CRITICAL SUCCESS FACTORS OF TECHNOLOGY TRANSFER: AN INVESTIGATION INTO THE HEALTH SECTOR OF BANGLADESH

By

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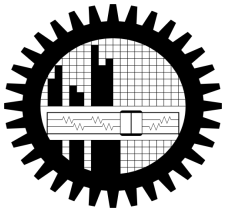

INSTITUTE OF APPROPRIATE TECHNOLOGY

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY

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A thesis paper submitted to the Institute of Appropriate Technology (IAT), Bangladesh University of Engineering and Technology (BUET), Dhaka, in partial fulfillment of the requirements for the degree of Master of Science (M. Sc.) in Management of Technology (MoT).

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Certificate of Approval

This thesis paper titled " Critical Success Factors of Technology Transfer: An investigation into the health sector of Bangladesh " submitted by Md. Ahsan Uddin Murad, Student ID-0413292054 (F) of session April 2013, has been accepted as satisfactory in partial fulfillment of the requirement of the degree of Master of Science in Management of Technology on 16th March, 2019.

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Declaration

I do hereby declare that the no part of this thesis has been submitted elsewhere for the award of any degree or diploma.

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This dissertation is dedicated to my parents,

Late Ahmad Hasan

and

Majeda Khanam.

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Abstract

The present thesis intends to find out the critical success factors, which exert defining role in the successful technology transfer from the technology-rich nations to the developing nation, being focused on the health sector of Bangladesh, which is increasingly playing pivotal role in raising the standard of living and physical nourishment, as well as the level of economy. The role of technology in this regard is well-founded, due to its reliability and economic value. Data was collected by questionnaire & conducting interviews at various levels of employees of different tertiary level hospitals, technology suppliers, policymakers and practitioners concerned with the heath sector of Bangladesh. Using a mixed methodology the study finds that very medium and low-level complexity instruments technologies has been transferred to the health sector of Bangladesh. The study also revealed that so far no technology owners has transferred whole package of technology to the their recipients in the sector. The study pointed out that due to very high technology gap, owners' willingness to transfer technology plays the pivotal role in the effectiveness of the technology transfer. The study also shows that recipient's Involvement in the transfer process, Effective Communication between technology senders and receivers, policy support, Internal readiness, Training, Bangladeshi Organizational culture, adequate testing are most critical success factors of effective technology transfer to the health sector of Bangladesh.

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CHAPTER ONE: INTRODUCTION

1.1 Background and Motivation

The age of ever-expanding technological sophistication and horizon has rendered the firm's core strength hinge upon its radar to perceive the continuous changes in the external environments. (Iansiti,1997). However, the dynamic relationship between the firm and the external environments has seen some changes with technology becoming more and more intricate, forcing companies team up with other ventures. What's more, the ever-broadening liberalization of market economy beefing up the competition by manifolds increase has lowered the product cycle, translating into a break-neck struggle to stay in the game (Grindley P. C., Teece, 1997). Not to lag behind in this race for technological dominance and flourish, the firms can collaborate with other companies in the form of exchanging technology knowledge they lack mutually, fostering a win-win situation for both the parties in a long-term vision. Acquiring and absorbing new technologies, the receiver can gain competitive edge in the market, while providing the transferor with an opportunity to left-over knowledge. Despite not being the guarantor of leadership and financial benefits, technology ascendancy has been a key factor in delivering advantages over others.

The topic of Technology Transfer is important in the context of developing and emerging economies because successful Technology Transfer and local technological development efforts can play a crucial role in the economic development of a recipient country to higher value added products/activities. It can also facilitate the recipient firms‘ efforts to move up the global value chain. For example, Korea, China and to some extent India, have moved up in value added global production networks on the basis of Technology Transfer and local technological development efforts. For the countries struggling to catch up with the developed countries, the Technology Transfer can be great deal, arming them with valuable technologies and knowledge extremely hard to produce locally, leading to a significant increase in production output and efficiency which has been evident in the case of China, Korea, Taiwan and other East Asian countries who have scaled up in the technology-intensive manufacturing and production (Lall 1992, 1998). Researchers enquiring the development of companies and country economies in the sphere of technological knowledge have confirmed the critical importance of transferred knowledge for the receiving countries in an effort to achieve core competency (Lyles and Salk, 1996; Tsai, 2001; Zahra *et al*., 2000) with many others scholars hinting at the same findings with regard to Technology Transfer (Szulanski, 1996, 2000; Dyer and Singh, 1998; Dyer and Nobeoka, 2000; Gupta and Govindarajan, 2000; Simonin, 1999, 2004; Zander and Kogut, 1995).

Some more respective scholars, likewise, have thrown weight to the effectual Technology Transfer in a surrounding of intense rivalry and uncertainty (Hansen, 2002; Pérez-Nordtvedt *et al.,* 2008; Bhagat *et al*., 2002) since commercialization of technological knowledge leads to higher degree of research and innovation (Cohen and Levinthal, 1990; Nahapiet and Ghoshal, 1998). Numerous scholars have been studying Technology Transfer from various views: Gupta and Govindarajan (2000) enquired the transfers to understrappers from the TNCs and Lyles and Salk (1996) endeavored to look at the exchanges among the MNCs to their sister concerns in the developing economies. Technology Transfer between joint ventures has also been scrutinized.

However, there has been a marked paucity of studies evaluating the role of Technology Transfer in the health sector of Bangladesh. Although the advantages of Technology Transfer are quite self-explanatory, there is an utmost lack of study determining the effectuality of Technology Transfer from technology-rich nations to Bangladesh. The study on the role of Technology Transfer in the health sector alone is a far cry. Our knowledge on which plays a pivotal role in a successful Technology Transfer is still in infancy since Technology Transfer among different firms or organisations is way harder to assess than those occurred among segments of the same companies (Inkpen and Tsang, 2005). Fruitful Technology Transfer becomes more difficult to achieve as some significant and unavoidable factors – the issue of trust, mode of transfer, the intention of the sender firms to hold back critical technology- come into the broad picture in the entire process.

The present thesis, therefore, intends to find out the critical success factors, which exert most critical defining role in the successful Technology Transfer from the technology-rich nations to the developing nation, being focused on the health sector of Bangladesh, which is increasingly playing pivotal role in raising the standard of living and physical nourishment, as well as the level of economy. The role of technology in this regard is well-founded, due to its reliability and economic value. The next consideration, consequently, is the transfer of technology from the developed country with possibilities of adaptation or application of the technology in the real-world business operation, which, in many instances, has been found substantially hard and a lot more difficult than assessed previously. A wide range of bottlenecks has presented the researchers the crucial task to figure out the optimal Technology Transfer process, suitable to a particular field or industry, i.e. health or microfinance (Mitchael, 2005). Researches accomplished thus far have identified the Technology Transfer process to be an issue with vast strategic implications (Hong Liu, 2000). This ongoing thesis, hence, warrants ample justifications and relevance in the context of the health sector of Bangladesh for multiple reasons:

- Firstly, the health sector of Bangladesh has experienced significant changes and modifications since its coming into existence in 1947. Starting with liberalization in the 1950s, Bangladesh shifted the course towards hardcore nationalization in 1970s, followed subsequently by phenomenal liberalization after the collapse of Soviet Union and the emergence of the unipolar world order.
- Secondly, the health sector encompasses significant R&D initiatives and calls for technological innovation in its day-to-day operation and provides arenas for vertical business opportunities for the local instrument/service suppliers and upstart with particular focus, as evident in the establishment of several prominent technology suppliers companies with local firms. Based on the context and experience, the thesis intends to evaluate the Technology Transfer effective with regard to the health sector.
- Thirdly, the health sectors can wield ripple effect in the economy as having the need for a large variety of components and critical instruments, which, in turn, demands a long supply chains. The MNC's establishment of manufacturing plants in the country can benefit the local suppliers.
- Fourth, successful technology transfer to the sector has tremendous and immediate impact on the community wellbeing as well as create a backward linkage of efficient gross domestic production from a healthy nations.
- Fifth, even though government expenditure on healthcare has become manifolds in recent years, it is reported on regular basis a large number of technology transfer failure in the

health sector.

- Finally, the finding sought from Bangladeshi case will provide landmark insights into the field of Technology Transfer and its effectiveness, enriching the hitherto studies on the Technology Transfer process.

1.2 Objectives

The objectives of the proposed study are

v To identify the potential Critical Success Factors (CSFs) of Technology Transfer to the health sector of Bangladesh considering triple helix framework

v To perform a multi-variable regression analysis on identified factors to assemble the most pertinent CSFs in context to the Health sector of Bangladesh.

v To evaluate path relations of identified CSFs in order to examine the possible causal linkage between identified CSFs using Structural Equation Modeling (SEM) approach

1.3 Research Design And Methodology

The research is qualitative in nature with some ingredients from quantitative analysis. Literature analysis lays out a brief overview of the basic building blocks in the execution of Technology Transfer process. The qualitative analysis, on some eighteen Dhaka based public hospitals, offers critical insights in the ordering of problems according to their level of importance and seeks existing linkages among the factors in attaining successful Technology Transfer projects. Out of the two-levels of data collection method of the thesis, the first one employs theory-steered explorative semi-structured interviews of twenty healthcare technology recipients/providers, fourteen big health care plant installers as well as ten officers employed in the Ministry of Health and Family Welfare. The research approach appointed in this data collection procedure has been elaborated in the chapter five. The second phase conducts survey method by providing fifty technology recipients' stakeholders and with face-to-face survey questionnaires. The rationale behind survey method is to gain quantitative data to define interrelationship among the variables (Saunders et al. 2009). The effects of the qualitative methods, in conjunction of the survey methods have been detailed in chapter three with Technology Transfer effectiveness in the health sector of Bangladesh earmarked as the context of the whole research.

