but agreements that the joint venture foreign partner should make efforts to develop internal capability, a matter which the government encourages. A synergystic pooling of resources is obviously highly desirable. The comtribution of modern production processes, the product know-how, technical training, management development and management systems of a multinational firm with the local partner's local capital management, existing plant, and knowledge of the country environment can result in an efficient productive enterprise. The synergies occur when both partners develop a more meaningful framework of technical and business collaboration.

The second most common method of technology acquisition is contractual arrangement where the arrangement only covers the infusion of product process know-how. Contractual arrangement encompasses a large variety of devices available for effecting technology transfer or technical know-how on an enterprise-to-enterprise basis. In such an arrangement, the technology supplier is not involved in equity financing and management control. One of the major advantages of this type of arrangement is the ability of the local companies to determine their own technological development with little interference from the technology suppliers. In such an arrangement, it is incumbent on the local companies to develop their own technological base in order to benefit from the contractual arrangement. The recipient companies will be able to participate fully with the technology suppliers in determining their technological needs. Since the arrangement did not exclude the local companies from sourcing from other suppliers, the companies studied were able to develop their own network of technology sources. In joint venture arrangements there is very little flexibility with regard to sourcing of technology because the foreign partners who are involved in the decision making process do not want to have other foreign companies involved in their own company's operation. Apart from the flexibility of sourcing a wide range of technology, the companies such as ASM, Seong Seng Asbestos and Tasek were able to determine their own sources of components and basic inputs. The primary interest of technology suppliers in this case is not to sell the end product but to supply technical know-how particularly related to the design and construction of the plant. Once the plant is fully operational, it is the responsibility of the local firm to develop its own expertise.

As indicated in the case studies, such methods of technology acquisition had led to the development of a wide range of local expertise. Several of the companies that acquire technology from contractual arrangements such as Petronas, ASM, and Tasek Cement had developed a wide range of technical expertise to undertake manufacturing operations since they cannot rely on continued support from the technology suppliers. The disadvantage of this type of arrangement is that not all technology suppliers have the necessary expertise to develop a fully operational plant. Some of the technology suppliers are basically machinery suppliers and have little experience in manufacturing a particular product. It was found that in selected cases, the technology suppliers were not able to supply working plants and subsequently had to be assisted by other suppliers, particularly foreign companies with established manufacturing operations. Another disadvantage is that turnkey contracts often deliver a plant together with instructions for operating it under the conditions assumed in its design, but fail to provide the recipient with an understanding of the full details of how the plant operates or why it operates as it does. This hampers the recipient's ability to improve plant operating production or to adopt to changes which may occur over time. However these outcomes can be avoided by having the firm's personnel participate in every phase of project execution as illustrated in the case of ASM. The company also prepared a comprehensive training programme for its staff to receive operating know-how in other steel companies in various parts of the world. In the case of Petronas, separate technical service agreement was entered with a established manufacturer like Caltex to transfer operating know-how. But companies like Seong Seng Asbestos and Associated Tiles Industry which relied solely on the service of turnkey contracts encounted serious operating problems during the initial stage of their operating.

The third method of technology acquisition is technology trade. Some of the benefits that can derive from technology trade or direct sourcing is to maximize the local technology, equipment and material content; this will lead to import substitution, increased domestic technology/design construction and equipment inputs. One of the main advantages in this type of transaction is that firms will know the cost of various inputs. The responsibility of putting the bits and pieces of the equipments into a fully operational plant lies with the recipient firm. However technology trade is only possible in mature industries where there are a number of independent machine suppliers. Technology trade may not be feasible for companies which lack the capacity to prepare project feasibility study to the economic and technological feasibility study stage and then to the engineering study stage. In this study only a few companies like ASM, Tasek and Malayawata Steel which had acquired a high degree of investment and project execution capability were able to source technology through technology trade.

Multiple strategies are available for local firms to source technology. For firms valuing autonomy there is a need to maintain a balance between external technological input and internal sources of technology. Initially there is a high demand for external technological input through foreign direct investment due to the lack of experience in industrial operations. As a firm matures and acquires expertise it should reduce the foreign technological input and encourage the development of local resources. At various stages of development of the firms, there is a need to vary the sources and components of external technological resources.

The difficulties are considerable in finding the appropriate methods of technology acquisition. In some cases the technology may be available from a number of independent suppliers and firms may be able to purchase the technology from a number of competitive suppliers. Differences in corporate strategy and perceptions of risk have implications on the choice of technology transaction. As pointed out earlier, there are several problems associated with teh different methods of technology acquisition. In making the choices, firms must consider the long term benefits derived from the widespread diffusion of technology.

CHAPTER VI

PATTERN OF TECHNOLOGY DIFFUSION

6.1 INTRODUCTION

This chapter will discuss the findings presented in Chapter IV on the characteristics of the diffusion process. First the researcher shall present some comments on the research efforts and then discuss the more detailed findings as they relate to the specific variables. It should be noted that while formal statistical analysis can identify some of the factors that have a significant effect on diffusion it cannot for instance capture all the interaction among various elements at work in higher or low diffusion firms. Hence the researcher will have to go behind and beyond the data in order to develop a more complete, meaningful and integrated picture.

The level of technological capability acquired by a firm reflects the extent of imported technology diffused in the company. According to Dahlman and Westphal (1982), it is possible, for example, to acquire foreign technology through direct foreign investment, licencing, know-how and technical service agreements and import of capital goods. Technological capability can be acquired only through development of human resources, on-the-job training, experience and specific effort to obtain, assimilate, adapt, improve or create technology. Attempts have been made by several writers to analyse the development of technological capability in developing countries. The study on the acquisition of technological capability in Mexico, Peru and Brazil sponsored by the World Bank broadly classified technological capability within four major areas relating to investment project acquisition, production management, capital goods, and plant construction.

Kenneth King (1984) emphasised pre-investment, search, negotiation and skills related to production engineering as components of technological capability. In a comprehensive literature review on technology transfer, Stewart (1979) classified local technological capability as having three components:-

(1) Independent search
(2) Technology change, and
(3) Development of new technology.

Among the various studies illustrated above, the World Bank-sponsored study is the most comprehensive research undertaken to examine development of technological capability in developing countries. According to Dahlman and Westphal (1983), three broad components, particularly investment and project management capability, production capability and innovation capability, are the basic components used to examine capability created in developing countries which have imported foreign technology. Taking into consideration the level of industrial development in Malaysia and on the basis of the pilot study carried out earlier, the researcher decided to classify technological capability into three broad components suggested by Dahlman and Westphal:-

(1) Investment and project execution capability
(2) Production capability, and
(3) Innovation capability.

The researcher has discussed the importance of the three broad components of technological capability in the research methodology section of the study. In establishing the level of technological capability acquired by the firm, the various companies selected for this study were asked to rank the level of the various components of technological capabilities acquired by local personnel. Each component was ranked in descending scale from 6 (highly developed) to 0 (not at all). Detailed explanations of each individual component were provided to the respondent. Having established the level of capability, attempts had been made to plot the relationship between specific variables and the level of capability created in the companies. The independent variables are as follows:-

(a) Ownership structure

(b) Management control

(c) Methods of technology acquisition

(d) Technical staffing

(e) Nationality of foreign partners

(f) Nature of technical cooperation

(g) Operating life of the firm.

The key variables were selected on the basis of the literature review related to development of technological capability. A brief hypothesis with regard to diffusion and development of technology has been advanced in the literature. Ownership has been identified as one of the factors influencing technological capability (Langdon 1984). Kidron's study (1965) in India reveals that technical staffing policy and management control are key factors affecting diffusion of technology in multinational firms and is one of the major factors affecting diffusion of technology in those enterprises. With regard to other key variables, such as method of technology acquisition, Farouk Contractor (1981) pointed out that licencing to developing countries would include know-how and other forms of technical assistance as these countries lack technological capabilities and industrial experience. From his study, Contractor concluded that know-how is often considered far more crucial a contribution than mere patent rights since the objective is to equip the licensee firm with the complete technological capability to the licensor. The importance of methods of technology acquisition as factors influencing technology capability was also highlighted by Mytelka (1978). In the study, Mytelka found that firms with licensing arrangements tended to purchase their machinery from the parent company or the licensor and followed the recommendation of their licensor or parent. In doing so, they have given up the opportunity to select new machinery to be purchased which would have enabled them to upgrade their technological capability by knowing more about the technology and selecting machinery more suitable to the environment. Studies on the development of technology capability at firm level are limited. From the literature review, certain key issues have been highlighted particularly those relevant to the organisational aspect of technology development. Since the research focused on the micro level study of technology diffusion the selection of variables will have to be based on specific internal characteristics of the firm. The researcher has selected the seven key variables above as a basis for investigating the issues of technology diffusion in Malaysian companies.

6.2 PATTERN OF TECHNOLOGY DIFFUSION

6.2.1 *Production capability*

Table 4.20, production capability is generally widely diffused in the companies studied with 48.4 per cent of the companies achieving a high degree of internal capability. As shown in Table 3.5 there are a number of elements in production capability. Firms which ranked the development of production capability as highly developed are classified as firms where production capability is highly diffused.

In companies with high diffusion in production capability, local personnel had assumed full overall responsibility for managing the production system. Many of the firms, particularly Tasek and ASM had employed short tenure expatriates during the initial phases of operation but had phased them out as local personnel acquired the necessary expertise. Production capability developed rapidly in these companies.

In joint venture companies, foreign technical personnel served in an advisory capacity. They provided technical advice on plant expansion, assisted in problem-solving and coordinated technical efforts involving their parent companies. At Alcom, Berjaya Kawat, and Federal Aluminium, the post of technical manager had been taken over by local personnel. All three companies reported very low barriers to the flow of technological knowledge. At Alcom, interviews with several of the personnel revealed that information on product process knowledge was widely accessible. According to the corporate technical manager, staff could source the technical data bank of the foreign partner's parent company so long as the information was relevant to its operations.

Similar views were expressed by the general manager of K.L. Glass, a joint-venture between Australian Consolidated Industries and local investors. The local chief executive explained that the company had benefited from the international network of its partners, particularly in the area of glass technology. Technical information on new product and process development could be sourced from any of the ACI subsidiaries in the region by despatching key technical personnel to the selected plant. Whis technical exchange network the company had also been able to keep abreast with technological developments in the industry.

Moderate diffusion firms are those firms which ranked their overall production capability within the medium scale or fairly developed. In moderate diffusion firms, expatriate technical managers tended to exercise less influence in the day-to-day decision making process. Their role was limited to planning and organising technical activities with their foreign parent companies. Day-to-day decision making had been delegated to local production managers. Expatriate staff, however, continued to exercise influence over procurement and major manufacturing decisions such as new capital investment. In most cases, technical information was channeled through technical expatriates who determined the quality and quantity of information to be diffused to the appropriate personnel. For example, at United Asbestos, the technical manager controlled process formulation and trouble shooting while tasks like production scheduling, quality control, repair and maintenance were delegated to the two production managers. Technical information was diffused to the extent that it facilitated the performance of routine tasks or any other tasks as determined by the expatriate technical manager. For example in one asbestos joint venture company , the expatriate technical manager would not allow local personnel to undertake trouble shooting activities. Test reports on raw material and product performance were not available for the use of local personnel.

The other companies showing this pattern of diffusion are local companies which were established within the last two to three years. Companies like Petronas Refinery and General Ceramics had just completed or were in the process of completing major plant installations. For example, the Petronas Refinery was in its second year of operation. The company had a four-year technical service contract with US-based Caltex to train and implement operating capability. General Ceramics, however, was implementing a major expansion project with assistance from a contractual foreign expatriate. The other two companies were former joint venture companies which had been fully acquired by local interests. For example, control of Malaysian Mosaic was recently taken over by local investors after the company had operated as a joint venture company with Japanese, French and Malaysian interests for over 20 years. A comprehensive training scheme had been implemented to upgrade the technical competency of its local personnel. Company personnel were beginning to undertake active involvement in production management with the assistance of a Japanese technical advisor who was formerly the technical manager. He had been retained on a short-term basis by the new owner to train local personnel in areas relating to tile manufacturing.

In companies with a low diffusion pattern, production management had not been diffused. Local personnel involvement was minimal if not totally non-existent in the decision-making process. Production control, quality control, repair and maintenance were all managed by expatriate technical staff. Knowledge in product process know-how had not been diffused. As Table 4.20 shows, only two companies were found to have this diffusion pattern. Take the case of one of the companies, an asbestos product manufacturing plant which started operations in 1961. It was established as a joint venture company between a Malaysian entrepreneur and a Japanese company to manufacture asbestos products and sheets. Despite 20 years of operation, local personnel involvement was minimal. The most senior local personnel in the production was a senior foreman who supervised the skilled and semi-skilled plant operators. Tight control over technical operation by expatriate staff had limited the flow of technological knowledge to staff. However this pattern was seen only in a small number of companies.

6.2.2 *Investment and project execution*

The second most widely diffused capability is investment and project execution. As shown in table 4.19, 32.3% of the sample had acquired a high degree of internal capability in project planning and execution. Many of these companies had developed a strong project team that could undertake feasibility studies, prepare bidding documents, handle technical negotiation and technology evaluation, and supervise plant construction. Three of the firms which had implemented major capital-intensive projects in steel and cement switched to direct sourcing of equipment from independent machine suppliers. Those with a moderate pattern of diffusion tended to collaborate with foreign firms in implementing, projects. Some degree of internal expertise had been developed but the companies depended to a great extent on external sources to provide technical support. Project teams to coordinate and supervise the projects comprised both local and expatriate staff. A majority of the firms had a moderate pattern of diffusion. Out of the 31 firms, 10 had a low diffusion pattern where the firm was totally dependent on foreign firms to plan and implement the project. Local personnel were not involved in planning and implementing of the project. Lack of investment activity could have also contributed to the low diffusion of investment and project execution capability.

6.2.3 *Innovation capabilities*

The degree of innovation capability diffused was evaluated on the basis of the development of in-house expertise relating to product process development, minor modifications, plant optimization, cost cutting activities, product improvement and quality improvement processes. As shown in Table 4.21, 67.7% of the sample had developed a moderate pattern of diffusion. Only two small firms had a high diffusion pattern. These two firms had undertaken a high degree of in-house R & D efforts. Innovative efforts were generally carried out by foreign expatriates in the case of most joint venture firms. Very little innovative efforts were carried out in these firms because most of them depended on external sources of technology for new product process know-how. Many of the joint-venture firms had their own R & D facilities located in the foreign partners' parent companies. New product process know-how was generally sought from the foreign parent company. The companies found little reason to change their products since many of them operated in a less hostile environment. Many of these companies were in import substitution industries where the products are sold in a domestic market. These companies were also protected by high tariff barriers as an incentive for them to locate their production in Malaysia. Hence, they found no reason to change their production since either the market required no innovation or competition did not force to adjust. Since government tariff structures protected such companies from foreign competition, most of the companies manufactured standardised products like cement, asbestos, steel and other building materials. The life cycles of these products were in the maturity stage of the product life cycle.

Some of the companies had short-term technical assistance to source specific product process know-how. ASM, for example, had an agreement with Funabashi Steel to acquire process know-how on furnace technology. During the initial stage of development, technical assistance agreements had been employed by companies for transferring basic operating skills. However, as the firm matured technical assistance agreements were regarded as more of a mechanism to source new product process know-how from technology suppliers.

The lack of innovation capability in the companies poses a serious problem to the development of Malaysian manufacturing industries. Case analysis revealed that innovation capability tended to emerge early in companies that had attained a high degree of production capability and investment and project execution. The two companies that had achieved a high degree of innovation had both attained high diffusion in production, investment and project execution. This has major implications in terms of technical development in local industries. There was a strong interrelationship between the three components of technological capability and this will be further discussed in the concluding chapter. Suffice to note here that the case analysis reveals certain evidence that this diffusion of technology had evolved within a set pattern. Production capability tend to emerge first, followed by investment and project execution. Firms that implemented major expansion and modification projects within a short span tended to acquire investment and project execution capability far more rapidly. Innovation capability emerged strongly if production, investment and project execution had been widely diffused. The development of innovation capability was much influenced by those engineering skills acquired in project execution and production engineering.

6.3. DETERMINANTS OF TECHNOLOGY OF DIFFUSION

6.3.1 *Ownership structure*

There are two categories of ownership structure: Wholly-owned local companies where the equity holdings are fully owned by Malaysian investors; and mixed ownership companies where the equity is jointly owned by local and foreign firms. The equity guidelines provided by the government required firms which were set up as part of the import substitution industries to allow local equity participation in the company. This led to the growth of numerous mixed ownership companies.

As shown in Table 4.22, 5.5% of the wholly owned local companies tended to develop a high degree of investment and project execution. On the hand 55% of the mixed ownership companies had developed some investment capability with 40% indicating low pattern of capability development with regard to production capability; 64% of wholly owned and 40% of the mixed ownership companies indicated pattern that they had acquired high degree of internal capability. Similarly around 70% of the wholly owned and mixed ownership company indicated some degree of innovation capability in their respective companies. It appears that both wholly owned and mixed ownership companies reflected a similar pattern of technology development. There is little difference in terms of different ownership structures and their diffusion patterns. The correlation value at the significant level of 0.05 does show not strong correlation between ownership structure and diffusion of technology.

This hypothesis has to be rejected in view of the weak relationship between diffusion patterns and the ownership variable. Case analysis and indepth interviews with the companies revealed some of the issues relating to this finding. First the researcher would like to probe into the possible reasons why wholly owned local firms did not show a higher diffusion pattern than mixed ownership companies as predicted in this study.

6.3.1.1 *Diffusion in wholly owned local company*

Interviews with some the wholly-owned local firms revealed certain important observations. With the exception of Tasek Cement which was established in 1964, the other companies were still in an early stage of development. Modern manufacturing industries in Malaysia had generally been dominated by foreign direct investment. Local entrepreneurs had only recently started to participate actively in modern manufacturing. This triggered the acquisition of foreign joint venture companies by Malaysian investors. In such cases expatriate staff had been phased out and intensive training implemented to upgrade the technical competence of local personnel.

Malaysian Mosaic, Century Batteries and Associated Tile Industries are a few examples of such companies. Owing to their early phase of development, these companies had yet to develop their capabilities. In this early phase of development much emphasis was given to the acquisition production capability. As shown in the data 64% of those companies had acquired a high degree of production capability. On the other hand innovative capability is fairly developed with high degree of reliance on foreign R & D resources. More important some of these companies are too small to have their own R & D department and would prefer to collaborate with foreign technology suppliers. As the data indicated only 10% of these firms acquired a high degree of innovative capability. It was earlier assumed that firms with local ownership which achieved a high degree of diffusion were motivated by their strong desire for independence. The researcher found that this was only true with a small number of owner-managed companies. In owner-managed companies where indigenous technological capability was an overriding objective of the entrepreneur, the company tended to unpackage the technology acquisition, source local components and deploy local personnel. Tasek Cement, ASM and all the owner-managed companies had adopted this strategy. As shown in the data 55% of the companies partly those who had adopted this strategy were able to attain a require high degree of investment and project execution capability. The analysis of mixed ownership companies also shows the weakness in the argument that change in ownership structure would promote greater local personnel participation and the development of internal expertise. Although the weakening of ownership control is an important precondition to achieve greater local personnel involvement, it could also give rise to other issues relating to technology.

6.3.1.2 *Diffusion in mixed ownership firms*

Executives in wholly owned local companies pointed out that greater ownership control by local investors in the early seventies had not really produced major changes in the technological development of their companies. Although most of the foreign firms had reduced their equity investment in local companies, this had not changed the technological relationship established during the initial operation of the company. They continued to exercise strong influence over the technical development and operation of the company. Through such technical collaboration, companies still retained their own expatriate staff and exercised strong control over the technical operation of the company. In certain cases, management contracts were signed between the local and foreign firms giving foreign companies the responsibility to manage the operation.

Ownership structure did not have much influence over the pattern of diffusion. The cross tabulation did not show up any trends between ownership and diffusion of technology. The data shows quite similar patterns of diffusion for both group of companies. This was also supported by the statistical analysis which did not reveal a strong relationship between ownership structure and diffusion of technology.

6.3.2 *Management control*

Control refers to the power of determining the broad policies guiding the operation. This power is exercised at two levels: strategic and operational. Strategic control involves decision over diversification, mergers and general objectives aimed at coping with environmental constraints. Strategic control must take these constraints into account and also attempt to alter them to enhance the position of the enterprises within the environment. The operational sphere involves activities to implement corporate strategies and operational control, budgeting, choices of technology, selection of equipment suppliers and the types of personnel to be recruited. In this study, the nationality of the chief executive had been noted to determine whether the company was under foreign or local management control. Being head of the organisation the chief executive determined the strategic direction of the company and also controlled the day-to-day operation. Foreign firms which had a high degree of equity participation in companies generally insisted that the chief executive be appointed by them and preferably be seconded from the parent firm.

6.3.2.1 *Analysis*

Table 4.26 shows the diffusion of investment and project acquisition capability according to management control. 18% of the firms under local management control had attained a high degree of diffusion in investment and project acquisition with 52% having developed some degree of internal capability in the same area. Almost 83% of the firms under foreign management control had a low diffusion of investment and project acquisition. Investment and project acquisition was an important phase of the firm's development. Choice of technology, selection of equipment suppliers and many other related decisions relating to the investment phase were very much associated with project acquisition phase.

Similarly, firms under local management control had attained higher diffusion of production management capability as compared to firms under foreign management control. About 56% of the firms under local management control had attained a high degree of diffusion. On the other hand only 17% of the firms under foreign management control had acquired a high degree of diffusion. In the case of innovative capability the two firms that had acquired a high degree of diffusion were both firms under local management control. The statistical analysis showed that management control had a strong relationship with diffusion of technology. There are many possible reasons why management control has a strong relationship with pattern of technology diffusion.

6.3.2.2 *Influence of top management*

Indepth interviews with executives of several companies under local management and foreign management control indicated the importance of management control in determining the diffusion of technology. Top management can influence the key decisions regarding the strategic direction and the operating activities of the firm. In the case of firms with local management control, top management tended to focus on the profitability and long term growth of the company. Chief executives were generally Malaysians appointed by the Board of Directors. They tended to safeguard the interests of local shareholders rather than the foreign partners as in the case of joint venture companies. These chief executive's loyalty lay with the company because they tended to associate their careers with the long-term development of the firms. On the contrary, expatriate chief executives particularly in joint venture firms tended to see themselves as part of the multinational system. Their loyalty lay with the parent company. They usually served for short stints of three to five years. Their primar role was to ensure that the investment strategies of the parent company were being met by the local subsidiaries. This therefore influenced their role in determining the strategic direction and the operating activities of the company. The primary interest of local chief executives was not only to promote the development of the firm but also to safeguard the interest of local shareholders. Furthermore, the local chief executive officers usually strived to reduce their dependence on foreign sources of technology and greater emphasis was given to the development of internal expertise. Development of production capability was strongly promoted. The data shows 56% of locally managed firms achieved within the high of production capability.

This is clearly illustrated in the case of H & R Johnson a locally managed firm. H & R Johnson is a joint venture company between Malaysian investors and H & R Johnson Richard Tiles Limited, U.K. which started operation in 1978. The company produced wall tiles and it recently embarked on a major expansion programme to manufacture ceramic tiles. The foreign partner had 15% equity participation and provided technical assistance under the technical aid agreement. H & R Johnson is the largest distributor of white wall times in Malaysia. During its first years of operation, the company was managed by expatriate staff. But because of frequent changes of expatriate staff and high turnover of local staff, Dunlop Malaysia, one of the local partners decided to assume management control of the company. Dunlop Malaysia had placed two of its staff as chief executive and general works manager in H & R. The technical advisor was an expatriate. The company had strengthened its technical manpower and developed the technical base through increased technical efforts during the recent plant expansion. The project team undertaking investment and project acquisition was headed by a local personnel. The team carried out feasibility studies and evaluated the technology of the various suppliers. They were, however, assisted by the foreign technical advisor although control and direction of the expansion project lay with the local management team. The general works manager was very pleased with the performance of the local management team in the implementation of their expansion project. Priority was given to local suppliers in sourcing the components and equipment for the project. However he acknowledged that the technical advisor and the foreign partner contributed enormously in the selection of technology because of their wide experience in ceramic tiles manufacturing. What was important was that opportunities were created for local personnel to undertake activities in the investment and project acquisition phase.

As shown in the above case study firms under local management control tended to source technology within the country and implement a high degree of local content in their plant construction. As such 56 % of the companies had developed some degree of investment and project execution capability.

Foreign managed firms tended to package plant construction, thus depriving local engineering firms of the opportunity to widen their technological capability. Hence they were unable to develop their investment capability. The data shows 83% of firms under foreign management control had weak investment and project execution capability. The control of foreign partners, particularly Japanese companies, in project management had been a noteworthy feature of Japanese joint ventures. The different approaches taken by firms under local and foreign management control reflected the different investment strategies of the company. Firms under local management control tended to emphasise the profitability of the company by controlling the cost of technology acquisition. Foreign firms, on the other hand, because of their transfer pricing practice, tended to increase the cost of technology acquisition. Instead of sourcing components locally, they tended to source from the parent company which charged higher prices. Consequently, this increased the investment cost of the project which then affected the long-term profitability of the company. However, this should be viewed within the context of the investment strategies of the foreign firms where their primary role was to maximise the sale of technology, raw materials and components of the company. It is therefore pertinent to know that the role of the expatriate chief executive officer is to ensure that these objectives are met satisfactorily.

Management control had a strong influence over the pattern of technology diffusions. Firms with local management control tended to attain high patterns of technology diffusion due to the strong influence exercised by local chief executives. Interviews with several local chief executives indicated that strong commitment by top management was essential in promoting a higher level of technological development. Hence, a lot of resources were allocated to developing internal expertise, diversifying technical resources, reducing external control by technology suppliers and promoting greater involvement of local personnel. They tended to emphasise long-term growth and profitability of the company. Expatriate chief executives were more interested in promoting the investment strategies of their parent companies through sale of technology, components, and raw materials. They tended to exercise greater control over the technical operation of the company with little involvement from local personnel. Diffusion was more limited in these companies resulting in slower technical progress.

6.3.3 *Technology acquisition*

6.3.3.1 *Data analysis*

Malaysian companies acquired their technology through foreign direct investment, particularly joint venture management and purchase of turnkey plants from independent technology supplies. For the purpose of this analysis, firms had been asked to indicate the methods through which they acquired technology in their most recent projects. Twenty one firms indicated that they had continued to source technology from their foreign partners while 10 firms indicated that they had purchased turnkey plants.

As shown in Tables 4.30 and 4.31, firms which had acquired their technology through contractual arrangement had acquired a high degree of diffusion in investment and project execution and production capability. In terms of investment and project execution, 60% of the firms that started through contractual arrangement had a high diffusion pattern. This compares to only 5% of the firms that acquired their initial technological input through foreign direct investments.

Similarly, in terms of production capabilities, Table 4.31 shows 70% of the firms that acquired their initial technological input through the purchase of turnkey transactions had a high diffusion pattern while only 38% of the firms which started through foreign direct investment achieved similar capability. With regard to innovative capability Table 4.32 shows 67% of the companies started through foreign direct investment had acquired some degree of innovative capability with 33% having low diffusion pattern. The statistical analysis in Table 4.33 indicates that a strong relationship exists between methods of technology acquisition and patterns of technology diffusion. This supports the hypothesis that the methods of technology acquisition determined the pattern of technology diffusion. In-depth interviews and case analysis revealed several factors, including participation of local personal and development of expertise, that could explain this phenomenon.

6.3.3.2 *Contractual arrangements*

As indicated earlier, firms which acquired technology through contractual arrangement such as turnkey contracts tended to achieve a higher diffusion of investment and project execution capability than those established through joint venture operations. The data shows 60% of these companies had acquired a high degree of investment and project execution capability. Unlike joint venture operations where the technology supplier in most cases was the co-owner of the company, a turnkey contractor does not have ownership interest in the company. In this case a seller-buyer relationship was established between the supplying and recipient firm. The responsibility for selecting the choice of technology and the suppliers rested with the recipient firm. From the initial stage, the recipient firm was already involved in key decision making, that is, at the pre-investment phase. Many of the companies studied established core technical staff to deal directly with turnkey contractors. These companies had made a great deal of effort in planning and implementing their respective projects. During planning, key local staff worked closely alongside turnkey contractors to supervise and at the same time understudy the foreign technical staff. As the project progressed, the company personnel began to take a more active role in the project execution stage. The learning effects derived from a high degree of involvement in the initial phase were retained in the firm.

Production capabilities developed to a higher extent in firms which had acquired their initial technological input through turnkey transactions. The data in Table 4.31 shows that 70% of the companies which started operation by purchasing turnkey plants had acquired a high degree of production capability. Seven firms had achieved a high degree of technology diffusion in production management. As pointed out earlier, the role of the turnkey contractor was to provide an operating plant. Development of production management capabilities was the responsibility of the recipient firm. In certain cases, the turnkey contractors assisted in providing training facilities and helped the personnel to solve technical problems in the initial trouble-shooting phase. Generally, after the plant had been commissioned, the recipient firms had to arrange for technical assistance arrangements, if they so wish, with the other independent manufacturers. Turnkey contractors were generally machine suppliers and engineering firms which had little experience in the manufacturing of those products. Unlike joint venture firms which generally relied on foreign expatriates to provide the production expertise during the initial phase of operation, firms with turnkey transactions had to rely on their personnel to undertake various production management capabilities. When experienced local personnel were not available, firms recruited foreign personnel on short-term arrangements. In the early sixties Tasek Cement recruited a number of staff from Taiwan to operate its plant and train local personnel during its first few years of operation. At that time the cement industry was still new to the country and there was a scarcity of personnel with experience in operating cement plants. The technological efforts expended in solving technical problems which cropped up in production also contributed to the high diffusion of production management capabilities in these firms. A number of companies that acquired technology through contractual arrangement had encountered serious technical problems due to faulty designs in the initial plant. Some problems are remedied by the machine suppliers but there were a number of cases where the machine suppliers were unable to remedy the faults. When a new plant was established, a number of modifications had to be made to meet local requirements. Since turnkey contractors were mainly machine suppliers they did not have the expertise and experience to solve some of the problems relating to the manufacturing process. In such cases, the recipient firms had to take their own initative to overcome those technical problems. ACW and Soong Seng Asbestos, for instance, had to form their own in-house teams to carry out modifications before they could start full commercial production. Some firms were able to solve these technical problems successfully by implementing certain modifications in the equipment they purchased. Attempts to undertake such technical efforts had generally propelled the firms to a higher level of technical development. Experience gained in carrying out such activities enhanced the innovative capability base of the firms as in the case of Soong Seng Asbestos. Soong Seng Asbestos had not only solved its problems but it was able to provide technical assistance to other manufacturers in Thailand, and the Philippines who faced similar technical problems with equipment from the same suppliers.

It is through these activities that many of the companies which acquired technology through turnkey transactions have developed a fairly rapid diffusion of technology efforts. In fact dissatisfaction with the faulty designs of the original turnkey projects had resulted in a degree of innovative efforts in two firms. Initial troubleshooting efforts by these firms had led to rapid diffusion of product process know-how at various levels of the organisations. Foremen, operators and engineers were all involved in diagnosing initial technological problems - a process which not only helped spread the flow of information but subsequently generated new technical information which contributed to greater understanding of the principles underlying the imported technology.

6.3.3.4 *Foreign direct investment diffusion*

In those firms which had acquired technology through foreign direct investment, the diffusion of production management seemed to be much lower than in those firms which started turnkey projects. The data shows only 36% had acquired a high degree of diffusion in production capability. In these firms, foreign expatriates had been phased out and the company personnel had taken over the whole manufacturing operation. However most of these companies still maintained their technical assistance arrangement with their foreign partners. The technical assistance arrangement was generally for the purpose of securing new product process know-how and training arrangements for staff and new personnel recruited by the company. Production management capabilities in the field of quality control and product process know-how had yet to be developed among local personnel. The companies relied on the infusion of technology from their foreign partners who played a major role in determining the production of technological development in the firms. For example, testing services, chemical analysis and other technical supporting services provided by the foreign partners had to a certain extent minimised the nature and level of technical activities within the company. The two firms which had a very low diffusion of production management capabilities continued to rely heavily on foreign expertise. Even day-to-day operation of the plant was managed by foreign expertise with little involvement by local personnel. These two companies manufactured standardized products in the building industries. Their primary aim was to take advantage of the incentives offered to the import-substitution industries. Generally, the companies had remained stagnant with very little technical progress since their establishment. Although they employed a number of local personnel, most of these were lower level manpower recruited as operators and plant supervisors. The foreign expatriates had from the start continued to exercise control over the overall manufacturing operation.

Firms which acquired technology through foreign direct investment continued to rely heavily on their foreign partners for technological development and provide new product process know-how. The diffusion of innovative capabilities had developed gradually over the years because of their limited experience in undertaking minor modification efforts. The data in Table 4.32 shows that 70% of these firms had developed some degree of innovative capability In most of these firms, the foreign partners were responsible for troubleshooting in the initial phase of the plant operation including the implementation of minor modifications. Personnel were recruited and trained when the plant was nearing commercial production. Hence diffusion of innovative capabilities did not grow as rapidly as in those firms which acquired their initial technological efforts through turnkey transactions. Secondly, most of the firms with foreign direct investment had entered into technical calloboration with their foreign partners. As pointed out by most executives interviewed, the primary role of the collaboration effort was to provide new product process know-how.

The methods of technology acquisition were found to have a strong influence over the pattern of technology acquisition. The analysis suggests that the choice of the transfer mechanism has a marked influence on technical capabilities. This has been illustrated by referring to the experience of some companies which had acquired technology through the purchase of turnkey plants. Firms which had acquired technology in this manner seemed to have acquired a higher degree of technical capabilities as compared to those that had continued to source technology through their foreign partners. In turnkey projects, the role of the foreign firms was limited to supplying the operating technology and the responsibility in diffusing the technology lay with the recipient company. This led to greater diffusion and skill formation. However it should be emphasised that much of the benefits of turnkey transactions depended on the technology strategies of the recipient firms. In companies where diffusion had not been emphasised, the acquisition of technology through turnkey transactions had not contributed to the firm's technical progress.

6.3.4 *Years of operation*

6.3.4.1 *Data analysis*

The age of the firm has been selected as one of the explanatory variables with regards to the diffusion of technology. Industrialization is fairly new to the country because systematic efforts to industrialize the country started only in the early sixties. Among the earliest firms are several joint venture firms in the sixties like Malayawata, the first integrated steel mill. Among the wholly owned local firms are Tasek Cement, the second integrated cement plant established in the country. (The first integrated steel plant was started by the Blue Circle group of Britain in 1954).

Within the sample several firms fell within the individual age groups. Hence, the representation of the firm according to age of operation was well distributed. The hypothesis was built on the premise that the number of years of operation has an important influence on the pattern of diffusion. As a firm progresses, it will acquire the necessary experience and enhance its diffusion of technology. During the various phases of development, the firm would undertake several types of activities like production process development, expansion of plant facilities and introduction of new technology to enhance its productivity. These would ultimately increase its learning process and widen its technological base. To a certain extent this would also enhance the diffusion of technology not only in the area of production management but also in investment and project acquisition and innovative capability. Table 4.34 shows the age of the firm and its diffusion of investment and project acquisition capabilities. As shown in the table there is a fairly wide distribution of firms among the various age groups and levels of diffusion. Of the four firms that started operation within the last five years one had acquired a high degree of diffusion investment and project execution. Among the eight firms which had operated for over 20 years, two had achieved a high diffusion pattern. From Table 4.34 it is shown that the operating life of the firm had very little influence over the pattern of diffusion of investment and project acquisition capabilities. There are a number of newer firms which had operated for less than 10 years and also a number of firms which had operated for over 15 years which had acquired a high degree of diffusion. No clear trend can be derived from the table with regards to the relationship between age and diffusion and the same thing can be said of the diffusion pattern of production management. In terms of innovative capability, two firms had acquired a high degree of diffusion; one has between six to 10 years and the other over 20 years of operations. From the three tables it appears that age of firm had very little influence on the diffusion pattern. Table 5.10 on the statistical results confirmed the observation. The correlation valves indicated a very weak relationship between age of firm and pattern of diffusion.

6.3.4.2 *Pattern of industrial development*

The findings show that age has no significant influence over the diffusion pattern. Interviews with the companies indicated several reasons for the weak relationship between age of firm and pattern of diffusion. First and foremost are the structural problems relating to the manufacturing industries in Malaysia. As indicated earlier, most of the firms were established through foreign direct investment particularly joint venture operations. The primary reason why these firms set up their manufacturing facilities was to gain access to the domestic market and take advantage of the import substitution programme launched by the Malaysian government. These firms were attracted by the high incentives and tariff protection given to local industries. Many of these firms were single product companies which specialized in narrow product lines. They acquired their technical expertise from the parent company and generally set up manufacturing facilities to undertake basic production activities. Product process development was sourced from the parent company resulting in very little in-house effort. Therefore there was very little learning by doing and very limited diffusion of technology. Secondly, since most of the firms were single product companies, the primary reason for operating in the country was to capture the domestic market. No effort was undertaken to export the product and compete in the world market. Consequently, there was very little technical effort to undertake product process development or diversify into new product lines to meet market change. Consequently technical stagnation resulted.

A good illustration in this case is Malaysian Mosaic. The company was established in 1964 by Japanese, French and Malaysian interests. It was later converted into a public company in 1973 with the French and Japanese taking up 51%. During its operating life the company had only manufactured mosaic tiles and had not diversified into other building products in spite of the rapid development of the building industry in Malaysia. The chief executive and technical managers were seconded from the Japanese parent company. In 1980, a local company, Hup Seng bought over 51% of the foreign interest in the company. Being a local company, the new owner wanted to phase out the expatriate staff. However, it found out that very little technical capability had been developed among the personnel of the company despite its 16 years of operation. None of the company personnel was technically qualified to take over from the expatriate staff. Part of the reason why the foreign party had sold the interest to Malaysians was because the company had made lossess for the last two years. Its failure to invest in new technology or diversify into new product lines had made the company less competitive. The market share for Malaysian Mosaic had fallen drastically because new tiles were being introduced into the market by other competitors. This company shows a typical example of the operations of foreign companies in Malaysia, particularly those which had not undertaken serious efforts to modernize and invest in new facilities. In this case the number of years of operation of the firm had not really contributed much to its development. Because of the lack of investment activities and technical efforts, local personnel had not acquired the necessary expertise and experience.

This analysis suggests the operating life of a firm has little relationship to the technical development of the firm. It was predicted that the years of operation would result in accumulation of technology through the growth of the firm's technical system. However the findings suggest otherwise. Most of the firms had not developed an integrated technical system. The observations indicated that most of the companies, particularly joint venture operations, had established only a partial technical structure and were sourcing the major requirement of their technical resources from the parent companies. Consequently this led to low technical efforts which retarded the development of local technical resources. The mere existence of a manufacturing operation is no guarantee that there will be diffusion of technology and accumulation of technological skills.

6.3.5 *Nationality of foreign partners*

6.3.71 *Data analysis*

Multinational firms pursue different strategies in operating their subsidiaries. According to Stopford and Well (1972) the managers of local subsidiaries of American firms had a higher degree of autonomy in their affairs. American firms found that they could better exploit their brand names by manufacturing them locally. For these reasons, American subsidiaries were interested from the beginning in maximising local production and thus gave local management a high degree of autonomy. British, Australian and Canadian firms pursued similar policies with regards to the operation of local subsidiaries. Among the firms studied, a number of British, Australian, and Canadian firms had formed joint venture companies in Malaysia e.g. H & R Johnson, K.L. Glass, Federal Aluminium and Alcom. Japanese companies, on the other hand, were closely controlled by their parent company. Unlike British or Australian firms, Japanese companies were still new to international operations.

Tables 4.30, 4.39, and 4.40 show the diffusion pattern among firms of different nationalities. For the purpose of this analysis, the nationalities were grouped into two categories: Japanese and non-Japanese joint ventures. As shown in the tables, there were 12 non-Japanese companies namely British and Australian. Japanese joint ventures constituted the largest number in the sample firms studied. Most of the Japanese firms were medium sized firms, which started operations in the early 1960s. In terms of diffusion pattern Japanese firms tended to have a lower degree of diffusion. However, 67% of the 12 non-Japanese firms had achieved a high degree of diffusion in production management capability. With regards to innovative capabilities, almost 71% of the non-Japanese firms had a moderate pattern whilst 66% of the Japanese firms had a the low diffusion pattern. As shown in the tables Japanese companies tended to have a lower diffusion pattern compared to non-Japanese firms. The statistical analysis shows that there is a strong relationship between nationality of foreign partner and diffusion of technology. This confirmed our hypothesis that the nationalities of foreign partners influenced patterns of diffusion in joint venture firms.

6.3.5.1 *Japanese companies*

Interviews with both Japanese and non-Japanese firms provided some explanation with regards to the differences in diffusion pattern between these two categories of firms. Non-Japanese firms tended to provide greater autonomy to the subsidiaries. Information on technology was accessible to local personnel. The role of the expertise was more of an advisory capacity. Generally, non-Japanese firms tended to show a greater understanding of the needs of local firms to enhance their technical capability. In many of these firms, production management skills were highly advanced and local personnel had assumed overall responsibility for the technical operation of the company. Foreign technical personnel served in an advisory capacity. They provided technical advice on plant inspection, assisted in problem solving and coordinated technical efforts involving their parent companies.

At Alcom, Berjaya Kawat and Federal Aluminium the post of technical manager had been taken over by local personnel. All the three companies reported low barriers to the flow of technological knowledge. At Alcom, interviews with several staff revealed that the technical information was widely accessible. According to the technical manager, personnel could gain access to the technical databank of its foreign partner's parent company so long as the information was relevant to its operation. Similar views were expressed by the general manager of Kuala Lumpur

Glass, a joint venture with Australian Consolidated Industries. The local chief executive explained that the company had benefited from the international network of its partners, particularly in the area of glass technology. Technological information could be sourced from any of the ACI's subsidiaries in the region. With this technical exchange network, the company had been able to keep abreast with technological development in the industry.

