TRANSFEROR-TRANSFEREE RELATIONSHIP

AND

TECHNOLOGY TRANSFER

By

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ABSTRAK

Keperluan pembangunan ekonomi moden adalah penambahan dalam kegunaan stok teknologi dan penambahan kepada penggunaannya. Kajian ini cuba mengkaji perhubungan antara kualiti perhubungan kelakuan manusia antara pemindah dan penerima teknologi dan kejayaan permindahan teknologi. Tiga pembuleh ubah, kepercayaan, kerjasama dan komunikasi sebagai elemen perhubungan pemindah-penerima dimodelkan dengan logik sebagai prediktor kepada kejayaan pemindahan teknologi.

Suatu kajian telah dijalankan dengan menghantar soal-selidik melalui email, pos dan penyebaran persendirian. Data dikutip dari firma di bahagian utara Malaysia dan Lembah Klang dengan sasaran responden daripada firma pengeluaran. Jumlah data yang dikutip adalah 110 dan dianalisis dengan mengguna perisian statistik. Bagi menguji model yang disarankan, analisis statistik yang diguna adalah analisis regresi bermoderator (MRA).

Akhir sekali, penemuan kajian ini menambah pengetahuan mengenai bagaimana elemen perhubungan dikaitkan dengan teknologi dalam kekompleksan teknologi dalam menyumbang kepada kejayaan pemindahan teknologi. Mengikut hasil kajian, tahap kejayaan proses pemindahan dikaitkan secara positif dengan tatap kepercayaan dan kerjasama antara ahli dari firma pemindah and penerrima teknologi. Walau bagaimanapun perhubungan positif ini benar bagi pemindahan teknologi berbentuk inovasi. Tahap sederhana bagi kepercayaan dan kerjasama diperlukan untuk pemindahan teknologi administratif bagi mencapai peringkat berjayaan yang optimum.

Tambahan lagi didapati bahawa tahap kerjasama yang tinggi mempunyai impak positif ke atas kejayaan proses pemindahan teknologi, sementara tahap

kerjasama yang tinggi tiada impak yang signifikan ke atas kejayaan pemindahan teknologi produk, yang hanya memerlukan tahap kerjasama yang sederhana.

ABSTRACT

The essence of modern economic growth is the increase in the stock of useful technology and the extension of its application. This paper seeks to examine the relationship between the quality of human behavioral relationship between transferor and transferee of technology and the success of technology transfer. Three variables, trust, cooperation and communication as elements of transferor-transferee relationship are logically modeled as predictors of success of technology transfer.

A cross-sectional field study was conducted by sending the questionnaire via email, post and personal distribution. The data were collected from the firms around northern Malaysia and Klang Valley, with target respondents from manufacturing firms. The total number of 110 cases was analyzed by statistical software to test the proposed model. The statistical method used is moderated regression analysis (MRA).

Finally, the findings provide additional insights about how the elements of relationship are associated with complexity of technology to contribute to the successful technology transfer. According to the results, the success level of the transfer process is positively associated with the extent of trust and cooperation between members from both transferor and transferee firms. However, this positive relationship applies to transfer for technological innovation. Only moderate level of trust and cooperation is necessary for the transfer of administrative technology to achieve optimum level of success. It was further observed that high level of cooperation has positive impact on success of process technology transfer, whereas, high level of cooperation has no significant impact on the success of product technology transfer, which needs only the moderate level of cooperation.

Chapter 1

INTRODUCTION

" Conveyance of the stewardship of a technology to the most reliable and responsible steward for that technology at its particular stage of development. "

John S. Roberts, Technology Licensing Specialist

Technology Management Office, University of Michigan

1.1 Background of the Study

Economic development of a nation depends on the growth and development of its economic entities such as business organizations. The firms that operate in developing and newly industrialized countries face many uncertainties when venturing into the global business environment. It is imperative that firms be able to survive and adjust to this continuously changing realm and to meet the challenge of strategically implementing advanced technology in an environment where the ability to adapt has become the measure of success.