The study, however, sustains various limitations. First, the samples comprise, for the most part, of hospitals situated in Dhaka, while the health sector concern with the whole of the country. Most importantly health sector is comprises of various sub sectors, for example pharmaceuticals industry, diagnostic center etc. However our focus is mainly on hospital subsector. Further research in this regard might address the spatial problems by conducting studies to find out territorial influences as well as subsector applicability. Secondly, the analytical level is confined to project level, not taking the recipient's long-run vision in the business. This might be addressed by further studies targeting on the entirety of the company (recipient) level. Empirical section involves the analysis of three statistical measures: means, cross tabulation analysis and ANOVA. Analysis of means was aimed at appraising the importance of the each proposed problem. Cross tabulations was employed to measure the correlations between various variables such as the types of technology and the size of the hospital (recipients). ANOVA was directed to seek to find out whether there is statistically substantial difference between different segments of the recipients regarding different size and social context. Linear and path relations between and

among factors is best explained and analyzed by LISREL software. However due to fund limitation, licensed LISREL software could not be organized. Hence equivalent analysis has been done considering Spearman Correlation value and Pearson value. However, only few relational inherence between variables have been tested, leaving others, considering huge numbers of possible combinations between/among variables.

1.4 Contributions

The present study concentrates on finding out ways to increase the level of Technology Transfer effectiveness in public health of Bangladesh, detailing on how the technology acquisition process can be smoothed, how the commercialisation projects could be advanced with a view to meet up the demand of the technology race of the time. The research will provide both the sender and recipient with valuable insights into the Technology Transfer process, contributing to the increase in the volume and scope of Technology Transfer programs. Without a prior feasibility study dedicated to apprise the possibility of assimilation and a post-installation evaluation of effectiveness, efficacy, efficiency, response from the user end, the degree to which the goals have been achieved, the Technology Transfer process is said to be incomplete and remains to be abstruse to gain any further insights for future projects, thus hindering the future projects to benefit from the past ones undertaken. A complete study of the Technology Transfer process, usually neglected in the recipient countries, would benefit us to monitor and predict the adverse or positive impacts of any fresh technology in a new environmental or social setting.

The research brings in contributions, which can be categorized as theoretical, empirical and methodological. The study can be described as the first of its kind in enquiring the effectual level of Technology Transfer in a grand focus with details on Technology Transfer process, typology of Technology Transfer, mechanism employed in the process, factors connected to recipient (intention to learn, capacity to absorb), organisation-to-organisation dynamics (the degree of trust and social bondage), sender related issues (i.e., sender's intention to share technology), etc.

Second, the study, instead of focusing on the total size of the Technology Transfer, chooses to scrutinize the effectiveness of the entire Technology Transfer process by utilizing delicate measurers such as the depth and breadth of the acquisition of technology as well as exploratory innovations.

Third, the thesis comes with a novel contribution in the field of Technology Transfer effectiveness by endeavoring, in addition, to find out the degree of efficacy in the health sector of Bangladesh.

Fourth, in contrast to previous researches, the present study looks into Technology Transfer effectiveness through the perspective of the senders, receivers and other entities linked with sectors vertically or horizontally, thus producing a holistic view of the Technology Transfer effectiveness which might be replicated in other national or international cases.

Fifth, combining different theoretical flows- resource-based view of the firm (RBV), Knowledge-based view of the firm (KBV), organizational learning (OL) and social capital (SC) perspectives, the research aims at studying Technology Transfer in an underdeveloped country apprising the utility of multiple theoretical perspectives.

Sixth, this study applies qualitative interviews supplemented with survey questionnaires.

1.5 Organisation of the thesis

Divided into seven chapters, the thesis will record in detail the critical success factors in the lead up to an effective Technology Transfer from the developed countries to the health sector of Bangladesh. Chapter 1 hashes out the background and driving factors, research approach and methodology, and potential of this research. Chapter two extends treatment on different theoretical perspectives - resource-based view of the firm, the knowledge-based view of the firm; organizational learning; and social capital- in an effort to untangle the composite development of Technology Transfer and its real-world implications by providing a solid foundational perspectives to realize the potential to gather worthful resources, the level and capacity of the receivers to absorb new knowledge and the valuation of intangible factors like trust-building and social ties in the Technology Transfer process to get practicable know-how. Chapter two also presents details on defining and much-used terms of the thesis, including knowledge, the transfer of technology etc. highlighting as well the need for the Technology Transfer process and the Foreign Direct Investment in this regard. Chapter three articulates the research questions and the abstraction of the research projects absorbing crucial penetrations from multidimensional theoretical discourses in a conceptual framework to devise codify and examine the data.

Chapter four submits the setting of the study by rendering a concise and succinct review of the health sector around the world with substantial emphasis on the Bangladesh health sector, looking critically at the policy matters and measures of Bangladesh in the overall health sphere. Chapter five formulates the research methodology by informing on the different qualitative and quantitative data collection method to look beyond the scale and volume of the Technology Transfer, i.e. the effectiveness of the process. Chapter six discusses the findings of the study by pulling in insights gleaned from interviews, observation, expert opinions and survey questionnaires to arrive at an overall view on the Technology Transfer process looking in depth on the typology of Technology Transfer, the physical setup to transfer the technology, the role of the receiving party, and the sender’s intents, trust building etc. In chapter seven, findings are summed up in a brief context and discussed shedding light on the existing literature reviews. At the end, the chapter closes the thesis by spotlighting the limitations of the thesis and future research guidance.

CHAPTER 2 LITERATURE REVIEW

2.1 The concept of technology

What is Technology?

Through the use of technology, human beings have eradicated their physical restrictions. By careful interact with their environments, continuous learning and gathering objective knowledge of the universe, humanity succeeded in breaking grounds to claim their place in the hostile environments eliminating the need to remain afraid of animals and other animate beings by establishing control through the effective and efficient use of technology (Basch, 1993, p. 354). Past researchers saw technology from different viewpoints, shaping research process and findings, influencing Technology Transfer negotiation schemes and government policy thereby generally, thus giving technology different connotations across different academia and policy levels of the entities involved. According to Kumar et.al (1999) technology consists of two primary components: 1) a physical component which comprises of items such as products, tooling, equipment, blueprints, techniques, and processes; and 2) the informational component which consists of know-how in management, marketing, production, quality control, reliability, skilled labor and functional areas. Technology is always connected with obtaining certain result, resolving certain problems, completing certain tasks using particular skills, employing knowledge and exploiting assets (Lan and Young, 1996). The concept of technology does not only relate to the technology that embodies in the product but it is also associated with the knowledge or information of it use, application and the process in developing the product (Lovell, 1998; Bozeman, 2000).

Tihanyi and Ruth (2002) contends technology as something articulated with obtrusive information difficult to decipher, thus giving technology a quality to be kept secret or hidden from the competitors which, by Polanyi (1967) it is called tacit knowledge - exclusive to a firm or company. Qualities as such hinder technology from being copied or transferred for further use by other entities with somewhat similar features (Rodasevic, 1999), which brings in competitive advantage for the company in control of the much-sought technology knowledge (Lin, 2003). Burgman etc. Al. (1996) viewed technology as a combination of theoretical and abstract knowledge, acquirement and artefacts applied in the production of products and services. Technology encompasses a wide variety of entities, ranging from people, concrete materials to cognitive processes, hardware, tools etc (Lin, 2003). Drawing from Sahals (1981), Bozeman (2000) saw knowledge and technology as intertwined as the transfer of technological product accompanies the diffusion of technology related it to the products transferred of which the knowledge of usage is a must to deliver when transferred. Mascus (2003) sought to broaden the horizon of the term technology by defining it as a combination of information and material hardware to produce a workable solution to the existing management, human problems, work process simplification, etc in the context organisation structure, management techniques, the system of financing mode etc.

2-2- The Basic Elements of Technology

Technology recognized as a transformer from input to output comprise of four rudimentary elements, namely

1. Techno-ware

The touchable or tangible materials belong to the first element of technology, constituting of solid machinery and component parts which function the major role of converting inputs into outputs. Appropriate to the discussion of tech-ware are two more factors, 1.1 the underdeveloped countries attribute more premium to the hard-elements of technology, occasionally neglecting the other three factors. 1.2 the interested political leaders and industrialist are fixated on acquiring more and more tech-ware instead of developing the other factors to produce intangible knowledge, thus obstructing the national advancement in critical technology and features.

2. Human-ware

Defined as the living component of the industry, the human-ware performs the core functions of management, operations, maintenance, adaptation, input-output dictation in the highest fruitful calculations etc. Shortage in the adequate knowledge of technology in the human-ware translates into lagging behind the developed countries in the race to technological advancements. Being the net importer of Technology, developing countries must strive to sophisticate their human-ware with sufficient Technology so as to utilize the imported Technology with the highest output possible. Adequate training in this regard might play a mitigating role.