One important observation is that most of these companies tended to decentralize their technical operation which meant that local personnel had greater opportunities to get involved in the technical and production activities of the firm.

However, the same cannot be said of Japanese firms. Several employees in Japanese joint venture companies felt that Japanese firms tend to be more restrictive with regards to the flow of technology to local personnel. Japanese expatriate staff tended to centralize technical activities in such a manner that only a particular few expatriate staff were involved in technical and production activities in the firm. Technical information was transmitted from the parent company to the Japanese expatriate. Local personnel were not allowed to communicate directly with the Japanese parent company. Local personnel tended to feel that Japanese expatriate staff were reluctant to develop expertise within the company. Most of them felt that Japanese expatriates were not flexible. Diffusion of technology was far more controlled in Japanese firms.

6.3.5.2 *Non-Japanese companies*

Unlike Japanese expatriates, German, British and Canadian expatriates tended to be more sensitive to the needs of their local subsidiaries. They tended to show more concern over the development of the local subsidiaries. In certain cases they had started to develop local expertise and cooperate with local chief executives to provide technical support to local subsidiaries. For example, Antara Steel, a joint venture with Kloekner of Germany was established to manufacture steel rods. The local chief executive was satisfied with the technical support given by the two German expatriates. The dedication and commitment of the two German expatriate staff in Antara Steel were widely recognised and appreciated by the company personnel.

It should be noted that most non-Japanese joint ventures also sourced the supply of raw materials to their subsidiary companies but this was done in consultation with local partners. In certain cases, the prices of those products supplied were quite competitive. The findings in the case study seem to indicate that Japanese companies tended to exercise tight control over diffusion of technology. Many of these companies produced standardised products which could be produced locally by local entrepreneurs. To prevent the erosion of their competitiveness, Japanese companies tended to exercise tighter control to prevent the leakage of their technology. On the other hand, non-Japanese firms were mostly large multinational firms. Their strategy of controlling local subsidiary was more developed and did not rely solely on the controlling of technological resources as the means of exercising influence over the operation of the companies. Non-Japanese joint venture companies like Alcom and H & R Johnson retained their competitive advantages and control through other means such as product differentiation.

In choosing the technology supplier, the firm must examine the investment strategies of its partners, their commitment to the development of local subsidiaries and the degree of autonomy in the decision making process. In this study a comparison was made between Japanese and non Japanese joint ventures.

This study suggests that the nationality of foreign firms' strategies has major implications on the accumulation of technical capabilities.

6.3.6 *Nature of technical staffing*

6.3.6.1 *Data analysis*

A large number of Malaysian companies had employed expatriates in various stages of their development. There are two categories of expatriate staff. For the purpose of this research, companies with short tenure experts were not considered as those employing foreign expatriates. Long tenure experts are those serving the company for a period over than one year. They are normally employed in management positions. Short-tenure experts are those hired on special assignments such as independent consultants or technology suppliers who provide technical assistance to the recipient firms. These short tenure experts are normally assigned to provide specific technical expertise or solve technical problems on a short-term basic. Table 4.6 shows the allocation of expatriate staff. Most of these companies had employed expatriate staff in technical positions. Employment of expatriates was not confined to joint venture companies but was also prevalent in wholly owned local companies. For example, General Ceramic, a wholly owned local company had employed expatriates for the last 10 years. Petronas, another local national company, also appointed expatriates to head its project planning team for the development of the refinery.

6.3.6.2 *Diffusion in non-expatriate companies*

It should be noted that in terms of project execution and innovative capabilities, several of the companies which did not employ expatriate staff continued to rely on short tenure foreign experts to assist in specific R & D efforts and implementation of new projects. The advantages of employing short tenure experts is that they are specially assigned to solve specific technical problems and train staff in certain areas. In most cases there was an effective transfer of skills and knowledge from the expatriates to local personnel. It should be recognised that many of these companies had employed expatriates during the initial stage of development. In the case of Tasek Cement, the company employed a large number of expatriates from Taiwan to assist in the operation of the cement plant. During the early sixties, the technical skills relating to the operating of a cement plant were not widely diffused. Very few local employees had experience in operating cement plants. Tasek Cement therefore recruited a number of Taiwanese to operate the plant. At the same time the company also recruited a number of local graduates to understudy the expatriates. As the local personnel acquired the necessary experience, the expatriates were phased out. The data shows that this systematic programme had proved to be effective in the transfer of technology from expatriates to local staff. In fact Petronas had also adopted a similar programme. The new Petronas refinery had been operated by Caltex which had a technical agreement with Petronas refinery. Several Petronas staff were assigned to understanding the Caltex personnel. Under the technical service agreement, Caltex would train Petronas staff in plant operation for a period of four years. It was indicated that at the end of the term, the plant should be fully managed by local expertise. A number of expatriates had been withdrawn as local personnel acquired the necessary expertise. Technology transfer programmes of this nature where expatriate staff were employed to impart specific skills for a specific period had evidently proven to be successful. Specific efforts by the management of these companies to train local staff to take over from the short tenure expatriates, had proven successful in ensuring a rapid diffusion of technology. As a result many of these companies did not hire expatriates as permanent staff in their company. Where such effort was not implemented, the company tended to rely on long tenure expatriate staff. General Ceramic, for example, acquired the technology of manufacturing ceramic tiles through turnkey processes and employed a foreign expatriate to head its technical operation. Because of the lack of systematic efforts to train personnel and develop expertise among local personnel, the company continued to depend on the expatriate staff after being in operation for over 10 years.

The high diffusion pattern in companies that had no expatriate staff was due not only to the systematic efforts to develop local staff and phase out expatriates but also to the high degree of local involvement in carrying out technical activities. In the case of Amalgamated Steel Mill, the company had phased out all expatriate staff in its second year of operation. This provided greater opportunities for local personnel to undertake the operation of the company. Companies recognised the high cost of employing expatriate staff. Therefore they tend to employ expatriate staff only during the initial stage of the plant while ensuring that the local personnel are properly trained to take over the expatriate posts quickly. Compared to many Malaysian companies that had undertaken capital intensive projects, ASM had performed exceedingly well because of its ability to operate without expatriate staff after only two years of operation.

6.3.6.3 *Diffusion in companies with expatriate staff*

Companies which had expatriate staff in its employment tend to have a lower diffusion pattern for a number of reasons. First of all, the expatriate staff were employed to safeguard the interest of the foreign partners. Unlike short-term foreign experts, the expatriate staff on permanent employment had a different role. In many of these firms, expatriate staff had been employed as technology gate keepers. Most of them were assigned to key technical positions particularly as technical managers As shown in Table 4.6 expatriate staff were generally assigned to technical department. Gate keeping has been defined as a communication behaviour of individuals who withhold or reshape information that they control as it flows into the system (Rogers and Shoemakers 1977). As will be discussed in the subsequent section, the technology strategy of foreign firms is to control the flow of strategic resources such technology. This is necessary in order to exercise influence over the operation of the company. Chapter VII deliberates on various issues regarding the technology strategy of foreign firms. Most of the joint venture companies indicated earlier are production units which manufactured products designed by their parent company. Therefore they tend to implement in-house technical efforts to a bare minimum sourcing the necessary technical assistance from the parent company. Raw materials formulation, test results and other technical dates are transmitted through technical managers. This is also confirmed by most personnel in joint venture companies. Thus it is important for the foreign firms to employ its own personnel to coordinate such activities with the parent companies. Technical expatriates had been perceived as a barrier to the diffusion of technology because of their role in controlling the flow of information to local personnel. The data in Table 4.14 on areas of conflicts shows that development of expertise tended to an important area of conflict in companies where expatriate staff were located in technical department.

The structure of the technical system in many joint venture companies was such that the key technical duties are assigned to the technical expatriates while less minor roles are given to local personnel. Hence, a number of local staff who are highly qualified ended up performing jobs of a less demanding nature. This created frustration among personnel as in the case of Malaysian Sheet Glass. Employment of expatriate staff tended to deprive local personnel of opportunities to acquire the necessary experience. In many cases, the expatriate staff had been employed on a long term basis. Many of the joint venture companies had employed expatriates since the beginning of their establishment. In Malex Asbestos, the first asbestos plant established in the country the company had continued to employ an expatriate as its production manager. The company started operation in 1961 and had yet to employ any local professional staff in key positions. For the last 20 over years, the foreign expatriates had exercised strong control over the day-to-day production activities of the company. Major technical efforts like trouble-shooting, quality control, raw materials testing and product process formulation were implemented by the foreign staff. This typified many other joint venture companies where expatriate staff occupied key technical posts. Not only were they involved in production management activities but also in the implementation of new expansion projects. In the case of Alcom, the foreign partner had seconded many of its staff from its Indian subsidiary to head the project team to implement the new plant manufacturing foil products instead of utilizing its own technical staff. Alcom had a number of local technical personnel with many years of engineering experience. According to Alcom personnel, the expatriate staff seconded to the project team had little experience in planning and implementing a of foil plant. To a great extent, this had deprived local personnel the opportunity to acquire the skills in project planning and management. It is important to note that Alcom had three expatriates in its Malaysian operation. Thus they were able to influence the decision making process regarding the planning and implementation of the project, favouring the employment of other expatriate staff in carrying out this project.

Expatriate staff played a key role in directing the technical operation of the firm. As shown in this study, the nature of technical staffing can determine the pattern of diffusion. If a desired pattern of diffusion is to be achieved, a firm must examine closely its technical staffing requirements. Where there is a shortage of trained and skilled manpower, a comprehensive programme should be implemented to phase out expatriate staff gradually while local personnel acquired the necessary skills. Public policy, particularly on the employment of expatriate should be reviewed in line with national technical strategy.

6.3.7 *Technical collaboration*

6.3.7.1 *Data analysis*

Technological collaboration was a major source of technology acquisition of firms in Malaysia. Technological collaboration refers to a broad range of technical services provided by supplying firms in the form of technical assistance agreements, management contracts, technical know-how agreements and a combination of various types of arrangements. Such arrangements were common among joint venture companies where the foreign partners had formalized the infusion of technical resources through technical assistance arrangements. Non-joint venture firms could also enter into a technical assistance with other independent manufacturers to acquire specific technology. This may either be long term or short term technical assistance. Technical assistance with a period of less than one year is considered short term. Among the 31 firms, 10 firms had no long term technical collaboration arrangements with technology suppliers. Companies like Tasek Cement, Associated Tiles Industries (ATI), General Ceramic and Associated Ceramic Works (ACW) tended to rely on international sources for short-term technical assistance and other informal links with suppliers of technology. From Table 4.46, it appears that 60% of the firms with short-term technical collaboration arrangement tends to have a higher pattern of technology diffusion. In the case of investment and project acquisition, as shown in Table 4.46, 60% of the companies with short-term technical collaboration had achieved a higher degree of diffusion as compared to only to 6% for firms with technical collaboration. Similarly, in production management capability, seven or 70% of the firms with short term technical collaboration had acquired a high degree of diffusion as compared to 38% for firms with long term tendered collaboration. The two firms that had attained high a degree of diffusion in innovative capability did not have any long term technical collaboration with technology suppliers. The statistical analysis as shown in table lends support to the hypothesis that technical collaboration has an important influence over diffusion of technology.

6.3.7.2 *Sources of technology*

The high diffusion pattern in firms with short term technical collaboration arrangements was attributed to several factors. Firms will only source external technical expertise if they feel that such formal linkages are beneficial to them.

The benefits should outweigh the costs of such an arrangement. Interviews with executives in firms which did not have long term technical collaboration arrangements indicated that companies generally considered alternative methods of sourcing technology with a view to minimizing the cost to the company. It was felt that technical collaboration arrangements would involve additional cost to the company, which would affect its competitiveness. Generally technical assistance agreements would require the recipient firm to pay royalty payments of around 3% to 5% on sale goods. Owner managed companies were very cautious about the cost of technology. The rational firm would seek to acquire technology through the most cost-effective method. In doing so, they tended to rely more on internal resources by establishing their own technical departments and employing a small number of professionally trained staff.

Analysis of two firms which manufactured the same product would provide some insight into the practice adopted with regards to technology acquisition. ATI and Malaysian Mosaic were established to manufacture mosaic tiles. ATI was a wholly owned local firm and was established through turnkey transactions. During its initial stage, ATI was assisted by Japanese expatriate staff in establishing its operating capability. ATI had no technical arrangement and had established its own technical department. It is pertinent to note that ATI had phased out all its Japanese expatriates and was fully managed by local personnel. Interviews with the technical manager revealed that much effort was put into increasing the technical base of the company through the employment of professionally qualified staff. ATI had three professional staff in the fields of chemistry and engineering. The technical department was responsible for product process improvement. A high degree of in-house technological efforts had been undertaken to improve the quality of its product. Such efforts provided greater opportunities for learning by doing. It had developed linkages with other manufacturers overseas through conferences, seminars and visits. On the other hand, Malaysian Mosaic was a joint venture company with a long term technical collaboration arrangement. Since its inception in the early sixties, the company had not employed any professionally qualified staff. There was one expatriate staff who handled all technical matters relating to production and product process development. Diffusion of technology in Malaysian Mosaic was very slow with little expertise developed over the period of 20 years as compared to ATI which was self-reliant in terms of its technical resources. Manufacturing mosaic is a mature technology where the product process know- how is well diffused. Such a technology could easily be acquired if a company focuses its efforts on developing internal resources as was done by ATI. By relying on internal resources, technology diffusion was much more faster.

6.3.7.3 *Development of internal resources*

Companies with short term technical collaboration arrangements also tended to strengthen their own project management teams to undertake subsequent technology acquisition. Those with long term technical collaboration arrangements will generally rely on their technology suppliers to provide the necessary expertise including the evaluation of technology and the management of projects. This could be seen from two companies, both of which are involved in the manufacturing of cement. Associated Pan Malaysia Cement (APMC) was one of the earliest cement companies established in the country in the late fifties. The first plant was established in Rawang. APMC is a joint venture between Blue Circle of United Kingdom and local investors. The company recently carried out major expansion work in converting the wet process to the dry process in two major plants. It had a technical collaboration arrangement with Blue Circle of U.K. During the implementation of the expansion project, its project team was headed by expatriate staff from Blue Circle. The company continued to employ a foreign expatriate as its technical manager. Although APMC had local management control it still relied on its technology suppliers such as Blue Circle to provide investment and project management capability. This is in contrast with Tasek Cement, a wholly owned local company which started operation in 1960. Subsequent investment in new projects was carried out by its own staff. The company did not have technical collaboration with any other suppliers. In fact it was supplying technical assistance to its associated company in Singapore. The company had established its own project team and was responsible for the implementation of major expansion and modification works. Subsequently Tasek Cement sourced technology direct from machine suppliers which gave the company greater discretion in selecting the various equipment without going through the turnkey contract. In the case of turnkey contract, the responsibility for assembling the plant lay with the turnkey contractors. APMC on the other hand continued to source its technology through turnkey transactions although it had been in business longer than Tasek Cement.

Companies with short-term technical collaboration arrangements also tended to develop wider networks and be more aware of technological development in the industries. Unlike companies with long term technical collaboration arrangements which could rely on information provided by their technology suppliers, companies like Tasek Cement, ATI or ACW had to develop their own information system through informal linkages with technical associations, raw materials suppliers and other independent manufacturers. Discussions with technical managers in these companies indicated their interest to work closely with local research institutes to undertake product process development.

6.3.7.4 *Summary*

The above description seems to provide an explanation as to the differences in diffusion pattern among companies with long term technical collaboration arrangements and those with short-term collaboration arrangements with technology suppliers. Diffusion patterns in companies with short term technical collaboration were higher due to their own in-house efforts to systematically develop their own expertise because of the need to reduce the cost of technology acquisition. The implementation of a high degree of technological efforts, the development of an in-house project team and creation of informal linkages had increased the pattern of diffusion. On the other hand, companies with long term technical collaboration arrangements tended to rely on their technology suppliers to provide all the necessary resources, thus limiting their own efforts to search for information and promote in-house technical efforts that could facilitate the diffusion of technology.

6.4 CONCLUSION

This chapter has conducted a preliminary statistical investigation of the differences in diffusion patterns among Malaysian companies. Development of indigenous technological capability has been used as an index for relative capabilities and it is assumed that this has been built up on the basis of imported technology. From the results of the statistical analysis, it nevertheless suggests some interesting tendencies which could be subjected to further investigation: ownership structure appears to have a weak link with technological capability and the presence of local ownership does not seem to promote technological development; management control appears to have a strong relationship with technological capability and, according to the cross tabulation, local management control seems to promote wider diffusion of imported technology rather than retard it.

Methods of technology diffusion appears to influence the level of technological capability. contractual transactions where the recipient firm assumes operating responsibility once the plant has been commissioned seem to have a positive impact on the development of technological capability. The study suggests that the development of technological capability did not depend on the operating life of the firm but on the nature of the technical efforts, investment activities and other factors. The age of the operating life of the firm has little influence on the diffusion of technology. The findings also indicate a strong relationship between the type of technical collaboration and the development of technological capability. It appears that informal short term technical collaboration seems to have a positive impact on indigenous technological capability.In view of the growing importance attached to the study on technological growth in developing countries and the relative poverty of theoretical and empirical knowledge on it, these findings should prove useful for policy makers and executives in Malaysian companies. It is also shown in the study that production capability was widely diffused among firms studied. Most firms considered the diffusion of production capability essential to the commercial viability of the project. Investment and project execution capability was not as widely diffused as production capability. This is due to the fact that local personnel were not involved in the initial setting up of new manufacturing facilities. Innovation capability was the least developed among the three components of technology investigated in the study. Since innovation relating to product development was sourced largely from external sources, very little indigenous effort was undertaken in local enterprises. Production capability tended to emerge early in most companies followed by some investment and project execution capability. Involvement by local personnel in project planning opened up new opportunities for learning by doing. Such efforts generally increase the role of local personnel and some degree of innovative efforts related to product process and adaptation, thus building up innovative capability.

These characteristics of technology and its determinants have a number of implications for each analysis. The first is that they help explain a considerable variation amongst firms in the same national market environment, in the level and composition of their technological capability. Second, given that technological capability is firm specific and cumulative, the relative technological strengths and weaknesses of firms do not change rapidly over time. The data relating to the age of the firms indicate that a number of companies remain technically stagnant over a period of years. This means that technological patterns in the recent past can be a reliable guide to events in the not too distant future. Third, the process of technological capability is not synonymous with the process of physical capital accumulation. Investment in new production facilities does not necessarily lead to higher levels of indigenous technical capability. Fourth, there is a clear inter-relationship between the three components of technological capability. Development of a high level of production and investment capability will facilitate the development of innovative capability. Finally, although some progress has been made over the past few years on the study of technological capability in developing countries, there is no unique method of measuring capabilities developed as a result of imported technology. Precisely what range of variables or indicator should be used in the analysis remains a matter of judgement. The above findings have important implications for policy-makers and executives in Malaysian companies. The study indicates that the government's ability to influence the direction of technology transfer in diffusion lies not with the restructuring of ownership alone but requires other forms of direct interaction, viz a combination of incentives, persuasion and other elements of regulation. Current efforts to promote technology transfer through administrative mechanisms would have to be re-evaluated in the light of these findings. It was assumed by policy-makers that greater ownership control ownership control by domestic firms would lead to more concerted efforts towards expanding the technological base in Malaysia. As indicated in the findings, ownership is not a strong factor in influencing technology development. There are other stronger factors that should be useful in developing an appropriate framework in strengthening the technological base of these companies. In fact, as the findings indicate, management control provides a more powerful influence in directing technology development. For Malaysian companies desiring to attain higher levels of technology development, the importance of management control should be considered seriously. In negotiating for joint venture arrangements local companies should give greater significance to management control because of its influence in determining the patterns of technology development. The findings indicate that much could be achieved if local companies are encouraged to assume more responsibility in managing their own operations. In the selection of methods of technology, companies should opt for transactions that would maximise local involvement and technological input. As indicated in the findings, the method of technology acquisition is an important factor influencing the diffusion of technology. However difficulties faced in finding the appropriate methods of technology acquisition are considerable. In some cases, technology may be available from a number of independent suppliers and firms may be able to purchase technology from competitive technology suppliers. Again the differences in corporate strategies and the acceptance of risks have implications on the choice of technology transactions. In making those choices, the firms must consider the long-term benefits to be derived from the companies' wide diffusion of imported technology. Various Malaysian companies have acquired technology through foreign direct investment, particularly joint venture arrangements which had provided a continuous flow of technology resources from foreign to local enterprises. The inter-company flow of information and technology know-how, to a great extent, has contributed to the manufacturing base of Malaysian companies. However, there is a need to look at other alternative methods of technology acquisition which would not only provide the initial technological input but also ensure the continuous 'deepening' of the technological base. Although joint venture arrangements will continue to be the main method of technology acquisition and development of industrial enterprises, the government should encourage companies to consider other alternative methods of technology acquisition such as licensing, contractual arrangements, and technology trade. For some companies, the ability to select appropriate methods of technology acquisition will depend on the ability to scan the technology market. Information is crucial in selecting the right technology suppliers. The machinery supplier anxious to make sales himself is unlikely to provide unbiased information on the performance of the equipment. Therefore it is imperative that firms build up an information base on technology available in the key areas. Such efforts should also be supplemented by building up stronger relationship with machine suppliers and overseas manufacturers. The accumulation of technological capabilities will require systematic efforts to promote technical development.

One of the areas of growing importance is the role of public policies in using firms to perform technological activities that would accelerate the learning process thereby producing a greater diffusion of technology. One of the findings emerging from this study is that in-house technological efforts by local companies, to a great extent, have contributed to the rapid diffusion of technology. Technological efforts through product process adaptation, plant optimisation, trouble-shooting and quality control provide the enterprises with the capacity to understand the principles of the technology they are using. Hence the number of years of operation would not ensure greater diffusion of technology if the firm itself did not conduct high levels of technical efforts to promote the learning process. Government policies with regard to technology development need to be orientated so as to make the utmost use of local enterprises to generate a higher level of technological capability.

With regard to the nationality of foreign partners, the findings indicate that the choice of foreign partners could determine the diffusion pattern in the companies. Multinational firms are naturally concerned only with the interests of their parent companies. Therefore, they pay no serious attention to the local firms' technological development. However, there are differences with regard to technology pursued by multinationals of different nationalities. The issue of foreign investments need to be considered carefully in the light of these findings. The study also confirmed findings by other researchers, particularly Yoshino, (1977) with regard to strategies of Japanese multinational companies. It was found that Japanese companies pursued strategies that would maximise the linkages with their parent companies. Hence greater effort is given to source raw material components and expertise through their parent companies with little effort to develop local enterprises. It is therefore essential to ensure that joint venture operations take the form of real cooperation and collaboration between local and foreign partners. Public policy intervention or regulation may be necessary to ensure such partnerships are created. For companies, the choice of partners should be considered seriously and the various problems raised in this research, particularly with regard to sourcing components and staffing of expatriates should be part and parcel of the whole negotiating process. In terms of technical collaboration, it was found that those companies which had sourced technology on a short-term basis had been able to exploit the technical resources made available to them. Multiple strategies are available to local firms to source technology. There is a need to maintain a balance between long-term and short-term technical collaboration. Initially, there is a need for the firm to source long term technical arrangement which may last for a period of three to four years but subsequently there is a need to also switch to short term technical arrangements which will provide greater flexibility. As the firm matures and acquires expertise, it can reduce the foreign technical input by exploiting the development of internal expertise. Short term technical collaboration also would allow the firm to develop linkages with numerous sources of technology suppliers and would also encourage the companies to continuously scan the technological environment. However, there are problems in this area because in certain industries, particularly emerging industries, companies may face difficulties in sourcing short term arrangements. Technology suppliers are more willing to make their technologies available to companies which would develop long term relationships with them through joint ownership to ensure secrecy and also limit diffusion of technology to local competitors. Similarly the firm should also consider the importance of employing short term and long term experts in building up their own expertise. The research findings indicate that the technical manpower policy has strong influences over the development of technology within the company. Again a balance must be maintained between long term and short term experts. The dependence on long term experts without giving due attention to developing internal expertise would hinder their diffusion of technology. A strong technical department staffed by local personnel would assist the firm in choosing technology appropriate for local raw materials requirement and in unpackaging foreign technology that would maximise use of local input which will lead to a reduction in foreign technological input. A strong technical department would also assist the firm to identify whether it should source those technical inputs from licensing, technical assistance agreements, know-how agreements or other methods of technology collaboration. The above findings will help policy-makers to frame more effective policies for promoting greater diffusion and development of technology. The findings also have offered some suggestions to companies that have a strong desire to promote wider diffusion of technology. However, there are limitations to these findings because of the small sample of firms which are basically in import substitution industries. Again a much larger study involving a wider selection of companies, is necessary to confirm some of these findings. However, despite these limitations the initial findings have provided an insight into some of the elements influencing the process of technology diffusion at the micro level. More detailed analyses with regard to public policy framework and company management of technology is provided in Chapter VIII and IX.

CHAPTER VII

MANAGEMENT RELATED FACTORS AFFECTING TECHNOLOGY DIFFUSION

7.1 INTRODUCTION

The preceding chapter has indicated the importance of technology acquisition, management control, technical manpower structure and technology sourcing in determining the diffusion pattern. Although the findings have increased our understanding of the diffusion process, there is a need to examine closely how management oriented factors such as the role of top management and its strategies have constrained and/or shaped the diffusion process. The findings reported in Chapter IV on factors limiting technology diffusion will be analysed in greater detail, using case analysis of the eight companies selected for detailed case studies: Petronas, Alcom, Amalgated Steel Mills, Malaysian Sheet Glass, Pernas NEC, Tasek Cement, H & R Johnson and Soong Seng Asbestos. The eight companies were selected because they had implemented major expansion projects and were able to provide significant input on the technology transfer process. More important they were willing to participate in the indepth interviews. Factors were selected on the basis of the literature review and pilot studies conducted by the researcher. Table 4.50 and 4.54 shows the ranking of the limiting and the facilitating factors.

What factors facilitate or inhibit the development of technology? Williams (1967) has provided an overview of the factors that affect technology development although he was primarily concerned with the situations in which rapid innovation is likely. Williams first noted that before there is innovation, there must be opportunities to innovate. Opportunities to innovate arise from innovations which can be copied or bought from other organisations. Many inter-organisational relationships are designed to permit organisations to share innovative ideas and information. In the field of technology transfer, technology exchange networks among recipient firms create free flow of information among firms attempting to master the imported technology. Technology development is also affected by characteristics of an organisation such as the distribution of decision-making power and the rigidity of the organisation's operations (Hage and Aiken, 1970; Zaltman et al, 1973). Top management plays a major role in influencing the innovative capacities of the firm. Mansfield (1968) also pointed out that decisions with regard to technological investments are linked to the nature of competitors, suppliers and consumers, to market structures to legal constraints, and to attitudes towards change on the part of managers. Some characteristics of organizations and their members can block technological development. Hall (1975) has pointed out that resistance by managers and works can contribute to decisions not to develop higher levels of technological capabilities. The components of decision-making are complex. They include the goals that an organisation is pursuing. The decisions are based on the acquisition and utilization of resources (White, 1974), as well as external politics (Allison, 1971) and internal politics (Pfeffer and Salancik, 1974). Organizational decision making occurs in the context of both an internal political economy and an external political economy. Freeman, (1982) in his discussion on the characteristics of successful innovating firms identified several of these characteristics which are relevant to this study such as in-house R & D, readiness to take risks, good communication with the outside scientific world and entrepreneurship strong enough effectively to coordinate R & D. Summing up the decision on factors affecting diffusion of imported technology one might conclude that among the critical factors considered are those related to the acquisition and management of technical resources. Before proceeding to discuss the factors in greater detail a brief introduction of the key findings is presented here.

7.1.1 *Factors limiting the diffusion of technology*

Factors limiting the diffusion of technology are as follows:

7.1.1.1 *Poor management of technology acquisition*

Poor implementation of the transfer process was one of the factors hindering the acquisition of technology by Malaysian firms. Companies had not prepared any detailed plan that would specify the skills to be transferred to local personnel in various activities related to the transfer process. In most cases, involvement of local personnel was only on an ad hoc basis. In many projects, recruitment of local personnel was not carried out until the later part of the project. Hence, local personnel were not able to acquire the skills related to project investment and execution phase.

7.1.1.2 *Lack of well-defined technology transfer programe*

The lack of definition of the technology transfer programe appears to be the most crucial factor limiting rapid diffusion of technology. Recipient firms were generally slow to recognise the need to formulate technology transfer strategies. Formulation of technological strategies requires firms to make decisions on choices of technology, types of technology transactions and selection of appropriate technology suppliers. Failure of companies to formulate long term technology strategies led to a poorly coordinated transfer process. Attention was not given to selecting the best technology transaction to ensure an efficient flow of technological resources to the recipient company. Little effort was made to search for and select technology suppliers that could provide the best terms of technology transfer at the initial set up of the enterprise.

7.1.1.3 *Lack of management effort to foster technological development*

A weak technological base in Malaysian firms had been attributed to the lack of management effort to promote technological development. Management had failed to build upon the technology which had been transferred at the intitial phase of the firms. Little effort was carried out to strengthen the technological skills of local personnel in order to reduce reliance on foreign expertise. The future development of the firm in terms of technological progress was rarely addressed during negotiations on technology transfer.

7.1.1.4 *Strategy of technology supply firms*

Another factor limiting the diffusion of imported technology was related to the strategy of foreign firms. Foreign partners in joint venture firms tended to exert strong control over the development of technological capability. By controlling the flow of knowledge and development of technological capability, local companies will be dependent on the know-how and skills of their technology suppliers. On this dependence lay the bargaining strength of foreign firms. The tight control over technology was also attributed to the fear that technological knowledge might be leaked to potential rivals.

7.1.2 *Factors facilitating diffusion*

The factors identified as facilitating technology diffusion are as follows

7.1.2.1 *Development of technical resources*

Systematic efforts to develop internal resources appear to be one of the major factors facilitating technology diffusion. Although it was essential for firms to rely on external resources initially, there was a need to develop programmes that would emphasise long term development of internal resources. Technological resources encompass technology acquisition, production management, innovative capability and the development of physical facilities. The study revealed that the rapid diffusion of technology in some successful companies was due to the strategy of the companies to develop strong internal capability since the pressure of internal development was seen as the best way to acquire the necessary skills and knowledge. Companies were willing to invest in manpower development, select the best terms of technology acquisition, develop strong linkages with other suppliers, and provide good compensation systems in order to attract experienced and highly professional staff.

7.1.2.2 *In house technological activities*

In house technological efforts tend to lead to rapid diffusion of technology. Such efforts not only accelerated the information flow but also subsequently generated new technical information which contributed to greater understanding of the principles underlining the importance of technology. Efforts by local firms to break through technical problems, when successful, often propelled the firm to a high level of technical capability. Such efforts also encourage a high degree of participation by local personnel in improving productivity and efficiency at the shop floor level. When constructing new facilities, local personnel were involved in designing and fabricating additional facilities. The major steel companies like ASM, Malayawata Steel had developed strong engineering teams to plan and coordinate expansion projects. At Tasek, constant improved modification and construction of the plant had been carried out by local personnel. From 1967, the companies engineered and constructed a high output limestone thrashing plant and a mechanised raw clay storage.

7.1.2.3 *Top management support*

Companies rank the importance of top management support as the third most important factor facilitating the diffusion of technology. In all stages of the technology transfer process, there was a need for top management to be involved and to monitor the process closely. The development of technological capability must be integrated in the overall corporate development plans and should form an important part of the companies' objectives. Top management support had a strong influence on the way imported technology was diffused within a particular company. Without top management support, companies would not be able to allocate the necessary resources for development of expertise, skills and information network.

7.1.2.4 *Strong linkages with alternative sources of technology*

Easy access to information is essential to accelerate the diffusion of technology. The study revealed that firms acquired their technological knowledge through the information network. The diffusion of technology within an enterprise depends on the efficient flow of technology transmitted into the firm from external sources. Firms which have acquired a high degree of technology diffusion undertook extensive search efforts to locate technology suppliers. They also sourced extensive information to evaluate the performance of those suppliers and in doing so developed a wide network of information exchange. This generally led to the development and establishment of a framework for future collaboration with most suppliers and independent manufacturers. Besides undertaking extensive search efforts, firms also built informal links with friendly manufacturers in the field. Such links facilitated the accumulation of specific product knowledge that enabled the companies' personnel to seek specific information which normally would not be divulged to other competitors.

7.1.2.5 *Selection of appropriate transfer mechanism*

The selection of the right mechanism for technology acquisition has been perceived as one of the important factors facilitating the diffusion of technology. In view of the various options available with regard to the different types of technology acquisition, such as foreign direct investment, contractual arrangement or technology trade, companies must develop a wide variety of choices in selecting the right technology suppliers. As experience has indicated in the various companies studied the right technology suppliers is critical to the development of technological capability. Considering the various options available in the context of the long term corporate development of the company, there are risks in acquiring technology through other methods such as licensing or technology trade. Such risks can be minimised if the company allocated sufficient resources to develop highly skilled and highly trained manpower.

7.2 FACTORS LIMITING DIFFUSION

7.2.1 *Poor management of technology acquisition*

The study revealed that poor planning and coordination of technology acquisition were important factors limiting diffusion of technology. The project planning and implementation stage was one of the most important phases of the transfer process. Lack of attention given to project planning and implementation had led in some cases, to a poor diffusion of technology. Since the transfer of technology involved the transfer of skills needed in feasibility studies, detailed studies, project planning and plant commissioning, it is important that the management structure its transfer process to capture those skills.

As executives pointed out, the lack of proper coordination and planning of the transfer process was due to the management's perception of technology acquisition in terms of the development of production capability. This influenced the management's participation in the planning and coordination of the technology transfer process and management tended to focus on the acquisition of production capability. The other phases of technology transfer such as feasibility studies, selection and evaluation of technology, coordination of planning contractors and suppliers were not given much emphasis. In many of the completed projects the researcher found that management had not participated actively in the coordination and planning of the transfer process. This led the foreign partners to plan and implement the project with very little participation from the company personnel. Recruitment of personnel was generally carried out towards the final phase, particularly when the plant was nearing completion, to enable the staff to be trained before they were appointed to operate the new plant. In most cases, they were sent to the foreign firm's operating plant to be given on-the-job training. As shown in Table 4.51 executives in mixed ownership companies had given a high rating for poor management of technology acquisition compared to wholly owned local companies.

Personnel interviewed indicated that they had not acquired technological skills, particularly at the project engineering and implementation phase. It was recognised that the acquisition of these skills was necessary to enhance their production capability. For example, in the planning and implementation of Antara Steel Mills, the local partner did not participate actively in the project implementation. The German firm, Kloekner, was thus given the responsibility to supervise and coordinate the plant construction. Only one local engineer was seconded to the project towards the later part to assist in administrative matters such as clearing of goods from Customs and other matters relating to the employment of foreign expatriates.

Firms interviewed recognised that the opportunity to implement large scale projects rarely occurred in the company. Such opportunity should be fully exploited. The foreign firms particularly Japanese companies, recognised the importance of getting their own personnel to participate in the transfer process. A number of engineers were brought in from the foreign company to work alongside their senior counterparts. The learning-by-doing process had always been a source of accumulating project management skills. As indicated in Table 4.53, executives in Japanese joint venture companies had attributed poor management of technology acquisition as an extremely important factor limiting diffusion.

However, only a small number of Malaysian companies like Tasek Cement and ASM recognised the importance of acquiring skills related to planning and implementation of industrial projects. Tasek and ASM executives noted that they had planned their projects carefully to ensure that their personnel accumulated as much investment capability as possible with company engineers and technicians assuming an expanding role in project design and execution. As a result, both companies were able to undertake their own investment and project implementation in subsequent expansion efforts with little assistance from foreign technology suppliers. With the exception of these two companies, most of the other firms had not participated actively in acquiring or in planning the transfer process and had instead left the task to foreign teams. Executives interviewed said that their companies were only concerned with getting the projects completed on schedule. No attempt was made to ensure that skills related to planning and implementation of industrial projects were diffused widely among the personnel. Proper planning and coordination of the transfer process are thus crucial to ensure the diffusion of technology.

7.2.2 *Lack of a well defined technology transfer programme*

Recipient firms were generally slow to recognise the need for a well defined technology transfer programme as an essential step in the transfer and development of technological capability in new enterprises. However when the necessity was recognised it was often too late as the firm had already committed itself to long term technical relationships which were often difficult to change. Most respondents indicated that the firm's inability to clearly define its technology transfer strategy appeared to be the most crucial factor hindering rapid diffusion of the technology. Successful acquisition of technology required not only the development of basic operating skills but also other skills, particularly general and project management skills, and innovative skills that determined the strategic long-term viability of the firm. The choice of technology, types of technology transaction and choice of technology suppliers were influenced by the firm's transfer strategy. As indicated by most recipient firms, the failure of top management to formulate and set in place a coherent set of long term technological objectives led to a poorly planned and coordinated transfer process. For example, little was known of the type of technological skills to be developed within the firm in some cases. Firms did not state clearly the type of capability they wanted to acquire in areas such as product design, project engineering or product management and the time frame for the capability to be developed within the company. Companies, particularly joint venture companies, felt that a clear definition of the transfer arrangement was essential. Attention was not given to selecting the best technology transaction to ensure the efficient flow of technological resources to the new company. Little effort was made to search for and select technology suppliers that could provide the best terms of technology transfer at the initial start-up of the enterprise.

In the case analysis of eight companies that had implemented new projects it was found that in negotiating the acquisition of technology, several firms did not identify areas of expertise that needed to be developed within the enterprise. The eight companies were those selected for detailed case studies as explained in the research methology section Negotiations were carried out with the suppliers without adequate knowledge of the long-term technological developments. In most cases, the firms lacked technological know-how and industrial experience and relied too much on foreign input to help them in the planning process. The importance of defining technical capabilities cannot be over-emphasized because this helps in defining the terms of the technology transfer arrangement. Without such long term development plans, firms were not able to identify the most appropriate terms of technology. Most of the firms felt they did not have the necessary experience and expertise to negotiate with the technology suppliers. Moreover, the commercial interest was the overriding objective in technology negotiations. Local companies were often more keen to see their projects completed on time than to pay attention to the long term technological objectives. Priority was thus placed on the operating capabilities and specific areas of expertise in order to start immediate production. There were no comprehensive programmes on technology transfer. As shown in Table 4.52 more executives in locally managed firms had perceived this problems as a serious limiting factor than those in mixed ownership companies.

7.2.3 *Lack of management efforts to foster technological development*

The weak technological base in many Malaysian companies had been attributed to the lack of management efforts to foster technological development in Malaysian industries. Key issues like the level of technical capability to be developed, the type of R & D activities, the degree of reliance on external sources and the choice of technology had not been integrated in corporate development plans. Most of the firms studied were established in the sixties and seventies under the import substitution programme. The main interest of the foreign firms was to start manufacturing operations in Malaysia. Local partners in joint venture operations were mostly businessmen with some trading experience. They had little knowledge of industrial operation. In the latter part of the seventies, local partners were generally public enterprises whose primary role was to have equity participation in the newly established joint members. Most of them had little trading or industrial experience.

In view of their lack of experience in industrial operation, local firms were unable to determine the type of programme required to promote a higher level of technological development. In most cases, the foreign firms had a stronger bargaining position because of their knowledge of the industries and technology. Hence, it was the foreign firms which determined the type of capability to be developed within the company. The technology collaboration arrangements entered into by local and foreign companies determined their relationship and the terms of transfer. The future development of the firms in terms of technical progress was rarely addressed during negotiations on technology transfer. As companies gained experience and learnt more about technology, they began to realize certain shortcomings in their agreements and terms of transfer.

Executives interviewed noted that many of the problems encountered in joint venture companies resulted because the management failed to identify critical issues on the development of the firm. Foreign expatriates interviewed similarly felt that major issues on technological development of the firms should have been discussed during the initial stage. Issues on technology transfer tended to arise only after five to 10 years operation and this tended to create tension between local and foreign companies. In most cases, the specific terms of technology transfer had already been agreed upon and problems arose if certain changes were requested.

A clear programme to foster technological development was not formulated. As pointed out by most of the executives the responsibility of initiating and promoting technical development lay with the local firm. Pernas NEC, for example, wanted to manufacture certain components locally and was not happy with its limited assembly operations. It requested additional technical information on the respective component from NEC. However, the foreign partner was quite reluctant to provide such information. NEC is a multi-national firm with global network and its interest in Malaysia was only in manufacturing specific products for the local market. Most of these components were sought from its associate companies in other parts of the world. However, the local partner, Pernas, felt that an increase in local content would not only meet the demands of its customers but would also develop technical skills among its personnel. After 10 years, Pernas NEC found that very few skills had been acquired in the field of manufacturing telecommunication products. Company executives felt that a lack of focus on developing internal expertise during its 10 years of operation was due to the absence of a long-term technical development programme. Pernas NEC relied heavily on external sources of technology from its foreign partner.

This situation would have been different if adequate attention was given during its initial establishment to identify critical issues on the direction of technological development that needed to be fostered within the firm. In doing so, Pernas NEC could have negotiated for specific terms to enable it to achieve the desired level of technological capabilities. Similar views were expressed by firms such as Malaysian Sheet Glass, Malex Industry and Malayawata which felt strongly that the firms could have been more aggressive in pushing towards a higher level of technical development.