More importantly, firms need to keep pace with new technical ideas provided that the technology is correct, fast, cost effective and support their core competencies. Company strengths must continually be assessed and used to readapt the organization into a fast response company. This can either be accomplished through technological innovation or through technological acquisition and adaptation. The acquired technology is then transferred to different organizations or different units of the organization located in different geographical locations. This process is called "technology transfer". The technology refers to the theoretical and practical knowledge, skills, and artifacts that can be used to develop products and services as well as their production and delivery systems.

Technology transfer is the transmission of knowledge, which enables the recipient firm to manufacture a certain product or provide a particular service (Tsang, 1997). Empirical research shows that key technologies were generally knowledge or experience in the industry and the methodology for producing product or service (Tsang, 1997). The business literature generally refers to at least three types of technology: product, process and, management. Each of these types of technology can create a competitive advantage for the firms that possess it. That is, although all firms possess each type of technology, an advantage accrues to firms that are able to obtain and deploy superior technology.

Transfer of technology from one place to another is not just a recent phenomenon, but has existed throughout the recorded history. Abundant evidence convincingly demonstrates that such transfer was an important aspect of prehistoric societies as well (Cantwell, 1999). However, only in recent years, has a concerted effort been made to transfer technology as a means to stretch the R&D investment dollars and to develop greater utilization of the existing science-technology base in order to generate greater economic impetus. Technology transfer offers the opportunity to obtain a greater return from past investments in R&D.

Currently, the developing nations of Asia are showing ever-increasing interest in technology transfers from the industrialized nations. The developing countries have weak technological bases and, on top of that, their capacities for research and development activities are limited. Such a situation forces these countries to rely on foreign investment as a major mechanism for technological acquisition. One of the newly industrialized countries, Malaysia has adopted the philosophy that the introduction of sophisticated technology is the only means to catch up with its industrialized partners in Asia. It has recognized the crucial role of foreign direct

investment (FDI) in helping to facilitate the transfer of science and technology knowledge from developed countries.

Foreign firms located in Malaysia not only began to automate production processes, but also to introduce more sophisticated technology to the local economy (Narayanan & Rasiah, 1991). Evidence of increased technology transfer in Malaysia is suggested by the fact that FDI in the period 1985-1990 was accompanied by a large number of "technology import agreements" (UNDP, 1991). Not surprisingly, Malaysian companies still require further development before they can match the technical pace of industrialized countries. A strategic advantage is gained from having exclusive knowledge of reliable technology. However, acquisition and implementation of flexible technology are still fraught with problems and setbacks despite the Malaysian government's efforts to the contrary.

Management is one of the major variables that affect the technology transfer process negatively or positively. The other factors include the technical absorptive capacity of the transferee and active participation of not only the transferor, but also that of the transferee (Tsang, 1997). The other factors such as manufacturing experience, ownership of suppliers, recipient's technology infrastructure, the size of the organization, intensity of the research and development as well as effectiveness of training also play important roles in the process of technology transfer.

However, it is the individual, who carries out technology transfer and the whole process occurs between people. It involves a great extent of interaction between people and the success of the process needs a sustained and favorable relationship between transferor and transferee over a period of time. From this standpoint, it has been argued that "ultimately, technology transfer is less a task to be accomplished than a set of relationship to be nurtured" (Anonymous, 1992). Thus, this study focuses the

aspects of transferor-transferee relationship and their impact on success of transfer process. The relationship of one-on-one personal kind, generally with counterparts in transferor's and transferee's organizations will come through consistently in this research as a focus for solving problems and defining its importance for the success of technology transfer in Malaysia.

1.2 Technology Transfer in Malaysia

The vulnerability of the Malaysian economy to changes in external demand for its primary commodities has made it realize the need for further diversification into manufacturing for export. R&D activities therefore have to be directed towards increasing productivity and diversifying the industrial base to ensure that Malaysia has a competitive edge and to enable entry into oversea markets. Malaysia is one of the countries where government is said to have recognized the crucial role of foreign direct investment (FDI) in helping to facilitate the transfer of science and technology knowledge from developed countries. Previous study conducted by Narayanan and Guan (1993) has revealed that the electronic and electrical goods sector in general utilizes relatively more sophisticated technology and that foreign technology has certainly taken root in Malaysia.