3-Info-ware

Info-ware is the major element of Technology; it embodies all the technical information necessary for the smooth implementation of machinery obtained. Naturally producers of "technology" are more protective of info-ware than techno-ware. The main reason being that such information may include references to intellectual property, sensitive data etc. It is up to the recipient country to use the supplied information to best advantage.

4- Org-ware

Org-ware can be defined as the instrument for achieving goals. It comprises such activities as management, resource allocation and marketing. The effective co-ordination of these activities renders the organisation more efficient. In general, org-ware canalizes skills and know-how of "Human-ware" in order to achieve the best use of men and machine. The interaction of "Tech.-ware" and "Info-ware" on the one hand and the increase in technical development of "Human-ware" should lead to further advances. This makes the need for adequate data processing pivotal if productivity is to increase in line with more absorbtion of information.

2.3 Types of Technology

The management literature generally refers to at least three types of technology: Product – related technology; Process-related technology; and Managerial- related technology. In this section, the emphasis is on product related technology.

2.3.1 Product related Technology

Product related technology refers to the knowledge used to produce any product, for example, the information that specifies the product‘s characteristics and its uses. In this type of technology, the flow of technological knowledge from the sender to the recipient firm is through the means of providing product design, the specification of products and the provision of feedback on specific product performance (UNCTAD, 2001). In the health sector context, suppliers may receive component design, technical specifications, quality control parameters and technical consultations on component characteristics and feedback on the performance of components from their technology owners.

2.3.2 Process related Technology

Process related technology consists of the knowledge used in the production process to organise inputs and the operation of the machinery. This type of technology relates to the process by which a given product or service is produced (Grosse, 1996). This may also relate to the assistance provided by the sender of technology in terms of providing machinery or equipment, or other process related technical support in the areas of manufacturing of products, quality control, inspection and testing. Through this assistance, the recipients may improve and streamline their processes to ensure that products meet the customer requirements.

2.3.3 Managerial related Technology

This type of technological knowledge is used in operating a business. The acquisition of this type of technology enables the firms to compete by using its resources efficiently. In the context of the health sector, technology owners may also assist their suppliers in adopting inventory management systems, for example, a just-in-time inventory. Technology owners may also provide knowledge related to financial planning, marketing know-how, purchasing and human resource development practices. Each of these three types of technology can create a competitive advantage for the organisation that acquires and possesses it. That is, although all organisations possess each type of technology, an advantage accrues to firms that are able to obtain and deploy superior technology (Grosse, 1996:782). Therefore, the transfer of these three types of technology from technology owners to the recipients of Bangladesh is the key for the development of a local recipient‘s technological base.

In this study, particular interest is given to the hard and soft aspects of Technology Transfer; mainly in the forms of **service-related; process-related and managerial- related technology** from International Technology Transfer owners have direct or indirect operations in the health sector of Bangladesh.

2.4 The concept of Technology Transfer from theoretical Consideration

2.4.1- Definitions and Description of Technology Transfer (Te Tr)

1-*Te Tr* may be defined as a "transaction" between two countries, by means of a treaty, or a contract between the provider country and the consumer country. As in all commercial transactions, pricing and market conditions play a crucial part.

2- From a legal view point, *Te Tr may* be conceptualised as the transfer or allocation of licence from the originator to the end user.

3- *Te Tr* is the importation of specific technologies from developed countries to underdeveloped ones, enabling the latter to apply the newly acquired tools to improve existing methods of production.

The chronological process of Te *Tr* is as follows: 1- Choice of Tech. 2- Acquiring of Tech. 3- Adoption of Tech. 4- Absorption of Tech. 5- Application of Tech. 6- Diffusion of Tech. 7- Development of received Tech.

In general, Technology Transfer can be defined as a flow of human knowledge from one human being to another, whether a transferor or a transferee is an individual, small or large enterprise, a university, a research institution or any other party (Souder, 1990, Ramanathan, 1994). A Technology Transfer can be carried out over different objects. Typically, such objects are associated with physical assets, for example, equipment, or some form of technical knowledge, which can take form of patent, documentation and others (Bozeman, 2000). Osman-Gani (1999) notices that Technology Transfer project can be implemented through the exchange of capabilities.

Technology Transfer refers to "the process of sharing and disseminating knowledge, skills, scientific discoveries, production methods, and other innovations among universities, government agencies, private films, and other institutions"(Acs & Audretsch, 2014, p. 1). Technology Transfer involves an array of formal and informal cooperation and action between technology developers and technology seekers. The transfer of knowledge, technical-know how, expertise, as well as physical logistic support and equipment installation all are part of Technology Transfer process. A technological innovation produced in a research and development (R &D) goes to a receptor organization by following several steps (Roupas, 2008, p. 4). Technology Transfer is an outcome of trade liberalization and the capital flows among countries as part of globalization. Foreign Direct Investment (FDI), a corollary of global capital flows, enhances the process of Technology Transfer from the developed to the poor countries (Ghosh & Guven, 2011, p. 33). The definitions and concepts of Technology Transfer have been discussed in many different ways based on the disciplines of research and according to the purposes of the research (Bozeman, 2000). Technology Transfer has been defined as the shared responsibility between firms in ensuring that technology is accepted and at least understood by someone with the knowledge and resources to apply or use the technology (T. Warookun, R. A. Stewart, and S. Mohamed, 2005).

The main beneficiary of this learning process is the country or firm on the lower technological trajectory. There are studies showing Technology Transfer between foreign affiliates and local enterprises between developed and developing countries B.Javorcik, 2004 on Lithuania and Garrick and Gertler on Indonesia. Past literatures have referred Technology Transfer as the transmission of know-how to suit local conditions, with effective absorption and diffusion both within and across countries (Chung, 2001; Kanyak, 1985). With multiple combinations, Technology Transfer has often employed to describe the process of moving ideas and conceptions from research facilities to the real world business environments (Phillips, 2002; Williams & Gibson, 1990), spreading of technology knowledge from the advanced countries to the underdeveloped ones (Derakhshani, 1983; Putranto et al., 2003), and the task to take business ideas to the end users. Technology Transfer enhances, as Autio and Laamanen (1995) came up

with a wider definition of Technology Transfer, an environment of interaction between parties in which the stock of technology related knowledge stays stable or grows in amount by the subtle process of technology exchanges between different entities for mutual benefit. Levin (1996) perceived Technology Transfer as the employment of technological know-how in the elimination of human problems

The concept of Transfer of technology knowledge goes beyond the consideration of exchanging appropriate technology or suitable machineries by taking into account the supposed degree by which the absorbing country will put the knowledge into realising the goals set earlier (Maskus, 2003) with Farhang (1997) voicing concern for the transfer of manufacturing related technology transfers in which the need arises for the inclusion of well-trained personnel and sophisticated, high-calibre engineering on top informative knowledge of technical know-how, product design, specifications, and other standard related issues. The paucity of the technology spillover effect in the developing countries is often said to be results of the lack of assimilation of the receipt technology into the local manufacturing discourse (L. Jabbour and J. L. Mucchielli, 2007). The development in many nations has been followed as the result of technology transfer, some studies find. (F. Najmabadi and S. Lall, 1995). Zoha and Reinsman (1992) in an elaborated discussion on Technology Transfer literature observe that the economists are disposed to describe Technology Transfer depending on the features of the type of the knowledge transferred with the central focus concentrated on variables relating to product design and manufacturing. They have also noticed the substantial contribution of the management researchers in the Technology Transfer literature who, unlike the economists, emphasized on transfer within a companies within similar nature and tend to look into the mutual interaction between management strategies and Technology Transfer (Rabino, 1989; Chiesa and Manzini, 1996; Laamanen and Autio, 1996; Lambe and Spekman, 1997). However, there follows a shift in the management studies to focus more on the alliance building and strategic partnerships to explain the importance of partnerships among companies to the emergence of Technology Transfer (Zhoa and Reisman, 1992).

2.5 Why Technology Transfer?

A great number of companies and firms are now resorting to Technology Transfer activities the importance of which can appreciated from looking at the contemporary technological business environments dominated by faster movements of services and products. Nonetheless, there remains a scarcity of studies aimed at understanding Technology Transfer effectiveness from organizational viewpoints. Technology Transfer encompasses the use of technology to achieve an objective that will be rewarded in the marketplace (Teece, 1976). Therefore, manufacturing, engineering, management, marketing, distributing and customer service are among the elements included in Technology Transfer. From the developed countries firms‘ point of view, there are two main explanations for Technology Transfer. Firstly, it is a tool or an instrument for them entering into other countries‘ market. As Baranson (1978) points out that developed countries firms‘ use Technology Transfer or technology sharing to avoid the associated risks of investing in developing countries resulting from economic and political issues.