7.2.4 *Strategy of technology supplying firms*

Foreign firms, particularly those in joint venture companies, would have a significant part of their assets, sales and profits tied to overseas operations and therefore they would have a strong desire to exercise control over these operations. For most foreign firms control was essential to ensure that the operation of subsidiary companies was in line with their investment strategies. For whatever reason the foreign firms were attracted to Malaysia, their primary purpose was to fulfill their investment strategies. It has been noted by Yoshino (1976) that one of the investment strategies of Japanese joint venture companies was to maximize exports from Japan to local subsidiaries in the form of intermediate goods and components. During the course of this study several personnel of Japanese joint venture companies confirmed that foreign partners tended to overprice raw materials and components. Several of the personnel noted also the large payments of technical fees and the higher prices charged to local partners on purchases of raw material and components. Attempts by the local partners to develop alternative suppliers were strongly resisted by the foreign partners. Control as viewed by foreign partners was necessary to ensure compliance of local partners, particularly in areas where there was bound to be disagreement and conflict. Local partners had to strive for control over important resources and access to information in order to assess the cost of raw materials, but these efforts had always been resisted by foreign partners. Local chief executives on the other hand resisted what they termed as strong-arm tactics by foreign partners to assert themselves in the management of joint venture companies.

Conflicts between foreign and local partners prevailed in some companies and had been discussed in Chapter V. Partners in joint venture companies can have, and frequently do have, incompatible preferences and goals. The technology strategy of foreign firms may be viewed within the context of the overall strategic control process. To the extent that the foreign firms controlled critical resources, as in this case technology, and if certain conditions were met they were in a position to influence the action of organization. This suggests that informational control is an important political strategy to strengthen the bargaining position of foreign firms. This creates a resource-dependent technical system where the local company will depend on the infusion of technological resources from the foreign firm. It is necessary for foreign partners in joint venture firms to assume control in order to maintain some degree of flexibility in determining the transfer prices of parts and components shipped to the local subsidiaries. There are considerable advantages to the foreign firm in being able to determine the transfer price particularly of components manufactured by its own subsidiaries located in other parts of the world. A strong local partner with a high degree of independence is likely to limit this flexibility since it would be anxious to obtain the lowest possible transfer price.

Discussions with key executives indicated that foreign firms usually adopted various strategies of controlling technology diffusion. First is the employment of expatriates in key places to control the flow of key technical information. Information on product process know-how was only transmitted through key technical expatriate staff. Foreign firms usually insisted that expatriate staff be appointed as technical managers. Investment policies in Malaysia allow foreign firms in joint venture companies to appoint expatriates in selected key posts. In the firms studied, almost all technical manager posts had been designated as expatriate posts. Kidron (1965) cites similar manpower strategy pursued by multinational firms in India. Kidron concluded that technical staffing policy pursued by many multinational firms is a key method of controlling dissemination of technology. It is possible that employment of expatriate staff as technical managers could be due to other reasons. For example Japanese firms would prefer to have their own nationals as technical managers to facilitate communication between local subsidiaries and headquarter staff since technical information generated by head office is generally in Japanese.

Among the firms studied, MSG had the highest number of foreign expatriates. The company is a joint venture between Malaysia investors and two Japanese companies, Toyo Menaka and Nippon Sheet Glass. The company started operation in 1971 with a total paid up capital of M$30 million. Toyo Menaka and Nippon Sheet Glass controlled 49 per cent of the equity structure while the remainder was distributed among local entrepreneurs and institutional investors. It started manufacturing tinted wired glass with initial production of 60,000 converted cases per month. In 1979, the firm expanded its production and introduced other glass products, particularly safety glass. The firm had embarked on a major expansion project involving the setting up of a float glass plant. Two different production processes are being used based on the "colburn" and the "Rollour" process technologies. MSG had eight expatriate staff including the managing director and technical director. It also employed several local professional staff at assistant managerial level. In terms of market share, the company controlled 90 per cent of the float glass market. During the last 13 years, all the key technical posts had been held by foreign expatriates in spite of the fact that the company is a local majority owned joint venture.

Apart from the need to exercise strategic control the foreign partner's tight control over the diffusion of technology was influenced by the need to discourage the entry of new competitors among local firms. The tight control over technology was also attributed to the fear that technological knowledge might be leaked to potential rivals which would create new competition through the movement of staff. This fear was clearly illustrated in the case of the asbestos cement industry. For over 15 years, the asbestos cement industry had been dominated by three joint venture firms. In 1977 a local entrepreneur who was refused dealership rights by one of the companies decided to start his own manufacturing plant. The process equipment was sourced from an equipment supplier in Thailand. This company, SSA, recruited a senior technical personnel from one of the joint venture firms. Commercial production was delayed for several months due to initial design problems. However, local personnel successfully made some modifications and the company was able to commence full-scale commercial production. Initially it started with asbestos cement flat sheet and successfully cornered 20% of the market share. The company recently established a new plant for asbestos cement pipes.

The technology strategies of foreign firms must be viewed within the context of the strategic control process. By controlling the flow of knowledge and development of indigenous resources, local companies will be dependent on the know-how and skills of their foreign partners. On this dependence lay the bargaining strength of foreign firms and their ability to exert control over the operation of the company. If the firm diffused all its technological knowledge it would not only lose its control over the company but also create new rivals and new competition through the movement of the labour force to locally-owned firms. From the local companies', standpoint the foreign firm's diffusion strategy retarded the growth of indigenous technological resources and diffusion of technology in the economy. Since joint venture companies constituted a major type of manufacturing organisation in the country, this strategy could have major consequences particularly in the development of indigenous technological capabilities.

7.3. FACTORS FACILITATING DIFFUSION

7.3.1 *Development of technical resources*

Development of technical resources was ranked the most important factor facilitating technology diffusion. For many organisations, development of internal resources was perceived as the major factor facilitating the diffusion. There were several compelling reasons why firms ranked to development of internal resources lightly. Companies generally acquired their intitial technological input from suppliers of technology. Although it was essential for firms to rely on external resources initially, there was a need to develop long term programmes that would emphasise the development of internal technological resources. Technological resources encompassed expertise related to technology acquisition, production management, innovative capability and the development of physical facilities. As indicated in Table 4.55 both wholly owned and mixed ownership had rated the development of technical resources as an extremely important factor.

Companies felt that without systematic efforts to develop internal resources, they would be dependent on external technological resources for a long time. The failure to emphasise the development of internal resources had led to technical stagnation in many firms particularly those which had not progressed beyond routine production management capabilities. As was pointed out by executives interviewed, foreign partners of joint-venture operation were only interested in setting up limited manufacturing facilities for specific purposes. They relied on the foreign parent companies to supply technological resources during the early years of operation. This obviated the need to establish their own technical resources because from the view-point of the foreign partners, it was more economical to source expertise from the parent companies which had a wider technological base. It is for this reason that many joint venture operations operated with minimum technical resources focusing only on the area of basic manufacturing operations pertaining to specific product lines. Executives interviewed felt that this was one of the main factors contributing to the weak technological bases of several Malaysian companies.

Secondly, a number of joint venture companies were trying to wean themselves from foreign technology control. It was therefore argued by most local executives that emphasis should be placed on the development of internal technological resources although some degree of dependence on external input was necessary. The vicious circle of dependence on external resources could only be overcome when the company started to draw some of its technological needs from internal resources.

Consider H & R Johnson, a joint venture between Malaysian investors and H & R Johnson-Richards Tiles Ltd (UK) which started operations in 1978 to produce wall tiles. It recently embarked on a major expansion programme to manufacture ceramic floor tiles. The foreign partner had 15 per cent equity participation and provided technical assistance under a technical aid agreement. It is the largest producer of wall tiles taking about 15 per cent of the market. During the first few years the company was managed by local and expatriate staff. Because of frequent changes of expatriate staff and the high labour turnover of internal staff, Dunlop

Malaysia, one of the local partners decided to assume management control of the company. Dunlop seconded two of its staff as the managing director and general works manager, retaining one expatriate as its technical advisor. During the last few years, the company strengthened its technical manpower and promoted rapid diffusion of technology by increasing local involvement in planning the implentation of its recent expansion project.

Thirdly most of the executives interviewed recognised that the rapid technology diffusion in some companies was due to the desire of the companies to develop an internal capability quickly since the pressure of internal development was seen as the best way of acquiring the necessary skills and knowledge. For example, a number of wholly owned local companies choose to forgo joint venture arrangements out of a desire to limit direct involvement of foreign firms in technology acquisition. In terms of the development of the company there was a considerable advantage in acquiring technology directly from the suppliers than through joint venture collaboration. The real effects generated through such efforts could accelerate the diffusion process although there could be a high cost in terms of initial investment in manpower development and the employment of independent experts and consultants. Executives felt that although heavy investment in human resources development may initially be required,the benefits of rapid diffusion of technology were of strategic importance to the company.

Internal development required the company to invest in the development of a sound technical organisation. It required the company to establish various organizational components relating to R & D, project engineering, management information system, human resource development and other related activities. While it was necessary to acquire certain expertise from the independent technical suppliers, some companies had strived to carry out their own technical efforts in the area of product process development, troubleshooting design and fabrication, plant modification, and established project teams to undertake subsequent technology acquisition related to diversification activities. Wholly owned local companies particularly those involved in complex projects like petrochemicals and steel had made serious efforts in developing these facilities. For example Petronas and ASM had various technical departments taking care of activities related to product process development and plant expansion. But most Malaysian companies, particularly joint ventures, had made little effort to invest in the development of technical activities that could enhance the diffusion process. These are some of the compelling reasons why firms interviewed had ranked the development of internal resources as the most important factor that could facilitate diffusion. Executive felt it was essential in the development of internal technological resources for a systematic effort to be undertaken to develop manpower.

7.3.2 *In-house technological activities*

Companies ranked in-house technological activities as the second most important factor facilitating diffusion.

Investment in internal resources required not only the development of technical organisation and manpower but also the implementation of inhouse technological efforts. According to personnel interviewed there was a need for companies to utilise expertise and facilities that had been developed to implement technical activities particularly those related to plant expansion. For example several companies like ACW, H & R Johnson and Soong Seng had utilized their own staff to undertake subsequent plant expansion and development of new facilities. Technological accomplishments of this nature brought new learning capacity to the organisation.

Local companies are beginning to recognise the importance of in-house technological efforts such as solving technical problems and improving operating efficiency. Interviews with key technical personnel revealed several types of in-house technological efforts carried out in the firms. During the initial operating phase local personnel were responsible for troubleshooting, product process adaptation and plant optimization efforts. Technological efforts of this nature are considered a major source of innovative activity in developing countries as shown by Teitel (1977). In joint venture operations, foreign expatriates with technical support from the parent company were responsible for implementing various adaptations and adjustments to ensure that the company started commercial production immediately. None of the joint venture companies interviewed reported active involvement of local personnel in solving technical problems during the initial operation. However in companies which had acquired technology through contractual arrangements, local personnel participated actively in initial troubleshooting efforts which led to rapid diffusion of product/process know-how at various levels of the organization. Foremen, operators and engineers were all involved in diagnosing initial technological problems which not only facilitated the flow of information but subsequently generated new technical information which contributed to greater understanding of the principles underlying the imported technology.

In the case of ACW and SSA, in-house technical efforts had been triggered by problems which were caused by the machine suppliers whose plants came with some technical deficiencies. ACW started operation in 1978 producing Italian floor tiles. The machinery was supplied on turnkey basis by an established Italian machine supplier. According to the executive interviewed, the machine described as a multi roller kiln was one of the latest in the market. After several months the company was not able to achieve the desired quality in spite of several attempts by the machine suppliers to rectify the fault. The problem was finally overcome by ACW with assistance from an independent manufacturer in Indonesia. This type of problem generally triggered off intensive in-house technological efforts. SSA, the first indigenous owned firm to start an asbestos cement plant, had faced similar technical problems in the first year of operation. The owner who had no knowledge of asbestos cement technology decided to purchase a plant from a machine supplier in Thailand which had quoted the lowest price. After three months of initial operation, the plant was not able to start commercial production. The process performance was unsatisfactory in spite of several attempts by the machine supplier to correct the deficiency. The company then decided to phase out the machine supplier and entrusted the whole project to its own personnel. According to the production manager "we played around with the fiber formulation, carried out extensive raw material testing and sought technical information from various sources. After several attempts we managed to diagnose the problem and successfully made the necessary modifications". During the second year of its operation the company made a healthy profit. At ATI, a manufacturer of tiles, the company had set up a small R & D unit to undertake product and process development. At Tasek, constant improvement, modification and construction of plant had been regularly carried out by local personnel. From 1967 to 1973 the company engineered and constructed electrostatic precipitators, a high output limestone crushing plant and a mechanised raw clay storage.

Capital intensive industries such as steel, petrochemicals and cement tended to set up special departments which designed and executed minor works and organised designs, process and construction for installations involving complex process plants. The major steel companies like ASM and, Malayawata had developed project engineering teams to plan and coordinate expansion and modification projects. A strong project team was essential because in industries such as steel, petrochemicals, and cement, the choice of process was problematic and the size and complexity of new installations required a good deal of original design work and advanced project planning techniques.

The importance of in-house technical efforts has also been noted by Bell (1984). According to Bell at least three kinds of technical learning seem to occur when these types of minor technical change are undertaken. First, greater understanding of the particular form of the technology is acquired. Second, greater knowledge of the more general principles involved may be acquired, allowing perception of possible wider applications of those principles. Third, increased confidence in manipulating the technology may be gained. Bell emphasised that all these kinds of additions to technological capacity seem potentially greater when the technological "black box" was more open during the implementation of major investment projects, for example, when a new industrial plant is created or when large additions to existing capacity were undertaken. The development of technical resources in the company is a learning process by which information is acquired, stored, processed and disseminated. Wider diffusion could be achieved if the firm is willing to invest in the development of good technical organisations and systems which were more than mere production units. By implementing a wide range of technical activities, it could enhance the learning process and accommodate the necessary skills and knowledge.

7.3.3 *Top management support*

Firms ranked the importance of top management support as essential to ensure rapid diffusion of technology. Diffusion, like innovation, is management intensive. It requires planning, coordination and monitoring of the various aspects of the diffusion process by top management. In all stages of the diffusion progress, there was a need for top management to be involved and monitor the process closely. Commitment of top management comes from understanding of the role of diffusion of imported technology in the development of the firm. Executives interviewed felt that diffusion must be integrated in the overall integrated development plans and should form an important part of the company's objectives. Firms which had acquired a high degree of diffusion attributed their success to the strong support and commitment of top management particularly chief executives. The top management's support had a strong influence on the way diffusion was managed within the company. After deciding on the desired pattern of diffusion, the management had to make choices about the nature of technological collaboration, choice of technology and amount of resources allocated for training and development. Top executives shared strong views that for firms in developing countries, the most critical efforts in acquiring technology capability were to upgrade the levels of technology diffusion and to integrate them into the long range technology planning. In their long range planning process, technology development objectives including selection of technology, allocation of resources development of internal capability, sourcing of external expertise must be integrated in the overall corporated objectives. Interviews with executives revealed that most of them were committed to promoting the diffusion of technology. However, the types of technology to be diffused were not precisely defined. The views differed from firm to firm. Generally, most chief executive officers tended to focus on the diffusion of production capability. Emphasis had been given to the development of production capability where resources were made available for training on basic operating ability. However, in firms where technology development encompassed areas from project investment to innovative capability, efforts to promote technology diffusion were far more comprehensive. Petronas perceived diffusion of technology to include not only production capability but also some degree of project planning execution and innovative capabilities. In the case of ASM and Tasek Cement, senior executives tended to define diffusion in terms of the overall development of industrial operation from planning of technology acquisition to development of innovative capability.

It was found that chief executive officers with a technical background seemed to have a broader perspective of diffusion than other chief executive officers. Capital intensive manufacturing operations like cement, petroleum and steel tended to be headed by chief executive officers with some technical qualification and manufacturing experience. The industrial educational background of the chief executive officers tended to influence the way they managed technology diffusion. They established good rapport with technical personnel and showed strong leadership in organising and managing technology. With their technical background and experience in manufacturing operations they could better understand the various elements of manufacturing operations.

Entrepreneur-managed firms like ASM, Soong Seng Asbestos, and Tasek Cement seemed to pursue highly aggressive technology strategies. They undertook a high degree of risk in direct sourcing from independent suppliers in constructing capital intensive plants. When Tasek Cement constructed its own plant in 1967 it drew a lot of foreign visitors from other Third World countries. According to the chief engineer, foreign firms had dominated the cement industry in developing countries in the sixties and when a local company undertook to start its own operation, it drew interest from other developing countries. Tasek executives even presented papers at international conference relating their experience in constructing the plant. The success of Tasek was attributed to its founders, the entrepreneurs who took enormous risks in developing the project. Like Tasek, the success of Soong Seng Asbestos or Amalgated Steel Mills was also driven by the entreprenural spirit of its owners who had opted for alternative methods of technology acquisition other than joint venture operations.

As described earlier, the three companies had achieved a high degree of diffusion. The study suggested that the top management's commitment and its willingness to take risks were critical in acquiring a high degree of diffusion. Analysis of selected cases shows that the success of such firms was also due to the ideological values of their owners or chief executive officers. Where the owner or chief executive had taken the role of what Miles and Snow (1978) termed "prospector", the approach to technology acquisition had been innovative. However in companies, particularly public enterprises, where the managerial values were more conservative, method of technology acquisition tended to be joint-venture operations where the risk was minimised. There was also a tendency to heavily rely on foreign expertise. Foreign technology had never flourished in these companies where diffusion of technology was highly restricted. The top management's support was critical in the diffusion of technology. The commitment of management, its willingness to allocate resources and undertake risks and the quality of entrepreneurship had great major influence on the diffusion of technology. The role of the chief executive was very dominant in companies which had achieved a high degree of diffusion. His active involvement in planning, coordinating and monitoring of the transfer process had significant impacts on the diffusion of technology.

7.3.4 *Strong linkages with alternative sources of technology*

Most of the companies studied were constrained to a significant degree respect by their environment, especially through their dependence on sole sources of technology suppliers. Joint venture companies, particularly, entered into all-embracing types of arrangements which limited their ability to develop linkages with alternative sources of technology. Diffusion of technology depended on the efficient flow of technology transmitted into the firm from external sources. The flexibility of determining the patterns of relationship with sources of technology was rarely found in joint-venture companies. Foreign firms did not encourage their local counterparts to establish linkages with other suppliers of technology for various strategic reasons. This to a great extent limited the flow of information to the firm and affected the diffusion of technology. It is for this reason that firms felt strongly that linkages with alternative sources of technology could facilitate diffusion. Executives were well aware that some of the wholly owned local firms like ASM and SSA had acquired technology from multiple sources and developed linkages with overseas firms and organizations.

The study also revealed that much of the efforts of local firms were devoted to the acquisition of information. Companies like Soong Seng Asbestos devoted a large part of their scarce resources to acquiring much needed knowledge and spreading whatever knowledge existed. It was not uncommon to find huge gaps of knowledge between local and foreign firms. As pointed by the general manager of Hume Industries, a highly diversified local company: "The more relevant the knowledge a firm had, the more likely it will know what to do well". For a local company, it was important to develop linkages with external organisations. Local companies seeking to expand into foreign markets, diversify its product line and build new facilities needed information in order to know what to select and develop. As the environment became increasingly competitive, local companies were pressured to expand, modernise otherwise they lost out to others.

Firms generally carried out intensive technological search efforts for relevant technical information namely selection of new product process technology for major expansion, troubleshooting and quality control. Almost always such information had to be searched out and acquired by the firm itself. In other words the flow of technological knowledge depended on the active efforts by the firm and required the deployment of adequate resources to make the search efforts. Normal channels of sourcing such information were machine and raw material suppliers, independent manufacturers and overseas trade and technical organisations. Even though a company might have formal technical arrangements with independent manufacturers, it had to carry out its own search efforts through various other sources.

For example, the study on ASM revealed that a lot of technological knowledge was acquired from external sources through a succession of technology contracts with foreign steel producers and equipment suppliers. In addition, the company had always made major efforts to seek and acquire technical information during overseas tours, plant visits and through informal links with other manufacturers. These companies made major efforts to seek and acquire information on the performance and technology of other plants. Search efforts were carried out for the purpose of selecting technology suppliers and determining choice of equipment. It was widely known that the chief executive of ASM contacted numerous steel plants and machine suppliers to acquire information on modern techniques of production and control; productivity and quality indexes achieved by other firms; and performance of the various equipment suppliers. Such efforts were continuous and whenever ASM decided to install new facilities, it despatched its staff to other overseas plants where the equipment under consideration was being utilised. These visits were often arranged by machine suppliers. Such visits not only enabled the personnel to evaluate the technology suppliers but also helped to expose ASM staff to production systems of other steel plants. This often led to an information exchange network and the establishment of a framework for future collaboration.

Establishing linkages with alternative sources of technology had enabled many companies seek technical data, training facilities and at the same time keep abreast with the frontiers of technology. Petronas, Tasek, SSA and ASM had close collaboration arrangements with independent manufacturers, regional industrial associations and machine suppliers.

7.3.5 *Selection of appropriate transfer mechanism*

Company executives felt that selecting the right mechanism for technology acquisition could enhance the pattern of technology diffusion. It has been emphasized that firms should define their diffusion strategies prior to making decisions on whether they wanted to acquire technology through joint venture, licensing or straight purchase of machinery and equipment. Those interviewed also indicated that selection of the right type of technology acquisition method must be made only after careful consideration of the various options and business risks involved.

Sufficient resources must be available to investigate and search for the right type of technology supplier to provide the best terms of transfer arrangement. It was pointed out that companies tended to make decisions on technology selection without expending much effort on evaluating and searching for the right suppliers and technology. It was observed that companies with some manufacturing experience tended to diversify their sources of technology such as purchase of turnkey plants, sourcing direct from equipment and machinery suppliers. They also sought short-term assistance from independent manufacturing firms to assist them in specific areas. Such strategies had been pursued by firms like ASM, ACW, Soong Seng and Tasek Cement which had achieved high degrees of diffusion. However, most of the executives felt that such strategies involved high degree of risk. They felt that it might take longer to bring the plant to the point of production. That would not be the case if the project had been left in the hands of foreign joint venture partners. Several firms pointed to the experience of those companies mentioned, particularly ACW and Soong Seng, which had encountered serious problems during the initial phase of production. But as pointed out by executives in ACW and Soong Seng, making mistakes on the plants would help engineers, managers and technicians to do better next time. Executives in other companies felt that management could not afford to take such risks. The situation was different in owner managed enterprises or family controlled firms like Soong Seng and ACW. In government companies such risks would not be taken by public officials who were accountable for the spending of public funds.

There was also general distrust for machine suppliers. Several companies, noting the experience of ACW and Soong Seng which had faced serious technical problems due to deficiency in plant design felt that machinery suppliers did not have experience in manufacturing and tended to supply plants which were less efficient and produced inferior products because of deficiency in design. It was felt that it was better to go into joint venture operation with established companies which had wide experience in manufacturing and which minimised the risk of technical problems cropping up during production. It was argued that firms which purchased turnkey plants would miss out on certain advantages offered in a technical tie-up with an international firm. For example, in the initial planning of the project, parent companies could draw on the experience both in the had office and in related facilities around the world. As stated by the chief executive of KL Glass: "Few facilities in developing countries are capable of making product process adaptation on glass technology and unless they are part of a multinational network they would not obtain the technology to do it".

7.3.5.1 *Technology market*

There were also other limitations in terms of seeking technology directly from machine suppliers. Certain technology may not be available direct from machine suppliers. Companies manufacturing their own technology did not typically make their first sales of technology until the competition was well established or when engineering contractors began to emerge into technology transactions. The life cycle of the technology was also one of the factors that determined whether the firm could obtain technology from the independent suppliers or from the manufacturers. Generally, as competition increased, firms would evaluate the know-how available through licensing and turnkey projects. As observed in the study, most of the firms which acquired technology through turnkey plants and engineering suppliers were in those industries like cement, steel and petroleum which were considered "mature" industries. In such cases, there were a number of technology suppliers who were willing to sell technology at arm's length transactions without imposing the need to buy equity of operating firms. However, in fields like electronics, firms had little choice because technology was still in the early life cycle and firms had difficulty choosing among independent suppliers.

As pointed out by executives, companies like Pernas NEC had little choice in selecting technology suppliers because telecommunication technology was controlled by a few large companies in the world. Most of them wanted to go into joint venture operation rather than to sell technology at arm's length transactions. Generally technology suppliers had a stronger bargaining position when they had a monopolistic advantage over the technology. But if the technology suppliers had some preferences about the country in which he wants to set up production, the government and the recipient company in the country may have some advantages on their side. Pernas NEC was given a multi-billion dollar contract to supply the switching system to the Malaysian Telecoms Department. In such a case, prior to the awarding of this contract, the government could insist on specific terms of transfer of technology. But as executives in Pernas NEC pointed out, little effort was made to study the terms of transfer and the implications on the diffusion of technology. In the first instance, the company had not formulated diffusion strategy in terms of the type of skills and know-how that would be developed within the company, for example, design capability, product innovation and other aspects of development of the switching system technology. Hence, after 10 years of operation, very little technical capability was created within Pernas NEC.

7.3.5.2 *Alternative method of technology acquisition*

Other alternative methods of technology acquisition transactions like licensing or purchase of turnkey plants are therefore preferable in terms of diffusion of technology and the independence given to the recipient firm in determining the direction and control of technology development. There are risks in acquiring technology through this method but efforts must be made to minimise these risks as was done in the case of ASM. First, the ASM management had hired an independent experienced expatriate staff who had worked in the steel industry to assist in project planning and evaluation. Second, the top management spent enormous resources to visit other steel plants throughout the world and speaking to various established technology suppliers. Third, they checked and evaluated the suppliers of technology and later entered into independent short-term technical assistance arrangements with established manufacturers such as China Steel.

Petronas, for example, used a number of independent consultants support by a strong project team. When Petronas decided to set up its own refinery in 1979 it engaged an American firm, Bechtel, as technical advisor to develop the basic design of the refinery. In fact Bechtel had earlier been appointed by Petronas to carry out some work related to the proposed Malacca refinery but when the government decided to implement the refinery project in Terengganu Bechtel was asked to extend its scope of work. Another consultant, C. Itoh, had drawn up a master plan which identified the need for a refinery in the East coast, particularly Terengganu. One of the major tasks of Bechtel was to prepare the "invitation to bid" document. Petronas assigned three of its staff to work with the consultant and they were sent to Houston to work with Bechtel to develop the basic design of the refinery. At this stage there was close interaction between the consultant and Petronas personnel.

In the meantime Petronas had also employed an expatriate who was later appointed manager of the refinery project department. This came under the Processing and Manufacturing (P & M) Division of Petronas. The department was responsible for the front end planning and continuing project administration. Petronas then approved the "invitation to bid" package and shortlisted contractors. After evaluating the proposals, recommendations were made to negotiate with the selected potential contractor. The Engineering Procurement and Construction (EPC) lump sum contract was subsequently awarded to JGC-C.Itoh of Japan. Bechtel ceased to provide further technical service as its scope of work was limited to preparation of the "invitation to bid" document and evaluation of the bidders.

To supervise the implementation of the project, Petronas formed a project management team comprising 15 local engineers and technical assistants. The project team was led by another expatriate provided under arrangement between Petronas and the Amoco Far East Oil Company. The purpose of the project management team was to monitor and control the quality, schedule cost, and acquire the necessary project engineering skills. The Petronas project management team set up an office in Yokohama to ensure that the detailed engineering design works were carried out according to specification. At the same time several members of the project management team travelled widely in Japan, Korea, Denmark and Norway to conduct inspection visits to various equipment suppliers. They worked closely with the contractor, project specialist and consultants enlisted for various engineering services and received on the job training guidance from these specialists. Several of the members of the project management team were later seconded to the Project Engineering Department to plan other projects and carry out minor modification works for the refinery.

With such efforts, firms could minimise the risks in terms of faulty design of plants that are specially provided by engineering suppliers. The other choice alternative was to go into licensing arrangements. In such arrangements, firms would probably maintain and control direction of their technical development. The licensor could assist the firm in recommending the type of plants available and the technology suppliers who had good track records. This would minimise the risk of getting faulty plants and at the same time enable the firm to maintain control over the development of technology. In cases when the firms needed to diversify or expand into other products, it could enter into separate collaboration arrangements with other suppliers and terminate whatever arrangements it may have with existing licensors. This flexibility was not available in joint-venture arrangements. In a joint venture a firm did not have flexibility in terms of determining the direction of technology development and implementation of its diffusion strategy.

Selecting the right transfer mechanism could facilitate the diffusion of technology. The choice had to be made by the firm after careful evaluation of the various options with a view to achieving the desired pattern of technology diffusion.

7.4 CONCLUSION

The case analysis indicates that technology diffusion tended to depend to a significant degree on the extent and nature of the top management's involvement, and its awareness and commitment to technical progress of the firm. Technology was widely diffused in companies where the top management was involved in the planning and implementation of the transfer process. In these firms, systematic efforts were undertaken to foster technical development and to develop linkages with other technology suppliers.

The study shows that many Malaysian firms rarely formulated specific plans or objectives to promote technical development. Often they allowed technology suppliers to determine the nature and extent of technology to be diffused. Technology transfer was often emphasised on in the initial stage but lack of policy and planning meant that the development of internal capability could not be managed effectively. The case analysis provided strong evidence that the choices of technology transfer made during the early development of the firm had term implications over the diffusion of technology. Most of the companies studied had delegated these choices to foreign firms. They had not given much attention or sought technical expertise or evaluated the implication of these choices. As a result technological decisions were made without examining the long term development objectives of the firm. In cases where technological decisions had been left to foreign firms, the interests of the subsidiary companies or local firms had not been protected. Efforts to review or subsequent changes to technological arrangements led to friction between local and foreign firms.

There was some evidence in the study to indicate that the foreign firms' corporate strategies were directed to closely control the related technological activities. Joint venture firms and foreign partners tended to exert strong control over the diffusion of technology. Control was necessary to ensure that the foreign partners' interests and bargaining strengths were safeguarded. Thus, the foreign firms' technology strategies must be viewed within the context of strategic control process. Control was also necessary in joint venture firms because of the desire of foreign partners to maintain some degree of flexibility in determining the transfer prices of parts and components shipped to local subsidiaries.

The findings also indicate that in-house technological efforts tended to lead to rapid diffusion of technology as such efforts not only accelerated the information flow but also subsequently generated new technical information which contributed to greater understanding of the principles underlying the imported technology. Efforts of local firms to break through technical problems when successful, propelled the firm to higher levels of technical capability. This confirmed the importance of the learning process. The study shows that in wholly owned local firms where investment activities were more or less continuous, there was a growing ability to undertake a range of tasks requiring a high level of technological skills. In these firms local personnel participated actively in project planning and implementation and subsequently assumed an expanding role in implementing creation of new production facilities. A high degree of investment capability had permitted these firms to switch to direct purchase of equipment in their subsequent plant expansion and modification.

Local firms which acquired their technological knowledge through the development of an information network tended to gain greater access to technical or strategic information. Wide access to information was essential to accelerate the diffusion process. While joint venture firms were able to tap their multinational network, wholly owned firms had to make major efforts to seek and acquire information. To sum up the analysis, the case studies tended to confirm that diffusion of technology depended to a significant degree on the extent and nature of the top management's involvement, its awareness and commitment to technical process, the degree and nature of technical activities, technology strategies of foreign firms and accessibility to technological information. It finally remains to ask what are the implications of the findings. The first implication is the need to recognize the importance of managerial leadership and technology planning in promoting effective diffusion of imported technology. Top management should focus on building a proper framework for negotiation with technology suppliers. The second implication is that government intervention designed to promote higher level of technological development in local companies should encourage R & D activities. In addition the development of specialised agency to assist firms in negotiation and planning technology acquisition. Both of these issues will be discussed in Chapter VIII and IX and this report.

CHAPTER VIII

POLICY IMPLICATIONS

8.1. INTRODUCTION

For many developing countries, development of technology has come to constitute an additional dimension of development efforts. Basically, technological development is a process of mastering gradually higher technological levels. It requires the strategy to develop technological capability which would lead to better capacity to make decisions on technology, to generate technology critical to national development, and to evaluate, absorb and improve on imported technology. Public policies can play a major role in influencing the pattern of technological development. In an analysis of the economic development of Japan after World War II, Oshima (1970) noted that Japanese industry imported a great deal of technology, although the imported technologies were improved on by the importing firms. This was a conscious effort. The government strongly encouraged competition within the country itself, but protected Japanese industry from foreign competition. Because the protected firms had to compete in domestic markets, their technological development could not remain static. Government can set technological policies by directing organizations to concentrate on certain activities. Ayres et al (1973) predicted that in the United States, Congressional decisions on pollution standards would affect future automotive technology by turning automobile manufacturers away from their concerns with more horse power and gadgetry. In assessing the state of technological development within Europe, Layton (1969) noted that governments vary in the degrees to which they encourage technological development. In those nations which encourage development, there is much greater likelihood of the development of technological capabilities

In the course of this study, several executives expressed the need for some kind of policy intervention in ensuring a wider diffusion of technology. In this chapter, the writer will examine the policy implications of this study and attempt to review some of the major issues that should be tackled through policy measures. The first part of this chapter will examine the major policies influencing the pattern of technology acquisition, namely the industrial and technology strategies evolved during the two decades post independence. The second part will discuss the role of public policy and how it contributes to the development of more effective transfer system. Governments in most industrialised countries have attempted to influence the pattern of technological development through public policies. Similarly, in developing countries, there is a growing awareness of the role of government in promoting technological development.

8.2 EVOLUTION OF INDUSTRIAL AND TECHNOLOGY TRANSFER POLICIES

8.2.1 *Development of industrial policies*

Objectives of developing countries in relation to technology transfer have evolved over the last 20 years. Initially keen to industrialise rapidly, most countries aimed to maximise the quantity of technology transferred. Hence they introduced a host of incentives such as tax incentives, duty drawbacks, protection and the provision of infrastructure, designed to encourage the inflow of technology. In many Asian and Latin American countries a policy was followed by recognition of the need for technology transfer and it was left to individual firms to decide the form and nature of technology transferred. However, as the consequences of unrestricted inflow, such as overpricing of inputs, excessive royalty payment became apparent, new objectives evolved. The policy has therefore given way to a much more interventionist strategy at both national and international levels. Generally the country's economic strategy has also influenced the different approaches taken on matters relating to technology transfer. Malaysia, like many developing countries, is dependent on external technological input in the initial phase of industrialization. The industrial strategies evolved during the past decades have influenced the pattern and modes of technology acquisition in Malaysian industries.

Industrialization is a major objective of developing countries as a means to attaining higher levels of welfare of the people of such countries. The post-independence era of Malaysia saw the emergence of wide ranging measures which have influenced the pace and pattern of industrial development over the last two decades. The Malaysian economy at the time of independence in 1957 was very much dependent on the agriculture and mining sectors. Manufacturing was a small economic sector confined to services related to the mining and plantation sectors. The development of the tin and plantation industries generated industrial activities like tin smelting, foundries, workshops, light engineering industries and other industries associated with the processing of state produce.

Recognising the need to expand the manufacturing sector, the government introduced the Pioneer Industries Ordinance. Companies qualifying for pioneer status were granted relief from company tax for a period of between two to five years depending on the amount of fixed capital investment. To supplement the Pioneer Industries Ordinance, the government introduced other measures including import duty exemption, free transfer of capital earnings, strict protection and provision of industrial estates. This led to a rapid growth of the industrial sector, particularly the import substitution industries manufacturing a wide range of basic consumer goods, including the setting up of a few large projects, especially petroleum refineries, steel mills, flour mills, fertilizer plants and motor vehicle assembly plants. At the same time several institutes were set up to provide support services to the manufacturing sector, namely, the Productivity Centre (1960), Malaysian Industrial Development Finance (1960), the Federal Industrial Development Authority (1965) and the Standards Institution of Malaysia (1966).

In 1968 the government introduced the Investment Incentive Act, 1968 which broadened the scope of and replaced the Pioneer Industries (Relief from Income Tax) Ordinance, 1958. The package of incentives offered under this new legislation includes: pioneer status relief; labour utilisation relief; investment tax credit; increased capital allowance form modernization of production techniques and the setting up of new modernised factories; export incentives; hotel incentives; locational incentives, and accelerated depreciation allowance for designated industries. This marked a shift in industrial strategy from import substituting industries to export oriented ones. By the end of the 1960s the manufacturing sector's share of the GDP constituted 13.1% as compared to 6% in 1957.

The seventies marked a major shift in government development strategies, brought about by the launching of the New Economic Policy (NEP) which also coincided with the introduction of the Establishment of the Free Trade Zone Act 1970. This Act allows export-oriented industries within the designated free trade zone to import machinery, equipment and industrial inputs to export their finished products free of duty. Hence during 1970 and 1971 Malaysia launched a vigorous programme to attract export oriented industries. As a result a new wave of export oriented industries was established including rubber and timber-based industries and textile and garment, precision products, electronic components and sub assembly of movie cameras and watch components industries.

In 1975 the government introduced the Industrial Co-ordination Act which requires manufacturing projects with shareholders' funds above MR250,000 and employing more than 25 full-time paid employees to be licensed. Licences are normally issued with several conditions attached, pertaining to location, equity, employment distribution, technical agreement, machinery etc. The Act to a large extent introduces two major elements, particularly on foreign equity and licensing which have important impacts on this research project.

8.2.2 *Policy on ownership*

The widespread presence of foreign investors in the Malaysian manufacturing sector may be explained by the range of measures introduced to attract foreign investment into the country. The Malaysian government generally welcomes foreign investors to participate in the industrial development programme particularly through joint venture arrangements. Foreign investors particularly multinational corporations are sought in terms of their technical know-how, management skills and export marketing outlets. To a large extent the Malaysian economy is heavily dependent on foreign investment. However Malaysia like other developing countries, would like to see a balance in the corporate ownership between Malaysian and foreign investors and also between Malaysians of various ethnic groups. It was noted that in 1970 about 60% of the share capital of limited companies was held by foreign equity. The aim of the New Economic Policy was to reduce the share of foreign equity in the corporate sector to 30% by 1977. It was against this background that the Malaysian government has laid down a set of guidelines on foreign equity ownership for the manufacturing sector. These guidelines lines apply both to new projects as well as to substantial expansion or diversification of existing projects. The guidelines are implemented with considerable flexibility taking into consideration a number of factors such as the size of the project, its process and level of technology, its location, the benefits occurring to the country through the spin-off effects, the extent of exports, the level of integration with existing industries, its promotional effects and how well established the industry is in the country. Generally foreign participation of up to 30% of the total equity will be allowed for projects where the products are sold in the domestic market. For manufacturing which is substantially for the export market, foreign majority ownership is permitted even up to 100%.

In addition to the guidelines on foreign equity the Malaysian government introduced guidelines on technology transfer arrangements in order to eliminate unfair practices and reduce the cost of technology. Manufacturing licences issued to companies by the Ministry of Trade and Industry usually carry various conditions, one of which expressly requires that all agreements entered into between the companies concerned and other parties will have to be approved by the Ministry of Trade and Industry prior to their signing. The condition reads as follows:

> "The company shall not enter into any agreement for starting up operations, technical know-how and assistance, services including employment of expatriate personnel, management, purchasing, marketing payment of royalty, patent and trade marks without the prior approval of the Ministry of Trade and Industry."

Malaysia has pursued an open technology transfer policy with little intervention from the government. This liberal strategy has been partly influenced by the government's generous attitudes towards foreign investment, which has continued to be an important channel of technology importation. The government's role as indicated earlier is limited to the registration of technical collaboration. In view of the need to strengthen the indigenous technological system, the government is reviewing the technology transfer system. As stated in the recent Fifth Malaysian

Plan 1986-1990, (Malaysia, 1986) "The development of indigenous technological capacity and capability depends on the transfer of technology from abroad which is often imported at very high costs. Few of these technologies have been assimilated and improved upon because of the lack of technical expertise in this country to undertake such processes. In view of this, the government will institute mechanisms necessary for the selection of technologies for industrial development, appropriate for the exploitation of the comparative advantage of the country. The government will also consider the establishment of regulatory, administrative, and technical instruments for effective technology transfer and absorption, while giving special emphasis towards the commercial exploitation of locally-generated technologies".

8.2.3 *Impact of industrial policies in technology transfer*

The role of industrial policies in the diffusion of technology is now becoming a major issue in the discussion of technology transfer. Several economists from various ideological schools have been debating these issues. The researcher's interest lies in the fact that the industrial policies, however vague, can play a major role in determining the firm's technological behaviour with regards to resource allocation.

Industrial policies have been used by several developing countries to develop national technological capability. Industrial policy has an important influence on the development of local industries. For example, when asked what type of public assistance could facilitate the development of technological skills, 70% of the firms responded by pointing out the need for further tariff protection. Their argument was that local companies might be unwilling to invest in plant modernisation or manpower development unless they were able to recover their investment through protection from foreign competition. However, these views are debatable. Most of the companies with moderate and low rates of diffusion of technology are import-substituting industries which have enjoyed tariff protection throughout their operating life. Several of them have stagnated and not progressed beyond their initial operation. There is thus a need to formulate industry-specific policy based on the maturity, scale, competitive environment of individual industry. Closely related to this issue has been the recognition that several newly industrialised countries have used industrial policy as a basis to develop national technological capability. Export-oriented and industrial planning strategies have been adopted to enhance the diffusion of technology and overcome the constraints of a small domestic market.

One of the reasons why firms in Korea, Brazil, Mexico and Taiwan have chosen to enter the world market was because their domestic markets were too small to enable them to employ large scale technologies (Dahlman and Westphal, 1982). Another factor is that export activity can promote the diffusion of technology. Feedback from overseas buyers can help firms gain knowledge of their product in terms of quality, reliability and consumer acceptance. In some cases, buyers have provided product design assistance, suggested equipment to be purchased and helped to install quality control systems. The survey revealed that this type of diffusion channel has not been used by local companies for the simple reason that none of them engaged in export activity even though this can promote the diffusion of technology. Moreover, selling overseas requires the ability to meet product specification at a competitive price and firms are likely to keep abreast of technological change and competitive environments in the world market.