In Malaysia, the extent of technology transfer depends on several factors, including the nature of the product, the type of sub-sector, the type of equity ownership of the firms and the size of the firms. The technology utilized is of the highest level in the semiconductor and other electronics components manufacturing sub-sector (ECS). Seven out of nine largest firms used high technology and production processes requiring a high level of technology. These were found to be mainly or wholly foreign-owned firms, particularly MNCs from the US.

Recent examples of technology transfers in Malaysia can be seen as the cooperation of Proton Sdn Bhd and Lotus Engineering Group from UK to develop smaller engine, which is more cost effective with very high performance in its class. Lotus's good engineering capabilities has contributed Proton to acquire new technologies such as cam profile switching, cylinder deactivation, and variable valve timing. Agilent Technologies is another example, which is planning to transfer production of proprietary electronic instrumentation systems from its eight offshore locations to Penang and double its investment in Malaysia to RM 3 billion over five years (The Edge, 2000). All these technology transfers can be the factors that contribute to the Malaysia's economic growth.

At the macro level, the degree of technology transferred to Malaysia can be measured against the extent to which the three stages of the process have been accomplished: **adoption, rooting** and **diffusion.** The adoption is measured by the number of technology transfer agreements concluded in any given time period. The rooting process refers to whether the adopted technology takes root in the domestically-based firm or not. This enables the recipient firm to undertake unaided, technological design and innovation. Technology transfer process is deemed complete with diffusion or the spread of technology to the local economy. According to Narayanan and Guan (1993), the nine types of agreements in Malaysia are:

1. Joint venture agreements
2. Technical assistance agreements
3. Know-how agreements
4. License agreements
5. Patent agreements

6. Trademark agreements

7. Management agreements

8. Sales/purchase agreements

9. Turn-key contracts

The Malaysian government has offered large incentives to quicken the pace of advanced technology adoption. Despite these incentives, the cost of adopting advanced technology is discouragingly high. External assistance is still required to manage the technology adoption process and the majority of the firms simply cannot afford this. Narayanan and Guan (1993) have suggested that the majority of companies surveyed, conducted little innovation and concentrated more on refining and improving existing products and processes. Thus, they fall into the "incremental" category for innovation.

The present technologies in use are, are at best, at their maturity stage, despite most of the companies still having a long way to go towards implementing a fully integrated, flexible, advanced technology. In general, Malaysian firms need further development to compete with firms of industrialized countries. More research is needed to determine the impetus for moving from an aging technology portfolio to one, which is more evolutionary in nature.

1.3 Problem Statement

It is clear that the secret of new product success lies in the effective transfer of technology. According to Galbraith (1990), manufacturing technology transfers are still fraught with a multitude of hidden problems, and unexpected issues often become major stumbling blocks while anticipated problems fail to materialize. The result is that many potentially successful products can be reduced to marginal, or even unprofitable operations. Thus, managing the process is inordinately challenging because it concerns

complex human interactions and interdependencies among the participants. Effective high-tech companies demonstrate distinctive competence in integrating diverse organizational skills and in harnessing creativity and synergies that results from their interactions. Poorly understood human and interpersonal issues, ineffective inter-functional communication and the lack of corporation get in the way of effective technology transfer (Jassawalla & Sashittal, 1996).

In order for the technology transfer process to be successful, both transferor and transferee have to pay careful attention to both external factors and internal factors, which may have impact on the success of the process. However, what appears to be more imperative is the relationship between transferor and transferee since there are many cases of failure in technology transfer due to miscommunication, misunderstanding, lack of trust in each other, and lack of interdependence. Many participants in the transfer process recount the interpersonal rather than the technological dimensions of technology transfer to be their most significant challenge.

Research by Australian manufacturing council and McKinsey & Co.(1994) on obstacles to linkages during technology transfer has revealed that major problems were attributable to a range of relationship and communication issues. These include absence of open dialogue, lack of collective problem solving, and need for more astute networking. On account of all these human factors and challenges, which take place in the process of transfer, this study is conducted with the objective to understand the quality of transferor-transferee relationship that is necessary to achieve the success of the process of the technology transfer.