Technology Transfer process, secondly, can be technically understood as a subtle and indirect mechanism to share the expenditure of developing technology by research and development

initiatives as scientific funding and resource availability, even in the most advanced countries, are not without constraints and Technology Transfer process facilitates the commercialisation and marketing of saleable technology boosting the companies ability to further research initiatives. Seen thorough the eyes of the companies and firms of the developing countries, Technology Transfer process is a suitable alternative to developing technology at home by huge investment and infrastructural development they simply can't afford, therefore accosting the MNCs for technological assistant which encompasses a pool of different assortments. The facts of resource unavailability and the hectic trajectory in the technology development worldwide push the technologically underdeveloped countries to assume the role of the technology followers. Technology Transfer initiatives in the international marketplace entail the sharing, exchanges and trade of technology by sender and receiver countries to produce in the developing countries to bolster national output and efficiency. (e.g., Chesnais, 1986; Baranson, 1976). As the stated reasoning above dictate, the Technology Transfer is necessitated by the demands arising in the developing countries' perspective, in which the firms can capitalise the valuable technology and informational initiatives developed in the advanced countries. The section following enunciates the multiple setup and channel through which Technology Transfer occurs among entities around the world.

The impact of productivity

Technology Transfer ushers in a lot of net positive benefit and advantages for the technology-lacking countries. The impact of which is treated in this thesis under some new headings: the differential level of productivity between the developed and developing countries stems from the divergence in the level of sophistication and installation of technological systems, thus the emerging countries catching up the developed countries are often seen bridging the gap in the field of science and technology, the effort to catch up is tantamount to reach the same level of productivity of the developed countries. Targetti and Foti (1997) drew comparability between two groups of economic prosperous nations with two most advanced nations that lie close to them- Four South American nations (Bolivia, Brazil, Chile, Mexico and Argentina) with their Northern neighbor- USA and rapidly expanding East Asian success, notably Hong Kong, Korea, Taiwan, Singapore with Japanese experience. The East Asian nations were bridging the technology gap with while the South American countries were facing stagnation in relation to the US technology, even backtracking in many cases owing primarily to instability, lack of good governance and other issues of business environments. (URL, 2014)

2.6. Channels of Technology Transfer

The process of Technology Transfer from the developed countries to the developing nations occurs through multiple steps or formats, as the case may be, namely licensing, parenting or joint ventures, expediting the transfer of basic knowledge, information, finding, understanding, innovative initiatives from the research establishment, facilities, government initiatives to the non-governmental or company-wise sectors (Parker and Zilberman, 1993). The Technology Transfer process is also credited with the role of filling up technology divide between the sender and the receiver nation (Arun, 2003), as well as benefiting the process of market development, business process improvement, outsourcing etc. (Moira, 2007).

As enumerated in the passages preceding, the receiver must take calculated strive and intense reciprocal relations with the technology supplier (sender) to benefit from the tacit aspects of the technological knowledge and information. Never considered and recognised as a public good, technology is a lot harder and difficult to be transferred and absorbed, due to unintended barriers and blocks,, than is popularly imagined. (Attewel, 1992). Despite the neoclassical views of technology depicting technology as a common public goods for unhindered access and usage, the modern literature tends to see technology as something beyond the characterisation of the hardware based material invention, rather some complicated invention neither easy to replicate nor easy to transfer (Mowery and Oxley, 1995). This is a compelling reason to view technology transfer as a lengthy process with information intensive (Mowery and Oxley, 1995).

Technology Transfer process is made possible by engaging some methods of interstate mechanism such as joint ventures, plant installation, foreign direct investment, providing licence, strategic partnerships, etc. the significance and effectiveness which differs across the countries. Foreign direct investment, among them, has been perceived to be most dominating channel in this regard, accomplished by the MNCSs, dominating the contemporary literature regarding Technology Transfer. The expansion of Innovation and the faster movement of technology from the incubation to the target users are greatly attributed to the liberal financial order of the late twentieth and the 21st century, which have sped up the seamless flow of capital and machineries around the world unhindered. (UNCTAD, 2001). However, all these hardly explain how Technology Transfer is done by companies involved.

The post-ww2 saw the emergence of MNCs in the developed world and the speedy movement of technology and capital among the nations, most of which were dominated by the transnational corporations and financial entities, spanning countries and, even, continents, leading as well in the R &D expenditure (Dunning, 1988). In a similar findings, Dyker (1999) enumerated no less than five distinct ways by means of which the host nation benefit from the FDI flow: (1) pulling the local economy into the orbit of the global economic order; (2) boosting the investment amount in a particular country; (3) supplying of hard manufacturing process technology to the developing nations (4) sharing of informative technology in the form of organisational development, business process automation etc (5) bring the local component suppliers and manufacturers in a refined platform. Thus, the developing nations got rid from the heavy burden of developing technology in their own facilities with an enormous cost and huge infrastructural set-up and, instead, relied on the multinational corporations and development partners for the acquisition of critical knowledge and information.

2.7. Defining Innovation models: From Closed to Open

With hefty backup of rich R&D resource and management capabilities, only the big corporations could take part in market systems to sell their products and services. To overcome the big corporations would require the establishment of costly R&D research facilities, which often precluded the entrance of newer firms in the market to make profits (Chesbrough, 2003). The balance of the business environments underwent radical changes as the large corporations started loosing comparative advantages emanating from the size and R&D opportunities as small firms and upstarts started looking for reasonable ideas to pick out market in other areas and presented sizable challenges to the large corporations, eliminating the advantage of the size of the firms. As a general rule, in-house R&D resource facilities lost the weight of crucial strategic assets which,

by Chesbrough (2003), was called Old Model “closed Innovation”- the traditional mode of Idea engendering and expansion through R&D initiatives attained in the grasp of the management efforts. Dominating the research establishment and facilities for a long times, the in-house research narrative had been the modus operandi for a long period of time (figure 1).

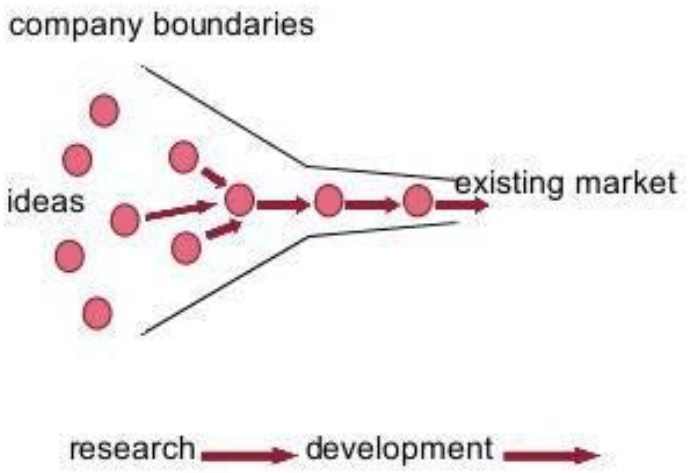


Figure 2.1. The Closed Innovation model (Chesbrough 2003)

The firms, following the closed Innovation model, spent a great deal on research initiatives, brought the brightest ones into the laboratory, and safeguarded the research outputs with highest level of security and secrecy as being seen as the prime factor of market leadership which ensured them expected market share and dominance, outdoing the others interested. Unsurprisingly, for the most part of the 20th century, the R&D factor has been influential determinant in the strength, performance and survival of a company or organisation in the market. The dominant trends of closed Innovation model was beginning to lose its luster as the advantage of R&D facilities started to erode due, Chesbrough (2003) the global mobility of work forces and skilled workers, i.e. the increasing availability of human capital which, again, translates into the expansion and spread of ideas from the long-held secrets hitherto exercised by companies around the world. On the other hand, the availability of upstart capital and unstoppable flow of financing made the acquisition of technology a lot more accessible and cost-effective. Partnering with corporations beyond borders, small companies could be able to compete with the large corporations falling under the pressure of the size itself. This process lead to the complete irrelevance of closed Innovation model and gave way to open innovation (OI) in which the knowledge and information become accessible in the wider marketplace, pushing secrecy in the back foot and calling into demand for the ideas producing elsewhere (figure 2).

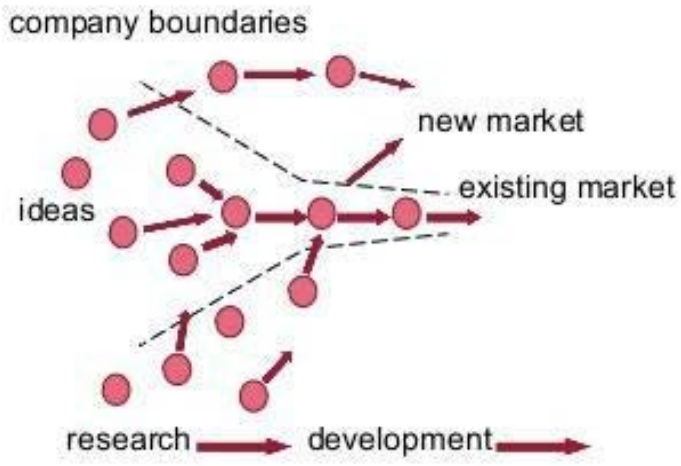


Figure 2.2 The Open Innovation model (Chesbrough, 2003)

2.8. Technology Transfer projects

The present study endeavours to find out the bottlenecks firms meet in the run-up to successful completion of Technology Transfer project, and the issues acting as building blocs in taking Technology Transfer initiatives. Realising of which requires an understanding of the essential precepts and the advantages of Technology Transfer projects, elaborated in this section, with a conceptual framework of Technology Transfer used widely. Among several reasons obstructing the successful completion of Technology Transfer project, the company's failure to realise whether the Opened strategy can add them any benefits whatsoever to be realised from long-term business perspective.