Interviews with some companies also revealed that the accumulation of project engineering skills was not a priority concern. Most joint venture companies felt that they were unlikely to expand to other areas and would likely remain a single product company. This is related to the investment objective of foreign firms whose interests are mainly to set up local facilities to manufacture their own products. Some local companies felt that certain industrial sectors were too fragmented with several firms operating in the sector. Investment activities would be limited, thereby preventing individual firms from accumulating project engineering skills. Executives interviewed suggested that proper industrial planning is necessary in order to promote technological development in the industries. Because of the small domestic market it was proposed that the government should encourage the consolidation of several manufactures and reduce the fragmentation of Malaysian industries. It was pointed out that many of the firms are too small to employ professional staff or establish their own R & D departments. Because of their size they rarely engaged in new investment activities such as plant expansion and modification. Hence there was very little technological learning in terms of project engineering, selection, evaluation of technology and minor modification. It is important to note here that a country's industrial policies have major implications on the diffusion of technology. The absence of specific industrial policies will mean that industries will grow on a piecemeal basis which can affect the diffusion of technology. Japan has long used its industrial policies to enhance its technological capability.

National policies on acquisition and management of technological resources vary significantly due to differences in the countries' specific factors and industrial strategies. However, the importance of technology planning and policy is increasingly being recognised in developing countries. With a national technology policy, a government is able to pursue a consistent strategy, allocate resources needed and provide more comprehensive measures to alter the technological environment. Consequently, this will lead to a greater sense of direction for the agencies and authorities involved in the development of industrial technology. The absence of such a policy means that programmes and infrastructures will grow in a less coherent manner with efforts diffused and fragmented among several agencies. Technology planning attempts to tackle in a comprehensive fashion the building up of a technology infrastructure in human resources and institutions, the optimal use of existing technological capabilities and the increase in the efficiency of technological activities. This requires that priorities be specified in accordance with the development style and national needs, and the programmes defined and carried out to attend to them. During the initial phase of industrialisation, public policy can play a major role in promoting in-house technological efforts in the firms and it is crucial for the absorption of imported technology.

As part of the study, the writer examined the potential role of public policy and how it can contribute to the development of a strong technological base in Malaysian companies.

8.3 ROLE OF PUBLIC POLICY IN THE DEVELOPMENT OF A MORE EFFECTIVE TECHNOLOGY TRANSFER SYSTEM

One of the major findings that emerged from this study is the importance of the method of technology acquisition in determining the pattern of technology diffusion. The limited diffusion in many joint venture companies raises the issue of whether foreign direct investment is the best source of technology acquisition and diffusion of technology. Since Malaysia will have to continue to rely on foreign investment as a source of industrial growth, what role can the government play in ensuring that the inflow of technology through foreign direct investment will promote technical progress in the firm? The observations on the firms studied indicate that the restructuring of ownership, giving greater ownership control to local investors, had not led to wider diffusion of technology. Ownership in fact had little influence on the pattern of technology acquisition. The restructuring of ownership control led to the foreign firms increasing their control of technology. Control was necessary because of the need to ensure that the local subsidiary complied with the investment objective of the foreign partners' parent company. From the standpoint of developing countries like Malaysia, the strategic behavior of foreign firms posed serious obstacles to rapid technological development. The option left is for greater intervention in the technology transfer system. First it is necessary to increase interaction between the government and foreign firms. The government's ability to influence foreign firms' decisions to provide whatever input is involved calls for direct interaction with a combination of incentives, pressures, persuasion and other elements of negotiation. The shortcoming of the approach lies of course in the discouragement of investment created by the negotiation process itself and the terms imposed. But these elements have become so commonplace today that most foreign firms accept them as part and parcel of doing international business. For example many countries including Malaysia had adopted the screening mechanisim which requires foreign firms to register their licencing agreements with the government.

Regulating import of technology became popular in the sixties and early seventies in the developing countries, mainly as a reaction against the abuses of foreign technology suppliers (overpricing of international goods, inputs, imposition of restrictions to the technology buyer, excessive royalty payments, etc.). One common method adopted by these countries to regulate technology is the registration of licensing agreements. In many developing countries the initial drive for controlling technology is prompted by financial consideration and technology issues are considered at a later stage. The Malaysian screening mechanism has three main objectives:

(i) To ensure that the agreement will not be prejudicial to the national interests;

(ii) To ensure that the agreement will not impose unfair and unjustifiable restrictions or handicaps on the Malaysian party; and

(iii) To ensure that the payment of fees will commensurate with the level of technology to be transferred and will not have adverse effects on Malaysia's balance of payment.

(iv) To ensure meaningful transfer technology.

While it is agreed that the above objectives are important for Malaysia during its current phase of industrialisation the resource shows that not all the objectives have been achieved particularly those related to the transfer of technology. The screening mechanism to a great extent has reduced excessive royalty payment and unfair clauses imposed by technology supplies. Most of the local partners in joint-venture companies indicated that the screening mechanism although not perfect in its operation has helped to determine fair royalty rates. However the research shows that the screening mechanism lacks the necessary expertise to undertake technology transfer assessement. Without such expertise it is not possible for the agency involved in the screening mechanism to ensure orderly transfer of technology in Malaysian companies. One major factor is the shortage of manpower. The unit undertaking screening of technical collaborations has only two full time staff. Hence assessments are made purely on economic criteria with little regard to the technological consequence and the impact on indigenous technological capability. It is therefore necessary that the scope of public policy on the acquisition process should be expanded to cover the following areas: as such the unpacking of technology, formulating technology acquisition programmes promoting alternative methods of technology acquisition, establishing technical information systems and promoting R & D efforts to enhance absorption of imported technology.

8.3.1. *Promoting alternative of technology acquisition*

In the survey, the writer found that almost all the medium and large companies interviewed had indicated joint venture as an important form of technological collaboration with overseas suppliers of technology. The ease with which Malaysian companies can get access to foreign technological knowledge through joint venture arrangements partly explains the lack of indigenous innovative efforts in local firms. Foreign partners are not keen to invest in building local technical resources because they could easily tap the resources of the parent company. Almost all the joint venture firms interviewed indicated that technical expertise and know-how were sourced from their foreign partners, thus obviating the need to develop in-house technical resources.

The government has an important role to play in influencing the development of technological capability by virtue of being the approving authority of all forms of technical collaboration. Recipient firms did not give much attention to the acquisition of technical capabilities during the planning and negotiation stage. In fact most companies interviewed revealed that technology transfer was often mentioned as part of the objective of the joint venture operation. However, most local partners were new to industrial operation and were not able to formulate appropriate strategies to enhance the indigenous technological base. Most had relied entirely on the foreign partners to supply the initial technological input. In certain cases local personnel do not see themselves as having a lot of responsibility concerning technology transfer. They planned their investment projects and business activities without bothering too much about the development of national technological capabilities. For example, packaged transfers simplify things for managers who are hardly prepared to run the risks involved in disaggregating technology packages or taking the innovative approach in their management of technology. In many cases the importance of developing in-house technical expertise was given little emphasis during the initial period of operation.

Most of the executives interviewed indicated that recipient firms did not plan the technology acquisition and left it entirely to foreign firms to dictate the terms of the technical collaboration. Joint venture companies like Pernas-NEC, Peristima and MSG felt that local partners were generally new to industrial operation and were more concerned with commercial success. It takes between five to ten years before any effort is made to reassess the technological relationship between a local firm and its foreign partner. In some cases disagreement between local and foreign partners on corporate policies such as procurement and diversification will trigger the need to reevaluate the technological relationship. In view of the shortcomings in joint venture arrangements entrepreneurs should be encouraged to opt for direct purchase of technology such as licensing, import of turn-key plant and direct purchase of equipment and machiney from various suppliers.

The difficulties are considerable in finding the appropriate methods of technology acquisition. In some cases the technology may be available from a number of independent suppliers and firms may be able to purchase the technology from a number of competitive suppliers. Differences in corporate strategy and perceptions of risk have implications on the choice of technology transaction. As pointed out earlier, there are several problems associated with the different methods of technology acquisition. In making the choices, firms must consider the social benefits derived from the widespread diffusion of technology. As noted by Dahlman (1978) "unless influenced by some form of public intervention, a firm acting alone may therefore not find it in its individual interest to take advantage of opportunities to increase domestic technological mastery as much as social objectives would dictate".

8.3.2 *Formulating technology acquisition programmes*

It is therefore proposed that the scope of the technology transfer control mechanism be expanded to deal with the technological consequence of the transfer arrangement. However, this requires an understanding of the long term development of national technological capability and the way in which the screening mechanism of technology imports can enhance the diffusion process. This study has revealed certain problems faced by local firms due to the technology strategy of supplying firms. It is therefore proposed that the government should be involved in the planning and implementation of technology transfer projects. Agencies involved in technology transfer should require local companies to formulate their technology acquisition programme. By requesting detailed programmes on the type of skills that will be diffused, public agencies can influence the allocation of technological resources in these companies. Evidence gathered from the local companies shows that it takes between five to ten years before sufficient in-house engineering skills are developed to enable these companies to switch transactions. The plan will indicate the degree of local involvement and the type of technological knowledge and skills that will be diffused. Where the technology is perceived as crucial to long term technological development of the country, the government should participate in the negotiation process and be fully involved in the selection of technology suppliers.

By requiring firms to specify plans and programmes on developing indigenous technological capability, agencies can indirectly influence the goal-setting process relating to technology transfer. As pointed out in Chapter VII, most companies did not formulate explicit policies on technology and corporate policies on technology had evolved over a period of time in response to their experience with their partners. In such cases indigenous technological capability had developed gradually on a piecemeal basis without any specific effort to accelerate the process. On the other hand, firms which had formulated long term strategies of building on the experience of acquired technology were more successful in developing a strong indigenous technological base as reflected in the case of ASM and Tasek. This suggests that successful development of indigenous capability requires the implementation of appropriate strategies. The development of in-house technical resources and sourcing technology through multiple transactions.

The development of a corporate technological base depends on explicit policy governing the acquisition and management of technology. Plans and proposals submitted by firms should be the basis of monitoring the transfer process. For example, experienced personnel in technology transfer agencies can also assist firms to formulate appropriate plans that would ensure the development of a strong indigenous technological base.

Again, agencies responsible for approving technical collaboration must insist that such arrangements be for specific purposes and not encompass broad areas of technical collaboration which may discourage the firm from developing its own technological resources and accumulate its corporate assets of industrial know-how.

In the study it was pointed out that most firms prefer to acquire packaged transactions such as joint ventures because the search, evaluation and selection processes could be assigned to the foreign partners. However when the advantages of arm's length transactions are recognised, firms tend to rely less on external sources and utilize indigenous personnel in order to reduce the cost of technology acquisition as illustrated in the case of Soong Seng, Asbestos ASM and ACW, thus saving the country from the outflow of foreign exchange and the inflow of highly integrated and packaged technology transactions.

8.3.3 *Technology information system*

It is suggested that an information system be set up to provide enterpreneurs information on the full range of processes and product technology suppliers that are of particular interest to the firm. Information is a major barrier to firms seeking to enhance their technological capability. Almost always it requires the investment of scarce resources to carry out technological search. Information is crucial in selecting the right technology suppliers; a machinery supplier anxious to make sales himself is unlikely to provide unbiased information on the performance of the equipment. Therefore, not surprisingly, companies such as ACW and Soong Seng Asbestos which had encountered technical problems due to the deficiency of equipment design had a general distrust for machine suppliers.

A rational firm seeking to acquire technology will seek to pay the lowest possible price. It is very unlikely to pay for additional technical assistance as long as it can obtain an assurance that the machine will work within the specifications. But more often than not this is not the case. Machine suppliers are not manufacturers of end products and may not have the experience and know-how of in-plant operation. The case of Associated Ceramic Works and Soong Seng Asbestos have illustrated this point. Firms generally lack information on the technology they are acquiring and rely on machine suppliers to provide the necessary information. When an entrepreneur is engaging in a new manufacturing activity he may have very little resources to carry out an extensive search and public agencies can assist in scanning the technology market and make available alternative suppliers of technology. This information-based system can also help other established entrepreneurs to continuously monitor the development of product process technologies in their respective fields. By setting up an information system of the technology suppliers, the government can indirectly influence the modes of technology acquisition. Entrepreneurs will have more information on alternative suppliers which will be able to offer more competitive terms of technology purchase. At the same time, it will develop initial skills in evaluating various combinations of acquiring technology other than joint ventures.

8.3.4 *Promoting in-house technological activities*

One area of growing importance is the role of public policies in inducing firms to perform technological activities that would accelerate the learning process thereby producing a greater diffusion of technology. One of the conclusions emerging from this study is that in-house technological efforts by local companies like Soong Seng, ACW, Tasek and ASM had resulted in rapid diffusion of technology. Technological efforts like product process adaptation, plant optimisation, trouble shooting and quality control provide the enterprise with the necessary capacity to better understand the principles of the technology they are using. They enable the company to introduce modifications that make it more suitable for their specific conditions.

In view of the extensive role played by foreign technology suppliers in Malaysian manufacturing industries, government policies in this area need to be reoriented so as to make the utmost use of local enterprises to generate innovation capability. Such reorientation should take into account the technological requirements of the production sector so as to mobilize limited available resources for innovative activities. Satisfying such demand has been emphasised on several occasions and can be seen in the achievements of companies like Soong Seng which had accumulated a high degree of technological competence within a short period as a result of extensive in-house technological efforts and technological search. The failure of the machine supplier to rectify the fault created an opportunity for local personnel, particularly the "production manager", to spearhead in-house technological efforts. In the field of innovation studies, this role has been associated with a product champion. Not only was the company successful in overcoming the technical problems but it also succeeded in exporting its know-how to other plants in Indonesia and the Philippines. The literature on technological change has frequently emphasised the importance of learning by doing. These efforts can also generate system-specific knowledge which otherwise would only be obtained through formal technical collaboration. For example, Soong Seng's product process formulations involving raw material mixtures and fiber formulae was developed as a result of its own efforts. In joint venture companies know-how product process formulations were company secrets and never revealed to local personnel. In most cases the formulations were worked out by the foreign firms and transmitted to the technical expatriate. Fiscal measures and other incentives should be provided to encourage such efforts and must to all intent and purposes be regarded as a type of research and development effort. Perhaps firms will be required to set aside a certain percentage of their profits to undertake R & D activities that could increase the absorption of imported technology. Of the 31 firms studied only two had departments responsible for implementing R & D efforts. The nature of R & D efforts had focused on productivity improvement and cost reduction. Such efforts also included evaluation of new machinery, selection of appropriate technology suppliers, and design and fabrication of specialized equipment. For example, Hume's R & D department had only three personnel helping in screening machine suppliers and collecting information related to the industry. In the case of Associated Tile Industry (ATI) the emphasis was on process improvement and quality control. ATI manufactures glazed and semi-glazed mosaic tiles. Local companies like ATI had to compete with imported products from Japan and other neighbouring countries. Although the government had imposed tariff protection measures, these were not high enough to discourage the importation of such products. Hence, ATI had to upgrade its product quality and a lot of effort was put into product process improvement. Very few executives were aware of the incentives provided by the government to promote R & D activities in the industries. Most companies felt that existing public support programmes on R & D had little impact on technological activities carried out by the firm.

Direct promotional measures aimed at encouraging domestic technological innovation have to be introduced. In view of the weak innovation capabilities in many Malaysian firms, a comprehensive package of fiscal and financial assistance is necessary. The existing fiscal incentives have been viewed by many companies as inadequate. Malaysia grants tax credit for expenditure on R & D. Some companies expressed the need to define R & D more broadly to include not only product process development but all other activities that promote technical progress at the enterprise level. These include activities such as plant optimisation, plant modification, and design and engineering efforts that demand a high level of technical efforts. The importance of financial assistance schemes was emphasised by several companies. Financial schemes to promote innovation have yet to be introduced in Malaysia.

8.3.5 *Local content programme*

Indigenous technological efforts can be promoted by encouraging firms to intensify product process development through local content programmes, export oriented industrial strategy and planning and implementation of technology acquisition. Government policies on local content programmes can facilitate the diffusion of technology. The Malaysian government has pursued the local content programme on the manufacture of final products but not on plant construction. The process of implementing local content is a learning process for the local companies and the local suppliers. It is important to recognise that emphasis on local content of the product manufactured can also result in the diffusion of technology. However, the local content programme has also brought about many problems such as the study of Pernas NEC has increased the understanding on the limitations of the local content programme as a measure to promote diffusion.

The Malaysian Government has encouraged local content programmes in order to achieve greater integration in the manufacturing sector. Firms are required to source local suppliers and achieve a certain percentage of local content in their product. This practice was implemented by Pernas NEC, a major supplier of telecommunication equipment to the Malaysian Telecoms Department. Initially it started by assembling the Frequency Division Multiplex (FDM) transmission equipment. Gradually the company decided to increase local content level by manufacturing certain parts in-house and sourcing other components from local suppliers. The foreign partner, NEC, initially opposed the idea of increasing local content but later agreed after being told of the importance of responding to national policy. The first version of FDM used mainly compactors, transistors and transformers, which were easily procurred in the country. Initially it had a lot of difficulties before it managed to achieve 30% local content. In 1981 the FDM B6 was replaced by a new version called the NV 5000 which uses a high degree of large scale integrated circuits. For this new equipment the Telecoms Department specified that the 60% local content programmes be implemented. By 1984, the company had achieved 45% local content. However, the company was uncertain whether it should proceed further to meet the 60% target since the FDM equipment had been replaced with the PCM technology. It was envisaged that when the current contract expired, the Telecoms Department would switch to the new technology. Company executives felt that local content programmes would not be practical for products with short life cycle. Because of the rapid technological change the learning experience in manufacturing one product is too short to enable the staff to accumulate the technical know-how.

The local content programme can be extended to project engineering in relation to plant construction. The study has shown that most local companies failed to capture the relevant technological skills in the transfer process particularly the project engineering skills embodied in the project investment phase. Out of the 31 firms surveyed, only six firms participated actively in the planning and implementation of new production facilities. The lack of local involvement in the project execution phase has also been analysed in Chapter V. In most projects local personnel involvement was limited to administrative and on-site duties.

Apart from the technology strategy of foreign firms, local management had also failed to recognise the importance of project engineering skills.

Management in Malaysian companies had not emphasised the diffusion of skills and technological knowledge embodied in project planning and implementation. The transfer arrangements with foreign firms were often negotiated on the basis of acquiring operating capability. Most joint venture companies had adopted this pattern of transfer arrangement. Once the project had been agreed upon local personnel were recruited and sent to the parent companies. Many of the personnel interviewed considered the training too basic and sometimes poorly coordinated. When the plant was nearing completion, the staff were brought back to work with foreign expatriates on a counterpart basis. For example, planning and implementation of Antara Steel Mills were carried out entirely by the German partner, Kloeckner, with only one local engineer brought towards the latter part of the project to assist in the supervision and coordination of the actual plant construction. Interviews with Antara Steel personnel revealed that local management made no efforts to participate in the planning of the project, leaving the entire task to the foreign team. As stated by one of the executives interviewed, "senior management of the local company was only concerned with getting the project off the ground and no attempt was made to define the nature of indigenous technological capability to be created". Similar views were expressed by other executives in another large government corporation. It was pointed out by an executive that technology transfer was often mentioned during the project formulation stage but once the project got under way, top management became preoccupied with the completion of the project. In addition, management had not specified the type of indigenous capability to be developed or the technology strategy of the new enterprise.

As reported by a number of local engineering firms, local firms are as much to be blamed as their foreign counterparts for the lack of diffusion in project engineering skills. According to the engineering firms interviewed, some local firms (both public and private companies) were too preoccupied with the completion of their projects. They planned their investment projects and business activities without bothering very much about the diffusion of technology in the investment phase and the degree of local content. This is a contrast to technology management in other countries like Korea where public policies are formulated to ensure Korean involvement in the project execution phase. In fact, as noted in one report, "in Korea the first plants were often built on a turnkey basis with indigenous involvement limited to assimilating as much of the production and investment capability as was practical. Construction of the second and subsequent plants followed quickly with Korean engineers and technicians assuming a rapidly expanding role in project design and execution. Indigenous involvement in project implementation expanded through concerted effort to assimilate the know-how involved in project design and execution. Much of this effort involved apprentice-like participation in the establishment of individual plants".

Many foreign firms have seized the opportunity to diffuse the skills to their newly recruited personnel by bringing a large number of their staff to participate in project planning and execution. It is not uncommon to find many junior foreign engineers working alongside their senior counterparts in many of the new projects. Several firms confirmed that large numbers of young engineers from the foreign firms were brought in to help in the planning and implementation of new production plants. Learning by doing has always been a source of accumulating technological skills. Foreign firms have taken the opportunity of passing on project engineering skills to their staff at the expense of local personnel. Executives in Federal Telecoms and other engineering firms like Wong Heng and

Sime Crest which participated in large scale plant construction have observed this practice. The researcher's earlier case studies discussed in Chapter V and Alcom and MSG have also illustrated this point.

8.3.6 *Developing project engineering capability*

Cooper (1981) argued that innovation calls for the same skills as those needed in the project planning and implementation phase. The evidence of the small number of local firms which had developed a high degree of innovative skills tends to support Cooper's argument about the importance of project engineering skills. All the six firms that had acquired a high degree of project engineering skills reported extensive innovative capability in terms of product process adaptation, plant optimisation, trouble shooting and in-house design and fabrication. In the three firms, Tasek, ASM and Malayawata, the acquisition of project engineering skills resulted in the companies switching to different modes of technology acquisition in subsequent expansion. The ability of these firms to adapt to direct transaction can be attributed to the experience gained in participating actively in earlier acquisition. Direct transaction means that the firms had to increase the engineering input in developing new facilities. The writer indicated earlier in the case studies the high degree of local and on-site fabrication carried out by companies such as Tasek and ASM which resulted in inter-industry diffusion of skills to engineering firms. Thus the development of in-house project engineering skills can also spread to other industries. There is a need for the government to provide incentives that would encourage firms to undertake their own project engineering and closely monitor the involvement of foreign personnel in new investment projects. It is therefore necessary to provide necessary advisory services to local firms on the planning and implementation of industrial projects that could enhance the diffusion of project engineering skills. Certain guidelines should be given to encourage sub-contracting works to local engineering firms in order to promote inter industry diffusion.

The researcher interviewed four engineering firms to investigate the benefits derived from carrying out sub-contracting work in plant construction. These firms were not included in the sample because they were small engineering firms and consulting organisations. Many of them attributed their ability to fabricate complex structures and components to the assistance provided by local manufacturers' engineering personnel. When Tasek Cement, ASM and Malayawata managed their plant construction on their own, a large part of the structural and mechanical works were handled by these engineering firms. Since many of them do not have experienced engineering personnel, they tend to get technical support service from manufacturers' in-house engineering personnel who are responsible for supervising and monitoring the quality of the fabrication works. One of the engineering firms interviewed was Wong Heng Engineering. This company had participated in the construction of Petronas Refinery and H & R Johnson floor tiles plant. According to the chief executive, the opportunity to carry out new large scale projects had widened the experience of his personnel and the experience gained had enabled him to undertake subsequently larger and more complex assignments. The quality of local fabrication work is comparable to that undertaken in other industrialised countries. This was also confirmed by foreign expatriates in Petronas. However, local companies like Wong Heng were deprived of the learning experience when plant construction was carried out on a packaged basis as generally found in new and subsequent projects implemented by foreign partners in joint venture companies. These views were shared by most of the engineering firms interviewed.

Foreign firms tend to acquire packaged plant from their home country without making much effort to source local components. As discussed earlier one of the reasons lies in the practice of transfer pricing that allow firms to overprice these components and charge it to its local subsidiary. In such cases, the government agency involved in technology transfer has an important role to play in influencing foreign firms to source local components wherever possible. It could also advise firms to opt for technology transactions like direct sourcing that would allow them to have control of the sourcing of components. For example firms can be required to submit various alternatives of acquiring technology. If one method involves a high degree of risk then fiscal measures should be provided to encourage firms to undertake such risk.

If the extent of the financial risks involved seems too great for the technology importing firm to bear, the decision will be difficult. But this risk can be minimised if the transfer process is adequately planned and implemented. Policy instruments should also be formulated to reward risk taking, particularly for companies constructing complex and capital intensive plants through direct transaction. For example ASM, Tasek and Malayawata implemented the unpackaging process in their third technology acquisition exercise by sourcing direct all the equipment from various machine suppliers. This study suggests that unpackaging has been an important technology strategy. This strategy has in fact influenced the companies' resource allocation in terms of manpower development efforts, technological search and in-house technological efforts. From the planning of their initial production facilities, the companies had laid down the groundwork for facilitating the rapid diffusion of technological skills. Public policy can influence the transfer process by ensuring the involvement of local engineering companies in plant construction and commissioning. In most of the case studies, companies pointed out the lack of government intervention in ensuring that foreign technology suppliers used local expertise and sub-contracted certain works to local engineering firms. Only through such efforts can local firms benefit from the industrialisation process and accumulate project engineering skills. The purpose behind the policies described above was to internalise the benefits of foreign technology by reducing the possible detrimental effects of what was perceived to be an acute degree of foreign economic and technological dependence.

The importance of adequate technology planning at the national level should be recognised. The main strategy is to build on what can be obtained from abroad while developing local capabilities in certain critical areas. Since everything cannot be done at once, selectivity is at the heart of national policy for technological development. It is seldom clear, however, how to design and implement policy measures most effectively. The suggested policy measures are not enough. There should be a more integrated approach on technological development involving overall manpower development programmes, education policies and intense efforts to develop a more dynamic economic environment. Most of all there must be a commitment by the government to set priorities involving technological development. It has been observed that measures to support and encourage local technical capabilities have frequently been at cross purposes with other elements of industrial policies. The need to monitor the transfer arrangement and impose additional measures may restrict the flow of foreign investment. In the case of Malaysia, foreign investment is considered a major source of industrial growth.. Perhaps the most important role of the government is in establishing an environment that stimulates recipient firms to engage in on-going technological efforts and encourage local control over the management and acquisition of technology.

8.4 CONCLUSION

The first point that emerges from this discussion is a clear articulation of a development strategy that should link industrial policies with technology transfer strategies. Macro economic policies, particularly industrial policies, are highly relevant in respect of technology transfer. It influences many variables affecting the transfer of technology. For example, policies on import substitution, royalty payments, foreign ownership structure, industrial incentives, employment of expatriates and other related issues influence the nature of technology transactions entered into between local and foreign firms. To a great extent, it determines the pattern of technology transfer between foreign and local companies.

Malaysia's industrial policy has not addressed the technological component of industrial development. In its effort to industrialise, Malaysia has formulated a wide range of measures to attract foreign investments and promote rapid industrial development. It has failed to introduce measures that would increase the absorption of imported technology. From case analysis, the researcher has discussed the relevance of public support programmes and policies to enhance the absorption of imported technology. Such measures as development of a national R & D system, promoting in-house technological capability, fiscal and financial support programmes, promoting the utilization of local technological input in plant design and construction, creating project engineering skills and the unpackaging of technological input are some of the measures necessary to enhance the absorption of imported technology. Government policies play direct and indirect roles in the development of indigenuous technological capabilities. In certain areas, there is a need for a more direct role of Government policies. The researcher has also recommended measures to increase the capability of the screening mechanisms. The objectives of such Government intervention include choosing the right technology transactions, importing technology on the best possible terms, encouraging local involvement in project planning and implemention, and stimulating the development of technological skills.

From the researcher's assessment, macro economic policies introduced in the last decade have not examined closely the strategies of technology development. It is often assumed that foreign firms which had invested in Malaysia would transfer technology to its Malaysian operations and it must be recognised that foreign firms are not in the business of transferring technology for whatever reason they are attracted to invest in Malaysia. Their primary role is to maximise their investment. The responsibility of ensuring the transfer and diffusion of technology lies with the local firm and Government. The correct framework must be developed with regard to technology transfer. Countries like Japan, Korea and other newly industrialised countries, introduced a wide range of policies and mechanisms to enhance wider diffusion of technology in the various countries in the various stages of industrial development.

In conclusion, the researcher hopes that the observations given above will justify the need for the introduction of wider policy measures that would promote and enhance the absorption of imported technologies.

CHAPTER IX

APPROACH TO TECHNOLOGICAL DEVELOPMENT

9.1 INTRODUCTION

This study has examined many aspects concerning the nature of technological development in a developing economy. The aim of the study, as indicated earlier, is to identify the basic factors affecting the diffusion of imported technology. On the basis of the findings the writer would attempt to develop a framework that would help firms to manage their technology development. The basic element of the framework requires the firm to define its technological objectives and formulate appropriate technology plans. The development of technology plans implies two assumptions. The first is that technology can be planned. The second is that organisations are capable of developing rational policies with regards to planned technology. Technology policies are developed and followed because of the preceived benefit to an organization (Dawn and Mohr, 1976). For the purpose of this study, the intent is to indicate that technology plans formulated at the firm's level can strongly influence if not determine the direction of technological development.

The study has shown that Malaysian firms rarely formulate specific plans or objectives to promote technical development in their companies. Often they allow the technology suppliers to determine the nature and extent of knowledge to be diffused. Technology transfer was often emphasised in the initial stage but the lack of policies and plans had meant that the development of internal capability had not been managed effectively. Case analysis provided evidence that choices made during the early development of the firm had long term implications over the diffusion of technology. More often than not, these choices determined the characteristics and structure of the firm. For example, choices on methods of technology acquisition could be affected by ownership structure, management control and the development of indigenous technical resources.

Most of the companies studied had delegated these choices to foreign firms. They had not given much attention to seeking technical expertise to make proper choices. As a result, decisions were made without examining the long term development objectives of the firms. In cases where the foreign firms made the choice, the interests of the local firms had not been safeguard. Efforts to review or make changes to these decisions led to friction among local and foreign firms. Therefore, it is important that firms formulate technology plans that will incorporate all the basic decisions regarding the technical development of the company. Technology plans therefore consist of the whole portfolio of choices and strategies that enable a firm to manage the acquisition and diffusion of technology more effectively. Such plans required the firm to make strategic choices pertaining to four areas viz, methods of technology, the level of technical capability to be attained, the source of technology and the nature of organizational framework that will allow their successful implementation.

9.2 TECHNOLOGICAL DEVELOPMENT OBJECTIVES

The choices have to be made within the context of the firm's objectives relating to technological development. From the case studies three broad objectives - indigenous technological capability, limited collaboration and dependent technical system - have been identified.

9.2.1 *Indigenous technological capability*

First a small number of companies like Tasek Cement and Amalgated Steel Mills had pursued objectives emphasizing the acquisition of a strong internal capability.

These objectives were motivated by the need to retain local ownership and management control over the operation of the company. The objective of attaining a high degree of indigenous technological capability had assumed a central position in these companies. Implicit in the acquisition process was the motivation on the part of the recipient firm to reduce the cost of technology acquisition emphasizing on expanding indigenous capability to plan and implement subsequent expansion and modernization. The achievement of some degree of self-sufficiency in design and engineering capabilities was an important objective in companies like Amalgated Steel Mills and Tasek Cement. Indigenous technological capability is easier to be developed in matured industries such as steel, petrochemicals and cement. In these industries, there exist large numbers of technology suppliers whose interest lies mainly in selling the technology and not controlling the manufacturing operations. In such circumstances the local firm has the best opportunity of selecting the most appropriate technology suppliers that are willing to transfer technical capability to the recipient enterprise.

9.2.2 *Limited collaboration*

The second objective focussed on limited collaboration with foreign technology suppliers. These companies were mostly joint venture operations with a strong desire to acquire control over the technical operation of the company. The objective was to ensure that the foreign firms created a loosely decentralised organisation that permitted the local company to operate with some degree of independence from their foreign parent company. The strategy was used to source selected technological input from the foreign partner with long term plans to develop a strong indigenous technological capability. It reflected a strong desire by local partners and owners of local companies to reduce the role of foreign technology suppliers in providing technological services and other industrial input. These firms, such as Malaysian Mosaic, Alcom, Malaysian Sheet Glass, after many years of domination by foreign partners, had continuously sought to reduce the dominant position of foreign firms by seeking greater involvement of local personnel in the management of the company. Local firms were also anxious to reduce the many barriers imposed by foreign partners to restrict the flow of information thereby limiting diffusion of technology. They were also interested to reduce the impact of transfer pricing and increase the profitability of the local companies.

There were substantial differences among the firms within this group in terms of their stages of development, size, technological capability, ownership and management structure. The first group of firms represented companies which started as joint venture companies but were subsequently acquired by local investors. Malaysian Mosaic and Century Battery are examples of companies which are trying to wean themselves out of the near exclusive dependence on former partners by promoting rapid diffusion of technology through recruitment of high level manpower, increasing in-house technological efforts and implementing company-wide training programmes. The second category comprised firms which were determined to encourage greater diffusion by limiting the role of technical expatriates to an advisory capacity. In these companies local partners had management control and were in a position to influence the direction and speed of diffusion. Malayawata Steel and H & R Johnson are among the companies which had successfully pursued this strategy. Limited collaboration is suitable for companies where large scale R & D is not possible due to resource constraint and where products are still in growth stage of the life cycle. Since new competitors are still emerging the local company must continue to receive technical support from established manufacturers. Examples of such companies are those which are manufacturing products related to the telecommunications and electronics industries.

9.2.3 *Dependent technical system*

The third strategy found in the case study is common among a few firms which had constantly relied on foreign technology suppliers throughout their entire operations. For example, companies where the manufacturing operation is highly integrated with the foreign companies, are generally single product companies which are vulnerable to rapid technological change. Their survival relied on continuous support of, and infusion of new technological knowledge from, foreign technology suppliers. Some of these companies were merely assembly operations which imported major components from overseas plants. The products manufactured were generally the result of intensive R & D carried out by the foreign partners. The foreign firms exerted strong control over the operation of the company. Technological development was pursued on a limited scale by increasing the local content level in the final product and the provision of backup technology services to the end users. Pernas NEC is an example of a company which pursued this strategy. A dependent technical system is only appropriate for wholly owned subsidiaries of multinational firms whose main reason for operating in Malaysia is to captive the benefits of low labour costs and tax incentives. Joint venture companies and wholly owned local firms should avoid adopting such strategy if long term technical growth is one of their main objectives.

The technological plan appropriate for an individual firm would clearly depend on the objective the firm was adopting - whether it is developing indigenous capability collaborative arrangement or technical dependence. In the research it was found that firms adopting a self-reliant strategy required a high level of competence in the technology. In terms of technology acquisition, the self-reliant approach had led to the selection of methods of technology that would minimise foreign ownership and control. This approach had emphasised local staff involvement in planning and implementation of the project, while a technical dependence strategy would rely more heavily on external assistance through secondment of expatriate staff.

9.3 FORMULATING TECHNOLOGY PLAN

A technology plan will have to be formulated in accordance with the technological objectives of the firm. The technological objectives will then be determined by several factors such as the resources of the firms, product and technology characteristics, corporate strategies of technology suppliers, government policy and other factors. However the intention here is not to discuss the determinants of these objectives but to illustrate how they affect the choices to be made in formulating of technology plan. The components of decision making are complex. They include the goals that an organization is proposing. Discrepancies between the desired and actual accomplishment lead to decisions to develop technological development plan. The decisions are based around the acquisition and utilization resources (White 1974).

In formulating a technology plan a firm must make choices in at least four areas:

9.3.1 *Methods of technology acquisition*

Selection of the methods of technology acquisition is of paramount importance. As discussed in Chapter VI methods of technology acquisition has a strong influence over the diffusion of technology. The case study of the selected firms such as Tasek Cement and Amalgated Steel Mills has shown that companies which were able to direct or control their technical development achieved a higher degree of diffusion. These few companies had opted for turnkey transactions and other forms of contractual arrangements. Firms which adopted the indigenous technological capability approach would need to choose methods of technology acquisition that would allow them to manage their own technological development.

The firm would generally share all the risks and gains with the foreign firm's payment for its technology.

Contractual arrangement is distinguishable from joint venture arrangements because it does not include sharing of control and decision making, liabilities, risks and profits in the same sense as in joint ventures. There are many examples of these forms of arrangement, from simple construction contracts or sub-contract for specific services, to complex turnkey contracts. The most important types of arrangement in this overall category include licensing agreement, know-how agreement and other technical services such as engineering services arrangement and turnkey contracts. The extent to which each firm can use its own technical resources varies considerably. Depending on the nature of technology and the level of enterprise capability, basic and detailed engineering services for example are frequently tied to the supply of plants and machinery and are common in processing industries such as steel, cement and petrochemicals. A number of processing industries like Tasek Cement, Amalgated Steel Mills and Petronas Refinery had acquired technology through turnkey transactions and other forms of contractual arrangements.

The appropriate choice of technology is an issue of particular importance for firms pursuing the development of indigenous technological capability. Firms will find that it is not always possible to acquire technology through contractual arrangements or arm's length transactions. Certain suppliers of technology will insist that they must have control over the operation of the company and this can only be done through joint venture arrangements. Certain types of technology are not widely available and are available in a small number of firms which are not willing to part with technology unless they were given equity participation and control over the operation of the companies. However, before choices are made on the methods of technology acquisition, firms must carry out extensive search efforts to identify suppliers of technology which are willing to sell the technology according to the terms and conditions specified by the buyers.

A number of firms studied, particularly Amalgated Steel Mills, Soong Seng Asbestos, have implemented extensive search efforts before deciding on the choice of technology. There are numerous ways where firms can carry out such search efforts. Firms can scan the technical environment and keep in close touch with independent manufacturers in small industries. They can also source information from machine suppliers and trade associations related to the industry. Where the technology market does not allow the firm to acquire technology through arm's length transactions, the joint venture arrangement is the only option left for firms to establish manufacturing operations. Joint venture arrangements as shown in the study, are not a good vehicle to promote diffusion of technology since foreign firms may pursue their own investment strategies which may be in conflict with the objectives of the recipient firms. Decisions on technology development are also based around external politics (Allison, 1971) and internal politics (Pfeffer and Salancik, 1974). Organizational decision making occurs in the context of both an internal political economy and an extenal political economy.

The parent-subsidiary relationship formed in many joint venture companies can restrict the strategy of the local partners in enhancing its diffusion of technology. A typical parent-subsidiary relationship such as that found in companies like Pernas-NEC will involve:

(a) Licensing of patents and trademarks to the subsidiary, giving rise to royalties, the most obvious form of payment for technology.

(b) Provision of technical and managerial assistance, headquarter services, and access to the parent's expertise, giving rise to direct fees and the allocation of a portion of the parent company's overhead to be charged to the subsidiary. Again, a part of such payment is for technology.

(c) Sales and purchase of goods between the parent and the subsidiary, giving rise to payments in both directions. Since the goods, especially intermediate goods sold by the parent to the subsidiary, may embody technology, part of the price of such goods is payment for technology. These transactions offer the potential for disguised payments in the form of overpricing of the intermediates goods.

(d) Equity investments by the parent in the subsidiary, giving rise to subsequent flows of dividends. These investments may be financial contributions, they may be in the form of machinery and other goods, or they may represent the capitalization of intangible know-how and good will. Thus dividends may represent in large part a payment for technology.

Suppliers of technology must be aware of the strategies of the supplying companies when they agree to a technology transfer arrangement. As has been indicated earlier, most multinational companies are not principally in the business of supplying technology. The fundamental objectives are to establish themselves in the market where they can provide sales and services. Most firms see technology transfer as a means by which they impart their ability to make sales and provide services. In fact many large firms especially high technology firms, are extremely reluctant to market technology, since they provide the means for creating new competition. Many foreign companies are concerned about the loss of their competitive position through sales of technology.

9.3.2 *Technological competence*

A basic prequisite of initiating a technology development plan is the evaluation of company technological capability both in terms of the capability to assimilate imported technologies and also to develop indigenous technological capabilities. For assessing the capability to assimilate technology attention should be given to the skills available in design and engineering, project management testing and quality control. Technological capability analysis can help in the identification of strengths and weaknesses of the firm's technical activities. The analysis will help in developing in house programmes aimed at improvement or changes in areas relating to manpower development, organizational framework with regard to R & D, technical information system and physical facilities.

Having done the capability analysis firms must then determine the type of technological knowledge and skills that would be diffused within the company. Malaysian firms particularly joint venture companies such as Pernas-NEC and Alcom. Generally tend to ignore the importance of defining the level of competence that needs to be achieved within the company. For example Pernas-NEC was not able to benefit much from technology transfer arrangement between NEC of Japan and the local subsidiary because it was not able to specify the technological resources required from NEC to upgrade its own technical development from what was negotiated As a result no systematic efforts are made to develop those skills. In many of the cases studied the firm rarely determines the level of competence before negotiating the technology of transfer arrangement. It is left to the foreign firms of technology suppliers to determine the skills that would be diffused within the firm. In many cases, the learning process is only limited to basic operation skills.

Recent literature (Cooper 1982, Lall 1981) seems to stress the importance of innovative skills in enhancing the development of indigenous technological capability. For firms that desire to develop strong indigenous capability approach, the development of technological skills is crucial in achieving the desired pattern of diffusion. Companies which have adopted this approach must have the ability not only to operate but also to improve on imported technology. Subsequent expansion and modification would require the firm to undertake project planning and acquisition. A strategy of developing indigenous capability would require the firm to develop a strong capability in project planning and evaluation. Such capability would also allow the firm to switch to different methods of technology acquisition particularly those that would require increasing the role of the recipient company.

The development of innovative capability is essential to the successful operation of the company. Although the firm may not initially require a high degree of innovative skills, changes in the market would force the firm to undertake new product development. But as found in the case studies,in firms such as Tasek Cement, innovative capability could only be acquired after the firm has developed strong engineering-based skills, particularly those related to production capability and project acquisition. It is essential for the firm to develop a systematic programme that will ensure the emergence of technological skills related to the overall management of industrial operations ranging from production to innovation capability.

Where the collaborative objective is adopted, firms should also strive to acquire a wide range of technological skills including innovative capability. This strategy is important because as the company progresses and matures, it may decide to move to a self-reliant approach.