1.4 Objective of the Study

The study focuses on a few interrelated aspects of technology transfer in Malaysia. In particular, this study seeks ;

- To survey the extent to which the technology transfer has been successful in Malaysia,
- To explore the extent to which, transferor-transferee relationship has impact on the success of technology process in Malaysia, and
- To examine whether the complexity of technology moderates the relationship between transferor-transferee relationship and the success of technology transfer

1.5 Research Questions

The above objectives raise a few questions related to the influence of human relationship and interaction in the process of transfer. These are:

- Does the success of transfer process depend on the quality of the communication between transferee and transferor?
- Does the extent of cooperation affect the level of success of the process?
- How does the level of trust influence the level of the success?
- Does the complexity of technology transferred, moderate the relationship between quality of transferor-transferee relationship and success of transfer process?

1.6 Scope of the study

This study focuses on transferor-transferee relationship from the aspects of communication, cooperation, and trust and their impact on success or failure of the technology transfer process. This study will support the fact that the process can be

successfully managed if there is a positive relationship between transferor and transferee of the technology being transferred. The emphasis will also be given to the complexity of the technology being transferred, and how it moderates the relationship between transferor-transferee relationship and success of transfer.

1.7 Significance of the Study

It is expected that findings of this study can contribute to the success of upcoming technology transfer processes in Malaysia by highlighting the necessary state and quality of relationship between the parties undertaking the transfer process. Moreover, it is expected that it can enhance the previous theoretical findings of the factors that determine the success of transfer process. For the empirical aspect, it is possible that this study can be able to help prevent the potential failure due to the human interaction factors. Moreover, the findings of this study will help the organizations undertaking technology transfer in future to identify the key factors in human interaction and relationships before undertaking the transfer process and arrive at the success.

1.8 Definitions of Important Terms

1.8.1 Technology

Technology is the application of scientific discoveries to the production of goods and services that improve the human environment. New more comprehensive definition of technology incorporates that element which describes firm-specific competence in production (Cantwell, 1999). Technology also includes all intellectual property and know-how.

The term technology is used to denote the body of knowledge that enables the ideas, inventions, concepts, or technique of science to be applied for commercial

purposes. Technology seeks the application of science to readily useful and primarily commercial ends (Dunning & Stever,1969). Hence, the term technology creation refers to the work the companies carry out to bring new product into market as well as the related work involved in developing and altering the product throughout its subsequent forms and improvements.

According to Ettlie (2000), core technologies are new products and service technologies, operation technologies such as those in manufacturing and information technologies. Sometimes, the concept of a single technology may be used in reference to a body of knowledge or know-how that is readily distinguishable from others owing to outstanding characteristics. It becomes apparent that a product may include several technologies.

1.8.2 Technology Transfer

J. Terry Lynch, NIST defines technology transfer as "the process through which an individual or organization transferring to another individual or organization the knowledge required to effectively and efficiently make use of a specific technology for a specific application". Technology transfer is the diffusion of technology from the place of its introduction to other markets around the world. The diffusion may take place through market transactions, with one firm selling a product, process or skill to another.

Alternatively, it can be carried out within a firm through its network of affiliates. Also, technology transfer may take place through alliances between firms which agree to mutually use that technology, as in a joint venture or a cross-licensing agreement. According to Hayami and Ruttan (1971), a further distinction can be made between three phases of horizontal technology transfer:

- Material transfer
- Design transfer
- Capacity transfer

Knowledge transfer can be considered within the context of a broad definition of technology transfer. Charles and Howells (1992), for example, described technology transfer as `the diffusion of the complex bundle of knowledge which surrounds a level and type of technology'.

1.9 Organization of the Report

This report is structured with five chapters organized as follows;

Chapter 1 gives the introduction on background and overview on the primary focus of the study by highlighting the objective and significance of the study with the recitation of the research problem and questions.

Chapter 2 presents literature review on technology transfer, which draws on theory and observations of recent practices in transfer processes to identify key characteristics of the transferor-transferee relationships along which, success levels of transfer process differ. Theoretical framework as the model of the study and relevant hypotheses are proposed to test the model.

Chapter 3 discusses about the research method used to develop measures and collect the data on which the research findings are based and also the data analysis method used to validate the hypothesis and test the model.