2.8.1. Competitive advantage of being "Opened"

Critical appraisal, of two cardinal drivers- cost and differentiation, is of pivotal importance in realising the degree and manner to which open innovation impacts competitive advantage (Reed and Storrud-Barnes, 2012). Three particular forms of rents- Monopoly rents, Ricardian rents and Innovation rents- play a vital role in the investigation of open strategy. For Reece (2014), monopoly rents entail the unnatural earnings materialised from monopolistic hold the company exerts without any thinking of competition from the rivals while Ricardian rents are sourced from the rare and precious resources. (Mahoney and Pandian, 1992). Hall (1993) identifies culture, values, goodwill, network, employee know-how as the elements of Ricardian rents. The latest type, Schumpeterian Innovation rents, vanishes with the advent of open innovation impacts forcing companies lay bare the fundamental technological know-how and information. The open innovation paradigm renders reverse engineering useless or less profitable as patents hardly make any sense. Taking all these issues into consideration, Reed and Storrud-Barnes (2012) offers a useful conceptual framework to look into the intricate relationship existing between open innovation and competitive edge the firms enjoy (see Table 2.1).

Table 2.1. What open innovation allows and takes away (Reed and Storrud-Barnes, 2012)

		Monopoly rents	Ricardian rents
Cost	**Allows**	Rents from barriers to entry from economies of scale in such areas as operations, and from experience curve effects in operations and knowledge management	Rents from employee know-how in such areas as operations, from organization culture, and from the network relationships with leaders in open innovation community
	Takes away	Rents from barriers to entry from scale benefits in innovation, and access to and the cost of capital	Rents from ability to capitalize on innovation synergies from R&D spillovers and the interaction between internal and external sources of innovation
Differentiation	**Allows**	Rents from product differentiations, distribution channel-control, and customer switching costs	Rents from firm reputation, employee know-how in such areas as operations, and organizational culture
	Takes away	Rents from proprietary product design	Rents from employee know-how and a culture that anticipates customer needs

Karnataka (2002) opines that companies will earn monopoly rents by resorting to Open Innovation, but doing so will diminish the rents that are achieved from capital requisite and the economy of scale. With increasing level of market competition and availability of capital rents, entry barriers for new competitors will die down, paving ways for harder market development (Kandampully, 2003) with Hall (1993) proposing the lingering of Ricardian rents relating to organizational values and strategic partnerships in the post-OI model, while the rents exerted from employee know-how will diminish in the process. This will also, Barney (1986) contends, increase the frequency of technology spillover and the failure of concerted R&D efforts.

2.8.2. Technology Transfer project implementation

What should come next into prior consideration is how the firms should pursue the successful completion of a Technology Transfer project, regarding of which integrative model, devised by J. P. Escher, of technology spreading gives us a deep perception of the Technology Transfer projects.

2.8.2.1. Escher's Integrative model of Technology Transfer

The Technology Transfer procedure conceived as the parallel stance of two technology flows was given by J.P. Escher(2005) (see Figure 2.3).

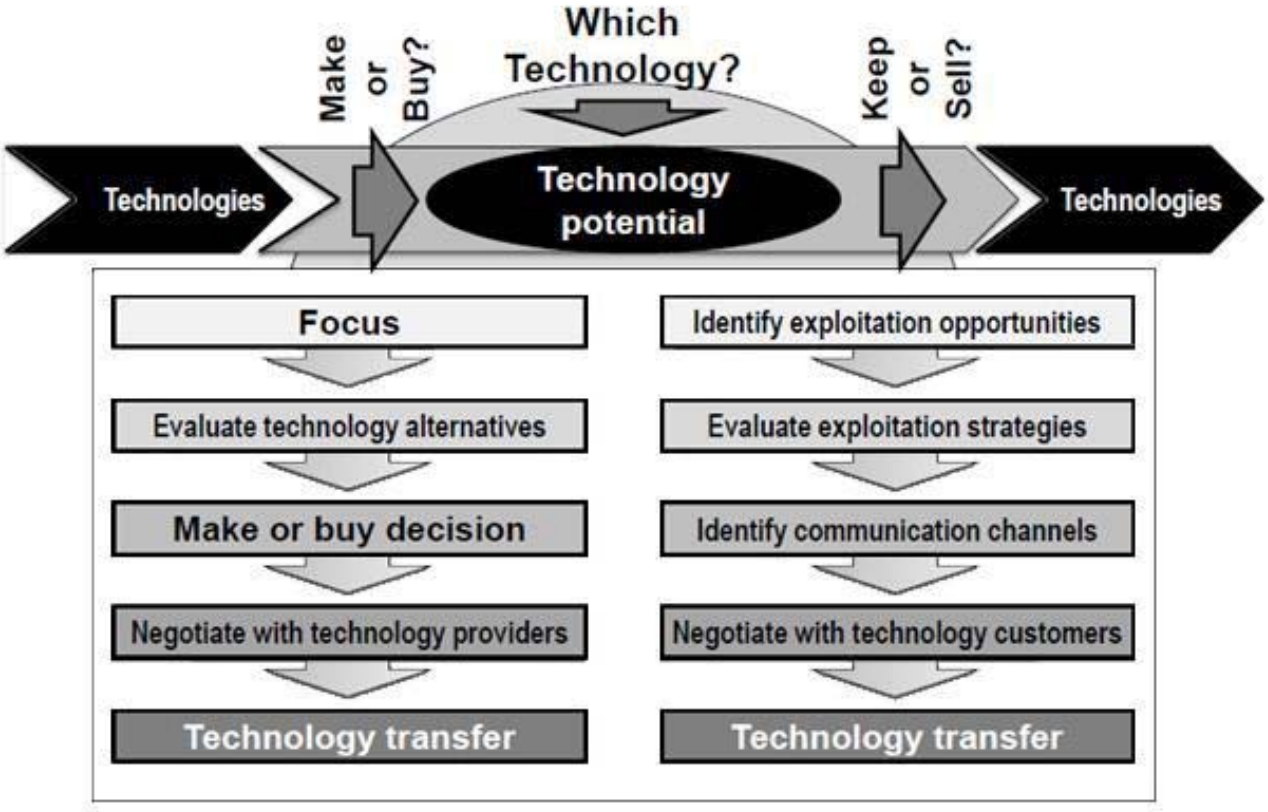


Figure 2.3. Integrative model of Technology marketing (J.-P. Escher's, 2005)

The external inflow begins with articulating the requirements essential to the company objectives, followed by tentative technology choices, meeting up the all the requirements previously agreed upon, are worded out which, in turn, is supplanted by another phase of holistic analysis in combination of evaluating financial and strategic advantages to the company. (Escher, 2005). The first step of inside-out flow initiates with scrutinising the technology options with exploitable in the marketplace, reaping adequate financial benefits to the company. As the channel for Technology Transfer is fixed by mutual correspondence, the sender firms decide to open up appropriate communication system to deal with upcoming technology transfer opportunities. Choosing the best partnership for Technology Transfer receiver becomes the central feature of the Technology Transfer process. The last stage (Escher, 2005) - putting Technology Transfer to real world application- occurs with companies conducting both aspect of the Technology Transfer by continuously developing the knowledge, brought through Technology Transfer, through internal research activities which necessitates the company a sophisticated mode of networking and communication systems to engage concurrently with a significant number of participants in the entire Technology Transfer process, making monitoring and evaluation a bit complicated.

2.8.2.3. Transferor and Transferee chains' connection

Technology Transfer, as Ramanathan (2000) considers, is a coherent designs of interrelated processes, namely, production of technology and assimilation through calibrated efforts as shown below in figure 2.4.

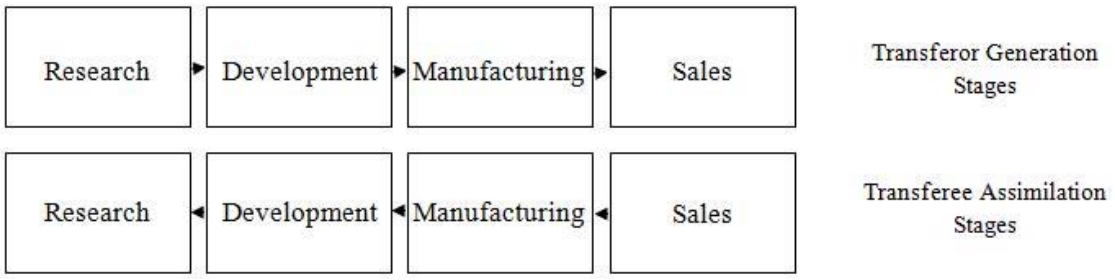


Figure 2.4. The technology development chains of the transferor and transferee (Ramanathan, 2000)

Ramanathan drew Technology Transfer typology into four basic dimensions: sales intensive, the most basic one, occurs when the technology is just commercially handed down to the recipient; manufacturing intensive corresponds to the sender's involvement in the manufacturing of the products on the technology transferred which occurs in the form of subcontracting negotiation, licencing of the product, etc; development intensive entails the joint development of a product by means of design, manufacturing etc; research intensive is the highest stage of involvement, in which the companies come into an elaborate forms of cooperation and mutual assistance, ranging from joint research planning, production, marketing etc. (Ramanathan, 2000). The scale and breadth of the Technology Transfer process largely depend on the interlinks of chains of the companies involved which in turn dictates the intensity and level of transfer between the sender and receiver as well as the technological capabilities of the transferee.