9.3.3 *Technical organisation and technological activities*

Having completed the technological capability assessment and identified the level of competence that needs to be developed to absorb the new technology the firm must select the various sources of technology where the new technological inputs could be acquired. In setting priorities and selecting technological alternatives, it is necessary to engage in forecasting what is possible, or is likely to occur in the fields of technology under consideration. For instance it may be futile to develop a technology when there are many reasons to believe that a superior, more cost-effective technology is being developed elsewhere and can be purchased at a price. If the capability within the firm is strong in certain areas it may want to source externally in areas where it is lacking to supplement its own technical efforts. It may adopt what is termed as make-some and buy-some technology strategy.

However the portfolio of technology choices can be decided after knowing the technology market and the performance of the various suppliers. Once the technology assessement has been completed and priority areas for strengthening technology development programmes have been selected, including options for technology sourcing, the firm will need to develop the approriate organizational framework to implement these activities. In the research it has been shown that one of the capabilities necessary for the successful implementation of technology transfer is that of being able to devise a suitable mode of organization to cope with the requirment of technological development in the firms. Successful companies which had acquired imported technology such as Amalgated Steel Mills and Tasek Cement had adapted their organizational structure to meet increasing demand in managing their technical resources. For example both these companies had established specialised technical units dealing in project engineering, project management, technical development, information gathering and technology assessment. If a firm does not establish the necessary specialised unit as found in many joint venture companies, not only will it be missing potential worthwhile opportunities of acquiring the necessary experience, but it may also be less effective in implementing the new project. For example many joint venture companies were limited in their ability to source local inputs and reduce the cost of their projects due to inadequate organizational support. On the other hand companies like Amalgated Steel Mills and Tasek Cement had a high degree of local technological input in a number of their projects.

Take the case of Amalgated Steel Mills and Malayawata Steels. The development of its technical capability is also reflected in its internal structure. A number of specialised technical departments had been established to assume responsibilities in directing subsequent expansion of its facilities. Where new projects were established, the various specialised technical units/development played a major role in coordinating and supervising the construction of new plants. The development of additional technical units influences the technical orientation of the company. Staff became more specialised thus requiring the recruitment of highly trained and specialised staff.

The structure of technical organisation and activities is crucial in determining the direction of technology diffusion. The case studies indicate that in-house technological efforts can facilitate diffusion of technology. In many companies studied, particularly joint venture operations, foreign firms tended to regard their subsidiaries as mere production units. This, to a large extent, has influenced the structure of their subsidiary companies since most of the technical resources are supplied from the parent company. Foreign firms see very little need to duplicate technical efforts in the subsidiary company.

Companies must establish a strong in-house technical department to carry out internal technical activities. Thus firms which have adopted the self-reliant approach will have to undertake external technical activities encompassing broad areas from project planning and investment to the implementation of innovative efforts. The respective technical department must be staffed with experienced and qualified manpower. For example, only two companies had established R & D departments. With the exception of those large capital intensive industries involved in the steel, cement and petroleum industries, the other companies did not establish their own project departments. For firms that have adopted the collaborative approach it is also essential to establish project departments to undertake subsequent expansion and modification. By establishing such capability they would be able to participate actively in the selection, evaluation and implementation of new projects. It was indicated earlier that foreign firms tended to source all the technical components during implementation of new projects, hence there is a necessity for local companies to participate actively in ensuring that local resources are utilized in the development of new manufacturing operations which would also promote inter-industry diffusion.

There is strong evidence to show that technical activities, no matter how minimal, can accelerate the diffusion process. Case analysis of several companies like Soong Seng Asbestos indicates that technological efforts like product process modification and adaptation, trouble-shooting, quality control, repair and maintenance, and plant optimization implemented by these companies have contributed to a higher level of technology diffusion. According to Bell (1984) technological efforts of this nature can increase the learning process of local personnel. For those firms that have adopted the self-reliant approach, it is crucial that they establish a department to undertake technical activities. This department should be entrusted with planning and implementation of technical activities. In some companies, the technical department has been assigned to undertake such activities while others had designated the R & D department to carry out a wide range of technical efforts.

It should be stressed that imported technology has almost always to be adapted and modified to local materials and equipment. Such efforts must be carried out by local personnel and not left to foreign technology suppliers. In many firms, particularly joint venture operations, adaptation and modification were carried out by foreign experts with very little involvement of local personnel. If diffusion is to be accelerated, local companies must ensure that those skills and knowledge involved in the adaptation process must be captured by local personnel. This can be done by ensuring their involvement in the modification and adaptation activities. In a number of cases, technology have to be scaled down to the size of the local market and adapted to available local skills. Adaptation is also a means of linking the imported technology to the domestic R & D. The progressive building-up of R & D is essential in firms if some degree of self-reliance is to be attained. Just as importantly, the whole climate of learning depends on the attitudes of the local personnel.

As emphasized earlier, R & D requires a group of fully qualified specialized technologists and technicians and a broadly equipped laboratory. The creation of innovative capability is an important objective. Management must allocate resources to recruit these personnel and set up such facilities as required. Apart from R & D activities, companies should implement other forms of technical services including raw materials studies, product and process development, information services, quality control and testing, and a variety of activities that could enhance the level of technical efforts in the company. Other services are also important, particularly those related to production planning and control, operation research, inventory control, material handling, cost accounting and data processing.

Manufacturing companies in Malaysia must establish an integrated technical service and strengthen their in-house management and technical activities to enhance the development of skills and knowledge. They should not be perceived as mere production units of foreign multinationals. For example, most joint venture companies such as Malaysian Sheet Glass, Pernas-NEC, and Federal Iron Works, source their technical support services from their parent companies. Product development, testing services and project design were carried out by their respective head office staff with little input from local staff. Such types of manufacturing operations will not improve the diffusion of technology in Malaysian industries. The setting up of specialised technical services departments can further improve the diffusion process. Generally such departments can provide services in design and engineering, economics and training. Design and engineering services in industrial project normally comprises the planning and implementation of a project during its setting-up stage, the preparation of the technical feasibility studies, the design of the plant, including the blueprint and drawings, preparation of tender documents and evaluation of bids, where tenders are made, supervision on behalf of the client, the construction of building and the installation of equipment, and assistance in start-up and initial operations. It is essential that some degree of investment and project acquisition capability be created for companies that have adopted the self-reliance approach.

In companies such as Tasek Cement, Amalgated Steel Mills and Malayawata Steel, a fairly high degree of investment and project acquisition has been established due to frequent investment on plant expansion and modification. It should be noted that these companies are able to source technology from independent machine suppliers. By establishing their own in-house engineering and consultancy departments they are able to undertake a high degree of local efforts in project planning and implementation during expansion and modification. Therefore, for companies which are able to acquire technology through direct sourcing, it is imperative that some degree of in-house capability with regards to engineering and consultancy services be created. Such capability has to be built up step by step. The road taken is therefore bound to differ from firm to firm. This also includes the comprehensiveness of all the engineering and consultancy services that can be attained at the firm level.

9.3.4 *Sources of technology.*

A firm must define the extent of reliance on external sources of technology in formulating technology plans. There is a need to identify the nature of the technical collaboration that will be entered into with foreign technology suppliers. Identifying whether a firm should source its technical input through licensing, technical assistance agreements, know-how agreements or any other methods of technical collaboration can determine the type of technology developed within the enterprise. One of the important findings is that most firms which have acquired a high degree of diffusion were able to diversify technical resources. They had acquired technology from different sources through different types of arrangements according to the needs of the companies. For example, Amalgated Steel Mills had technical assistance agreements on a short-term basis with several technology suppliers. These suppliers are known for their expertise in the field. Hence Amalgated Steel Mills was able to tap the source of technology which had established its reputation.

Multiple strategies are available for local firms to source technology. The strategic implication of valuing economy is the flexibility of determining the source of technology. Many joint venture firms are not able to diversify and source technology from other suppliers. Most of the time they are dependent on a single source of technology. As a result they are unable to select the best source of technology. For firms adopting the indigenous technological capability approach, there is a need to maintain a balance between external technological input and internal source of technology. Initially there is a high demand for external technological input due to the lack of experience in industrial operations. As a firm matures and acquires expertise, it could reduce the foreign technological input and emerge with the development of local resources. At the various stages of development of the firms, there is a need to vary the components between external and internal technological resources. Firms which have acquired a high degree of diffusion are those that had developed linkages with numerous sources of technology and continuously scanned the technological environment. A firm which strives for some degree of self reliance has to be able to develop a mechanism to acquire strategic information. It has to develop reliable information on many external phenomena such as population, industry trends, new and imparting technology and exporting market opportunities. The ability to acquire and process information is essential. Having developed the mechanism to process and select information, firms should consider developing their own R & D resources. The preferred strategy is to rely on external resources with concurrent efforts to develop technical expertise.

9.4 THE IMPORTANCE OF INDIGENOUS TECHNOLOGICAL CAPABILITY IN TECHNOLOGY PLANNING

There are various approaches to technological development. One is stressing long-term growth through indigenous technological capability. Another is emphasizing collaboration with the view of developing some degree of self reliance. Still another approach focusses on technological dependence. Nevertheless, indigenous technological capability should be the objective that firms should strive to attain. Developing indigenous technological capability is a long-term dynamic process which requires deliberate efforts on the part of the firm to systematically enhance its technological base. Having achieved technological capability, firms must ensure that their capability remains competitive and that they keep up with new technologies, new products, new management methods and new marketing in the competitive industrial environment. Despite costly investment in manpower development, firms should continue to develop their indigenous technological resources to maintain their technological competitiveness. Investment in human resources, training programmes, and recruitment of short-term experts requires a huge budget. This is essential in order to develop high quality manpower which forms an important element in the development of technological capability. There are costs to pay for technological development and competitiveness. No firm seeking a high degree of technical reliance is exempted from such costs. Successful companies such as Amalgated Steel Mills and Petronas which had acquired a high degree of technological capability allocated 2 to 3% of their operating budget to manpower development.

It can be seen that the most important weakness of wholly-owned local firms with a low level of technological capability is in their inadequate attention given to the building up of technological capability. Most local partners in joint venture companies consider expenditure on the development of indigenous technology resources particularly those for the development of technical capability extravagant in view of the limited financial resources. In most joint venture companies the development of industrial operation merely means simple production capability. Not understanding the concept of technological self-reliance they continue to seek assistance from foreign technology suppliers. In effect, they have substituted imported technology expertise at the expense of local technical resources. From the view-point of local partners, the development of industrial units is just the process of importation of foreign manufacturing facilities. No one can deny that developing technological capability is an expensive undertaking but it is also undeniable that without a strong technological base, local firms will never be able to compete in the world market in line with the government's industrial strategy which calls for the development of export oriented industries.

A small number of firms which have emphasized a high degree of internal capability devoted their resources to internal development find themselves capable of not only purchasing goods but also determining the choice of technology, negotiating better terms of transfer arrangements, supervising plant construction, sourcing local expertise and moving firms to higher level of technical capability. Only those firms that are unwilling to invest in the development of indigenous technical resources had continued to depend extensively on foreign sources without gaining the ability and flexibility to direct their own technological development. Unless they quickly learn this lesson, firms in developing countries like Malaysia will remain underdeveloped technologically. Technical stagnation, underdeveloped technical systems and lack of demand for high level technical skills will characterize the pattern of technological development in Malaysian industries. It is therefore essential that firm pursue the developmental approach as a means of achieving higher levels of technical development. By intergrating this approach in the technical process, firms will be required to carry-out strategic sourcing with regards to technology acquisition. The technology planning process will facilitate in determining the direction of technological development in the long-term. Only through such efforts can firms in developing countries like Malaysia achieve higher levels of technical progress.

9.5 CONCLUSION

In summing up the discussion the researcher would like to mention the following factors. First Malaysian companies lack a tradition to formulate an offensive industrial technology policy. Second, most companies do not possess efficient tools to make the timely and complicated analysis which is required to implement technology transfer programs. Third, Malaysian companies also lack the necessary management know-how for implementing technology transfer programs and has unclear expections of the programs. Too much importance is given to purely commercial objective rather than the catalytic roles of achieving technological capability. The short comings mentioned will require time and hard efforts in order to improve the situation. In this chapter the writer has suggested a framework that would help companies to formulate appropriate technology plan. Each company must formulate viable technology strategies to meet corporate development objectives.

CHAPTER X

CONCLUSION

10.1 INTRODUCTION

By means the empirical data acquired through the studies, the researcher had a glimpse of some of the problems that are involved in the diffusion and development of technology in Malaysian companies. This chapter will now attempt to present a broad overview of the whole problem and an integrated perspective based on all the pieces of information and the images that emerged from the study. It will attempt to synthesize the findings. This is necessary in order to complete the change in the reasoning and achieve some conclusions on the subject of diffusion and development of technology in Malaysian companies. To recapitulate, basically, there are 3 research questions:-

(1) What are the costs and benefits of technology acquisition in Malaysian companies?

(2) Is there a significant degree of association or relationship with regard to organizational and transfer characteristics and the diffusion pattern?

(3) What are the management related factors limiting and facilitating diffusion of imported technology?

The primary focus of the analysis was three-fold: the acquisition of technology, the development of technological capability and the role of management in influencing the pattern of technological capability. The key productive factors in the process of technical change are enterprises. Much of what constitutes technology or ways of doing things are acquired and developed at the level of the enterprises as a result of the expenditure of human efforts by its management and employees and is specific to the enterprise. The relationship between technology transfer and development of technological capability is complex. As shown in the study the ability to acquire technological capability is something which is developed cumulatively over time via the acquisition of skills obtained through production experience, investment in R & D and learning and imitation. As noted by Nelson and Winter (1982), the knowledge is, in part, tacit - which means that one may know or learn how to do something and yet at the same time be unable to explain satisfactorily how it is done. All of this is a way of saying that an important part of technology is firm specific; it cannot be simply transplanted but must be learned by experience, or more precisely, by interaction between experienced technology transfer and R & D. But in its search to master new technologies and turn out products including those involving radical jumps from the past, the enterprise will be constrained by its existing technology base and experience. Hence diffusion of imported technology is important because it is a process by which imported technology spreads and grows. Without it, technology will remain localised in the hands of the initial suppliers of technology. The extent of technology diffused is evaluated on the basis of technological capability developed within the Malaysian companies. Technological capability is divided into three broad components: investment and project acquisition, production management and innovation. Traditionally, technology transfer in developing countries appears to be associated with production management capability but the acquisition of production capability will not ensure the viability and independence of local firms to develop and expand their technological base. Initially the basic production function provides the foundation for its initial stage. Technological function embodies a much broader base, therefore the technological base should be defined broadly enough to encompass all those activities that are related to the planning and implementation of industrial operations. A corollary of this concept is that the component of the technological base should reflect an overall technical stance of the company. Therefore it is convenient to define such a base to encompass all the broadly various technical activities ranging from investment, acquisition, production activities and development of innovation capability.

The importance of technical progress in the economic growth has been largely recognised in economic areas and practice. Industrial countries have considered technology as a critical factor for reaching trade targets. For developing countries like Malaysia, technological development is critical to the industrial development programme. The rapid industrialization programme implemented within the last two decades has brought about a massive inflow of foreign technology. For Malaysia to move to a higher level of industrial development, it needs to ensure that the foreign technology imported is embedded in the indigenous technical system.

10.2 PATTERN OF DIFFUSION

Drawing on the empirical study and the basis of the researcher's observation it can be concluded that the diffusion of technology evolves in stages. Most firms considered the diffusion of production capability essential to the commercial viability of the project. Massive training programmes have been implemented with the view to developing the areas related to production capability. In-house technological efforts such as troubleshooting, product process and adaptation, repair and maintenance and quality control will enhance the diffusion of imported technology related to production activities. Production capability tends to be diffused early followed by investment and project acquisition capability. Increasing participation in project planning and implementation by local personnel opens up new opportunities for learning by doing. Such efforts have led to an increasing role for local personnel in undertaking plant modernization and adaptation thus building up a high degree of innovative capability. Diffusion of imported technology therefore is a multi-stage process involving a complex coupling process through a number of stages from initial technological input to the development of innovative capability.

10.2.1 *Characteristics of firms according to the intensity of diffusion*

10.2.1.1 *High diffusion firm*

Managers acquiring technology would like to know the characteristics of firms which attained different diffusion patterns. As indicated in this study, a large number of Malaysian firms have not progressed beyond the basic production activities. However, there is a small number of successful firms where imported technology has flourished. In these firms, diffusion of technology has progressed rapidly. Many of these companies share similar characteristic in terms of initial technology input, direction of technical effort and managerial leadership. Most of these companies had acquired technology through contractual arrangements such as turnkey transactions. The founders of these firms were entrepreneurs with some product process knowledge and industrial experience. The success of these firms in developing production capability quickly led to further investment and plant expansion. Successive investment activities also led to further involvement of local personnel in implementation of new production facilities.

Development of this capability is also reflected in its internal structure. Technical departments have been established and begun to assume responsibilities in directing technical development. Where new projects were established, the technical department played a major role in coordinating and supervising the construction of new plants. This can be considered a major development because it reflects an increasing independence of the firm in making the choice and selection of technology. In some cases, initial operating problems due to deficiencies in equipment supplied by machine suppliers triggered a high degree of in-house technical efforts related to plant modification and adaptation. Such efforts have led to further diffusion of internally generated technological knowledge.

The development of technical structure follows the technical orientation of the company. Certain technical staff became more specialised, thus requiring recruitment of highly trained and professional staff. At this stage, the company may restructure by creating more specialised areas. For example, companies that acquire technology through direct purchase of plant equipment will need a high degree of interfacing management skills. The technical department has assumed the role of coordinating and supervising numerous equipment suppliers and independent contractors. This appears to be a challenging task for companies that are involved in developing capital intensive plants such as petrochemical, cement and steel.

A high degree of diffusion in these firms can be attributed to several factors. Managers can draw some lessons from firms which have achieved a rapid diffusion of imported technology. The absence of foreign control is an important factor but the absence of foreign control alone is not sufficient to ensure a high degree of diffusion. Firms must be willing to invest in the development of manpower, implement product process and adaptation and promote local personnel involvement in the various stages of the project. These few companies have allocated a great deal of resources in planning and implementation of their respective projects. During planning, key local staff worked closely with foreign technology suppliers to ensure that some of the learning processes derived from the project are retained in the firm. Further expansion of the plants facilities enabled local personnel to increase the accumulation of technological skills thus achieving a faster diffusion of newly acquired skills in both planning and plant operations. Learning and information effects had accelerated as a result of internal in-house technological efforts. The absence of foreign interests helps to reduce some of the barriers to the flow of technical information within the firm, but it is also important that firms seek out the new necessary information and know-how on its own.

Unlike joint venture companies which are part of the multinational network, local firms are single units operating plants which had developed their own technical exchange networks. They had engaged in formal and informal links with independent manufacturers, raw materials suppliers and regional industrial organisations. The promotion of information linkages helps the company to keep abreast with technological developments and competitive environment. These firms continuously engaged in technological scanning to keep abreast with the frontiers of technology. The boundary spanning activity was normally carried out through overseas plant visits, seminars and information exchange networks. The researcher found that firms increased their diffusion of technology by engaging in a wide range of technological efforts. The experience gained in problem solving tended to lead to a higher level of technology diffusion.

A high degree of diffusion achieved within firms is also broadly explained by the positive actions on the part of management to develop strong internal capability so as to reduce the cost of subsequent technology acquisition. All these firms had used relatively mature technology and in such cases will be able to seek technology from independent machine suppliers. The rapid investment activities have accelerated technological learning because of the short interval between the construction of successful plants. The success of these few firms has demonstrated that local enterprise can achieve a high level of technological development if they are willing to allocate resources, develop a systematic efforts to foster technical development and formulate a well defined and cohesive plant. The evidence in this study, although limited to some extent, has shown that achieving a high diffusion of technology also relied on the strength of the predisposition of indigenous firms in goals directed action.

10.2.2 *Characteristics of low to moderate diffusion firms*

Most of the companies with a low to moderate diffusion pattern are joint venture companies. These companies were established under the import substitution programme and many had been in operation for the last five to 20 years. Technology has not been widely diffused in these companies. Most of the firms, particularly joint venture firms, relied exclusively on the parent companies to supply the necessary technological input. Local personnel's involvement in planning and implementation of production was minimal if not totally non-existent. When importing technology they drew heavily on parent or affiliated firms. Local technical resources are bypassed, resulting in very little inter-industry diffusion.

Inter-firm technical collaboration provided a continuous flow of technical resources from the parent companies of the foreign partners. It is therefore apparent that the foreign parents not only provided the necessary resources but also played a major role in directing technical development of the company. Inter-company flow of information and technology are facilitated through key expatriate staff located in management positions. The role of expatriate staff can be associated with that of technology gate-keepers, controlling and regulating information in the company.

Conflicts between foreign and local partners were often reported in these firms. The desire of local partners to take advantage of their growing technical ability to reduce foreign control of their operation tended to lead to friction. The desire to develop local expertise was often cited as a major source of conflicts. Most joint venture firms were also heavily dependent upon parent and affiliated firms for ideas and information relating to their product and process innovation. None of the joint venture companies has established their own R & D department. As a result diffusion of innovative capability has not progressed rapidly. Overall low and moderate diffusion firms are very much dependent on external sources of technology.

If there is a single issue that has played a central role in the diffusion process, it is the question of the impact of the technology strategy of foreign firms. For whatever reasons the foreign firms are attracted to Malaysia, their primary purpose is to maximize the investment of their parent companies. One of the important objectives of foreign firms is to maximize export of raw materials, components, technological services and expertise from the parent companies. Inter-firm trade tended to lead to the practice of transfer pricing. Foreign firms therefore had a strong desire to maintain some degree of flexibility in determining the transfer prices of parts and components.

Control is therefore viewed by foreign partners as essential to ensure compliance of the local partners particularly in areas where there is bound to be disagreement and conflicts. As long as the local subsidiary is dependent on certain strategic resources such as technology, the foreign company can exert some degree of control over the operation of the company. It is therefore important from the viewpoint of the foreign firms to regulate the flow of technology so as to ensure that the local subsidiary will continue to depend on certain essential technological resources essential for the continued viability of the firm. As a result the local joint venture firms will continue to be dependent on the flow of technical resources from the parent companies. Figure 10.1 illustrates the viscous circle of technology dependence common among many companies in the study. As shown in the figure, the initial stage of development. Due to the lack of participation in involvement of local personnel, there will be little indigenous efforts to undertake the wide range of technical activities leading to low diffusion and absorption of technology. Consequently foreign technology will not flourish in the firms because of the lack of concurrent efforts to promote indigenous capability. Expansion and diversification will require further importation of technology. The development of dependent technology systems in Malaysian companies will have wide implications on the long term development of the companies and national industrialisation efforts. Figure 10.1 reflects this phenomena commonly found in many of the companies studied.

10.3 DETERMINANTS OF TECHNOLOGY DIFFUSION

10.3.1 *Methods of technology acquisition*

The study confirmed the hypothesis that methods of technology acquisition influence the degree of technology. Malaysian companies acquired technology through foreign direct investment, contractual arrangements and to a lesser degree direct purchase of equipment. A number of alternative technology transactions such as direct sourcing, and licensing are available and this raises the concern that for one reason or another, the range of effective options open to Malaysian firms as to the potential alternative sources is not varied.

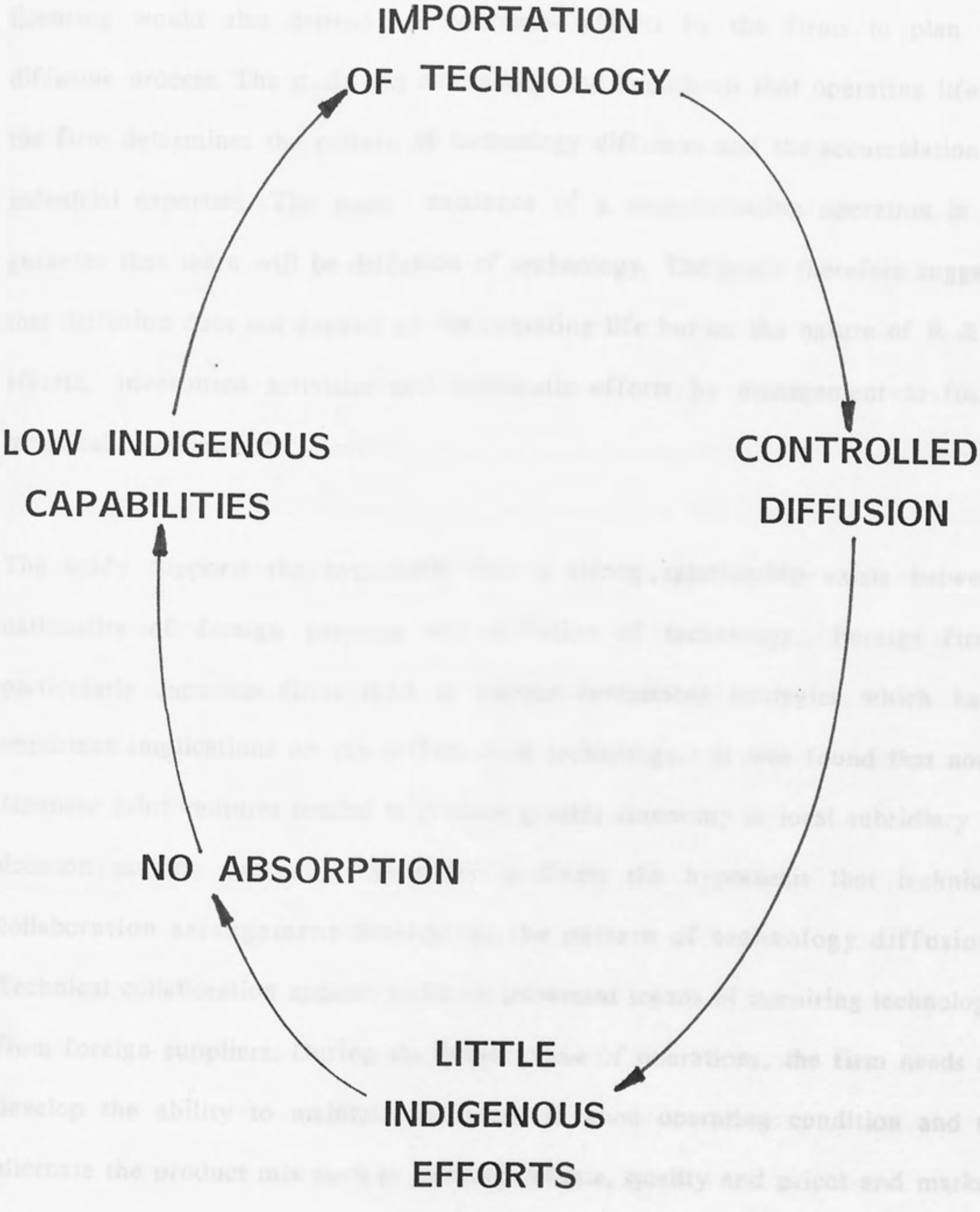

Figure 10.1 Vicious circle of weak diffusion system

The study therefore suggests that the effectiveness of non-equity technology transfer agreements such as turnkey projects, pure technical collaboration and licensing would also depend on systematic efforts by the firms to plan the diffusion process. The study did not support the hypothesis that operating life of the firm determines the pattern of technology diffusion and the accumulation of industrial expertise. The mere existence of a manufacturing operation is no gurantee that there will be diffusion of technology. The study therefore suggests that diffusion does not depend on the operating life but on the nature of R & D efforts, investment activities and systematic efforts by management to foster technical development.

The study supports the hypothesis that a strong relationship exists between nationality of foreign partners and diffusion of technology. Foreign firms particularly Japanese firms tend to pursue investment strategies which have important implications on the diffusion of technology. It was found that non-Japanese joint ventures tended to provide greater autonomy to local subsidiary in decision making process. The study confirms the hypothesis that technical collaboration arrangement determines the pattern of technology diffusion. Technical collaboration appears to be an important means of acquiring technology from foreign suppliers. During the initial phase of operations, the firm needs to develop the ability to maintain the plant in good operating condition and to alternate the product mix such as product volume, quality and prices and market changes. Formal technical collaboration would facilitate the flow of knowledge and expertise to the recipient firm. However, an excessive dependence on such an arrangement will obviate the need to establish its own technical resources. The research points out that ownership control does not have a strong influence over the technology acquisition pattern. Pattern of diffusion will be determined by the party that carried out the entrepreneurs' function including the technical operations. It is therefore essential to ensure that joint venture operations take the form of real cooperation and collaborations with local and foreign partners. Public policy intervention may be necessary to ensure that such partnership is created. An inportant element in the industrialization and national strategy is the attempt to liberalise the manufacturing industry from the domination of foreign technology suppliers. The attainment of this objective depends on the government's technology transfer policy and measures that would permit the development of local technological resources. The reseach confirms the hypothesis that management control tended to have a strong influence on technology diffusion. Firms under local management control tended to have greater autonomy in determining the long-term development of the firm. In many of these companies, locally appointed chief executives had sought to source local technical resources and develop strong inhouse expertise in order to reduce the cost of technology acquisition. A significant proportion of local personnel in key management positions in these firms had opened up more opportunities for local staff to be actually involved in critical production areas and in the process of project planning and acquisition, thereby enhancing the diffusion process. By contrast, a relative lack of local management in key positions in firms with foreign management control seemed to restraint the diffusion of technology. Expatriate staffing had been employed in key roles in most of the companies. However the type of service, the nature of their jobs and the terms of employment differed from firm to firm. The findings confirm the hypothesis that a strong relationship between technical staffing structure and diffusion. Firms which employed foreign expatriates tended to have a lower degree of diffusion than firms which did not have expatriates. Although many of these firms employed expatriates in the initial stage of operation, these expatriates had been replaced by their own local personnel. In such cases, the local personnel had assumed full responsibility for the overall development of the firm. In firms which employed foreign expatriates on a long-term basis, local personnel had little opportunity to implement product process knowhow. As a result, very little learning had been accumulated and technology was not widely diffused.

10.4 OTHER FINDINGS

10.4.1 *Management of related factors*

Apart from testing the above hypothesis the research reveals other initial factors which emerge from the extensive case analysis. The case analysis indicates that technology diffusion tended to depend to a significant degree on the extent and nature of top management involvement, its awareness and commitment to technical progress of the firm. Technology is widely diffused in companies where top management is involved in the planning and implementation of the transfer prices. In these firms there are systematic efforts to foster technical development and develop linkages with other technology suppliers. The study shows that many Malaysian firms rarely formulated specific plans or objectives to promote technical development. Often they allowed the technology suppliers to determine the nature and extent of technology to be diffused. Technology transfer was often emphasized in the initial stage but the lack of policy and planning meant that the development of internal capability had not been managed effectively. The case analysis provided strong evidence that the choices of technology transactions made during the early development of the firm have long-term implications over the diffusion of technology. Most of these companies had delegated these choices to foreign firms. They had not given much attention or sought technical expertise or evaluated the implication of these choices. As a result technological decisions were made without examining the long-term development of the firm. In cases where the technological decisions had been left to foreign firms, interests of the subsidiary companies or local firms had not been protected. Efforts to review or make subsequent changes to technological arrangements lead to friction among local and foreign firms.

The findings also indicate that in-house technological efforts tend to lead to rapid diffusion of technology as such efforts not only accelerated the information flow but also subsequently generated new technical information which contributed to greater understanding of the principals underlying the imported technology. Efforts of local firms to break through technical problems when successful propelled the firm to higher levels of technical capability. It confirmed the importance of the learning process.

Wholly owned local firms acquired their technological knowledge through the development of an information network to gain greater access on technical or strategic information. It shows that wide access to information was essential to accelerate the diffusion process. While joint-venture firms were able to tap on their multinational network, wholly owned firms had to make major efforts to seek and acquire information. To sum up the analysis, the case studies tend to confirm that diffusion on technology depended to a significant degree on the extent and nature of top management involvement, its awareness and commitment to technical process, the degree and nature of technical activities, technology strategies of foreign firms and accessibility to technological information.

10.5 DEVELOPMENT OF INDIGENOUS TECHNOLOGICAL CAPABILITY

Multi national firms are naturally concerned only with interests of their parent companies and therefore paid no serious attention to the local firm's technological development. The issue of foreign investment must be considered very carefully in the formation of industrial strategy. A developing country like Malaysia should not be contented with just mere production units of foreign multinationals. The development of the manufacturing industry must be focussed on the mobilization of indigenous entrepreneurial and technical resources and only within this context is technological capability truly indigenous.

The observation in this study has confirmed that although the importation of technology has brought about a certain degree of manufacturing capability it has not contributed to development of indigenous technical capability. It is within this context that the researcher has argued that for the development of the indigenous technological capability in Malaysian industries. This technology development strategy should be incorporated in the overall economic development process. Entrepreneurs are not too concerned with the long-term technological development of Malaysian industries because of their limited goals and resources. There is a need for greater policy intervention that would provide a higher degree of technical development. The policy of promoting indigenous technological capability would provide crucial support to local investors in the utilization of technology. For this reason, technological development as part of the national economic development process requires proper public policy and other institutional support.

There appears to be a conceptual misunderstanding of the technological development process in most of the firms studied. It is taken for granted that once some degree of production capability is developed, the process of technological development begins. The research has shown that unless firm takes a deliberate and systematic efforts to promote a high degree of production investment and project execution capabilities, it is unlikely that innovative capability will emerge in the firm. Therefore the attainment of technology capability is a planned long term process which is not automatic in its mechanism. Finally for Malaysia to succeed in industrialisation it has to ensure the rapid development of indigenous technological system.

For most developing countries, importation of foreign technology is one of the key methods of developing industrial capability. The development of a strong industrial base depends on the diffusion of imported technology. The findings indicated that the diffusion process in recipient firms is not one of passive acceptance but involves systematic efforts to acquire and diffuse the imported technology through the adoption of aggressive technology strategies. A company's system of diffusion may enable it to make very rapid progress through the appropriate combination of imported technology and local adaptation and development. On the other hand, weaknesses in the company's diffusion system may lead to the ineffective use of imported technology and poor development of technological capability. In order to appreciate the complex dimensions of the problems involved in technology development, the researcher has developed a simple model which explains the primary factors and variables which affect the diffusion and acquisition of technology in Malaysian companies. The model also emphasises the need to continuously effect the numerous variables indicated so as to be able to comprehend and understand the major forces, as they affect the supply, acquisition and development of technology. There is no single cause of technology under-development in Malaysian companies; there are many, and they are not independent of each other. They are integral. Together they constitute the viscious circle. The researcher is aware that only a strategy and policy which fully recognises the multi-facetted dimensions of the problems given herewith, the profile, the growth impetus in technological development in a Malaysian company can make meaningful contribution to Malaysian in its industrial development.

At the heart of the findings is a belief that a "paradigm shift" is required in industry, particularly if the manufacturing sector is to rise to a higher plane. Increasing the level of Malaysia's technological capability particularly innovative capability holds the key to Malaysia's industrialisation progress. The weak technological capability has been identified as one of the major barriers to higher levels of industrial development by the Industrial Master Plan (IMP) Report

(MIDA-UNIDO, 1985). In this respect, the development of technological capabilities is indeed imperative. It is, therefore, important to understand the barriers as well as the facilitators to the development of technological capability in Malaysian industries. The researcher hopes that this study has provided an insight into the technological as well as management barriers that impede the effective acquisition, diffusion and development of technology within the industrial sectors in Malaysia. The basic aim of this research was to attempt to substantiate generalizations about diffusion through systematic investigation in selected companies with a view to contributing to the development of a theoretical framework on the diffusion of imported technology in developing countries. The study suggests interesting conclusions. Further systematic testing of generalizations and hypothesis is essential to achieve greater understanding on the diffusion process of imported technology. Much of the literature of technology development in developing countries falls into two categories: public policy study on technology transfer and theoretical analysis lacking empirical foundation. This study is an attempt to provide firm evidence to support some of the hypothesis on the diffusion process. Summing up this discussion and the evidence discussed in this thesis, we might conclude that among the characteristics of successful technological diffusion in the industries considered were:-

(1) Strong in-house technological efforts
(2) Readiness to take risks in the selection of technology
(3) Strong linkages with external technology suppliers
(4) Careful selection of technology and substantial efforts to evaluate the various technology suppliers
(5) High level of managerial commitment in promoting diffusion of technology
(6) High degree of local involvement in planning and implementation of production facilities

(7) Management by the owner and a high level of entrepreneurship

(8) Technology acquisition through direct transaction

(9) Local management control

10.6 RECOMMENDATIONS FOR FUTURE RESEARCH:

Systematic and more detailed research, specifically on diffusion and development of technology in Malaysian companies, is urgently required. Such findings as there are in this empirical inquiry suggests that there are many problems in promoting technology development. The initial stage of technology development relating to technology acquisition is apparently fraught with many problems. We need to know more precisely why some companies are more successful in acquiring technology than others. Further research may, for instance, show that other methods of technology in small firms which import equipment and machinery are far more successful in acquiring technology. The research conducted here only focussed on medium-size import substitution industries. However, there is a large number of small scale enterprises, particularly in the area of engineering, metal working and plastic industries which may have sourced technology more successfully through less formal methods of technology acquisition. Our study indicates that joint venture companies are not effective mechanisms of technology acquisition. However, there is a large number of wholly-owned foreign companies that operate in the Free Trade Zones. The extension of the study should also look at the technological capability amongst indigenous personnel in these firms. The future research should also look at other variables in relation to technological capability. For example, size of company, product and technology characteristics, intensity of R & D and quality of technical personnel may also have some direct and indirect influence over technological capability. Finally we should add more variables and answer some questions that our present study did not fully explore.

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APPENDIX I

Aston University

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Dear Sir,

ACQUISITION AND MANAGEMENT OF TECHNOLOGY

This letter is being communicated to you for the purpose of enlisting your cooperation in a research project currently being carried out as part of my Doctoral programme. This project in which I am inviting your participation is one on the Acquisition and Management of Technology in Malaysian manufacturing industries. As you are aware, that a company technological growth result from the diffusion of the imported technology and its subsequent application to the provision of product and processes. At present most Malaysian companies imported foreign technology to develop their manufacturing capabilities. To a large extent, Malaysian companies had relied extensively on the importation of technology. Despite the important role of foreign technology in Malaysian industries, little efforts had been made to identify problems and issues of technology transfer and development of technological capabilities.

2. Against this background, a study of the acquisition and management of technology in Malaysian industries is both relevant and timely. Very briefly, the project seeks:-

(1) to examine major issues facing Malaysian firms in the acquisition of technology;

(2) study the nature of diffusion of imported technology and to identify critical factors that could explain the differences in diffusion pattern among Malaysian companies;

(3) to examine issues related to the management of the firm which could facilitate and limit diffusion of technology;

(4) to explore how the findings bear upon the role of national policies to promote the diffusion of technology.

3. The research methodology has been designed as a function of limited resources available for field work and the need to concentrate within a short time frame. It is proposed to carry out a limited number of interviews with companies in order to establish firms' profiles. These interviews which will seek to capture a more qualitative aspects of firms experiences, will focus on the links and the relationship established by the firms with other key actors or companies, for the purpose of acquiring technology. In addition, firms' views will be sought on the effectiveness of different types of technology acquisition. They will also be sought on policies and practices which have tended to impede or facilitate the diffusion of technology.

4. Case history yielded by firms interviewed, supplemented by discussions will be the basis of this research. If you agree to take part in firms interview, an interview questionnaires will be communicated to you shortly before hand. It should be, perhaps, be emphasised that the questionnaires are provided for the purpose of communicating to participating firms, the current perception of key questions affecting the diffusion of technology and should not be regarded as a rigid format.

5. Information obtained during the course of this interview will be treated as strictly confidential and used as exclusively for the purpose described in the foregoing paragraphs. It is hoped of course that firms interviewed will also participate in the subsequent indepth interview which will be based on a detailed questionnaire. To a large extent the success or failure of this project depends on the interests and response of individual firms. It is hoped in this case that findings will be directly relevant to current preoccupation on the impact of technology transfer in developing countries.

Yours sincerely,

(HAMZAH KASSIM)

APPENDIX II
Part I

INTERVIEW GUIDE ON THE ACQUISITION AND MANAGEMENT OF TECHNOLOGY

Name of Company : ....

Address : ....

....

....

Telephone No : ....