Chapter 4 presents the analysis based on the results of the measurement work and relationship between variables based on the analysis output.

Chapter 5 concludes with a discussion of the results and their implication and contribution to theory, research, and practice for technology transfer.

Chapter 2

LITERATURE REVIEW

2.1 Introduction

This chapter presents the literature review on technology transfer, which draws on theory and observations of recent practices in transfer processes to identify the key characteristics of the transferor-transferee relationships along which, success levels of transfer process differ. Theoretical framework as the model of the study and relevant hypotheses are proposed to test the model.

2.2 Overview of Technology Transfer

Although international technology transfer has been going on for a long time, the scale and impact of such activities have vastly accelerated in the past 150 years or so. The industrial revolution, beginning in Great Britain in the last third of the eighteenth century, had at its center, a rapidly expanding armamentarium of new technologies involving new power sources, new techniques of metallurgy and machine making, and new modes of transportation. These new technologies when successfully organized and administered, brought immense improvements in productivity that transformed the lives of all participants (Cantwell, 1999).

The business literature generally refers to at least three types of technology; product, process and management. Each of these types of technology can create a competitive advantage for the firm that possesses it. That is, although all firms possessed each type of technology, an advantage accrues to firms that are able to obtain and deploy superior technology. One of the most interesting aspects of the history of technology transfer is the difficulty of controlling and containing its spread (Cantwell, 1999).

According to Lake (1979), Internationalization of a company's operations will generally involve several forms of technology transfer. Three main categories of transfer of primary importance are market level, production level and research-level transfers. The training and movement of people provide one vehicle by which new technology is diffused and applied. The economics of such activities depends upon how this is organized and the type of specialized knowledge being transferred.

In any event, the movement and training of individuals to effectuate the transfer of technology is likely to be designed so as to minimize cost of coordination (including costs of transportation, communications, training and administration). With the internationalization of company activities, the economics of marketing, production and development activities determines, to a great extent, the form and the mode of international technology transfer within overall corporate strategy (Cantwell, 1999).

Transfer of technology was mainly done through the training and transfer of experts and organizational forms of wholly owned subsidiaries and international partnerships. The technology brought in by multi-national corporations (MNC) is thought to be superior to that of domestic companies and through a number of mechanisms such as Foreign Direct Investment (FDI). FDI has been regarded as the dominant form of resource and technology transfer from developed to developing countries (Cantwell, 1999). MNCs have become the most important actors in the generation, application and international transfer of modern technology, when it is generally agreed that technology is a key determinant of economic growth, international competitiveness and trade performance.

Technology can be transferred in many ways and for a variety of reasons, but three most prominent situations are the following:

a. technology can be transferred within the realms of science and technology themselves,

b. technology can be transferred within societal level from one geographical location to another usually for economic gain, and

c. technology can be transferred from one society level, both internationally and intranationally, ostensibly for development.

Technology transfer can be either horizontal or vertical. Vertical transfer is generally internal to the enterprise and takes place by the incorporation of new knowledge from the idea stage to its final development. Horizontal transfer involves the transfer of proven or tested technology from one industry or country to be adopted or applied in another industry or country (Bradbury, 1978). In any type of technology transfer, the prime objective is to transfer production knowledge from one location to another in order to undertake specific production activities.

The **speed** of technology transfer processes depends upon the rates of change at three levels. At the **market level**, the product innovations of the MNC shape the utilization of resources in the host country directly through their influence on international patterns of competition, consumption and production. At the **production level**, the technical ideas, methods and skills of the MNC stimulate technology directly by changing the processes and organization of production in the host country. Finally at **R & D level**, the host country firm or foreign subsidiaries are capable of pursuing parallel and competitive R & D programs.

Measures of **intensity** of technology transfer between countries can be based on the extent to which consumption patterns and resource utilization patterns are changed through the introduction of new technology and the extent to which its utilization invokes the absorption of new methods and techniques into the fabric of

economic activity. Alternatively, the **level** may be measured in terms of utilization of new technology for market entry in the host country (Cantwell, 1999).