2.8.2.4. Models of Technology Transfer

In order to get a holistic picture of Technology Transfer project nature some of the fundamental classical qualitative and quantitative models are reviewed in the following section.

2.8.2.4.1. Qualitative Models of Technology Transfer

Qualitative models are bent on outlining the functional process of a Technology Transfer project (Jagoda, 2007). Below (figure 5) is presented a qualitative model involving four stages, offered by (Bar-Zakay, 1971) in the Figure 2.5.

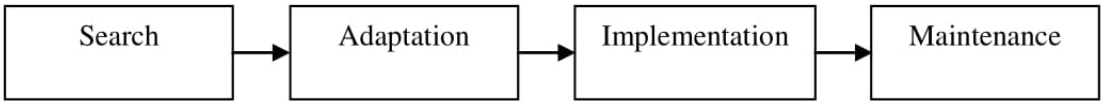


Figure 2.5. Bar-Zakay Model of Technology Transfer (Bar-Zakay, 1971)

Chantramonklasri (1990) lays out a five-phase model, demonstrated in figure 6. Abiding by these steps was found to make better the overall effectiveness of the projects (UNIDO Manual on Technology Transfer Negotiation, 1996). Chantramonklasri (1990) proposed a five-phase model, which is presented in Figure 2.6.

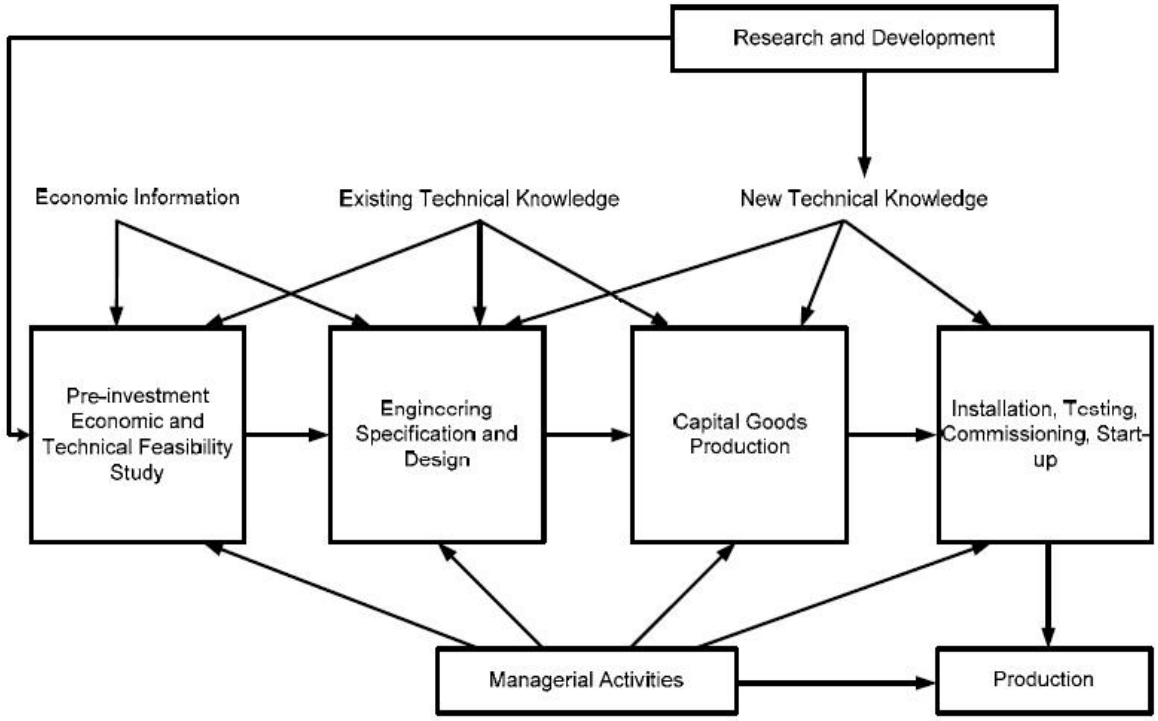


Figure 2.6. The Five-phase model of international Technology Transfer (Chantramonklasri 1990)

Starring with elaborate scrutiny of the feasibility and necessary funding, the model provides a detailed description of the technology to be exchanged as well as the consideration of whether supplementary instruments and machineries will be manufactured, set-up and brought to in congruity with the existing ones, followed by the initiation of production and intensification of manufactures.

2.8.2.4.2. A brief overview of Quantitative Models of Technology Transfer

Quantitative models of Technology Transfer projects are reviewed extremely sparsely in the literature. The first quantitative model of Technology Transfer project was presented by Sharif and Haq (1980). They introduced the concept of Potential Technological Distance (PTD) between Technology Transfer parties. The main idea of this model is that transferor and transferee should have not too great and not too small PTD between them in order to implement Technology Transfer project effectively. The second important model was presented by Raz et al. (1983). This model is concentrated on technological "catch-up" concept. It presumes that the transferor of technology can help the transferee to develop its technological level. In this case the transferee is called "Technology follower". The main implication, which can be made from this

model, is that there are three main phases of TTee growth. They are first slow phase with significant capability gab, faster learning phase and technological catch-up phase when capability gab is reduced or eliminated at all.

The last quantitative model, which is reviewed, is Technology Transfer econometric model proposed by Klein and Lim (1997). This model evaluates technology gap between the industries in which the parties operate in order to define how the companies should build their partnership. Namely, which measures should be undertaken to assimilate, improve and localize the technology by the superior transferor.

2.8.2.5. Technology Transfer project life cycle model

Universally recognised process of Technology Transfer is subdivided into the stages of planning, gathered data analysis, Technology Transfer implementation, inter-organisational discussion, post transfer communication and controlling (Lichtentaler 2004 35). The reviewed model, which considers the assorted implications, is of six stages (see figure 2.7).

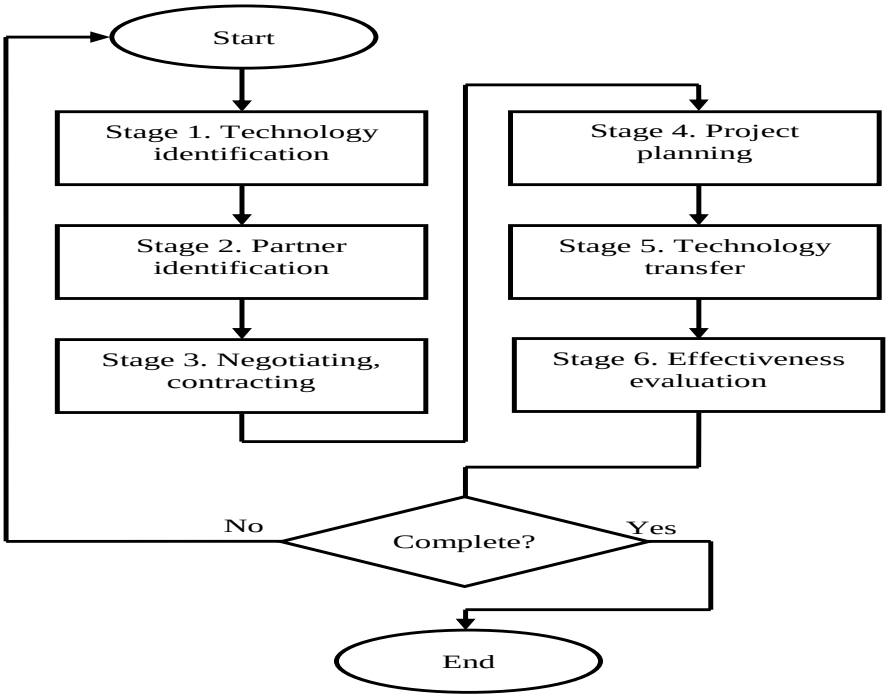


Figure 2.7. Technology Transfer six stages model

The stage begins with the technology receiver identifying the technology requirements, making a tentative selection of technology and analysing those technology to check whether or not they meet the demands. The sender, on the other, goes for considering exploitable technologies at hand. The prospective recipient, in the second stage, chooses the potential technology owner to procure the technology. The receiver makes connection with the technology owner, sends documents, thus commencing the planning stage, in which the parties choose the transfer mechanism, depending on issues such as the operating environment, technological capabilities, the extent to which intellectual property rights can be maintained and some other factors. The

fourth stage enhances the real Technology Transfer process, including improvement and adjusting to the transferred technology. The following stage, the parties appreciate the merits of the implemented Technology Transfer. The model implies that the Technology Transfer process initiates, in fact, through receiving part's contact with the technology senders. Likewise, the process does not end with expected technology procured.