Background of the firm

01. Ownership structure

(1) Wholly owned local company ☐ ☐

(2) Mixed ownership ☐ ☐

02. Ownership control

foreign ☐ ☐

local ☐ ☐

03. Percentage of product exported

(1) None ☐ ☐

(2) 1 - 25 % ☐ ☐

(3) 26 - 50 % ☐ ☐

(4) 51 - 75 % ☐ ☐

(5) over 75 % ☐ ☐

04. Management Control

foreign ☐ ☐

local ☐ ☐

05. Date of Establishment: ....

06. Type of Industry: ....

07. Type of product manufactured: ....

Technology Acquisition

08. Methods of technology investment

Foreign direct investment	☐	☐
Contractual arrangement	☐	☐
Direct purchase of equipment	☐	☐

09. Nationality of foreign partner

Japanese	☐	☐
Australia	☐	☐
British	☐	☐
American	☐	☐
Others	☐	☐

10. No. of personnel :..

11. No. of expatriate employed : ....

12. Placement of key expatriates

Marketing	☐	☐
General management	☐	☐
Finance	☐	☐
Production/technical dept	☐	☐
Personnel	☐	☐
None	☐	☐

13. Type of technical collaboration

Technical assistance

Licensing

Management contract

Not applicable

14. Terms of technical collaboration

Short term

Long term

15. Important of contribution by technology suppliers (rank in order of importance)

	Most important					None at all
Selection and evaluation of technology						
Sourcing of raw materials and equipment						
Training of local personnel						
Technical know-how						
Providing management expertise						

16. Source of conflicts with technology suppliers (rank in order of importance)

	Very important					None at all
Implementation of technical colloboration						
Project planning and implementation						
Control of technological resources						

Development of local expertise ☐ ☐ ☐ ☐ ☐ ☐

Transfer pricing ☐ ☐ ☐ ☐ ☐ ☐

17. In acquiring technology in subsequent projects do you change to different channel of technology acquisition.

Yes ☐

No ☐

18. If yes what method of technology acquisition has been adapted.

Foreign Direct Investment ☐

Contractual arrangement ☐

Direct purchase of equipment ☐

19. Has your company carried out recent expansion or and modification of plant

Yes ☐

No ☐

	Very high					None at all
20. To what degree has local personnel been involved in the planning of the modification/expansion project	☐	☐	☐	☐	☐	☐
21. To what degree has local personnel involved in the set up of the initial operation.	☐	☐	☐	☐	☐	☐

22. To what extent has indigenous technology capabilities been created in your firm relating to the following activities.

i. Project execution: ability to search, evaluate conceive plan, design, supervise commissioning of production facilities.	☐	☐	☐	☐	☐	☐
ii. Operating capability: operating plants and equipment, quality control, production planning, repair & maintenance.	☐	☐	☐	☐	☐	☐

		Very high					none at all
iii.	Innovative capability: product process adoption & modification, plant optimization, & other minor innovation or productivity improvement efforts.	☐	☐	☐	☐	☐	☐

23. Perception as the most important factors limiting diffusion of imported technology.

		Very important					None at all
(a)	Lack of management efforts to foster technical development	☐	☐	☐	☐	☐	☐
(b)	Poor management of technology acquisition	☐	☐	☐	☐	☐	☐
(c)	Strategies of technology supplying firms	☐	☐	☐	☐	☐	☐
(d)	Lack of well defined technology transfer programme	☐	☐	☐	☐	☐	☐

24. Perception as the most important factor facilitating the diffusion of imported technology.

(a)	Development of internal technological resources	☐	☐	☐	☐	☐	☐
(b)	Top management support	☐	☐	☐	☐	☐	☐
(c)	Selecting appropriate transfer mechanism	☐	☐	☐	☐	☐	☐
(d)	In house technological efforts	☐	☐	☐	☐	☐	☐
(e)	Strong linkages to alternative sources of technology	☐	☐	☐	☐	☐	☐

25. Please specify the most dominant type of in-house technical efforts

(1) Product/process modification ☐

(2) New product development ☐

(3) Product/process improvement ☐

(4) Raw material studies ☐

(5) Others please specify ☐

APPENDIX II

PART II

CASE STUDY INTERVIEW GUIDE

(1) HISTORICAL ORIGIN OF THE FIRM

(a) How did the firm originate for example, was it set up by foreign investors or local entrepreneurs.

(b) How did the founding members set it up and what is their degree of involvement in the technology acquisition process.

(2) DEVELOPMENT PATH OF THE FIRM

(a) What were the initial fields of activities.

(b) What had been the major changes in the manufacturing activities since the firm was created.

(c) Have the foregoing been a consequence of initial long term strategy or the need to adapt to changing market demands.

(d) In which directions has the firm evolve:
towards diversification; increasing export market; implementing local content programme.

(e) To what extent were its directions a result of a institutional arrangement such as technology transfer agreement, joint-venture arrangement, links with international companies.

(f) Has the original organisation of the firm been significantly modify in terms of technology acquisition, increasing technical capabilities.

(g) How are further prospects perceive in regards to maintaining an increasing technological competence.

(3) ACQUISITION OF TECHNOLOGY

(a) What has been the principal sources of technology and know-how.

(b) To what extent have systematic or adhoc relation been established with other technology suppliers for example, independent manufacturing firm, raw materials suppliers and other consulting organisations.

(c) Has the firm made systematic efforts to gather technological information through for example: foreign contacts participation in international congresses; memberships of trade associations.

(d) What are currently perceived as the major problems encountered in acquiring new elements of technology.

(4) DIFFUSION OF TECHNOLOGY

(a) To what extent has the firm benefitted from the acquisition of foreign technology.

(b) Has local personnel participated actively in the acquisition and implementation of new production facilities. If not, what are the major constraints.

(c) Has the firm benefitted significantly from the planning and implementation of new production facilities. If not, why it is so.

(d) Are firms' policies regarding recruitment, training, diversification, in-house technological efforts perceive as contributions to the diffusion of technology.

(e) Has the firm technological capability developed rapidly within the last few years, if so, how did this happen.

(5) EVALUATION OF POLICIES

(a) What governmental policies has positive or negative effects on the diffusion of technology.

(b) Has the technology transfer control system influence the diffusion of technology.

(c) What were the more important forms of government supports system required to accelerate diffusion at macro and micro level.

(d) Have foreign investment policies affected the diffusion of technology.

(e) What policy instruments do you think would further enhance the diffusion of technology in Malaysian industries.

APPENDIX III

CASE STUDY NO. 1: MALAYSIAN SHEET GLASS

Company Background

Malaysian Sheet Glass (MSG) was joint venture operation between Malaysian and Japanese interest. Before MSG was formed most of the glass products were imported from Japan and other foreign countries. Local interest particularly those involved in the importation of these products saw the opportunity of manufacturing these products locally in-line with the growth of building industries.

The set up of MSG was set up was typical of the many joint venture operations that mushroomed in the 60's and 70's. A factor unique in Japanese joint venture companies was the role of Japanese trading companies in bringing these joint activities into fruition. In this case the Japanese trading company, Toyo Menka had been instrumental in identifying the main foreign partner, Nippon Sheet Glass, that would be responsible for supplying the technological and managerial resources to this new company.

The company was established in 1971 with a total paid up capital of 30 million. Toyo Menka and Nippon Sheet Glass control 49% of the equity while the remainder was distributed among local entrepreneurs and institutional shareholders. The plant was located on a 64 acre site in Sungei Buloh, Selangor. The company started with the manufacturing of tinted and wired glass.

Initially the production was 60,000 of converted cases per month. In 1979 firm expanded its production capability and introduced other glass related products particularly safety glass and tinted glass. Sales performance had also done quite well growing from 9 million in 1972 to 90 million in 1982. The firm had also embarked on a major expansion project involving the setting up of a float glass plant.

In 1984 MSG was the only company licensed to manufacture flat sheet glass. As the sole manufacturer of flat glass it controlled 90% of the domestic market for safety glass. In term of safety glass, its nearest rival was MCIS safety glass partly owned by the Asahi group. Other major glass plants in Malaysia are the KL Glass, JS Containers and Malaya Glass.

Technology Acquisition Process

As in most joint ventures, the foreign partner particularly the technology supplier, Nippon Sheet Glass, had undertaken the major task of establishing the manufacturing operation. Local entrepreneurs involved in this venture had no manufacturing experience and relied solely on the Japanese partners to organise and install the plant. To facilitate the transfer of resources to this new plant Nippon Sheet Glass had entered into a technological collabration agreement with MSG. Such an arrangement would not only entail the foreign partner to design and build the plant but also train local personnel to operate the plant.

In the initial phase, around 70 local personnel were sent to Japan for in-plant training. The whole planning and implementation of the new plant was a Japanese affair with very little involvement from local personnel. The whole manufacturing process of basic design, detailed studies, detailed design, construction and procurement, plant start-up and commissioning received very little local technological input. Protecting its technology appeared to be crucial to Nippon Sheet Glass and this was a great obsession with the company. Like many other Japanese companies, Nippon Sheet Glass had acquired its technology from American and British firm. It had also invested through its own R & D efforts in improving and developing its own technological capability.

When MSG started their operation in 1971 the Malaysian Government granted the company pioneer status and provided tarrif protection thus closing its door to other suppliers. For its investment MSG received royalty for the sale of its technology. MSG had turned out to be a profitable venture with a major expansion project in the pipeline. In the past 10 years its sales turnover had increased.

Despite the success interview with senior executives of the company showed evidence of growing disenchantment of local staff with way the foreign partners managed the technological resources. Athough it was supposed to be a company with joint management control a close-examination revealed a different story.

The company had eight expatriate staff comprising the managing director and seven other technical managers. The most senior local executive was the Administrative Director who was responsible for personnel, procurement, general administration and finance. The Japanese also transplanted their managerial system and industrial practice in the shop floor.

The company strived to develop quality management within the company through its quality control circle and other social activities which characterised Japanese Managerial System. The local staff pointed to the fact such activities hid the rigidity in which the foreign partner controlled the company that left little room for local involvement.

Development of technological capability

One of the issues highlighted by local staff during the interview was the degree oaf their involvement in the management of the technical system. Involvement here refers to the decision-making process within the production administrative structure. The main decision-making activities could be classified according to broad types of decisions that had to be made in production management. The types of decisions can be grouped into areas relating to (i) schelduling (ii) maintenance and trouble shooting (iii) quality control (iv) modification and adaptation.

Two different production process were used, Colburn process and Roll-out process. The Colburn process was used to produce clear and tinted sheet glass while the Roll-out process was used to produce figured and figured wire glass. The production technology was fairly automated with the entire batch feeding, melting, annealing and cutting process computer controlled. Labour was mainly used in monitoring and in collecting, stocking and transporting the finished glass sheets.

The production function was organised around the two major product lines, sheet glass and safety glass. The sheet glass section was headed by a Japanese production manager and supported by a local assistant manager. The Safety Glass Section which started production in 1979 was headed by a General Manager supported by a production manager and a development manager. Both these managers had local assistant mangers reporting to them.

Discussions with the local assistant managers revealed that day to day operation of the plant had been delegated to them. The local assistant managers were themselves qualified engineers trained in local and overseas universities. They were very much involved in determining production scheduling, supervision of production workers, checking, quality control and solving minor maintenance problems. However, decisions about modifications either in the production line or in a particular machines or in the particular furnaces were the responsibilities of various line managers and other senior technical executives, all of which were expatriate staff.

Innovative activities was detached from the local personnel. The flow of technical information related to innovative activities came directly to the expatriate personnel which planned and implemented the changes without much involvement of local personnel. The strong hierarchical communication pattern within the organization was perhaps caused by the need to maintain complete secrecy of technical information. This practice, however, tended to disrupt the working relationship between local personnel and foreign expatriate. A number of technical executives reported the reluctance of the Japanese expatriates to diffuse organizational and technological know-how down the line. The development of indigenous technological skills had been slow much to the frustration of the young engineers who had been looking for a challenging career to develop their own technical competency. As a result of this, a few of the technical personnel left the company. To overcome this problem the foreign partner had requested that the company should not employ local professional staff. This suggestion was however, met with strong objection from the local partner which perceived it as a threat to its long term strategy of developing its own in-house technological capability.

Local personnel felt that the foreign partners were not managing the technological resources in the best interest of MSG. Not only was it causing an over-flow of valuable financial resources to the Japanese parent company but also deprived MSG from fully benefiting the technological collaboration it had entered into with Nippon Sheet Glass.

The researcher was informed of two major instances where local learning by doing would have resulted in the accumulation of technological knowledge among local personnel. First was the major overhaul of the plant carried out in 1978 when MSG paid the parent company a few million ringgit, the actual sum of which was not disclosed. Around 30 Japanese technical staff was flown in to undertake this major repair and maintenance job. Since this involved a major plant shut down, it was expected that local technical personnel would be called in to help their foreign counterpart thus providing them a valuable experience in undertaking future job of this nature. Much to the disappointment of local personnel, this did not take place and local technical personnel were left to supervise minor job on the shop floor. However, local personnel felt that they were as much as to be blamed because they took for granted that the Japanese would count on their involvement. In future, as pointed by the Senior Executive, local personnel will be involved in the planning and implementation of such major work.

The company had embarked on a major expansion project involving the construction of a float glass plant. The float glass plant was expected to commence production in the middle of next year with an installed capacity of 200,000 converted case per month. Presently, all such float glass products were imported. The increasing use of float glass products in high rise commercial office building had prompted MSG to consider seriously manufacturing these products locally. Secondly another Japanese company, the Asahi group had already established two float glass factories in Thailand and Singapore. Products from these countries were already finding their ways into local domestic market. Asahi was also a joint venture partner in a company manufacturing safety glass in Malaysia.

According to one of the Managers, MSG Japanese partners were quite reluctant to invest in another facility since they had completed a major expansion in 1979. When the project was finally approved in 1982, MSG set up a committee to coordinate and monitor the planning and implementation of this new plant. This committee known as the float committee was headed by the Technical Director.

To a large extent the planning and implementation of the new plant was not different from previous projects. Nippon Sheet Glass as the technology supplier provided the basic design, detailed engineering procurement and construction of the plant. However, the local partner had requested that the Japanese used local components and sub-contracted out some jobs to local engineering firms. As one of the officers pointed out, if left entirely to the Japanese they would even acquire small items like wheelbarrow from Japan which was 10 times more expensive than what could be easily acquired locally.

The writer was told that the other Japanese partner Toyo Menka would benefit very much from this project. As a trading firm it handled all the necessary procurement of spare parts, equipments and raw material. It was interesting to note that the project manager, a local personnel, was never involved in the designing of the new plant. In fact, one of the tasks of the project department was to carry out major expansion and modification programme. In this case, his role was confined to supervising the installation of new equipments on site. The

Japanese was reluctant to supply complete drawings for parts to be fabricated locally.

During the initial operation the company was staffed by at least fifteen foreign expatriate in key managerial positions but as the company grew the number of expatriate were reduced. Almost all the key management posts were staffed by the personnel from the parent company except the Administration Director.

The expansion of production capacities in the 70's had led to rapid growth of local manpower. However, local personnel were not too happy with the existing manpower structure particularly those at the middle management level. As one executive pointed out, "The number of expatriate was for too high for a company at of this size particularly when the technology was not as complex as it appeared to be. I don't see any much prospect of my career progressing beyond what it is now if the existing pattern of expatriate employment is maintained. Five or six years ago I would not have raised this issue as the company could use the service of this expatriate but today many of us are disillusioned with personnel practices in the company".

The writer was told that management had refused to recognise the growing tension between local and expatriate staff. It was pointed out if the local managing partners had worked on a plan for gradual phasing out of expatriate staff, the present situation would not have occured. The writer raised some of these issues with the Administration Director who was the most senior local executive in the company. He felt that if top management continued to ignore staff problem, the company may loose some of its experienced and trained personnel.

In Malaysia the employment of expatriate staff was subject to government approval. In most cases the local partners would have to support the extension of work permit in order to obtain favourable consideration from the the Government. It had been the policy of the government that employment of expatriate staff was a temporary measure and companies were required to train local staff to take over expatriate staff with the exception of certain key staff as may be approved by the government. Despite 10 years of operation the company had retained a large number of expatriate staff. In fact this was one of two companies that have relatively large employment of expatriate staff in the 31 firms that had been surveyed. Hence diffusion had been rather slow with heavy dependence on foreign staff on technical support.

PRODUCTION AND EMPLOYMENT TREND OF MALAYSIA SHEET GLASS COMPANY, 1973-84

YEAR	TOTAL SALES OF OUTPUT ($ MIL.)	TOTAL EMPLOYEES
1973	9.0	N.A.
1974	11.0	310
1975	17.0	340
1976	25.0	350
1977	30.0	400
1978	28.0	450
1979	36.0	500
1980	51.0	610
1981	74.0	650
1982	90.0	780
1983	N.A.	830
1984	N.A.	1,020

SOURCE : MSG ANNUAL REPORT

Process Flow of Sheet Glass Manufacturing

a. COLBURN PROCESS: (SHEET GLASS)

1. **Raw Material Mixer**
2. **Batch Feeder**
3. **Melting Tank**
4. **Drawing machines to pull molten glass vertically up.**
5. **Annealing Lehr**
6. **Cutting Table**
7. **Washer Dryer**
8. **End Product**

Clear sheet glass

Cool pane sheet glass

b. ROLL OUT Proccess

1. **Mixer of Raw Material**
2. **Batch Feeder**
3. **Melting Tank**
4. **Roll-out machine**
5. **Annealing Lehr**
6. **Cutting Table**
7. **Washer Dryer**
8. **End Product**

Clear figure glass

Figured wire glass

Cool pane grey figured glass

CASE STUDY 2 PERNAS NEC

Company Background

Pernas NEC is a joint venture company formed in 1973 between Nippon Electric of Japan (NEC) and Pernas Engineering, a subsidiary of the government-owned trading corporation Perbadaran Nasional (Pernas). NEC won a contract to supply and install the Frequency Division Multiplex (FDM) Equipment to the Telecommunication Department. The contract required NEC to set up manufacturing facility with a local company.

NEC owned 40% of the equity while the rest was held by Pernas Engineering. Pernas NEC was only the company in Malaysia assembling FDM equipment and supplying to the telecom department. Initially the company was responsible for assembling FDM components imported from Japan and providing engineering service, installation and commissioning. Subsequently the company won another 10 years contract to supply and install stored programme control (SPC) switching system to the telecommunication department.

As part of the contract Pernas NEC was required to set up another subsidiary to manufacture the switching equipment known as NEAX 61. NEAX 61 digital switching system uses stored programme control. Due to its high flexibility resulting from a unique building block configuration, modification of networks to virtually any scale is possible without alterations. It is this adaptability that makes the system efficient and flexible for use in office, remote switching centers in rural areas, mobile telephones and international switching exchanges. The company manufactured both transmission and switching equipment.

NEAX 61 uses modular construction system. Each of the rack comprised 16 module. In each of the module there are 32 circuit cords/circuit packet. The module has its own card shelf and back wiring board. The circuit wiring uses multilayer printed circuit and connector cables. In 1982 the company was given another contract to supply a more advanced version of FDM equipment NV5000 replacing the previous B6 FDM equipment.

Technology acquisition process

Initial production of FDM (B6) started in 1974 with several local personnel being trained in NEC Japan. Its major expansion occured in 1981/1982 when it won the contract to supply the switching system. The sales increased from 13.6 million ringgit to 41.6 million ringgit in 1981/1982. In fact the contract for the switching system was valued around 1000 million dollars for the supply of 1.7 million lines for the period 1981 - 1990.

The second plant located in the Northern part of Peninsular Malaysia started operation in December 15, 1982. A sophisticated equipment of this nature requires a high standard of assembly and installation procedures. During its 10 year operation the company continued to receive technical support in term of new technology. Rapid technological changes resulted in making the FDM a dying technology. Recently the company tendered unseccessfully for a new transmission equipment based on Pulse Code Modulation 8 PCM.

The company had 4 division headed by a local chief executive. The main divisions were the Service Division, Technical Division, Research Development, and Training and Marketing. Most of the key post were held by local personnel. During the interview it was made known that some of the key posts like the production manager was held by local personnel.

Like in most joint venture company, key posts were normally held by expatriate during the initial period of operation. When the company decided to build a new factory to assemble switching key equipment, it appointed 8 Japanese expatriate personnel to key positions including the Technical Director, Engineering & Installation Manager, and Production Manager. At the same time, the company also recruited local staff to understudy the expatriate.

The Company offered annual scholarships to students pursuing their education at local institution of higher learning. It regularly sends production personnel, technicians, supervisors and engineers to NEC factories in Japan for short term refresher courses and technical training. In its efforts to train more personnel on the operation techniques of the NEAX 61, the company formed a Software Training Centre.

Development of technological capability

The technical operation of the company can be divided into two functional areas namely manufacturing activities and operating activities. The operating activities included installation commissioning, maintenance and operation of the system. It included other long term activity like training of telecommunication technicians. These activities were crucial to the operation of telecommunication system. Because of the rapid technological changes resulting in the introduction on very sophisticated telecommunication equipment, the company had to focus on continously upgrading the operating capability of its client in this case the telecom department. Most of its engineers were young and inexperienced and the company had relied heavily on NEC staff to provide the necessary technical back-up service when it introduced new equipment in the market.

The production activities was generally an assembly operation. Local content programme was implemented to meet the telecommunication department requirement. The company started to incorporate local content when it first began to assemble FDM. However, no target was given by the telecommunication department on percentage of local content to be achieved. The company did achieve 25% local content for the FDM-B6. Local content programme for NV 5000 was specific. The company was required to achieve 10% local contentby 1985.

There are several problems posed by the local content programme. One key role of the R & D & Traning Department was to source local supplier that could manufacture some of the components. For the FDM - B6 the company took the decision to manufacture part of the components in-house. The decision did not please NEC because the particular component was very profitable to NEC. In fact NEC resisted strongly Pernas NEC plan to manufacture part of the component and was very reluctant to provide the necessary technical drawing and specifications.

In 1983/1984 the company achieved a sales turnover of $155.2 million of which $42.4 million was from FDM and $112.8 from switch key system. The company manpower had also expanded from 100 in 1973 to the existing strength of 400.

The rapid technological change on the telecommunication industry had made the company vulnerable to competition from other multi national firms. Although it was the only company supplying FDM equipment to the telecommunication department, the company had to share the market for its switching equipment with Ericsson, which also established another local manufacturing company to manufacture switching equipment.

The Malaysian telecommunication department works on an open bidding system. As pointed by one of the executives in the company, the telecommunication department practice of getting access to the most advanced technology posed serious challenge to the company. Recently, Pernas NEC lost their bid to supply additional transmission equipment to the telecommunication department. Marconi, a European based company had won the latest contract to supply transmission equipment. This new development had posed serious threats to its transmission equipment business in Malaysia. The existing contract on transmission equipment would end in 1988 and there was an element of uncertainty with regard to the future of transmission division.

Another major challenge faced by the company was the intense competition on the international market between the five or six large multinationals which had the technical and financial ability to bid for a large foreign contract. It was widely speculated that the failure to obtain the last two contracts on transmission equipment was due to the technical superiority and financing facility offered by its competitors. Like many other developing country Malaysia can acquire the equipment it needs through competitive bidding from a small number of multinational firms. In order to obtain the contract, the bidder must not only be prepared to supply the best technology but also to establish a local manufacturing facility usually on a joint venture basis. Two other companies, Ericsson and Marconi had also established joint venture operations.

NEC entered into a joint venture agreement with Pernas NEC which among others also specified the scope of its technical assistance arrangement. Generally, the technical assistance agreement will specify the nature of technical information and know-how to be provided to facilitate the operation of the new Company.

The company revised its joint venture agreement in 1981 to incorporate a new technical assistance agreement covering electronic switching equipment. The new technical assistance agreement was drawn up to cover supply of know-how and licensing for the NEC NEAX 61 stored Program Control (SPC) electronic switching system. The revised joint venture agreement also provided for a reduction in NEC equity shareholding from 40% to 35% in 1986. In addition to assisting in setting up the assembly operation, the technical assistance agreement had included the provision of technical back up service for maintenance and installation of the switching system. The introduction of digital switching system required a strong development in data processing. Software engineering was required in order to maintain and operate the system. NEC was also required to provide technical support to set up a software engineering center. One of the major activities of the company was to train personnel of the telecommunication department in the operation of the system. In order to do so the company built a strong in-house expertise in installation and maintainance of the new switching key system.

Japanese expatriates were despatched to the company to provide the necessary expertise while several personnel was sent to Japan for short term tranning. In addition, a number of telecommunication personnel was also trained in Japan. During the early phase of operation, the only local effort was purely assembly and testing. It was only towards the beginning of 1980's that prompted the company to consider inhouse manufacturing of selected components.

One of the item identified for in-house manufacturing by Pernas NEC was the transformer. Using its own resources, the company attempted to manufacture the transformer without much difficulty. NEC was not too happy about this and insisted that the transformer be purchased from them. However, Pernas NEC persisted with this idea and managed to persuade NEC to allow them to manufacture the particular components. According to one executive, the cost of components supplied by NEC were sometime 4 - 5 times higher that what was available locally. To a great extent, the local content program had enabled local personnel to develop so knowledge on the manufacturing know-how of particular item. During the implemention of the local content programme the personnel found the most of the technical specifications were in Japanese. In fact, it was a major problem because none of the local staff could understand the technical documentation submitted by NEC Japan.

Another item identified was cable and several cable manufacturers were approached on the possibility of manufacturing the cables locally. Most of them were able to manufacture according to the specifications provided by NEC. But, unfortunately, the minimum quantity quoted by these manufacturers were too large for the current contract. Pernas NEC were using cables of various colour of similar specification for purpose of identification. In implementation the local content program, local personnel became familiar with the product and process know-how of the particular item. They developed a good relationship with local manufacturers and were able to evaluate the technical competence of various suppliers. Local content with regard to FDM-B6 was achieved at 32% of which

2% consisted of local component and rest were labour cost for assembly, testing and inspection.

There was a lack of direction as to how the expertise should be developed. It was found that the Telecommuinication Department's open bidding system had not taken into consideration Pernas NEC efforts to promote the local content programme. A lot of efforts had been put in the local content programme for the FDM NV5000 which would have achieved 60% local content by the year 1986. In 1984, the company had managed to achieved 45% local content. Some questions had been raised whether Pernas NEC needed to proceed further to meet the 60% target since the FDM equipment was being replaced by the PCM technology. It was indicated that when the supplying contract ended in 1988, the Telecom Department may not be procurring anymore FDM equipment. However, Pernas NEC was confident that it could also bid for the PCM technology. Its parent company, NEC had the PCM technology but the success of bidding this contract in 1988 in the eventuality that Telecommunication Department would require PCM technology would depend on NEC ability to meet the specifications required by the Telecommunication Department.

In 1984, NEC had bid for the tender for the supply of transmission equipment based on the PCM technology but lost the tender to another supplier. The company also lost its position as the sole supplier of transmission equipment to the Malaysian Government. The replacement of the PCM technology and the phasing out of the FDM had raised some doubts as whether the company had to continue in the local content programme on PCM equipment. The rapid technological changes had also been perceived as a major set-back to the local content programme as a means of diffusion of technology. When the company introduced the new PCM equipment replacing the B-6 mode, they found that certain components were difficult to be sourced locally. In many ways, the new equipment had contained very powerful integrated circuit and high technology component which cannot be sourced from local suppliers. Nevertheless, the company managed to obtain certain minor parts frames and provided circuit boards from local suppliers because of the high volume order by Telecommunication Department on the new FDM NV5000. With the FDM NV5000 series, the foreign partner was very helpful in assisting Pernas NEC to attain the 60% local content target. It was pointed out that FDM was a dying technology and the foreign partner NEC wanted to impress the relevant authorities with the achievement of the local content programme. More than anything else, it was NEC marketing strategy to maintain this position in the Malaysian market in view of the strong competition from several suppliers which were beginning to enter the telecommunication industry. The transmission technology was undergoing a rapid change from analogue to digital.

Several competitors were offering the Telecommunication Department the PCM transmission equipment which would rendered the FDM obsolete. NEC was very generous with technical assistance in ensuring the 60% target realising that the Telecommunication Department would not be procurring the FDM equipment in 1986. NEC felt that it had nothing much to lose with increasing the local content because of the replacement of the FDM transmission equipment by PCM base transmission equipment.

Pernas NEC envisaged more problems with the next generation of transmission equipment. It would require less assembly works but more sophisticated components and its much more technology intensive. Whatever technical expertise that it had accumulated on the FDM equipment would not be useful because of the rapid technological change. The learning experience accumulated over the years may not be translated into the new generation of equipment that would be manufactured by Pernas NEC. But, Pernas NEC felt it was in the telecommunication business and would have keep abreast with new products introduced by the telecommunication industry. The company would bid for the Telecommunication contract to supply the next generation of transmission equipment. It felt it could exploit inhouse expertise developed over the years in the assembly and manufacturing of telecommunication equipment and was confident in achieving local content programme required for existing products. Although it had lost the tender to Marconi, Pernas NEC would strive to bid for future contracts.

As a Government company, Pernas NEC was much committed to the development of local expertise. As pointed out by the staff in the R & D department, there were some elements of uncertainty as to the future direction of the development of technical expertise. Although some learning had been accumulated through the implementation of local content programme, Pernas NEC should embarked on a more systematic effort to integrate the manufacturing process that would ensure the development of local expertise. In the past, it had only focussed on assembly operation. The new contract awarded to Pernas NEC in telecommunication switching equipment would provide some opportunities for companies to enhance its technical capability. A high degree of expertise had been developed in the operation side relating to the installation and maintenance of the various telecommunication systems. It was indicated that NEC would only help in developing local expertise in areas where the technology had been replaced by the newer generation of products. Technological changes in the telecommunication industry were likely to be faster and more complex than in technology they replaced thus making it more difficult for local firms to catch up technologically.

The introduction of digital system into telecommunication products means that companies must developed a high degree of engineering knowledge.

The Malaysian Government strived to introduce the latest technology in its efforts to upgrade its telecommunication network. In its bidding system, are Telecommunication Department awarded contracts to companies which could provide the latest technology. Companies like Pernas NEC had no choice but to compete in the world market. There was an element of uncertainty with regards to its future when its contracts to Telecommunication Department would come to an end. In the last tender in 1981, it offered the FDM equipment while other major competitors had been offering the PCM technology.

In the development of the local expertise, industry characterised by high products life cycle, posed serious problems to development of expertise. There was little R & D efforts undertaken by Pernas NEC and such efforts were not seen as necessary because NEC had a large R & D department. Initially during the establishment of the company, the local partner was seen as only interested in acquiring equity participation. There was no negotiations for a technology plan to develop industrial expertise. This was only recognised after the company was in operation and local personnel found that their technical tranining had not been fully utilised. The company was very much dependent on its parent company. The joint venture arrangement was also very rigid where Pernas NEC was not able to venture into other telecommunications products to meet the growing market of the telecommunication industry. Its business plan was dictated by the corporate strategy of its foreign partner, NEC which was only interested in the supplying of transmission equipment and switching systems. It was perceived by local personnel that the foreign partner was only interested in selling equipment and developing expertise in technology which had become obsolete. There was also a lack of top management committment in capturing and maximising opportunities in acquiring the telecommunication technology. In addition, the Malaysian Government being the sole purchaser of telecommunication equipment had not given much attention in ensuring that Pernas NEC, a Government company, acquire expertise in manufacturing of telecommunication products. As a result, Pernas NEC had not develop expertise in designing, manufacturing and production of telecommunication products.

CASE STUDY NO. 3: AMALGAMATED STEEL MILLS (ASM)

Company Background

Amalgamated Steel Mills (ASM) was established in 1974 to manufacture wire rods and reinforcement bars. Presently ASM supplied about 90% of the nations's requirements of wire rods which were used for the manufacturing of BRC mesh, galvanised wire fencing, nails, bolts and nuts and welding electrodes. Commencing production with its first rolling mill in November 1978, ASM embarked on an ambitious expansion programme. The Company prides itself as having one of the most modern steel mill in the region. ASM had a turnover of M$43m with pre-tax profits of M$18.6m in 1984. ASM was a publiclisted company and a member of the Lion Group of Companies. The parent company, the Lion Group of Companies, was family controlled. In ASM, one chief executive was also the founder member of the company.

Technology acquisition process

The company had developed within a short period of time a high degree of technological and managerial capabilities. From the beginning of the operation of the plant, local personnel had assumed high degree of operational responsibilities. ASM had mobilized experienced personnel to spearhead the development of the steel mill. A number of its personnel was recruited from older steel mills. In the planning of the steel mill, ASM have formed a core project team to assist the chief executive in the selection, evaluation,planning and implementation of the project. It also recruited a contract executive from foreign steel mill to assist in the planning process. The chief executive and the planning team was involved in identifying key technology suppliers to establish the steel operation.

To develop operating capability, ASM launched a massive training programme to train all levels of staff in collaboration with other steel companies like China Steel of Taiwan. It also sourced training facilities with foreign technology and machine suppliers. Most of its personnel, executives and supervisors had been sent for training in China Steel. At the same time, the company also brought in short term experts on specific areas to provide on the job training. When the project was initiated, the company had very little knowledge in the steel industry and technology although the parent company had been involved for quite some time in the manufacture of steel products. To assist in the planning stage, a retired steel executive with several years of experience was hired from Hong Kong as the company technical advisor. For several months during the planning phase, the chief executive and its planning team visited several steel plants and machine suppliers. Through extensive visits and contacts with steel producers all over the world, key executives of the company became very informed about the development of steel technology and performance of various machine suppliers. It was widely known that the chief executive visited at least 40 steel plants. Initially, ASM decided to set up its rolling mill with 150,000 ton per annum capacity, one 70,000 ton electric arc furnance complete with the latest development in arc furnace technology namely water cooled panel and oxy field burners. The furnace was designed to produce steel billets utilizing either steel scraps or sponge iron. ASM also installed 16 continuous casting machines capable of producing billets.

On the completion of its first steel rolling mill, ASM embarked on Phase One of its expansion programme involving the setting up of the melt shop. The plant came into operation in 1978. The first rolling mill was constructed under a turnkey contract. Danieli of Italy was the turnkey contractor for this project.

ASM personnel participated actively in the planning and implementation of the first rolling mill.

ASM completed its second expansion programme in 1981 involving the installation of the second rolling mill with minimum capacity of 250,000 ton per annum. The mill was equipped with programmable logic controller. Unlike its previous technology acquisition, the second phase was done on a turnkey basis. The company evaluated the various machine suppliers, selected its requirements from four different suppliers in Italy, West Germany, Switzerland and France. The second expansion was carried out on a direct transaction basis. The company engineering personnel was responsible for the follow-up of the detailed plant layout, coordination with the various suppliers and supervisors and the construction and installation of the plant.

<u>Development of technological capability</u>

According to executives of the company, ASM had clearly formulated specific objectives with regards to technology acquisition. In all its technology acquisition, the company had ensured a high degree of participation of local personnel. The chief executives which also had family interests in ASM was responsible for developing a high of technical capability within a short period of time. He had taken a strong personal interests in the selection, evaluation and development of human resources. The company had subscribed to the policy of recruiting calibre staff. It was made known that ASM had strived to achieve technical excellence in its manufacturing process. The company had successfully exported its products to Taiwan, Japan and Korea.

ASM believed in developing highly skilled personnel. It had encouraged its staff to evaluate technology before making key decisions in selecting the choice of technology suppliers. It encouraged its staff to develop close contacts with machine suppliers world wide. Staff were assigned to visit other plants overseas to acquire information on technology suppliers. ASM felt that the success of the company will depend on its ability to develops highly skilled and experienced personnel.

In its efforts to expand the plant, ASM had always sourced local components. Its strategy was to develop a high degree of internal technological resources in specific areas. In areas where the company did not have sufficient technology resources, ASM would seek external assistance. It had entered into a technical assistance agreement with several technology suppliers, to source technology in specific areas. ASM had entered into a technical assistance agreement with Funabashi Steel to acquire technology relating to furnace technology. Its key strategy was to develop a highly efficient plant through modernization and technological development. This strategy can only be achieved through investment in new plants and development of human resources. It also formed linkages with other steel companies like China Steel of Taiwan. These linkages were considered important in order to exchange technical information. ASM, in fact, did not have anyexpatriate working in its plant after the second year of operation. It acquired high degree of production and investment capability within a period of 5 years. As it developed internal resources, the company tend to rely less on foreign expatriates. The rapid expansion of the plant led to the creation of learning by doing. Staff began to participate more actively in subsequent expansions. The absence of foreign ownership and management control enable ASM to determine its technological capability. A high committment to inhouse expertise was reflected through the willingness of the company to allocate resources for manpower development. ASM had also avoided long term technical arrangements.

It preferred to seek multiple arrangements with various technology suppliers on a short term basis. Among the companies studied, ASM could be considered as one of the success stories of technology transfer in Malaysian industries.

CASE STUDY No. 4: ALUMINIUM COMPANY OF MALAYSIA (ALCOM)

Company Background

Aluminium Company of Malaysia (ALCOM) started operation in 1963 as a wholly owned subsidiary of Aluminium Company of Canada (ALCAN). When it started operation, the company manufactured simple aluminiumproducts such as flat sheets for the building industry. Since industrialization was then still in its infancy stage, ALCOM product line was limited to few aluminium products. This was the first attempt by a multi-national firm to set up a marketing outlet for its aluminium products.

In 1968, the company set up a second mill and employed a number of local personnel at sub-professional level. The company went public in 1969 and restructured its equity in line with the New Economic Policy. The first extrusion plant was also built in 1969. The increasing demand for aluminium products led to the establishment of the second extrusion plant in 1979. With the rapid development of the industrial base, ALCOM decided to establish a foil plant manufacturing a wide range of more sophisticated aluminium products.

Technology acquisition process

ALCAN provided the necessary technological support to ALCOM through various types of technical collaboration arrangement. The management contract between ALCOM and ALCAN provided management expertise for operating the manufacturing facilities in Malaysia. ALCAN seconded expatriate staff to various key management positions. In addition to the management contract, ALCOM also had a into technical assistance agreement with ALCAN. ALCAN had to supply the necessary know-how including new product development to ALCOM.

In the establishment of the plant, ALCAN had initially provided all the necessary technological input. No local personnel was involved. Local involvement started with the development of the extrusion plant in 1969. Some local personnel were been assigned to help in the planning of the extrusion plant. ALCAN sourced the technology from various machine suppliers to set up the extrusion plant. A local person was also appointed to head the extrusion plant. ALCAN then began to reduce the number of expatriate staff as that local personnel cxould acquire the necessary experience. By 1983, ALCOM had only three expatriate staff. They were the Managing Director, Marketing Manager and Technical Manager.

ALCOM had enjoyed a strong technological relationship with ALCAN in sourcing technology for the manufacturing of aluminium products. Through continued infusion of technical assistance by ALCAN, ALCOM was able to keep abreast with technical developments related to the manufacturing of aluminium products in the domestic market.

ALCOM had also entered into a raw materials contracts with ALCAN. 80% of the raw materials were supplied by the parent company.

The planning and implementation of the foil plant was one of the major projects carried out by ALCOM. This project was meant to expand ALCOM'S manufacturing base in Malaysia. A team was set up to prepare the working plan in implementing the feasibility study. The initial study was carried out by a local technical team assisted by the technical support from the foreign parent company. Once the project was approved by the Board, ALCOM sent a number of its local personnel to the foreign partner's parent company to plan for the new plant. A special team was set up in Canada to work on the detailed plan of the project including the procurement of equipment.

ALCAN relied heavily on independent machine suppliers and engineering companies to provide the product process technology. Several factors were taken into consideration in selecting the choice of technology for the new plant. For example, the degree of automation to be incorporated would depend on the availability of technical back-up services and the skill of the professional in the existing plant. In this project, it was decided that the company would source the technology a number of machine suppliers. Instead of turnkey contracts, ALCOM decided to opt for direct purchase of equipment. In this type of transaction, ALCOM'S project team would have a strong influence in the selection and procurement of equipment. The company assumed the overall responsibility of managing the project. To carry out the implementation phase, ALCOM set up its own project team. Members of the project team was drawn from ALCAN subsidiary in India. It was reported that the foreign partner felt that ALCOM personnel should not be involved heavily in the implementation phase since this would affect the operation of the existing plant. The Indian subsidiary was a wholly owned company by ALCAN. A number of Indian personnel was seconded to the project team.

Only two ALCOM personnel was involved in the implementation phase. It was reported that the personnel from the Indian subsidiary had little experience in managing project of this nature. Various packages were tendered for the project. According to ALCOM'S personnel, serious efforts were made to source local inputs. The ALCOM local personnel involved in this project worked hard to source local components including contracting the fabrication of machinery and equipment to local engineering firm. A steering committee was also formed to monitor the implementation of the project. The committee was chaired by the company Managing Director with members drawn from ALCAN, ALCOM and the project management team.

A high degree of expertise was acquired by the members of the project team particularly by the Indian personnel. It was reported that ALCAN benefitted from the implementation of this project. Personnel from the Indian subsidiary acquired a high degree of experience in project management. ALCOM personnel had not participated as much as those personnel from the Indian subsidiary. As a result, the learning experience was accumulated by the personnel from the Indian subsidiary. It was reported that ALCAN exercised a strong influence over the management of the project. ALCOM personnel felt that the local company should have exercised stronger influence in the choice of technology packages. Since the project team was dominated by the foreign partner personnel, the choice of equipment suppliers and content of those packages may not reflect the interests of ALCOM. However, it was estimated that 40% of the project was sub-contracted to local telchnology suppliers.

Development of technological capability

When the project was completed, ALCAN provided the necessary expertise to operate the plant. The technology for the new plant was supplied by independent machine suppliers. A number of personnel was recruited and trained to operate the plant. Experts were brought in to impart know-how and experience. Interviews with personnel indicated that technical suppport was necessary to develop competency in the production line. It was reported that the Malaysian plant took 18 months to achieve the specified technical performance. It was felt that local personnel would acquire the necessary expertise rapidly if necessary assistance and opportunities were provided to undertake such job.

In negotiating for the packages, the project team identified various components where it had to be tailor-made to the new plant. In the initial operation of the plant, troubleshooting efforts were carried out by local and expatriate staff. Several of the key personnel was sent to overseas plants for training. The new plant was headed by the local work manager who had wide experience in ALCOM. The technical expertise developed to operate the new plant was considered successful due to the effort of local personnel to learn and acquire the necessary expertise.

Although ALCOM had local ownership control, the foreign partner continued to exercise strong control over the operation of the plant. There was little change in terms of management control although the company had restructured its equity giving control to the local partners. The raw materials contracts also ensured that ALCAN supplied 80% of the raw materials requirements to ALCOM. It was reported that the raw materials constitute 70% of the production cost. By entering into the raw material contract, ALCAN had retained its position as the sole supplier of bauxite to ALCOM. As pointed out by key personnel ALCAN strategy was to find market for its bauxite production.

The recent project completed indicated that foreign partner had not given much emphasis to promote local expertise in project investment. By excluding local personnel in the investment phase, the foreign partner had maintained strong control over the prices and choice of technology. Innovative capability had not been fully developed because ALCOM sourced its product process development from the parent company through its technical assistance arrangement. Although ALCOM had a large number of engineering personnel, most of them did not participate in the planning and implementation of the expansion project. The case study here highlighted the technology strategy adopted by foreign firm in carrying out their operation in Malaysia.

CASE STUDY NO. 5: TASEK CEMENT BERHAD

Company Background

Cement Berhad is a public limited company established in 1962. Its cement manufacturing operation began in 1964 with a production capacity of 250,000 tons per year. The project was initiated by a group of local entrepreneurs. The founder members of the company were mainly senior executives from a small cement plant established in the 50's. The chief executive of the plant was the prime mover for the development of Tasek Cement. In 1984, Tasek Cement production capacity was 1.2 million tons. The company produces four types of cement namely, ordinary cement, Portland cement, moderate sheet cement, and rapid hardening cement.