2.3 Importance of Technology Transfer

Technology in any firm is a product of a steady search for improvements and a learning process (Usher, 1929 in Cantwell, 1999). Little of human endeavor or condition is untouched by technology today. New products account for significant revenues, new processes enhance productivity substantially and business process reengineering is a fact of life in many companies (Ettlie, 2000). Technology is the fascination of all walks of life. The advantages of using the technology were predicted to make significant improvements in manpower use, machining time, prolonged tool life, quality and inventory savings.

New technology changes the knowledge base of organizations by enhancing the product or service capacity of units and underwrites the processing capability of operations. The creation of technology, even without its actual application means that it has a "technological reserve capacity" in case its markets are challenged. The plan of tactical defense by the multinational corporations (MNC) in the event of challenge or competitive threat is frequently embodied in reserves of technology that remain underutilized until required (Cantwell, 1999).

Ansoff (1965) has suggested that the strength of individual corporate strategies lies in choosing technologies that are most complementary to the firm's existing facilities and its desired direction of movement. The synergies arising from complementary technologies may thus shape corporate strategy. On the other hand, a firm with adequate cash flow may utilize a part of it to branch out into new technologies so as to achieve a stronger overall approach to technical markets and

territories and retain its advantages over rivals and sustain its company growth (Cantwell, 1999).

Cantwell (1999) argued that advanced science and technology, which used to be an "advantage" in earlier phases is fast becoming a "necessity". The reasons are

i. basic scientific knowledge is playing an increasingly crucial role in opening up new possibilities of major technological advance;

ii. many recent breakthroughs have occurred as a result of cross-fertilization between scientific disciplines, and

iii. technology has acquired stronger systematic features.

These features are the hallmark of not only spectacular developments in space technology, telecommunications or military systems, but also of more mundane, albeit revolutionary, technologies in CAD/CAM, new materials, etc.

2.4 Theories of Technology Transfer

Drawing upon the theoretical perspectives, theory of technological competence, resource dependency theory, social exchange theory and team effectiveness theory, our study develops and tests a model of success of technology transfer process that incorporates the effects of the relationship between transferor and transferee as mediated by complexity of technology.

2.4.1 Theory of Technological Competence

Basic technological competence is a condition for survival of firms, but there are varying degrees and types of competence among surviving firms. First, the theory proposes that in any international industry, firms with a higher degree of technological competence will grow faster than others, thereby increasing their market shares.

Second, the theory rests upon the nature of technological development. Third, it determines the level of technological competence of the firms.

The theory forms a part of a broader approach to competitive advantage. This broad approach views firms as having inherent capabilities for expansion, rather than simply responding to changing conditions in the external markets. The theory suggests that variations in innovative capability are a result of the nature of technology and the way in which it develops (Cantwell, 1999). The basic tenet is that technology is partially tacit, is specific to the context in which it has been created or adapted (the firm and the location), and independent upon the learning and skill of those who have developed and operate it. Technology in any firm is a product of a steady search for improvements and a learning process (Cantwell, 1999).

According to this theory, firms should possess technological competence in order to be gain competitive advantage over rival firms and it is imperative for them to acquire advanced technology by means of technology transfer unless they can create their own technology, which in turn leads us to another theory, the resource-dependency theory.

2.4.2 Resource-Dependency Theory

The basic premise of resource dependence theory is that organizations are open systems. From this it follows that organizations (1) are not sufficient, (2) cannot generate necessary resource internally, and (3) must mobilize other resources from other organizations in their environment if they are to survive (Yuchtman and Seashore, 1967).

To acquire the necessary resources involves interacting with other organizations that control that critical resources (Pfeffer & Salancik, 1978). A

technology can be embodied in all three types of firm resources; physical, human, and organizational (Tsang, 1997). Hence, it can be assumed that technology transfer is to a great extent based on the concept of resource dependency theory.

Resource-dependency theory (e.g., Pfeffer and Salancik, 1978) suggests that mutually dependent parties, being interested in sustaining their relationship, will be more accommodating, open to influence, and willing to make adaptations than asymmetrically dependent parties who will either coerce or be coerced. Thus, this concept guides us to look at the technology transfer from the following theoretical perspective.