2.9 Technology Transfer effectiveness

The degree to which Technology Transfer projects have been effective has caught little attention in the context of global Technology Transfer value chain, the subject matter of this chapter. Receiving of successful technologies as well as gaining mastery over those is a necessity for the local firms to achieve technological capabilities, particularly in the Bangladesh health sector context. This research has measured Technology Transfer effectiveness through the added value in the forms of breadth and depth of technological learning and the scope of exploitative and explorative innovation. The success of Technology Transfer projects undertaken differs substantially. To make a Technology Transfer effective, it requires being adjusted and assimilated by the receiving end (Leonard Barton, 1988). Galbraith (1990), echoing similar notion, suggests that Technology Transfer becomes more effective when the technology is easy and the receiver finds it easy to assimilate. The central target of Technology Transfer transfer the sender's knowledge to the local suppliers, while the local suppliers absorbs and integrate the sent technology. The same notion is held true for the component providers too. Technology Transfer successfulness, therefore, refers to the prospect of turning the transferred technology into competitive advantage to acquire exploitative Innovations and gain breadth and scope of organisational learning (Zahra et al., 2000), for the knowledge itself is the source of competitive advantage(Grant, 1996).

Apart from efficiency and adjustment, effectiveness is also perceived in terms of performance dimensions (Katsikes et al. 2000). For a successful transfer, as Buckley and Carter (1999) opine, the sender should understand the required technology from the receiving party and prepare the format as such. The Technology Transfer and Innovation scholars see Technology Transfer efficacy in the capacity of the receiving party to recreate the transferred knowledge to gain maximum benefits. Successful technology knowledge and information sharing should, these scholars believe, empower the recipient to gain mastery of the product-related design, equip with newer operating schedule and manufacturing process (Nelson, 1993). The Technology Transfer cases could safely be called effective and successful, only when do it contribute value to the company's dynamic capabilities learned through successful Technology Transfer completion. Capabilities won't translate into competitive advantage unless accompanied with breadth and depth learning (Inkpen, 2000). A successful Technology Transfer completion is said to have occurred through the receiving firm gain the ability to exploit the transferred knowledge and integrate it into its usual operations (Ramanathan, 1994). As the indicators of successful Technology Transfer vary between the sender and the receiver, the overall successful Technology Transfer depends on a host of issues, including absorptive capacity from the recipient viewpoints(Cohen and Levinthal, 1990) and financial considerations and technology commercialisation from the sender's perspectives (Lichtenthaler, 2007). A traditional measure is the degree of commercialisation and its economic output, comprising of criteria such as the number of products in a financial period, the amount of financial resources spent on research initiatives.

2.10. Technology Transfer problems commonly faced by firms (From Previous Studies)

The rudimentary reasons behind the TT failure is the lack of clearly chalked out pathways for the project success factors, market evaluation, market share reduction, the stance in the industry environment, reduction in the customer loyalty (Ramanathan, 2000). According to the study of Jagoda (2007) and Ramanathan (2007), the problems faced by TT parties are of three categories: issues of TT projects, issues of corporate capabilities and the operating environment which are briefly outlined in the next table 2.2. Problems regarding corporate capabilities include inexperienced workforce, lack of training facilities, syndrome of not invented here, employee dissatisfaction, cultural and language barriers. Problems arising out ineffective management are the absence of dedicated and committed managerial personnel, lack of clearly defined goal and vision, insufficient staffing and Human resource management.

Table 2.2: Technology Transfer problems commonly arising during the project implementation

Stage	**Problems**
Technology Identification	❖ Locked in complimentary assets ❖ High Complexity of technology ❖ High complexity of assimilation ❖ Necessity of significant adaptation to local conditions ❖ Questionable patent clearance ❖ Obsolescence of technology for the time of Technology Transfer ❖ Corruption of choice of technology
Partner Identification	❖ Corruption in partner's choice ❖ Unreliable data gathered about the suppliers ❖ Small quantity of suppliers available ❖ Not effective mechanism o partners search ❖ Too complicated communication with possible partner
Negotiations and Contracting	❖ Differences in negotiations approaches and strategies ❖ Differences in working methods ❖ Differences in culture ❖ Goal incompatibility during negotiations ❖ Inability to come up with agreements about the price, marketing and product strategy ❖ Lack of trust ❖ Not effective communication channel
Project Planning	❖ Not effective communication between partners ❖ Low partners involvement in planning ❖ Unwillingness of the partner to provide all data required ❖ Inaccurate estimation of firm's own capabilities
Effectiveness Evaluation	❖ High costs and low quality of local suppliers of product and services ❖ Inadequate monitoring and control ❖ Inability to hold scheduled training ❖ Failure to gain quality score ❖ Inability to meet planned production level ❖ Inability to meet deadlines

CHAPTER 3: CONCEPTUAL FRAMEWORK

We have elaborated the theoretical positioning and the relevant literature, building blocks of a study, of Technology Transfer in chapter two. And also in this chapter, probable success factors in terms of problems faced in different stages of Technology Transfer, in context to "**Triple Helix Framework"**, also have been manifested. Finally a conceptual framework for this study is established.

3.1 Triple Helix Framework of Technology Transfer replacing Traditional Process:

Introduced in the 1990s by Etzkowitz (1993) and Etzkowitz and Leydesdorff (1995), incorporating ideas from the works of Lowe (1982) and Sabato and Mackenzi (1982), the Triple Helix Model of university-government-industry alliance presents an account of changes in the modern society from one dominated by industry-government dyad of the industrial society to the knowledge society characterized by university-industry-government tryad. The central theme running through the spine of the Helix thesis is the transferred equilibrium of economic development and success of the knowledge society, which emanates from the cardinal role of the university and industry, meditated and interfaced by the government institutions and regulations, in the creation of technology, knowledge, and transfer of technology benefiting the society in a brand new way. Recognising creative destruction as a natural innovation dynamics (Schumpeter, 1942), the model enlightens the creative renewal which appears in the each institutional stage of government, university and industry, in addition to those in their intersection such as technology transfer.

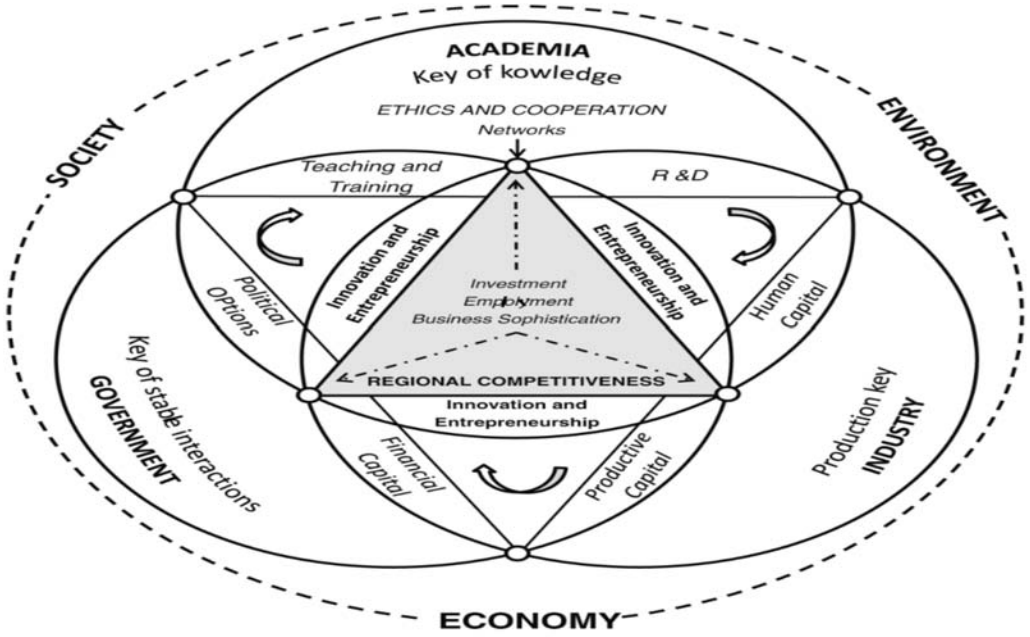


Figure 3.1: Triple Helix Framework of Technology Transfer Process

Following the consequent development of the model's theoretical and empirical research in the last two decades preceding, a general framework has been produced to draw insights into the Technology Transfer dynamics and to aid the national, regional and international level

innovation and related policy making. Critical Success Factors (CSFs) for a specific Technology Transfer project, according to Reagans and McEvily (2003), can be optimally understood by the Triple Helix collaboration framework. There are other factors, as well, including human capital (HC), absorptive capacity (AC), network connectedness (NC), trust (Trust), prior expertise in global or technological partnership (PE). Moreover, size (Size) and sector diversity (SDIV), as known as control variables.

The Helix model hoists the Entrepreneurial University as a prime focus of its argument, which involves proactively in the generation and utilisation of knowledge and advancing technology using it. Instead of traditional linear innovation model, the Helix model works through an interactive process, with firms and university sharing ideas and knowledge as they raise their technology knowledge. The government plays the role of an intermediary, more of a facilitator and rules-setter of the Technology Transfer game, in addition to its traditional overseeing functions. Government assumes the leading function of striking a win win situation by shouldering responsibilities, on behalf of the innovator, to transfer the whole package of technology. The recently concocted idea of Triple Helix Systems of innovation (Ranga and Etzkowitz, 2013) as an analytical framework consolidates the essential factors for success of Technology Transfer into an innovative format, characterised, following the systems theory, by the interactions and interplay among technology transferre, technology transfer and government. Distinctions are made between the component of the Triple Helix Systems: (i) R&D and non-R&D innovators; (ii) “single-sphere” and “multi-sphere” (hybrid) institutions; and (iii) individual and institutional innovators. The interrelationships existing between the components are subdivided into five categories: technology transfer, collaboration and conflict moderation, collaborative leadership and medication role, recipients absorptive capacity, and social tie. The relationships between components are synthesised into five main types: technology transfer, collaboration and conflict moderation, collaborative leadership and medication role, recipients absorptive capacity, and social tie. The overall systems of Triple Helix Model is coordinated by the government in the sphere of Knowledge, Innovation and Consensus. The model, therefore, equips the interacting actors with an explicit framework which helps eliminate the existing blockage of Technology Transfer, streamlining the process in a balanced and win-win manner between the owners and the receiver. The model, through the crystallisation of space and nonlinear interactive mode of operation, produces a new set of critical success factors in the transfer of technology from the university to the firms and , ultimately, to end user with Government functioning as watchdog meditator.