Tasek Cement was one of the capital intensive industrial projects started in the country during the initial stage of industrialization. The company decided to acquire technology through a turnkey transaction. The manufacture of cement is a rather complicated and long drawn-out process, basically involving the process of proportioning, blending and grinding of the raw materials - limestones, clay and iron ores. After chemical analysis and laboratory testing, the raw materials were treated separately and grounded in the mill into fine, dry powdery and a very light yellow in colour substance known as raw meal, which was homonized in special silos before being installed in huge silos - 70.5 metres long. Closed conveyors system, 70.5 metres tall and 12 metres in diameter, transported the raw meal to the kiln which has a temperature about 1500 degrees centigrade was generated by oil firing, where it burn the raw meal into clinker, which looked like small pebbles, almost black in colour. Stored in a giant silo, the clinker was moved by a chain bucket conveyor system to the grinding mill where about

250,000 tons of steel bolls, from 40mm to 100mm in diameter, pulverized and mixed the clinker with a small quantity of gypsum to turn them into cement so fine that it can go through a tiny mesh sieve. The cement was then proportioned through parts by pneumatic air pressure into storage silo ready to be automatically loaded either in bulks or in bags for transportation by road or rail to the consumer markets.

Technology acquisition process

Tasek Cement acquired its technology on a turnkey basis from German machine suppliers. AG of Germany was the main contractor for this turnkey project. Tasek Cement executives had previously worked with AG to supply machinery to the small cement plant in Batu Caves. The key executives involved in starting Tasek Cement had some experience working with AG. Having worked in a cement plant, key executives in Tasek Cement decided to start this project on their own with technical support from the turnkey contractor. AG was responsible for the construction and procurement of the plant.

To operate the plant, Tasek Cement sent some ofits key staff to Taiwan. 20 contract staff was recruited from Taiwan to operate the plant. Tasek then recruited fresh graduates from various universities particularly overseas universities to work along the experienced expatriate staff brought in from Taiwan.

Tasek Cement first started production in 1960 with a capacity of 250,000 metric tons annually. The plant adopted the Lepol Process. Prompted by the country's increasing demand for cement, Tasek Cement decided to go into expansion immediately after the commissioning of its first production line. In the second project, Tasek Cement introduced an open bidding system where key machinery suppliers were invited to bid for the project. The tender was awarded to a Japanese firm. AG Germany which participated in the tender was appointed as the project manager. The second kiln, Japanese ACL system went into operation in 1966, doubling the company initial production to 500,000 metric tons. From 1967 to 1973, the company engineering personnel constructed two more electrostatic precipitators, a high output limestones crushing plant, a mechanized raw clay storage, a unique dry clay proportionate installation, automatic simple conveyor system and a complete self designed No. 3 grinding plant.

At the end of 1972, the company immediately launched the 3rd phase expansion project which brings the initial capacity to 700,000 metric tons annually. The planning team involved in this project visited several overseas cement plants and machine suppliers before deciding the technology for the new expansion project. After evaluating the various technologies available, the planning team draw a general specification which was standard to various machine suppliers. This entire expansion project was undertaken by Tasek own engineering staff. The planning team comprising expatriate staff from Taiwan and local personnel implemented the feasibility studies, specifications preparation, project planning, tender formulation, bidding, scrutinizing and technical negotiations. There was no external consultants appointed to assist in the project. Tasek decided to opt for direct transaction in procuring equipment from numerous suppliers. It decided to evaluate the various machinery and select whatever was available on the basis of prices an performances. This function was carried out by the turnkey contractor in the earlier projects. Tasek Cement M$60 million extension project was commissioned in 1976 after 3 1/2 years of planning and consultation. The plant, capable of producing 70,000 metric tons of cement adopted the straight line layout principle which minimize materials conveyors distances and site coverage, a modern planetary cooler system for clinker cooler, a slip-formed based reinforced concrete, clinker silo 200 feet tall and 100 feet in diameter capable of storing 50,000 tons, largest of its kind ever built in Malaysia. During the entire expansion project, Tasek own project team used extensive schedule controlled and progress reviews were done with critical bars scheduling systems. The centralized automatic system controlled the entire plant to stablize operational manufacturing process and to maintain effective coordination of various production. The project incorporate several technical innovations in energy conservation and air pollution control.

Development of technological capability

Tasek Cement developed high degree of operating capability and project management. In the initial phase of the plant, the company had encouraged local personnel to work along Taiwanees expatriate staff who were recruited to operate the plant. It was difficult to recruit experienced local personnel because cement industry was fairly new to the country. Apart from developing operating skill among local personnel, Tasek Cement also ensured the involvement of personnel in the planning of all expansion projects. In addition, Tasek personnel were encouraged to undertake inhouse engineering efforts particularly the construction of additional facilities. The company engineers constructed and fabricated the precipitators and grinding plant. By 1976, the company had phased out almost all the Taiwanness personnel with the exception of one or two expatriate staff which had chosen to remain permanently in the country.

The engineering department which was established in 1972 undertook various kinds of inhouse efforts. A high degree of inhouse technological efforts had facilitated rapid diffusion of technology. The technical office also set up to scan technological development in the cement industry and coordinate with the project team. In undertaking expansion projects, Tasek Cement had subcontracted major components to local engineering firms. It assisted local fabrication and engineering firms to produce components according to specifications required by turnkey contractors. Many of Tasek engineers worked along with local engineering firms. The company also found the Japanese machine suppliers were reluctant to leave their technical drawings. The engineering department was given the task to produce drawings and maintain the technical documents for future projects.

Local engineering and fabrication companies benefitted tremendously from the Tasek expansion projects. Tasek achievement in constructing the cement plant drew visitors from all over the world. This was the first attempt by a local company to set up its own manufacturing plant on its own. In the 60s, the cement industry was controlled by a few multi-national firms. Tasek personnel delivered papers in several international conferences underlying its success story in planning and constructing its own cement plant. The technology acquisition strategy adopted by the company was considered bold and innovative by friendly competitors. While most cement plants had move on a joint venture basis, Tasek Cement had strived to develop its own capability. As a result of its accumulation of technical capability, Tasek also provided technical assistance to its associate plant in Singapore. The rapid development of technical in the areas of production and project management help to reduce foreign content in subsequent technology acquisition. As pointed out by Tasek executives direct transactions was one of the best way of acquiring technology because the company was able to select the various equipment and machinery on a competitive basis. It is a ar more costly effort than turnkey projects where decisions on machinery procurement was much left to turnkey constractors. However, direct transaction also involved high risk and required high degree of management and technical skill among Tasek personnel. During the erection and commissioning, engineers and specialists from various machine suppliers worked along with Tasek personnel. In order to reduce the project cost, Tasek encouraged local fabrication to the greatest extent possible in accordance with manufacturing working Local fabrication, particularly for its 3rd phase expansion project consisted of 3000 tons of steel was all done on site under Tasek supervision. This include 85% of the rotary kiln cylinder in 37 sections, complete with planetary cooler tubes, rotary dryer, pre-heater cyclones, air separator housing, crusher housing, etc. This volume of local work was considered to be the largest ever attempted by any cement producer in the world. Teething problems had been experienced at various departments during the commissioning of the plant for the third expansion. Most of these problems were overcome within three months. Tasek was one of the most profitable cement companies in Malaysia and its success in developing high degree of technical expertise indicated that companies could pursue technical excellence in developing countries.

CASE STUDY NO. 6: KL GLASS

Company Background

KL Glass was established in 1967. It was a wholly owned subsidiary of Malaysian Containers. The Australian company, Associated Consolidate Industry (ACI) controls 50% of Malaysian Containers. KL Glass manufactured products such as glass bottles and glass packaging materials. It was the first glass products making plant to be established in Malaysia. The Australian partner, ACI is a diversified company with interests in building products, packaging products and plastic products.

Technology acquisition process

ACI provided the technological input in starting the manufacturing operation. It seconded 14 Australian staff to manage the plant. At the same time, local staff were also recruited and trained overseas. As local staff acquired the necessary skill, foreign expatriates were phased out. From 1978, the company had only one expatriate staff as technical adviser.

ACI of Australia provided comprehensive technical support to the company. It had a technical service agreeement with KL Glass. ACI itself sourced technical expertise from Owen of Illinois, which was one of the largest glass manufacturing company in the United States. KL Glass felt that it had benefitted from the technical assistance arrangement with ACI. It had also worked closely with companies owned or associated with ACI in the Asean regions in terms of technology exchange and training.

Development of technological capability

The local staff had acquired high degree of production, capability which includes trouble shooting, quality control and maintenance. Local staff had participated actively in upgrading and modernizing the plant with some assistance from the foreign partner. The company was headed by a local Chief Executive. All the expatriate staff had been phased out with the exception one technical adviser.

Technical assistance was sought in terms of introduction of new product to counter competition from alternative packaging materials. The small Malaysian market had introduction of newer plant and equipment. ACI had provided a wide range of technical service to KL Glass through its technical assistance agreement. Because of the small size of the company, KL Glass felt that it needed a strong back-up from companies like ACI. It had also try to develop products as required by local customers. Although it had no R & D department several of its personnel had continued to look into product development for the Malaysian market. To a certain extent, innovative efforts had been developed because of the need of KL Glass to manufacture product according to specific customers' requirements. According to executives of KL Glass, ACI conducted regular audits of the plant. Several KL Glass personnel had been exposed to the latest technology in glass manufacturing through its association with ACI.

The company was facing strong competition from several manufacturers of alternative packaging materials. However, KL Glass was quite optimistic of the future of the glass industry in Malaysia. The local chief executive felt that the Australian partner had transfered the technology to Malaysian personnel and local personnel were able to undertake all the manufacturing operation independently. Technical collaboration with established companies like ACI was necessary in view of the need to acquire information regarding the changing technology and market environment. It was also reported that KL Glass had exported part of its products to the Middle East market though its links with ACI. One of the major constraints faced by local companies as pointed out by the chief executive was the size of the Malaysian companies. It was felt that companies like KL Glass was too small to undertake its own technical efforts and did not have sufficient resources to develop its own internal expertise. It was therefore more economical if its resources were acquired through linkages with foreign companies. Technical collaboration with foreign technology suppliers would also enable small companies like KL Glass to get access to world wide technolgical development in the respective areas.

CASE STUDY NO. 7: ASSOCIATED TILES INDUSTRY

Company Background

Associated Tiles Industry was established in 1964 by Japanese investors. The company was then known as Fancy Tiles manufacturing semi-glazed, non-glazed and fully glazed tiles. The factory was established through turnkey arrangements with the Japanese machine suppliers. In 1984, the company was fully acquired by Malaysian interests and the name was later changed to Associated Tiles Industries.

Since the establishment, the company had depended greatly on Japanese expertise to operate the plant. However, after the company was acquired by Malaysian interests in 1984, the local investors had slowly phased out Japanese expatriates. At the same time, a number of local personnel was recruited to take over the posts vacated by Japanese expatriates. The plant was supplied by the Japanese machine suppliers and the initial technological input was provided by Japanese technical staff. During the first 10 years of operation, there was very little local personnel involvement in the operation of the plant. Although the company's manpower strength grew to about 60, there was no attempt to recruit technically qualified personnel. As a result, when local investors took over the company, there was very little indigenous capability to manage the plant. This prompted the local investors to retain key Japanese expatriates to manage the plant. At the sametime, qualified local personnel were recruited to be trained with the view of taking over key posts. The company recruited 10 local engineers to work closely in various fields. Among the 10 professional engineering personnel were 5 mechanical engineers, 4 chemical engineers and one electrical engineer.

The plant had been fully Malaysianized with key local staff taking over all the key posts. It was reported that the Japanese expatriates were finally phased out because the company felt that they were unable to solve certain technical problems. In terms of technical set up, the company had established a technical department to look into product process development. This department had initiated high degree of technological efforts to improve the quality and evaluate the acquisition of new technology. It was indicated that there was a need for some kind of external assistance particularly from established tiles manufacturers. The company did not intended to go into joint venture operation but would seek short term experts to solve technical problems relating to product quality. The company imported about 20% of its raw materials. It had also seek the assistance of machine and raw materials suppliers to help in problems solving efforts.

Development of technological capability

In 1983, the company embarked on an expansion project. Technology was acquired from Italian machine suppliers. The expansion project was planned and managed by its own personnel. It was found that suppliers from Italy and Germany were quite reliable. In the expansion project, the company also work with consultants in the selection of equipment and technology. In the manufacturing of tiles, it was indicated that raw materials was an important component in production process. One of the important role of the technical department was to identify the correct raw materials to achieve the specified quality. As pointed out by personnel in the technical department that one should not rely on the advice of machine suppliers in selecting machineries. It was felt that independent consultants should be appointed to evaluate the various suppliers of machinery and the performance of their machineries. One of the major activities of the technical department was to improve the performance of the plant and made adjustments and adaptation to ensure that the products were produced according to the specified quality. Technological efforts of this nature was crucial because the utilization of local raw materials would require minor adaptation to be made to the plant. The company had also set up a comprehensive quality control system. For the last few years, the company had also implemented a quality circle concept in order to create greater consciousness on quality among local personnel. A high degree of operating capability was being developed in the firm because of the systematic efforts by management to phase out Japanese expatriates. The absence of long term technical collaboration also encouraged the technical department to undertake a major role in product process improvement. In building up the additional facilities, the company had undertaken its own project planning and implementation thus indicating a high degree of local efforts. ATI felt that some kind of assistance or linkages need to be established with foreign technology suppliers in order to make its product more competitive than those imported from other countries. The company also faced stiff competition from Japanese suppliers of tiles. Although the Government had given tariff protection. ATI felt that the duty imposed was not adequate to prevent foreign company exporting their products to Malaysia. ATI was examining the possibility of exporting its products to the Middle East.

CASE STUDY NO. 8: INDO MALAYSIA ENGINEERING COMPANY

Company Background

Indo Malaysia Engineering Company was established in 1976. This joint venture company was established between Malaysian and Indian investors. The Indian partner, Korloskar started its trading office in Kuala Lumpur to handle South East Asian orders on electric motors and alternators. Its labour force comprises of 270 staff with 15 degree holders. Korloskar was the 5th biggest engineering firm in India. Korloskar of India has 45% ownership of this company. It was the only company in Malaysian making electric motors and alternators. The company faced stiff competition from overseas market and its turnover as reported in 1984 was M$11.5 million. The company was headed by an expatriate Indian Managing Director.

Technology acquisition process

The Indian foreign partner provided the necessary technical expertise in establishing the manufacturing operation. The foreign partner exercised strong influence over the operation of the company. Product process development was carried out in the Indian parent company. Very little R & D was implemented in the local subsidiary. The company employed a number of graduates personnel. Personnel were involved in supervising the assembly operation and also operating the foundry operation. Interview with local personnel indicated that training and manpower development had not been implemented. It was reported that the company had difficulty in attracting highly qualified workforce. One of the reasons stated was the low salary structure and poor conditions of services as compared to joint venture of other nationalities. The Indian expatriates were responsible for the technical development. One of their achievement was the introduction of new materials in Malaysia.

Development of technology capability

In the initial stage of the establishment of the plant, there was very little involvement by the local personnel. Kirloskar of India brought in about 20 Indian expatriates to start the manufacturing operation. Production capability had not been developed among local personnel. The company sourced its expertise from its parent company which had established its own R & D. It was reported that there were 75 staff in Kirloskar R & D department in the field of electric engineering and 150 staff in the diesel engine. In view of the high degree of control by the parent company, local participation in the technical operation had been limited to certain areas like finance and personnel management. There was very little opportunities for advancement for local staff because foreign participation had continued to occupy the key posts. There was also a high turnover of staff particularly due to the poor service condition and unattractive work environment.

Some degree of design work was carried out particularly those that had to meet customers' requirements. The company had only focus its production to local domestic market. Interviews with personnel indicated that there was no systematic efforts technical development within the company. Almost all technical know-how were sourced from the Indian principal. Various factors had affected the development of the company. The lack of manpower development, the highly centralized decision making process, the lack of technological efforts and low morale among staff were among key issues highlighted by technical personnel. In such a situation technology development had not flourished and there was very little diffusion of technology in view of the high turnover of local technical personnel.

CASE STUDY NO. 9: MALAYAWATA STEEL SDN. BHD.

Company Background

Malayawata Steel Sdn. Bhd. (MSSB) was the first integrated steel mill established in Malaysia. The company was set up as a joint venture between a group of Japanese companies and Malaysian investors. Being the first integrated steel mill in Malaysia as well as in South East Asia, the company was granted pioneer status by the government in 1962. During its initial operation in 1964, the company was producing hot metal, ingot and billet, rolled products and reinforcing bars. Since then other range of steel product include angel bars, wire rods, slit coils and light gauge steel. Its production capacity had increase from 100,000 ton per year in 1967 to 500,000 ton per year in 1984 as a result of severalexpansion projects carried out over the years. Yawata Iron and Steel Co. Ltd (now Nippon Steel) was the main Japanese party involved in the setting up the integrated steel mill. The company became a public limited company in 1967 with the public issue of about 4.2 million ordinary shares raising the paid up capitalto $31.1 million. In June 1975, the equity was restructured to ive Malaysian 71.9% equity with Pernas Engineering a subsidiary of the government owned trading company, as the largest single shareholders. In the initial planning and implementation, all the plant was largely carried out by the Japanese partner particularly Nippon Steel Corporation.

Technology acquisition process

Like most other joint venture operations, the company had entered into a technical service agreement with Nippon Steel. The construction of the mill was carried out in two phases. Construction of Phase I had started in 1966 and was completed in 1967. Phase I consisted of a DI sintering plant, blast furnace connector for steel making, a re-heating furnace, a rolling mill and oxygen plant estimated at a cost of $40 million. In 1969, the company installed its No. 2 blast furnace including the expansion of the steel making plant. It was followed by another expansion project involving the installation of a arc furnance, a continuous casting plant and other facilities. In 1973, the company carried out another modification project which involved enlarging and relining of No. 1 blast furnace and modifying the rolling milling both to increase its capacity. The Japanese were very much involved in the planning and implementation of the expansion and modification project. There were 20 Japanese expatriates working on the operation side in 1972. Although the company had recruited a number of local personnel they were assigned to work as counterparts to the Japanese expatriate staff. However, by 1976 most of the Japanese been phased out and local personnel began to assume operational responsibilities. The company then began to plan the development of its second rolling mill which would expand its production capacity to 500,000 ton a year.

In 1976, the company had also restructured its equity giving greater local ownership control. The construction of the second mill was different from previous expansion project. A local project team was set up to evaluate and select the technology for the second rolling mill. Instead of sourcing the plant through a turnkey arrangement, the company decided to source directly from various machine suppliers. The project was broken into several packages where direct was conducted with the respective machine suppliers. The company appointed its foreign partner, Nippon Steel as a consultant to this project. Although Nippon Steel was a major partner in the company, it was decided that the construction of this project would be done independently by local personnel with Nippon Steel acting as its technical advisor. Previously, the company had undertaken several modification projects with increasing participation of local personnel. In the construction of the second rolling mill, Malayawata personnel was involved in the writing of specifications and calling for tenders for the supply of those equipment. With Nippon Steel acting as adviser, Malayawata personnel evaluated and selected various suppliers of equipment. It was pointed out the Nippon Steel was the main turnkey contractor for the first steel mill. Malayawata felt that the construction of the second rolling mill should be a good opportunity to develop local capability in project planning and implementation. Hence, it had decided to minimize Nippon Steel involvement in this project.

Development of technological capability

According to Malayawata personnel the acquisition of technology through direct transaction had many advantages. Not only were they able to evaluate the individual component, the company was able to develop strong linkages with numerous suppliers of technology. A large number of staff were given training and the training facilities were made available by the machine suppliers. Malayawata was able to diversify its training facilities and also was able to acquire specialised training facilities for its personnel. Project engineering efforts was enhanced when local personnel began to be involved in troubleshooting, maintenance and repair of the plant. Although there was no R & D department, the engineering division of the company had been responsible of undertake a wide range of technical efforts. The decreasing role of Nippon Steel as the major supplier of technology led to greater emphasis of local involvement. As a joint venture company, Malayawata had successfully diversify its sources of technology and developed a wide network of technological information through its recent efforts to source technology directly. To some extent, direct transaction had enabled the company to widen its sources of information and linkages with other technology suppliers. In the past, the company had relied heavily on Nippon Steel to provide information and technological input. The ability of Malayawata in developing its own internal expertise indicated that joint venture companies could ensure the diffusion of technology if systematic programmes to phase in local personnel was established.

CASE STUDY NO. 10: H R JOHNSON (M) SDN. BHD.

Company Background

In 1975, a special committee was formed by Dunlop Malaysian Industries Berhad to look into various possibilities of diversification. The committee decided that the manufacture of high quality ceramic tiles was the most viable in view of the rapid expansion of the building industry at that time. Negotiations were soon initiated to form a joint venture with H & R Johnson - Richards Tiles Ltd. (UK). On June 289, 1978 the company $10 million plant was officially opened. H & R Johnson - Richards Tiles Ltd (UK) was given 15% share of the company under a Technical Aid Agreement. The other partners comprise the following:- The Armforces Provident Fund and the Police Cooperative (M) Sdn. Bhd., 30% and 21% of the shares respectively and Dunlop Malaysian Industries Bhd., which had 34%. The company was the largest manufacturer of wall tiles in Malaysia taking about 65% of the market. Marketing was done largely through the company's network of distributors which had a total of 112 sales offices and 400 sales personnel throughout.

Technology acquisition process

H & R Johnson - Richards Tiles Ltd. (UK) under a Technical Aid Agreement was responsible for setting up the initial manufacturing facilities. The factory used equipment supplied and installed by the Engineering Division of H & R Johnson, Thomas Peakes Ltd (UK). The company started with an initial production of 5 million pieces a month with a total staff of 170. For the first few years, the foreign partner assumed operational responsibility of the plant. At the same time several local personnel were also trained in the partner's plants in United Kingdom in various aspects of tiles production. Gradually the number of expatriate staff were phased out with the exception of the production and technical managers.

Dunlop Industries decided to take over the management control of H & R Johnson. It then appointed a local executive and a Works General Manager. One expatriate was retained as the technical adviser. A comprehesive plan was formulated to develop local personnel. According to the executive interviewed, local personnel responded well to the efforts of the management to increase their technical input. Local executives appointed to take over the company later visited H & R Johnson plant in UK. Having studied the plants in UK and other countries, the management felt there was a need to do some basic changes. It then embarked on an improvement programme. In 1983, H & R Johnson decided to launch major expansion project to manufacture heavy duty floor tiles. A team was established to look into the implementation of the new additional manufacturing facilities. In seeking technology for the new plant, H & R Johnson work with its foreign partner, H & R Johnson of United Kingdom. It was felt that the United Kingdom partner had a lot of experience in manufacturing tiles and was able to provide valuable assistance in the selection of technology. Several suppliers were short-listed and evaluated closely. The project team was established to implement this project and played a key role in the selection and evaluation of technology.

Development of technological capability

The members of the team were mostly local personnel assisted by the technical adviser. The members of the project team visited several plants overseas to examine the performance of the various types of machinery. Local personnel participated actively in local components and a major portion of the work was contracted to local fabrication works. H & R Johnson executives felt there were several good local engineering firms which were able to undertake sophisticated work in fabrication and design. The executives took great interests in participating in the implementing of this project. H & R Johnson was very much aware of the technical problems faced by the other tiles manufacturing plants. In this case, the company had seek all the necessary advice from H & R Johnson, United Kingdom with regards to the technical performance of the new plant. The company work closely with machine suppliers to come out with the necessary formulation.

H & R Johnson felt that the technical assistance agreement with its foreign partner had helped the development of the company. Unlike some other tiles manufacturing firms which had encountered serious problems in the initial operating phase, H & R Johnson had the advantage of sourcing the valuable experience of its foreign partner to minimize teething problems in the operating phase. The company felt that the good relationship between the foreign partner and the local company had contributed to the success of the project. It was felt that there was a need for local management control to ensure rapid development of local expertise. Executives in H & R Johnson expressed the committment of top management in ensuring systematic manpower development. This could only be achieved through a deliberate involvement of local personnel in all phases of project planning and implementation including the production phase. Local personnel had accumulated high degree of experience in the recent expansion project. The taking over of management control by local partner had made tremendous difference to the diffusion of technology. It was stated that earlier when the company was managed by the foreign partner, there was no effort made to increase the development of local expertise. In addition, there was also wide spread transfer pricing practices where the foreign partner had sourced almost all the raw materials and components from its parent company in the United Kingdom. This reduced the profit margin of the local subsidiary. As shown in this case study, a joint venture company would be a useful mechanism to acquire technology if it is properly managed by the local partner. A strong and capable local management team is essential to ensure rapid diffusion of technology. H & R Johnson felt that management must be committed to changing attitudes in local personnel with regards to the acquisition of knowledge. It had emphasized training programmes to develop greater awareness among newly recruited personnel on the importance of acquiring experience and also to develop a sense of belonging to the company. It was pointed out that high turnover of labour particularly well-trained personnel would hinder the development local expertise. Emphasis had been given to provide an attractive benefit and remuneration including a good working envionment so as to retain the capable staff that the company had developed. The case of H & R Johnson indicated the importance of top management committment, systematic training programme and a good working environment as an essential ingredients to enhance the diffusion of technology.

CASE STUDY NO. 11: MALEX INDUSTRY BHD.

Company Background

Malex Industry Bhd. started as a joint ventured company in 1959 between K.C. Boon and Cheah Co. Ltd. and Nozawa Corp. of Japan. The company had a initial paid-up capital of $1m and was the first manufacturer of asbestos cement products in Malaysia. When the favourable economic conditions continued to precipitate the building boom during the 60s, Malex Industry embarked on a $1m expansion programme to its premise in 1970 to meet the market demands. In 1972, Malex became a public listed company with a large paid-up capital of $13m. The second production line was introduced in 1972. In 1975, the new decorative ceiling panel, Decorec was introduced to meet more sophisticated commercial taste. In 1982, Malex built its second factory at a cost of $8.6m. Nozawa Corporation was the main foreign partner in this joint venture when the company started operation in 1957. Nozawa Corporation provided the necessary technology, management and other resources to start operation. The Malaysian partner merely participated in this venture as a commercial partner.

Technology acquisition process

Malex had entered into a technical assistance agreement with Nozawa Corporation. As part of the arrangement, Nozawa provided the necessary technological resources to operate the plant. Malex had two expatriates working as the Chief Executive and the Technical Manager. The two expatriate staff continued to play a key role in managing the company. Recent expansion and modification projects had all been planned and implemented by the foreign partner. Nozawa had five other factories in Japan manufacturing asbestos cement products. The role of the Japanese partner had change very little since the establishment of the company 28 years ago. The 240 employees were mostly operators and supervisors. There was no local personnel with professional qualifications. According to Malex, it had difficulty trying to recruit personnel with professional degrees. The local involvement had been confined to day to day operation of the plant. Key decisions on plant operation were made by Japanese managers including procurement of raw materials and spare parts and product process formulation.

Development of technology capability

The principal shareholder in this company was Nozawa Corporation holding 50% of the equity. It was pointed out by local personnel that Japanese expatriates maintained very rigid control over the technical operation of the company. Technical efforts such as product process development and quality control and maintenance had been carried out by Japanese expatriate staff with very little involvement of local personnel. It was reported by local personnel that Japanese partner had been reluctant to employ local personnel with professional qualification. Malex to a great extent was very much dependent on Nozawa Corp. technical resources. Throughout the 20 over years of operation, the foreign partner had limited the diffusion of technology. For instance, the planning and implementation of all new projects was carried out by Nozawa Corp. with little participation from local personnel. The selection and evaluation of technology including the construction and installation of the plant was all carried out by the Japanese expatriates. Raw materials had continued to be sourced from Nozawa, and as pointed out by local personnel, transfer pricing practices was quite rampant. Local investors and local key personnel had very little influence over the operation of the company. Production capability had not been developed among local personnel. It was made known that the Japanese partner had been pressured by certain authorities to appoint more high level manpower in order to ensure greater diffusion of technology. It was indicated that the authorities had not renewed the technical agreement because it felt that there was nothing new that Nozawa can provide to the local susbidiary. Malex imported a high degree of components, raw materials and spare parts from Japan. Tight control of Malex by the foreign partner had affected development of local expertise. Inspite of its operation in Malaysia for the last 28 years, Malex had failed to diffuse technology related to the manufacturing of asbestos products.

CASE STUDY NO: 12: PERSTIMA

Company Background

Perstima's Electrolytic Tinning Plant was planned and built by the Japanese foreign partners particularly Kawasha Corporation with technological input from its parent company Kawasaki Steel Corporation. Perstima entered a five year Technical Assistance Agreement with Kawasaki Steel Corporation. Under this agreement, Kawasaki provided Japan's advanced techdnical expertise with experienced technical staff to supervise the plant's operation for 5 years.

Technology acquisition process

This was a phase-in phase-out technology transfer programme with the Japanese initially operating the plant and gradually handing over to the local personnel. Malaysian personnel had been assigned to understudy their Japanese counterpart to acquire the necessary operating skills. Japanese personnel had been phased out gradually and by the fifth year the plant would be fully Malaysianized. During the construction phase the Company despatched 7 of its engineers and 5 foremen to Japan for six months of intensive training.In addition to the Technical Assistance Agreement the Company also signed a Technical Know-how Agreement with Kawasaki Steel Corporation which ensured that the Japanese Steel Company made available all the latest technology in the tinplating industry. For both of these agreements the company had to pay 200 million yen to Kawasaki Steel in installment. A cold reduced strip either single reduced strip or double reduced was used as a base metal. The base metal constitutes 20% of production cost and supplied by one of the Japanese partners. The whole project was carried on a turnkey partners having overall control over project management. In addition to the technical personnel the Japanese partners had also two other key personnel in sales and finance.

At the top of Prestima's hierachy was the company's board of Directors composed of Malaysian and Japanese industrialists. At the management level, a management committee was set up which consists of the General Manager, Factory Sales Manager, Finance and Accounting Manager and Corporate Affairs Manager. The General Manager and Corporate Affairs Manager are both local personnel while the three other managers are Japanese expatriate personnel representing Mitsui and Kuwasho.

Development of technological capability

It had been agreed from the beginning that Malaysian parties will have ownership and management control over the running of the Company. However, during the initial negotiation the Japanese insisted on putting their own staff in selected managerial positions. As pointed by one of the executives although the Japanese may have more managerial posts but the appointment of a local General Manager makes a lot of difference. Local executives had a certain set of ideas on how the Company should be administered. Conflicts had arisen between local and expatriate executives on important policy issues. Although decision were made by consensus there had been occassions where the local chief executive had pushed certain decision inspite of strong resistance from the foreign partners. A good example was the procurement of raw material and spare parts. 70% of the production cost of the company was made of the base metal which was imported through Mitsui Trading.

Initially the Japanese wanted to control purchasing but local management insisted that purchasing should come about by local personnel. It wanted the procurement of raw material to be done on competitive basis. The company had attempted to develop alternative suppliers and found that quotation offered by these suppliers were for more cheaper than those quoted by the Japanese partner. In the case of cold strip the company found that the Japanese partners quoted certain item like chemicals 60% to 70% higher than what offered by other suppliers. In the first six month of operation the company agreed that all items will be imported through arrangement made by Japanese partners. After the first six month of operations local purchasing personnel decided to develop their own sources as a way of checking the quotation offered by Japanese counterparts. It had also been agreed in the joint venture agreement that procurement will be on a competitive basis. In the case of cold strip which was the basic raw material the company had obtained quotations from many countries like Korea which had offered the products at competitive prices. On many occasion the Japanese had obstructed the deal claimimg that those purchased from other than its own sources were inferior in quality. Problems of this nature had strained relationship between local and Japanese executive. Local executives argued that the Japanese partners were 'milking' the company through spare parts, raw materials and technical fees with little interest in the profitability of the company. According to the General Manager, Perstima corporate strategy was to reduce its independence on its foreign partners and to develop its own technological and resources. Senior personnel expressed concerned on the attitudes of local staff in term of their willingness to learn and acquire technical expertise. Similar views had been expressed by the Japanese on the reluctance of local staff to get their 'hands dirty'. Another major concern was the resignation of staff who had been previously trained in Japan. Out of the twelve staff sent to Japan for the 6 months training three had resigned. Because of the Japanese partners reluctance to provide further training facility Perstima can ill afford to lose any more of its staff. Generally most of its staff did not have the relevant industrial experience. It was pointed out that the company should have recruited more experienced personnel with some industrial or management experience. Even the senior management staff did not have necessary industrial and technical background. These posed serious limitation because local managers cannot communicate effectively on technical matters with Japanese who may perceive this strategy as conflicting with their overall interest in the company operation. Manpower development had also continued to be another major source of conflict. Local engineers reported that the training offered were too basic and not properly structured. Request for further training facilities were ignored by the foreign partner until recently when some follow-up training programme was agreed upon. Both Japanese and local managers had their own version of how the company should be organized particularly at the shop floor level. During the recent months there have been several reorganization with each parties putting up their own organization charts. According to one local manager, the various departments had to be restructured as local staff become more familiar with the operation. Part of the overall strategy was to allow local personnel to vary the task as they progress. However local partners agreed some of problems were caused by local personnel themselves. In most cases local enior staff rely on local engineering personnel to identify their needs. The General Manager maintained close rapportwith all local technical personnel and monitored their progress closely. He relied on constant feedback particularly from the plant superintendent who was the most senior local personnel in the factory. Frictions between local and Japanese personnel at the shop floor level had also been reported partly as a result of different work style and values.

<u>Development of technological capability</u>

The company was in its third year of operation and local staff had been increasingly assuming greater role in the day to day running of the plant. The company had another two and the half year before coming to the end of the first five year technology transfer programme started in 1982. Management felt that progress achieved so far was satisfactory but more could had been done if foreign partners had expertise. Skills in trouble-shooting, maintenance and quality control were yet to be developed. Generally management expressed some misgiving on the way of project was implemented particularly the absence of local involvement in the planning and execution phase.

As pointed by the General Manager the success of technology transfer relied heavily on the committment of the team.

CASE STUDY NO. 13: GENERAL CERAMICCS

Company Background

General Ceramics started operation in 1969 as a manufacturer of white wall tiles. The company was established through a turnkey arrangement with Interkiln of United States. Interkiln not only became the turnkey contractor for this project but also provided the technical support through technical assistance arrangement. In addition, Interkiln provided one expatriate staff to assist in the development of General Ceramics. In 1984, General Ceramics embarked on an expansion project to manufacture heavy duty floor tiles. The project for this floor tiles was supervised by the expatriate staff which have been employed since 1969. The existing plant was carried out in 1970. The second expansion and modification was carried out in 1978. The new plant that was being constructed will enhance General Ceramics' position as the major manufacturer of floor and wall tiles.

Technology acquisition process

The technology for the floor tiles was sourced from Germany. General Ceramics had considered arranging a technical assistance agreement with a German technology supplier. The company felt that there was a need for a technical assistance agreement in order to acquire technical resources in expertise. In the past, the company had no technical agreement and found this to be difficult. General Ceramic pointed out that several of its competitors were able to achieve high level of technical development due to their technical linkages with foreign technology.

In view of the rapid development of the building industry, and the injection of new technology into several Malaysian tiles manufacturing companies, General

Ceramics was in view that it should also enter into a foreign arrangement with overseas manufacturers. These arrangements would benefit General Ceramics in terms of product process development, training of its personnel and possibly the use of foreign trademarks in its products.

<u>Development of technology capability</u>

With regards to the development of its new technical resources, General Ceramics had not given much emphasis and had relied on the employment of foreign expatriatessince its establishment. The company had also entered into sales agreement to market some of the products of its German counterparts. Although local personnel had develop some capability in production, the expatriate staff continued to play a key role in organising and managing resources. There is little R & D carried out in the company although there was minor modification work implemented by the expatriate staff with some local personnel. General Ceramics felt that the expatriate staff had provided valuable assistance to the company. The company will continue to employ expatriate because of the shortage of highly experienced local personnel in the field of ceramics manufacturing. General Ceramics had no long term plans of developing expertise. Its primary role now is to expand its product line and to meet the competition from other manufacturers.

CASE STUDY NO 14 : CHLORIDE MALAYSIA

Company Background

Chloride started its operation in Malaysia as a fully owned subsidiary of Chloride, UK. The company had since restructured its equity with local investors holding 51% . The equity structure resulted in Chloride, UK entering into management contract and technical services agreement with its local subsidiary. The company manufactures automotive storage battery and battery related products and components. When it was first set up, Chloride was operated and managed by its parent company. Inspite of the equity restructuring giving local ownership control there was very little change in management and technological control exercised by the UK company. The company had a foreign expatriate as its chief executive. Local personnel were employed to undertake production and marketing activities. It also carried out minor modification to meet local customers requirements. The company had 12% of the battery market in Malaysia. Through the management contract, the foreign partner would be required to provide management expertise.

Technically Acquisition Process

The company relied on the foreign partner to provide the necessary technical input. Information and other support services had been sourced from Chloride, UK. The technical assistance agreement also had restricted the local company from exporting its products to other overseas markets.

Development of technological capability

Production capability had been developed. The company employed two technical personnel to supervise the production activity and had no plans to undertake R & D efforts. The company felt that the battery industry was highly competitive. The parent foreign partner company had its own R & D capability and it would be to the advantage of the company to continue to source technological information from its UK based company.

CASE STUDY NO. 15 : CENTURY BATTERY

Company Background

Century Battery was established in 1959 by an Australian company. Subsequently, the company was restructured as a joint-venture company with local equity participation. The technical assistance agreement was entered between Century Battery and its Australian partner. In 1984, the company was fully acquired by Sime Darby, a local conglomerate. Under the new management, Century Battery reviewed its technical assistance arrangement with its foreign partner. It was stated that this arrangement would not exclude the company sourcing technology from other alternative suppliers.

Technology Acquisition Process

For the past 25 years, the Australian partner had provided technical support. The company basically manufactured its product on the basis of components supplied by the foreign partner. The battery market was very competitive and Century Battery had planned to upgrade its capability. It had also started to export its products to other overseas market.

Development of Technological Capability

Before the acquisition of this company by Sime Darby, Century Battery had operated with minimum technical efforts. Product development was carried out by foreign partner. The sale of products had been restricted to domestic market. The new management had expanded manufacturing facilities to meet the demands from overseas markets. The company planned to develop wider linkages with other technology suppliers in the United States. The new management had decided to recruit more professional manpower for the technical department.

CASE STUDY NO. 16 : BERJAYA KAWAT

Company Background

Berjaya Kawat Company was incorporated in Malaysia under the name Berjaya Kawat Sdn. Bhd. in 1968, with the principle objectives of manufacturing bright wires, galvanised wires and wire ropes. The parties involved in this joint venture was the Broken Hill Proprietary Company Limited, Australia and local investors. Berjaya entered into a technical service agreement with the Australian Wire Company Limited related to the manufacturing of production and marketing of the company products. Berjaya later became a public limited company. As one of the largest manufacturer of wire ropes, Berjaya controlled 60% of the market.

Technology Acquisition Process

Technical assistance arrangement with the Australian Wire Industry had enabled the company to acquire the necessary expertise to set up the manufacturing activities. A number of foreign personnel were brought in to manage and trained the local staff. The technology suppliers had continued to play a major role in supplying technical resources including the introduction of new products and process technology. Almost all of its products were sold to Malaysian market particularly to cable manufacturers. Berjaya products were produced in several grades and specifications to meet the wide range of commercial customers. The company felt that the technical collaboration was necessary to acquire new product process to meet the changing market demands. The company had also acquired a wire mesh plant. Its products was mainly for civil engineering works. In 1974, Berjaya Mesh had entered into a licence agreement with a British company, BRC, UK to manufacture wire mesh under licence. The licence agreement however had been terminated and Berjaya Kawat technical department had been assigned to assist in providing the necessary technical resources to its wire mesh factory.

Berjaya Kawat foreign partner had been responsible for providing technical support and training of most of its personnel.

Development of Technological Capability

The technical department was managed by local personnel and Berjaya Kawat was satisfied with the infusion of technical resources from its foreign partner. Local personnel had also participated actively in-inhouse technical efforts. Berjaya viewed that it has acquired high degree of technical expertise and was confident to undertake its own operation. However, it had not developed innovative capability and would considered technical collaboration essential with foreign suppliers of technology. It was indicated that Berjaya would develop technological relationship with several other technology suppliers. In the past, the company had relied only on one individual foreign company. The company felt that it was necessary to establish new and wider linkages with other sources of technology. Competition from overseas suppliers had posed new challenges to the company. As stated by the production manager, Berjaya Kawat had acquired high degree of operating capability which was developed during the past few years. Several of its technical personnel had accumulated 10 to 12 years of industrial experience. The company had also established a small R & D department with three personnel. The main activity of this department was on product development and adaptation. Due to the changing demand of its major industrial users, the company was constantly required to carry out in-house technical efforts while developing its own technical capability. The company felt that it was necessary to continue to work with foreign technology suppliers. As a small company, Berjaya felt that it had to rely on established foreign firms which can constantly provide technical information on new products as required by its own customers. The company had worked closely with its Australian counterparts and was happy with the technological relationship developed over the years. However it had come to the stage where the company had to develop a strong in-house expertise relating to innovative capability. Therefore the company had made plans to expand its R & D department. With the acquisition of full management control, the company had set its goals to enhance its local expertise and develop new technological relationship. In the past, it was constrained because of the joint-venture arrangements with its Australian counterparts. Since the Australian counterparts had decided to sell off its interests in the company, Berjaya would have greater freedom in developing new technology strategy to meet its own corporate goals under new management.

CASE STUDY NO. 17 : FEDERAL CABLE WIRES AND METAL FORMING

Company Background

Federal Cable Wires and Metal Forming was incorporated in 1966. It started as a joint venture between Pacific Electric Wire and China Wire & Cables Limited of Taiwan. Initially the main product of the company were PVC wire cables and cords, PVC insulated steel wires and armoured powdered cables. In 1975, Federal Cables terminated its relationship with China Wire and Cables Limited and entered into a joint venture arrangement with Fujikura Limited of Japan. It employs 600 staff. The company had entered into a technical assistance in know-how agreement with Fujikura.