2.4.3 Team Effectiveness Theory

Another point of view of technology transfer is from the perspective of team and teamwork. In most cases, members of both donor and recipient firms carry out technology transfer in a form of team process. Thus, it is imperative to look at the effectiveness of teamwork as a prerequisite of transfer success. Obviously, the transfer team consists of members with either homogenous or heterogeneous characteristics.

Demographic research on team composition has examined differences in observable characteristics such as age or functional background, showing that team similarity is positively associated with team effectiveness and interpersonal attraction (Hambrick & Mason, 1984; Tsui et al., 1992). Second, the cultural diversity literature (e.g., Cox, 1993; Cox, Lobel, & McLeod, 1991; Jackson et al., 1992; Watson, Kumar, & Michaelson, 1993) encompasses studies of team members' demographic backgrounds and highlights demographic variables presupposed to relate directly to cultural attributes, values, and perceptions.

It is necessary to look at the effectiveness of a team by its conformity to norms and cohesiveness. According to Schermerhorn, Hunt and Osborn (1999), the highest performance is achieved when there is highest level of cohesiveness and most positive performance norms.

2.4.4 Social Exchange Theory

Technology transfer can also be viewed as a social exchange process since social exchange relationships develop between two parties through a series of mutual, although not necessarily simultaneous, exchanges that yield a pattern of reciprocal obligation in each party (Blau, 1964).

According to the theory, one party makes a contribution or provides a service to the other party, and in so doing develops an expectation of a return at a future time. The other party, having received something of value, develops a sense of obligation to reciprocate. With the roots in social psychology, the social exchange theory emphasizes techniques of managing dependence and uncertainty (Anderson & Narus,1990; Frazier & Summers 1994; Salancik 1978).

Social exchange theory explicitly considers the role of adaptations in interpersonal relationships, though it refers to such adaptations as investments (Rusbult, 1983). Social exchange theory's premise is that there will only be incentive to reciprocate the vulnerability inherent in cooperative behavior if exchange partners are dependent on each other (Homans, 1961). The cooperation required to capture the stag is only forthcoming when all the hunters perceive their interdependence.

2.5 Conceptual Foundation

Nowhere has such new thinking been more evident than in the arena of relationships in technology transfer processes. All participants in the transfer process count the interpersonal rather than technological dimensions of the technology transfer to be their most significant challenge (Jassawalla & Sashittal, 1996). Recent studies have supported the fact that all types of technology transfer often require closely coupled relationships between transferor and transferee.

Building on and adapting theories from a variety of disciplines, marketing researchers have provided new insights about how factors such as trust or commitment influence behavior in relationships (Anderson & Weitz 1992; Morgan & Hunt 1994), and the effect of relationship characteristics on key performance outcomes (Lusch & Brown 1996, Noordewier, John & Nevin 1990). These studies have advanced knowledge hypothesizing and testing linkages among a wide variety of relationship-relevant constructs.

As the preceding suggests, it makes sense to characterize the relationship between transferor and transferee of technology in a variety of different ways. During technology transfer process, some may be connected or related with formal contracts as well as trusting agreements; some may be connected with open communications or some may treat every piece of information as secret; some may be connected by a shared sense of cooperation and others may act as if they were totally independent (Cannon & Perreault, 1999). Thus, it makes sense to conceptualize relationships in terms of multivariate profiles of these different predictors of successful technology transfer.

Building from theories of relationships and empirical research across several disciplines, this study specifies three key underlying dimensions (predictors) that

characterize the manner in which both parties involved in the technology transfer process relate and conduct relationships. Measures for these relationship connectors such as communication, cooperation and trust are developed in a series of pretests. Furthermore, the research specifies moderating nature of technology (complexity of technology) and shows how it affects the success of transfer, when specific types of relationship are used. The literature of variables, which are conceptualized in the model of this study, can be reviewed as follows.

2.6 Success of Technology Transfer

Views for what constitutes success in technology transfer can vary considerably; some say a transfer is successful only when it becomes a profitable product or process, while others claim a transfer is successful when the technology is at least reviewed for possible use by another person or organization. Successful knowledge transfer, which in line with Zander (1991) means that transfer results in the receiving unit accumulating or assimilating new knowledge.

Generally, it is accepted that increase in market share, increase in revenue, profitability, cost reduction and improved product and process quality reflects the success of transfer process. According to Leonard-Barton and Sinha (1999), the success in technology transfer in terms of user satisfaction depends upon both the characteristics of the technology and process of the transfer. Characteristics of technology include performance and cost effectiveness of a new technical system and its compatibility with existing practices in terms of

1. Skills,

2. System's performance,

3. Functionality for task performance, and

4. Overall fit with organizational needs.

The successful transplantation of a technology involves the domestic capacity to alter, modify, and adapt in a thousand different ways, often subtle and evident to a person with considerable technical expertise. An economy that lacks the domestic capacity to do these things is most unlikely to make successful use of innovations developed far away and in response to a very different set of circumstances (Cantwell, 1999). Conversely, the economy that possesses or acquires this capacity is in a position to draw upon more advanced technologies abroad in ways that can yield spectacular results. Social, organizational and technical objectives can be achieved through harmonization, organizational restructuring, enhanced task flexibility and the adoption of new technology (Preece, 1987).

Increasing use of alliances and globalization are two established trends, which have important implications for the success of technology transfer because the diversity of relationships is increasing rapidly. There are continuing challenges to capture benefit and avoid the cost or "reverse technology transfer penalties" from working with the representatives from transferor's or transferee's firms. Most companies do not have this experience in managing these relationships, but this know-how is difficult to imitate and therefore a competitive advantage to arrive at success (Ettlie, 2000).

Thus, the success of technology transfer is driven by a strong technological as well as strategic logic and positive relationship between the participants of transfer process. There is an expectation that it would enable the two firms in the transfer process to take advantage of the complementarity of each other's knowledge and expertise to achieve synergistic benefits and raise their competitiveness in the global

market. The successful relationship between transferor and transferee thus depends on their ability to develop an organizational infrastructure and working relationships to forge the 'knowledge links'. It hinges on the effective management of mutual exchange and transfer of knowledge and expertise.

2.6.1 Measurement of Success

Measuring the success of transfer becomes necessary to know whether the model of this study is good or not and also to know the impact of transferor-transferee relationship. In order to measure the success of technology transfer, a multitude of factors should be explored. In the research done by Noori (1996), the dimensions used to measure the success of advanced manufacturing technology implementation are product quality, manufacturing skills, delivery speed, inventory control, price, R&D skills, marketing skills and ability to handle variable product volume and variety of product design, i.e., flexibility.

It can be concluded from the findings that the implementation was successful by the factors of "faster turn around, reduced labor cost" and reduced overall unit cost" with respect to the actual impact of the technology on vendor companies. With respect to the actual impact of technology on anchor companies, the greatest impact was achieved in the areas of "better quality, "reduction of labor cost" and "increase in offering a wider range of products" and "greater capacity to meet demand.

In this study, the measurements of technology transfer process of are based on the concept performance measurement of Tenner and DeToro (1992). The three dimensions they used to measure the performance of product or service are in three levels, process, output and outcome. Thus, in this study, the measurements of success

of transfer process are categorized into output and outcome to determine the level of overall effectiveness of transfer process.

2.7 Transferor-Transferee Relationship

The role of key individuals and key relationships is signified in innovation management processes, where the distinctive practice is based on an understanding that it is people who actually manage and transfer technology.

The relationship model of technology transfer implies not only of the technical knowledge to produce a product, but also the capacity to master, develop and produce autonomously the technology underlying such products through the reciprocal relationship between transferor and transferee. Knowledge is generated and stored 'organically' in team relationships and the mode of coordination is human network based. This type of knowledge is not amenable to systematic codification and can only be accessed and transferred through intimate social interaction and coordination (Kogut & Zander, 1992).

Knowledge is utilized and transmitted through intensive and extensive interaction between group members. Stable, positive relationship is achieved through frequent reciprocal communication, mutual adjustment and mutual adaptation among members with common knowledge and shared implicit 'coding schemes' accumulated through group interactions.

A research by Sivadas and Dwyer (2000) used the term "cooperative competency" to refer to the midrange variable composed of interrelated facets: communication, coordination, and trust. Cooperative competency is a property of relationship among the organizational entities participating in new product