Technology Acquisition Process

Federal Cables acquired the initial technological input from Taiwan Wire & Cables Limited. As market demands began to change , Federal Cables started to move into new products. However its Taiwanness partner was not able to supply the necessary technology resources. The development of Malaysian telecommunication industry increased the demand for several types of cables. The company found a new partner, Fujikura which had a strong technological base in cable manufacturing. The company felt that there was a need for a strong technology company that would be able to provide the technical support to keep abreast with new product development. Fujikura had been known for its strength in cable manufacturing. In the expansion of the plant, the Japanese company provided the expertise and financial support for Federal Cables. Linkages with Fujikura provided opportunities to acquire the latest technology in the telecommunication industry. It was stated by the production manager that technical and know-how agreement was essential to acquire product process know-how from Japanese partner. Because of its reliance on its foreign partner, the company had not developed its own technical resources.

<u>**Development of Technological Capability**</u>

Federal Cables had also drawn up a ten years plan incorporating some of the elements of technological capability. Although the company recognised that technical capability was essential, it also had been developing some of its staff in special areas. One of the constraints faced by the company as a joint-venture company was the involvement of foreign expatriates in determining the technical production of the company. Federal Cables found that the Malaysian cable manufacturing industry was highly fragmentated. To sustain systematic technical development, the company felt that it required technical resources.

For technology development to occur the company felt that there was a need for the cable manufacturer to be involved not only in manufacturing but also in installation. The company was also aware about the competition from optical fibres. Without R & D base, it would be impossible for Malaysian companies to remain competitive and to keep abreast with technological development. The company felt that there must be systematic development of manpower in order to meet the challenges of technological development. As a joint-venture company, it felt that there was very little need to develop its own expertise because it could easily acquire whatever technology from its foreign partner. However if the company decided to go on its own, it had to develop its own expertise. One option was to acquire technology through licensing. This would enable the company to develop some independence with regards to technological development. However, as pointed out by the executives interviewed, licensing required a high degree of industrial expertise. At the moment, the company had 15 professional staff. Key decisions regarding the future technological development had to be made in line with its 10-year plan. The company did not perceive that it could be self-reliance because of limited resources to undertake its own technological development. Hence, the emphasis was on developing production capability with heavy reliance on the Japanese partner to provide innovative and project investment expertise.

CASE STUDY NO. 18 : INDUSTRIAL BOILERS ALLIED EQUIPMENT (IBAE)

Company Background

IBAE was established in 1973 manufacturing boilers and pressure vessels. The company was started in collaboration with an Australian firm which provided the technical know-how. The products were made under license from the Australian company. IBAE had another technical arrangement with a UK company, Tauler & Sons to manufacture industrial boilers. Under the licensing agreements, the technology supplier would provide the design, know-how and other technical information to enable IBAE to manufacture industrial boilers and pressure vessels according to the specifications required.

Technology Acquisition Process

The licensing agreements was entered in 1973. This 30 year agreements enabled IBAE to source all the necessary know-how from its technology suppliers. The basic design was prepared by the Australian company. However, certain changes were done to meet the specifications of local customers. The long term agreement also provided training and other necessary facilities required by IBAE. Any changes in design had to be reported to the Australian company. IBAE supplied most of the pressure vessels and boilers to local industries particularly the palm oil industry and petroleum industry. It had also exported its products to Thailand, Burma and Indonesia.

Development of Technological Capability

To upgrade its technical capability, IBAE also had formed its own design team. It had developed contacts with other technology suppliers particularly those from Japan and Spain. It had also prepared some plans to increase its in-house design capability. The company had relied 60% of its technical requirements from foreign expertise. To enable it to expand into other engineering activities, IBAE had also worked closely with a Singapore based company known as Sun Metal. Technical capability with regard to design work need to be developed. Although its principal technology supplier from Australia provided the basic necessary design work, IBAE felt that it must enhance engineering and design capability. Because of business conditions particularly due to the economic slow down, IBAE was unable to strengthen its technical manpower. However, the company had been acquired by Innovest which will be able to provide financial resources to strengthen IBAE.

Innovest is a public listed company with interests in engineering and food industry. IBAE had developed a strong manufacturing base with regard to industrial boilers but need to develop its capability related to design of new products. As an engineering-based company, the technical capability had been systematically developed over the years with infusion of technical expertise from its technology suppliers. By being associated with larger companies like Innovest, IBAE hoped to acquire greater expertise in other engineering products.

CASE STUDY NO. 19 : FEDERAL TELECOMS

Company Background

Federal Telecoms is a joint venture company established between Japanese cable manufacturer, Fuji and local investors. The company manufactured cable conductors and power cables. It employed two expatriate staff which had been assigned to provide the technical expertise. The company also employed 150 local staff. Fuji of Japan provided the necessary technical resources a through technical assistance agreement.

Technology Acquisition Process

Fuji also was responsible for starting the company and provided the necessary technical know-how. During the initial development of the company, local involvement was minimum. The joint venture arrangement was necessary because local investors did not have the necessary expertise to start cable manufacturing. Some degree of technological efforts had been undertaken to improve design of equipment, manufacturing product according to customers requirements.

Development of Technological Capability

Local personnel had participated actively in the production side. In terms of new technology, the company relied extensively from its foreign partner. In the recent expansion carried out by Federal Cable, the company acquired its necessary expertise from its foreign partner. According to local executives, Fuji despatched key technical personnel to plan and implement the expansion project. There was very little participation from local technical personnel in planning the project. Federal Telecoms personnel felt that there should be a high degree of local involvement in the expansion project. The Japanese partner played a dominant role in the technical and production activities of the company. It was pointed out by executives that the company would increase local involvement in manufacturing of cables. Most of the products were supplied to local customers particularly the National Electricity Board.

CASE STUDY NO. 20 : ASSOCIATED CERAMIC WORKS

Company Background

Associated Ceramic Works (ACW) is a member of the Hong Leong Group of Companies. It was established in 1981 to manufacture Italian floor tiles. Before the company started operation, Italian floor tiles were largely imported from other countries. When Hong Leong decided to embark on this project, it went searching for the appropriate technology. Having evaluated the various machine suppliers, it decided to purchase from Citi, one of the established machine suppliers in Italy.

Technology Acquisition Process

The project was acquired on a turnkey basis with Citi supplying all the major equipment. Citi also took the minority interests in the company. One of the major equipment supplied was the multi-roller single kiln which was the first of its kind to be introduced in Malaysia. ACW was interested in this technology because of the cost saving advantage with regards to energy consumption. As far as Hong Leong was concerned this technology was also new to the company although it had some experience in manufacturing mosaic through its subsidiary company, Associated Tiles Industry. Instead of a single channel fire kiln, the company selected the multi-channel kiln because of the advantage it had over single channel. Hong Leong offered Citi the equity participation of 15% to ensure commitment by the technology suppliers. To ensure the success of this project, ACW had employed a number of its engineers to work along with the machine suppliers during the installation of the plant.

Development of Technological Capability

During the initial phase of trial production, the company encountered serious quality problems. ACW had used local raw materials in its manufacturing process.

It was pointed out that modification had to be carried out in order to remedy the technical problem. The usage of raw materials normally requires some degree of modification. Citi was unable to remedy the technical problems and ACW had to seek assistance from another tile manufacturing company in Indonesia. The Indonesian company studied the problem and make the proper modification. Problem encountered by ACW came to knowledge of other manufacturers. Citi had difficulty selling its equipment to tiles manufacturers in this region. The technical problem was finally solved by the Indonesian manufacturer after having made the necessary modifications. Subsequently, Citi visited ACW plant and studied the modifications. It was reported that Citi modified all its new equipment. It was able to recover its sales of machines to other countries. It was pointed out by ACW that machine suppliers should not be relied upon in providing a working plant. The experience faced by ACW had increased its capability to manage subsequent technology acquisition. The company felt that proper evaluation of technology should be carried out and it was an advantage to seek short term technical assistance from companies with manufacturing experience. Machine suppliers generally did not have experience in manufacturing process and would not be able to provide good technical support. The company had developed its own operating capability in the field of trouble shooting, quality control and maintenance. It had not employ any foreign experts. Most of the technical assistance had been sourced from independent technology suppliers. The development of this project had given valuable experience to ACW with regards to technology acquisition. Apart from the problem encountered in the initial stage, ACW had developed a high degree of industrial capability in the production field. The company also pointed out that it was focusing more efforts in improving the product quality and the possibility of exporting to other countries.

CASE STUDY NO. 21 : SOONG SENG ASBESTOS

Company Background

Soong Seng Asbestos was a diversified family owned business with interests in manufacturing, trading, plantation and finance. In 1977, Soong Seng Asbestos was set up to manufacture asbestos products namely flat and corrugated roofing sheets. Its other manufacturing activities were confined to building materials such as galvanised roofing sheets. The parent company, Soong Seng Industry, started its business in trading activities. However, later the company decided to venture into manufacturing of building products. The company decision to enter into the manufacturing of asbestos products was due to the reluctance of other asbestos manufacturers to provide dealership facilities. Having failed to obtain dealership, the owner himself decided to set its own manufacturing facilities making asbestos products. In 1978, the company began manufacturing asbestos roofing sheets. The manufacturing of asbestos cement products was dominated by three joint-venture companies namely Hume Industries, Mallex Industries and UAB Cement. The entry of Soong Seng Asbestos represented the first attempt by a wholly owned local company to enter into manufacturing of asbestos products. It was reported that the company had made a turnover of MR20 million in 1984. Soong Seng Asbestos (SSA) had been successful in manufacturing of asbestos cement parts despite some setbacks in the early phase of its development.

Technology Acquisition Process

SSA had limited manufacturing experience in the selection of technology for the asbestos cement products. The company owner requested several machine suppliers to submit quotations. Among those companies that had agreed to supply the plant for making asbestos cement products was manufacturer in Thailand. It was reported that the decision to acquire the technology from Thailand was due to the competitive prices quoted by the company. Some preliminary evaluations was done by the owner himself with no assistance from consultants or other third party. The owner himself had little product process knowledge related to asbestos cement products manufacturing. In 1976, the plant was commissioned. SSA found that the products were of inferior quality and did not meet the specifications required for commercial production. Inspite of several attempts by the machine suppliers to remedy the defects, very little results was achieved. SSA had no technical assistance arrangement with machine suppliers. Instead, it had short term expert to assist in the transfer of product know-how. It was felt by SSA that machine suppliers would be able to provide whatever product process knowhow necessary to achieve the desired quality. During the pre-commercial production phase, SSA had to bear the expenses incurred by the machine suppliers. This involved payments of salaries to the expatriate staff and other expenses related to trouble-shooting efforts. SSA subsequently decided to terminate the services of the machine suppliers in the third month after the plant had been commissioned.

It then appointed a special technical team headed by its own Production Manager who had several years of experience in one of the major companies manufacturing asbestos products. The major task of this team was to identify the key technical problems and make the necessary adjustments and modifications to the plant. The first step taken by the team was to write to several other machine suppliers, raw materials suppliers and technical associations seeking technical information with regards to product process know-how. In addition, the team started to examine closely on the raw material mixture. One of its efforts is to change the fibre mixing combination. This attempt was necessary in order to strengthen the materials that could eliminate the cracks in the products. After several attempts, the team managed to make a major breakthrough with regards to fibre mixing combination. It went ahead to further improve the strength of the materials. It also started to examine ways of reducing the raw materials consumption that would cut the cost production. The technical team also made some minor modifications to the plant. In the first few attempts, the special technical team managed to improve the quality of the products. This technological effort involved staff from all levels. The Production Manager was the key man in leading the in-house technological efforts. When the team started to implement the technological efforts, very little product process know-how existed among its personnel. Having carried out this task for a few weeks, the personnel had acquired a high degree of product process knowledge. To achieve correct fibre formulation, the team had to carry out modification by incorporating additional instruments since the fibre comes from various sources. Each type of fibre required different formulation. After a series of trial runs, the company was successful in overcoming the initial problems. This modification was carried out successfully with very little additional expenses. Earlier, machine suppliers estimated that a sum of MR250,000.00 was required to carry out the necessary modifications. The team worked closely with management. There was tremendous support from top management in encouraging the staff to undertake the technical efforts. There was regular production meetings late in the evening and regular reports were submitted to the Chief Executive on the progress made by the team.

When the company embarked on its first expansion project to manufacture asbestos cement parts, a special team was set up to carry out technology evaluation. The company hired a local consultant to assist in the technology evaluation. Key personnel were despatched to North America and European countries to visit machine suppliers and plants producing asbestos cement products. Many of the mistakes made earlier with regards to technology acquisition had not been repeated. The technology for asbestos cement pipes was acquired on a turnkey basis from a German machine supplier. A major part of the plant was fabricated locally. The company had decided to enter into a short term technical assistance arrangement with the German firm. SSA had also developed its own information network with machine suppliers and raw materials suppliers world wide in seeking information relating to technological development.

Development of Technological Capability

Asbestos industries in the region was fairly small and SSA had remain in close contacts with other South East Asian manufacturers. When SSA successfully solved its technical problems, the news spread to other asbestos cement manufacturers who had acquired equipment from the same manufacturer in Thailand. Having heard about the success of SSA, two manufacturers from Indonesia and Philippines sought SSA technical assistance to help them to commission their plants. Unlike many other manufacturing companies in Malaysia, SSA started without formal technical assistance from any foreign manufacturers. It had to developed its own management system and procedures relating to manufacturing operations. The staff were assigned to start their own systems and procedures relating to quality control, production planning, inventory control, financial system and personnel practices. Having solved the technical problems, the technical personnel began to focus their efforts in improving the organisational system. The company recognised the importance of participative management and involvement of personnel from various levels in building up this new manufacturing organisation. As a young firm, it relied heavily on immediate feedbacks from its personnel. The personnel department had put up a strong case in upgrading the quality of the workforce. The company had embarked into a training programme that would develop the skills of its staff from time to time. SSA had sent a number of its staff for management training. According to the Production Manager, salaries paid by SSA is considered among the highest in the industry. As a growing company, SSA had to mobilise its available resources in developing an efficient manufacturing system. It also set its goals in exporting some of its products overseas.

The high degree of diffusion of technology among its personnel was triggered by the deficiency in the plant design. However, the benefits gained in solving this problem had enable the company to move to a higher level of technical development. It shows that companies can achieve high level of diffusion if sufficient efforts is given to manpower development, in-house technological efforts and commitment by top management. As a wholly owned local company, it has shown that indigenous technical capability can be developed if systematic efforts is made to enhance local personnel involvement technological development. In planning technology acquisition, SSA had recognised the importance of scanning the technology market and evaluated the available technologies. Extensive search carried out during its expansion project reflected the importance of proper technology evaluation. SSA products was widely used by the industries. It provided a good after sales services because of its low overhead and manufacturing costs.

CASE STUDY NO. 22 : HUME INDUSTRIES

Company Background

Hume Industries was established in 1964 by an Australian firm. It is a highly diversified company manufacturing a wide range of building materials. Subsequently, Hume Industries was acquired by a local company, Hong Leong Industries. The study focused on one of the divisions of Hume Industries responsible for the manufacturing of asbestos cement products.

When the local company, Hong Leong Industries took over Hume Industries, it terminated a technical assistance agreement. Hong Leong acquired all the interests of Hume Industries of Australia. In the initial phase, Hong Leong had little experience in manufacturing of cement products. When it acquired management and ownership control of Hume Industries, Hong Leong appointed a number of local professional staff in key positions. Hume Industries was managed by a number of local personnel who had acquired a high degree of production capability. Hong Leong strategy was to increase technical capability in areas of R & D and project investment.

Technology Acquisition Process

In view of the lack of a strong technological base, Hume Industries decided to seek technical collaborations from established foreign technology suppliers. The technical agreement was signed with a Danish group which had large interests in the manufacturing of building products. Hume Industries felt that it was necessary for the Danish partner to participate in the equity of the company. It was felt that the foreign technology supplier would have greater commitment if it had a stake in the company. The Danish partner was known to have large technological resources and Hume Industries would benefit from this type of collaboration.

Since technology in the building industry was changing rapidly, Hume Industries would want to tap the resources already available in the Danish company. It would take a longer period for Hume Industries to develop its own technological base since the Malaysian market for the building materials was quite competitive. Hume Industries felt that it was necessary to receive an immediate injection of new technology to make its products competitive. At the same time, Hume Industries decided to develop its own R & D capability.

A joint venture arrangement entered between Hume Industries and the Danish company was perceived as meeting the interests of both parties. According to Hume Industries, the Danish party was interested to have a foothold in the Asian region. Hence, the company was willing to work closely with Hume Industries which had also experience in the manufacturing and marketing of building products. A number of short term experts from the Danish partner was sent to Hume Industries. Hume Industries continued to exercise ownership and management control of the company. According to company executives, this arrangement was considered a good model of joint-venture arrangement where the local partner continued to exercise ownership and management control. In this case, the foreign partner which had a minority equity interests would be required to strengthen and assist in the development of the manufacturing facilities. As a local company, Hume Industries felt there was a need to develop close linkages with overseas companies where it could scan the technological and market environment. It felt that information was difficult to acquire unless a system of network was created that would help the local companies to acquire the necessary information. The Danish company was known to have a strong technological base. By entering into arrangement with the company,. Hume Industries hope to introduce new building materials into the domestic market.

Development of Technological Capability

The R & D department set up by Hume Industries in the asbestos cement product had focussed its efforts in product process development. The division had worked closely with foreign technology suppliers and had carried out evaluation on machine and raw materials. In setting up new plants, Hume Industries had ensured that local components were sourced. In most of the projects it had strictly ensured that project management should be carried out by local personnel. According to the staff, the holding company, Hong Leong had insisted that there must be local management control and local participation in all phases of project development.

As a highly diversified company, Hume Industries continued to source technology from several suppliers. Unlike other joint venture companies, Hume Industries had the freedom to seek alternative suppliers apart from its foreign partner. The company had developed high degree of expertise in the field of production, management and engineering. Its staff had participated actively in project investment. The company had sourced external input to strengthen its investment capability particularly in selection and evaluation of technology. Innovative capability had yet to be developed. Hume Industries felt that innovative capability would take a long time to develop because of the investment involved in developing R & D capability. The company technology strategy is to source new product process development from its foreign partner but maintain a small R & D capability to undertake product process adaptation. As a diversified company, Hume Industries believed that its technological strength will depend on the company commitment to move into new products which required high external technological input. The technology will first be acquired from foreign sources and subsequently Hume Industries would develop internal expertise.

CASE STUDY NO. 23 : MALAYSIAN MOSAIC

Company Background

Malaysian Mosaic was established as a joint-venture operation between French, Japanese and Malaysian investors. The company manufactures clay mosaic tiles for the domestic market. It was set up in 1966 with the Japanese and French having 51% controlling interests while 49% was held by the local investors. The company employed three expatriates in the position of General Manager, Technical Manager and Marketing Manager. The Japanese partner provided the technological input. The French was involved in the marketing of the products. In 1981, the company was fully acquired by local investors.

Technology Acquisition Process

The technological input was provided by the Japanese partner, Kowa of Japan. Kowa was a trading firm but subsequently ventured into manufacturing of mosaic tiles. Since the initial establishment of the company, the Japanese partner had retained the management of technical control. Although the company performed quite well during the early years of its operation, it had not diversified into other products. No new investment was made to inject new technology or expand its production line. When the local investors took over the company in 1981, they found that very little indigenous technical expertise had been developed. None of the local personnel employed had any technical qualification. The technical know-how of the manufacturing process had been closely guarded by the few expatriate staff. There was very little diffusion of technology and the new investors had to retain the Japanese technical manager. The company then embarked on a programme to recruit a number of professional staff. They had sent to Japan to undergo intensive training. The company entered into a technical assistance agreement with Kowa which now act as an independent technology supplier.

Malaysian Mosaic also continued to source raw materials and components from Kowa. However, it had also built its own network of raw materials and machine suppliers. The company had terminated the monopolistic practice where Malaysian Mosaic had to source all the components and raw materials from Kowa. Similarly in terms of technology, Malaysian Mosaic had also developed alternative sources of technology. Its relationship with Kowa was a short term measure to ensure continued operation of the plant. The technical agreement entered between Malaysian Mosaic and Kowa was based on a lump sum payment. Local personnel had been appointed to various key management positions. When Malaysian Mosaic embarked on the manufacturing of heavy duty floor tiles, it acquired technological input from various sources. There was also high degree of involvement by local personnel. The company had diversified into heavy duty floor tiles because of the declining market in mosaic tiles. The manpower strength had been expanded to include a number of professional staff. It planned to recruit eight specialized staff in various fields. According to the executive of the company, the foreign partner had not invested in new product development during the 60s and 70s when Malaysian Mosaic was doing well. As a result, new building materials introduced into the market which had reduce the market share of mosaic tiles. The lack of long term commitment by foreign investors affected Malaysian Mosaic performance.

Development of Technological Capability

There was no systematic efforts to train local personnel and promote the diffusion of technology among local personnel. As a result, there was little indigenous efforts in production, investment and innovative capability being created. One of the major problems encountered by the company was the frequent change of expatriate staff. Some of expatriate staff had very little experience in manufacturing industry. Local personnel had little prospects for upward mobility. A number of good personnel left the company. The lack of management efforts both local and foreign partners to ensure technical development had lead to the low diffusion of technology and declining performance of the company. However, with the injection of new capital, there is greater local ownership and management control. The company had changed its direction and is in the process of improving its performance. Various kinds of technical efforts had been carried out under the new management to improve the technical expertise of the new personnel. One of the major efforts was to improve the capacity of the kiln. Such efforts as plant optimization and product development jointly carried out with the Japanese experts were the main types of technical activity. Another major effort undertaken by technical personnel was quality improvement on the production of new floor tiles. The company hoped that with systematic programme to develop local technical resources, the company would make a major impact in the local building materials market.

CASE STUDY No. 24 : ANTARA STEEL MILLS

Company Background

Antara Steel Mills was set up in 1982 to manufacture mild steel round bars and mild angle bars. This project was a joint effort between state enterprise and Kloekner of Germany. The company has a turnover of MR50 million. The steel mill acquired its technological input from Kloekner which is one of the largest steel company in Germany. According to the executives of Antara, the local partners had very little knowledge of steel industry when they started operation. Kloekner was appointed to provide the necessary expertise in setting up this steel operation. The project evaluation, feasibility studies, choice of technology, project management and development of operational capability was provided by Kloekner.

Technology Acquisition Process

Kloekner was the main turnkey contractor for the project and other foreign companies were also involved in supplying machineries and equipments. Since none of the local partners had experience in steel operation, Kloekner took the responsibility of implementing the project. One of the local partners, Bank Pembangunan seconded one project officer to assist the project team. The role by the project officer was to help in providing administrative support to the project team. Kloekner which had technical assistance with Antara, provided a wide range of technical services. It has also seconded three of its staff to Antara. These personnel were the Technical Manager, Engineering Manager and the General Manager. According to Antara Steel, the technical assistance was necessary in view of the lack of local expertise and experience in managing the steel plant. It was reported that the local partners' major objective was to get the project implemented as soon as possible. The element of technology transfer was not one of the major component in the decision making process. The over-riding consideration was to make the project viable. It was after the project became operational that the local partner became interested in having control over the operation of the steel mill. According to Antara, Kloekner had done a competent job in supervising the whole plant construction and also carried out the necessary modifications. Antara was very satisfied with the relationship with Kloekner. The staff seconded by Kloekner gave close cooperation to local personnel. They had provided the necessary training and also made serious attempts to built up an efficient plant. For example, it was indicated earlier that the mill was supposed to produce 25 tons per year per shift. However in 1984, the production capacity had increased to 105,000 tons on three shifts. This was considered a tremendous achievement on the part of Antara.

Development of Technological Capability

It had been decided by Antara key executives that local personnel would be able to undertake full operational responsibilities in 1987. To achieve this target, Antara had recruited qualified professional staff to work along the German expatriates. This programme had also received support from Kloekner. Antara felt that there was a need to carry out systematic efforts to develop local personnel capability. Trouble shooting efforts had been carried out by the foreign expatriates. Since the plant began operation a year ago, the management priority was to ensure the commercial viability of the project. Once this had been achieved, the management would look into the possibility of having more local involvement in operating the plant. This had been the approach taken by Antara Steel. It was pointed out that the development of operational capability would be affected if local personnel which had worked closely with expatriate staff moved to other job. Mobility of personnel could be a major obstacle to rapid development of technical capability. Antara therefore had to provide a comprehensive staff benefit scheme in order to retain some of the trained personnel. According to the chief executive, Antara believed that a good organisational environment was essential to rapid acquisition of knowledge. Many of the companies had not been able to acquire technology due to mobility of staff. It was indicated that if existing personnel left the company, technology transfer would be seriously affected. This would mean that the services of the German expatriates would have to be extended and new personnel would have to be appointed to acquire the necessary expertise. It felt strongly that top management responsibility was to create conducive working environment that would not only attract experienced staff to stay with the company but also generate interest to acquire the necessary knowledge. Since this was one of the first manufacturing plant set up by the two local partners, the transfer of management knowledge by the German partner was essential to the success of this operation. The German partner had trained several of the local personnel and also established operating procedures and systems in the plant. It was also reported that Kloekner also supplied components and raw materials to the local plant. The company was seriously thinking of sourcing some of the spare parts and components locally. The cost of acquiring components and spare parts from overseas suppliers was quite high. The company also found that some of the components supplied were not according to specifications. One of the major efforts of creating local expertise was to promote the fabrication and design of components and spare parts. The company had recognised the importance of keeping all the technical drawings which would facilitate the fabrication of local components. It was reported that a complete set of technical drawings would be kept by the company. Executives of Antara felt that the turnkey contractors should be supervised closely. It felt that it was the responsibility of the local firm to seek the necessary information and technical knowledge from the technology supplier. In the case of Antara there was not systematic efforts to plan the development of technical capability. Much of the efforts that had been done was mostly carried out on a piece-meal basis. This was one of the major drawbacks as far as Antara was concerned with regards to the development of technical capability. The chief executive had worked closely with the foreign expatriates to formulate detailed programme that would ensure local personnel to take full responsibility of the plant in 1987. Much of the learning that took place was a result of in-house technical efforts. According to the chief executive, it was only through in-house engineering efforts such as modification and adaptation, design and fabrication of minor components that the learning process could take place. Much emphasis had been given to ensure a rapid acquisition of technical skills. Antara felt that the result of its efforts can only be seen in 1987 when the German expatriate will be phased out.

CASE STUDY NO. 25 : MCIS SAFETY GLASS SDN. BHD.

Company Background

MCIS Safety Glass was established in 1972. The company manufactures automobile safety glass, anti-glared mirrors, laminated glass and quality mirrors. MCIS was set up through joint venture arrangement between Malaysian investors and Hindustan Safety Glass. The company also entered into a technical assistance agreement with Hindustan Safety Glass. A royalty of 2% of product cost was paid for a period of 5 years to Hindustan Safety Glass. In 1982, MCIS terminated its technical assistance agreement with Hindustan and entered into a new joint-venture arrangement with Asahi of Japan. The new technical assistance arrangement was entered between MCIS and Asahi. MCIS was one of the two Malaysian companies manufacturing safety glass.

Technology Acquisition Process

During the initial establishment of the company, the foreign partner, Hindustan Safety Glass provided all the necessary technological input. Three Hindustan employees were seconded to MCIS to provide technical training and advise staff on plant operation and process techniques. Three other Malaysians were also sent to Hindustan plant for on-the-job training between one to three months. Hindustan provided the necessary technical information, design as well as maintenance and repair, machinery and equipment. When Asahi became the new joint-venture partner in 1982, it provided three expatriate staff as key personnel in the company.

Development of Technological Capability

In 1984, the local partner took over management control and appointed one of its executives as the Chief Executive. According to the Chief Executive, Asahi maintained tight control over technical operation of the company. There was very little opportunities for local personnel to participate in various types of technical activities undertaken by expatriate staff. Initially there was resistance from expatriate staff when the local partner was appointed the local Chief Executive. Expatriate staff were reluctant to provide technical information to local personnel. The local Chief Executive was not happy with the level of technical capability acquired by local personnel. He insisted on specific training programmes to transfer technical capability to local personnel with the view of slowly phasing out the Japanese expatriate staff. It was indicated that the manufacturing process was not difficult and local personnel can acquire high degree of manufacturing capability if they were given opportunities to undertake technical efforts. The expatriate staff were assigned as Factory Manager, Production Manager and the Technical Manager. As indicated by the Chief Executive, the new management was determined to ensure rapid development of local expertise. It was envisaged that within a year, the company would be able to replace the Japanese expatriates. However, this required determined efforts by local management to work closely with Asahi of Japan to ensure that its expatriate staff provided the fullest cooperation in imparting knowledge to local personnel. The local management was not satisfied with the development of production capability. Investment and innovation capabilities had not been developed.It was indicated that it was only fairly recent that local management had shown some interest in the development of local expertise.

CASE STUDY NO. 26 : ASSOCIATED PAN MALAYSIA CEMENT

Company Background

Associated Pan Malaysia Cement Sdn. Bhd. (APMC) was incorporated in Malaysia on 30 March 1967 as a result of the merger between two cement companies, viz. Malayan Cement Bhd. (MCB) and Pan Malaysia Cement Works Bhd. (PMCW). APMC's current authorized capital is $200m, paid-up to $15m and is jointly held by MCB and PMCW. The company produced mainly ordinary Portland clinker and cement, oilwell clinker and Masonry cement. It also has facilities to produce sulphate resisting portland cement, rapid hardening, low heat and other special cement. With just over 2.1 million tons of cement per annum, APMC is the largest cement producer in Malaysia.

Technology Acquisition Process

APMC had two cement plants in Rawang and Kanthan. The Rawang plant was established by Malayan Cement Berhad (MCB) which was incorporated in 1950. MCB established the country's first major cement plant at Rawang in 1953 with technical assistance from Associated Portland Cement Manufacturers Limited, U.K. (who was now known as Blue Circle Industries Limited, UK). Rawang works initially had one kiln with a production capacity of approximately 112,000 tons per annum. A second kiln capable of producing 150,000 tons of clinker per annum was subsequently installed in 1959. The new dry process plant to be erected by KHD France SA, shall at least maintain the present 560,000 tons per annum capacity. The new plant will adopt the modern pre-calciner dry process system and will fully incorporate the most up-to-date improvement in automation and quality control.

APMC's Broad of Directors was headed by two Co-Chairman, a nominee from each of its owners. The Managing Director cum Group Chief Executive is responsible for the overall management of APMC. He was supported by his Executive council of Senior Managers vis the General Managers of APMC and CMC, the Group Chief Accountant, Group Sales and P.R. Manager, the Company Secretary, (Administration Manager, Group Internal Auditor and Systems Manager and the Group Personnel Manager. The administrative operations of APMC however were managed by the General Manager assisted by his Committee of Departmental Heads. Both the Managing Director and APMC General Manager had many years of experience in the cement industry. The group concept was introduced five years ago as part of modernization programme.

Prior to 1st January 1981, APMC marketed its cement through various distributors. However, following a recent management restructuring, her sister-company, CMCM Perniagaan Sdn. Bhd. was appointed sole agent for APMC with effect from 1st January 1981. This arrangement provided better control and more efficient distribution of cement throughout the country. It also enables APMC to concentrate on manufacturing activities. The present workforce of the company is approximately 1,100. Senior management main objective is to develop a highly dedicated and efficient workforce APMC had drawn a programme to upgrade its technical expertise in line with its modernization project implemented in the two plants. The cement industry had become very competitive with the establishment of new manufacturing facilities. APMC had relied on its foreign partner for the last 30 years to provide the necessary technical resources.

<u>Development of Technological Capability</u>

Blue Circle of UK had provided the necessary technical resources in developing new production facilities improving existing production and also providing and upgrading the performance of the plant. APMC continued to employ expatriates in key technical positions. These positions were production controller, engineering manager and quarry advisor. Although both the plants had been managed by local personnel, expatriate staff continued to lead the production and technical team thus creating greater awareness among the local personnel to enhance their technical capability. In the recent project, local personnel had played an increasing role in project management. APMC was also aware that although it is the oldest cement plant in Malaysia, it had not developed a high degree of technology self-reliance as its competitors like Tasek Cement. APMC felt that there is greater awareness among management to reduce their dependence on foreign partners. APMC felt that technical support from Blue Circle was necessary until such time when APMC had developed its own expertise. Technical arrangement with Blue Circle had been perceived as beneficial in view of the continued flow of technical information, product process know-how and project management expertise. Blue Circle played a key role in negotiating and evaluating technical suppliers in the expansion project implemented by APMC, Blue Circle seconded several key experienced personnel in leading the project team. As far ar APMC is concerned, one of the most important step to increase greater diffusion of technology is manpower development. APMC has reorganised its corporate structure and review the set up of both plants. The development of local personnel will involve instilling new work ethics which can enhance their ability to acquire new skills, industrial disciplines and productivity. Having developed those values, APMC felt that it would be more easier to upgrade technical skill. One of the basic ingredients was to develop a conducive working environment which would lead to rapid learning and skill enhancement. Top management had strived to encourage local personnel to participate actively in production and development of new facilities.

CASE STUDY NO. 27 : UNITED ASBESTOS CEMENT

Company Background

United Asbestos Cement Sdn. Bhd. (UAC) principal activity was the manufacturing and distribution of fibre cement, building products and pipes. The company was established in 1966 by James Hardy Industry which was also a leader in the asbestos products in Australia. UAC is a public listed company with James Hardy Industry as the largest single shareholder. The company manufactured a wide range of asbestos cement products namely flat sheets and asbestos cement pipes. UAC reported a turnover of $92.4 million in 1984. It had been granted a licence by the Malaysian authority to manufacture PVC pipes, fitting and bathroom products. Several other new products had been introduced as part of its programme to produce a wide range of building material products. A new plant had been constructed to manufacture cement-fibre building materials.

Technology Acquisition Process

During the last 20 years of its operation, the company had relied extensively on the expertise of its foreign partner. The General Manager and Technical Manager were both expatriate staff. Major expansion work had been planned and supervised by the foreign partner. As a multinational company, James Hardy Industries had introduced manufacturing systems developed by the company for its overseas subsidiaries. The company employed 8 local engineers in key managerial positions. It was indicated that the professional staff had developed a high degree of production capability. They had participated actively in managing the technical operation of the company.

Development of Technological Capability

UAC had also developed training programmes to enhance the technical expertise of the professional staff. Most of the local personnel had participated actively in trouble shooting, R & D, maintenance and minor product process development efforts in the company. They were also involved in the implementation of new products particularly in the development of new production facilities. According to UAC personnel the parent company, James Hardy Industry had encouraged local personnel to participate actively in the operation of the company. With regards to new product process development, UAC relied extensively from its foreign partner's parent company. New product had been introduced to meet the development of local building industry. A five-year plan had also been developed to review the company position in the building industry. UAC had also benefited from the infusion of management expertise developed by its foreign partner's parent company. A healthy relationship had developed between the foreign and local personnel. To a great extent, UAC had also benefited from the R & D resources made available by its foreign partner. The company hoped to develop some capability in product design particularly to meet the specified requirements of the Malaysian consumers.

CASE STUDY NO. 28 : PETRONAS REFINERY

Company Background

The Terengganu Refinery was commissioned on March 9, 1983. The following month, its first refined product, naphtha was lifted for export to Japan. The Refinery is Malaysia's first indigenous refinery, owned and operated by the National Corporation through its wholly-owned subsidiary, PETRONAS Penapisan Sdn. Bhd. The Refinery complex was built at a cost of MR260 million. The facilities include a recovery unit and bottling plant for Liquefied Petroleum Gas (LPG), marine facilities, power plant and distribution facilities. The main business of the Refinery is to refine crude oil into saleable products for distribution to the market. The crude is known as Tapis Blend which is of premium quality produced from the Tapis, Bekok, Pulai Tiong, Kepong and Tinggi oil fields. The Refinery capacity is 30,000 barrels per stream day. It is capable of producing the following products: Liquefied Petroleum Gas; Motor Gasoline; Light Straight Run Naphtha; Heavy Straight Run Naphtha; Illuminating Kerosene; Diesel; and Low Sulphur Waxy Residue.

The Refinery received its crude supply from vessels which unload their cargo at a Single Point Mooring Buoy situated approximately 2.1 kilometres from the shore. It was equipped with a water-treatment system, steam generation unit, fuel gas and fuel oil system, electronic power generation unit and refinery air system. It also had facilities to receive and compress associated gas received from the Terengganu Crude Oil Terminal to operate the gas turbines used for power generation.

Technology Acquisition Process

It was reported that the refinery had not started in the best footing. Although the construction progress well, the maning of the plant had not get along well. In this case, there was a operating service company Caltex, running the refinery and local personnel understudied them in order to manage the refinery in the same efficient way. Petronas refinery was given four years to develop its own capability but the staff was not aware how the four years were arrived at. It was probably based on the Indonesian model where foreign expatriates were required to take over operating responsibilities within the specified period of four years. The deadlines offered to Caltex was 1986. By that time, Caltex personnel would be phased out with local personnel taking over the whole operation of the plant. Expatriates had also been phased out gradually. From the discussion, it was indicated that local personnel would be able to acquire the necessary expertise to manage the plant on their own. However this programme was affected by frequent conflicts between Caltex and Petronas personnel. From the view point of Caltex personnel the transfer of technology was being hampered by the quality and attitude of local personnel. It was felt that local personnel should developed stronger desire to learn and accumulate as much experience as possible. It was pointed out by Petronas personnel that Caltex staff were good operators but bad trainers. They were only interested in operating the plants and had given little emphasis in training local counterparts. Some of these conflicts were cultural in nature. Caltex brought along a number of expatriates from the various plants all over the world. The personnel came from different nationalities. Languages used by expatriates were considered offensive by local personnel. The relationship between local and foreign counterparts had become quite strained. Although some orientation programmes were conducted by Petronas to familiarise foreign expatriates with local culture, this had not brought about the desired effect. As the saying goes, "Old habits die hard". The problem was more serious at the non-executive level. The relationship between the operators and supervisor staff with foreign expatriates had not progressed well. Petronas management felt that although it had given trainable people, the knowledge was not translated in proper English although English instructors were brought in to assist in the communication. This problem was also aggravated by the fact that local personnel at supervisory and operator level were not conversant in English. Hence, there was a communication gap between the personnel of the operating service company and the recipient, in this case, Petronas refinery.

Development of Technology Capability

It was reported by expatriates that Petronas had not planned the technology transfer properly. The whole project was in fact seen as a muddling through exercise. Petronas had not defined precisely the corporate strategy relating to the technical capability of the personnel. What was stated was its interests to take over full operation of the plant within four years. But Petronas had not defined precisely the type of skills that need to be developed. One of the areas that had been widely discussed among Petronas personnel was the placement of the project team. It was pointed out that the project team which was responsible for the planning and implementation of the project should have been absorbed as part of the operation team. Petronas recruited new personnel to operate the refinery instead of absorbing the members of the project team which had worked along turnkey contractors and machine suppliers during the construction of the plant. Those staff which were members of the project team had acquired valuable experience and their experience would have accelerated the ability to acquire operating skill. Several personnel interviewed felt that recruitment of operating personnel should had been done when the project was in the implementing phase. Many of them joined Petronas refinery when the project was nearly completed. It was made known by Petronas refinery parent company that there was need to develop a strong project team which would help in planning subsequent projects. There was a need that the project team be retained at the headquarters level. Petronas refinery executives however felt strongly that the recruitment of operating personnel should not have been held and there was a strong desire among the personnel to participate in the planning and implementation of the project. Many of them were not comfortable to be brought in to operate the plant without getting involved in the actual planning and implementation. According to the personnel it was essential that they worked along the project team during the planning stage. Since this was never done, Petronas refinery should have absorbed the members of the project team as part of the operating staff. It was later learnt that several of the project team was subsequently absorbed as members of the operating staff. This was done because Petronas refinery had not carried out subsequent projects and it was felt that the members of the project team should be absorbed as part of the operating staff. Among the other issues raised by staff was the recruitment of personnel. Many of them pointed out that Petronas refinery had not recruited suitable staff to the company. Since there was need to work closely with the foreign counterparts and to acquire as much knowledge as possible within a period of four years, there was a strong need to recruit personnel with the appropriate qualification and motivation. There were some cases where personnel were recruited with qualitifications which were not relevant to refinery operations. For example in case where a post should be held by a process engineer, personnel holding the post had electrical engineering qualification. The staff interviewed criticized recruitment practices. Foreign expatriate interviewed also expressed similar views that Petronas refinery should recruit the right people with the right qualification in order to accelerate technology acquisition process.

It was jointly perceived by the company that technology transfer was a training function. The training officers were assigned to coordinate the technology transfer programme and work closely with foreign expatriate staff to solve problems. This training coordinator was responsible to monitor and evaluate the technology transfer process. It was felt that training was important and Petronas refinery had also invested enormous resources in manpower development. However, there were many other organisational needs that were required to be closely examined. It was felt that Petronas refinery should operate like a manufacturing concern. Decisions were quite slow and highly centralized at the headquarters level. The personnel department was not happy with the centralized decision making process pertaining to recruitment and firing of personnel. Since the refinery was the first manufacturing activity of Petronas, it was felt that the company would have to evolve its own organisational culture. Caltex had strived to transfer most of the operating procedures and management systems to the refinery. However, technology transfer as examined in this case revealed that emphasis on transfer of skills is not the only criteria in ensuring the success of technology transfer. There is need to implement a company-wide programme in implementing technology transfer programme. There is need to review the overall organisational system such as the style of leadership, recruitment of personnel, management system, personnel practices and other elements of the organisational environment to ensure greater success of technology transfer. The case of Petronas has shown that failure to address these issues could hinder the overall programme with regards to the diffusion and development of technology.