Our core research objective is to find out Critical Success Factors of Technology Transfer keeping Triple Helix Framework as a centrepiece. Therefore a schematic pictorial presentation of critical success factors of technology transfer extracted from both the Triple Helix Framewrok and Tradtioanl technology transfer process are presented. Finally a conceptual framework for this study has been developed and funrshined at the end of the chapter.

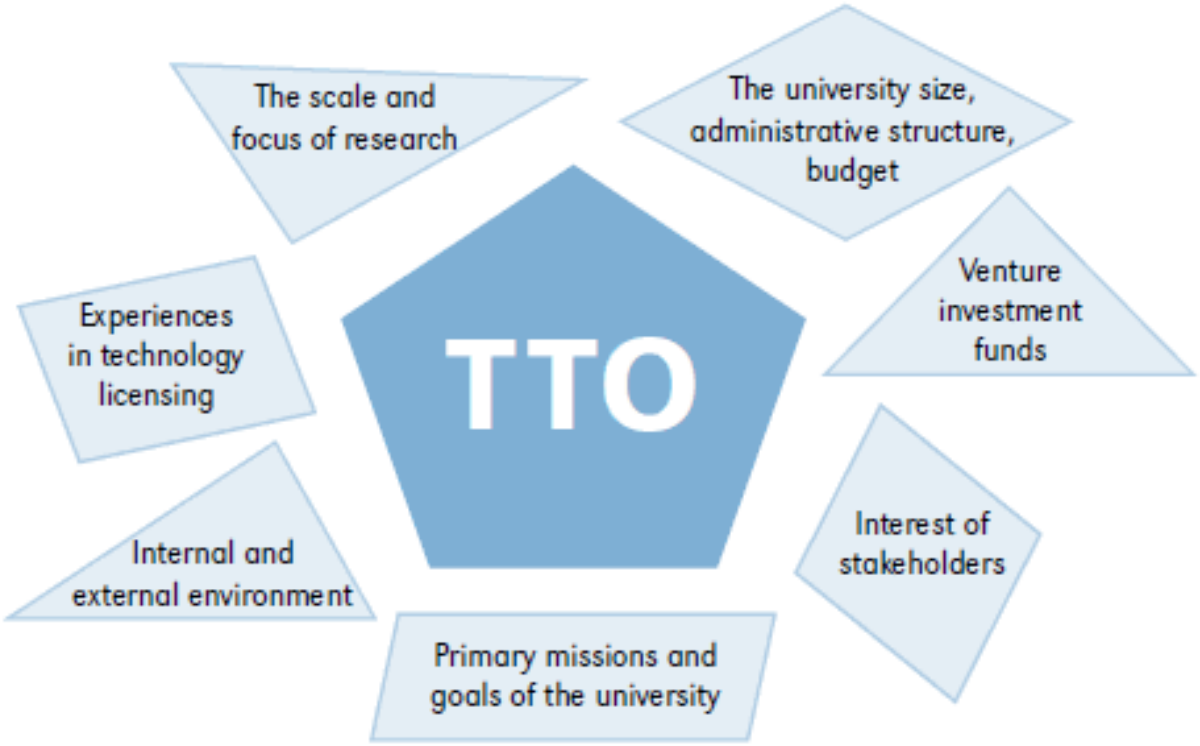


Figure 3.2 Internal and external factors influence technology transfer (Traditional Approach)

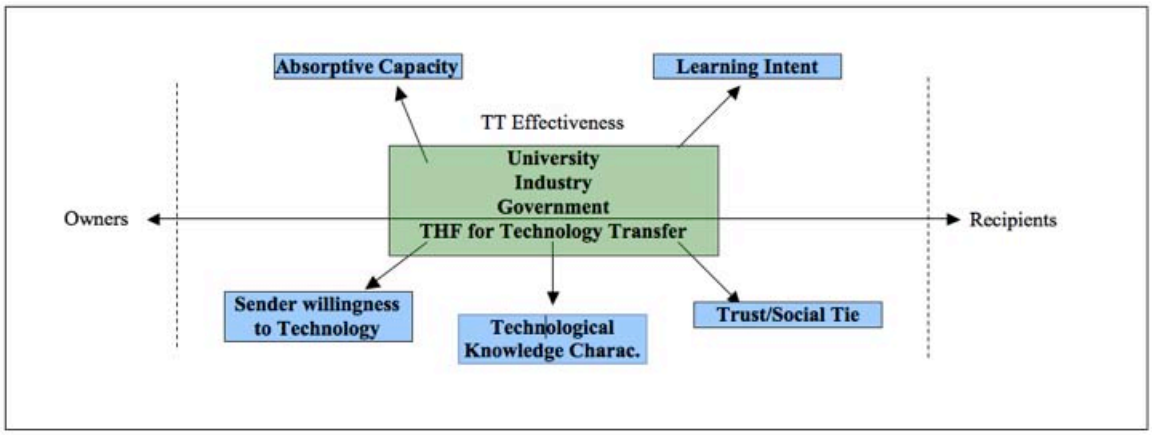


Figure 3.3: Triple Helix Framework of Technology Transfer Success Factors

This research strives to understand the Technology Transfer process and it effectiveness in the Bangladesh health sector, which will have important learning for the global health sector and particularly for the health sector Bangladesh. Elaborating the previous literature on Technology Transfer, theories and studies, the present study has sought to bridge the gap through measuring the efficacy and success of Technology Transfer activities from the developed to developing

countries, with Bangladesh health sector set-up as a pertinent context. The question following will guide our study investigation:

What extent TT is effective from the technology owner of the developed countries to Bangladesh health sectors in terms of exploitative and exploratory innovations breadth and scope of knowledge and technology learning, and what constitutes the critical success factors, which impact the TT successes? The discussion of TT literature has helped us find out a number of key issues, which, we believe, impact the TT successes. Thus, we have come up with sever other questions as addendum:

- What is TT process and are the distinct phases of TT mechanism from the technology owners to the receiver?
- What kind of technology is being sent to Bangladesh health sector and are the impacts and effectiveness of these technologies?
- What are the mechanisms that have been used in TT in Bangladesh?
- Have the mechanisms been useful?
- To what degree and extent the technology senders are willing to transfer different kind of technology (product, process and managerial-related) to the Bangladeshi suppliers?
- What is the influence of organisational learning intent in TT successfulness and effectiveness?
- What role does recipient's absorptive capacity play in the lead up to the process of TT and its efficacy? How an organisation build up absorptive capacity from its own perspective?
- What extent does social ties play in promoting TT and effectiveness from suppliers to their Bangladeshi technology receiving suppliers?
- What is the role of trust in TT and its effectiveness?

Chapter six is dedicated to the theoretical grounding for the research questions we have setup and to the conceptual framework of the study. The concepts of the conceptual framework being the following:

- Technological knowledge characteristics;
- Sender‘s willingness to transfer technology;
- Suppliers learning intent;
- Absorptive capacity;
- Inter-organization dynamics in the forms of trust relationship and social ties; and
- TT effectiveness.

In this chapter, we elaborate these concepts in order to develop a better understanding about this research. The following section discusses the characteristics of knowledge.

3.2 Technological Knowledge Characteristics

Technological knowledge characteristics play a substantial impact as to the process of the Technology Transfer itself. Scholars have opined that tacit knowledge, due to being hard to imitate, accrues more benefits to the organisation than the explicit knowledge (Barney, 1991; Nonaka, 1994). Tacit knowledge is often problematic in transferring, as it's often codified and organisation-specific. Kogut and Zander (1993) found that the transfer of knowledge is

dependent on the nature of the knowledge itself. The recent studies show that the cost and complexity of a transfer projects is related to the characteristics of the technology. These technology characteristics entail most of the characteristics discussed in the prior research (Winter, 1987; Lyles and Schwenck, 1992; Zander and Kogut, 1995).

In the modern world, knowledge has taken center stage in the efforts to achieve sustainable competitive advantage, the commercialisation if which could add immense financial returns to the company. Scholars of technology studies have been traditionally focused on a single type of technology (Kogut and Zander, 1995; Simonin, 1999, Gupta and Govindarajan, 2000). The study widens it focus of technology by incorporating product, process and knowledge related technologies. When knowledge is accompanied with both the tacit and explicit dimension, it becomes a source of substantial advantage over other. Scholars stressing in the knowledge based view of the firm (Grant, 1996; Kogut and Zander, 1992; Rodan and Galunic, 2004) see competitive advantage as incumbent upon the diversity technologies put together. However, there has been a gap in the understanding of the success and merits of technology transfer which has remained unexplored till today. The research, therefore, makes an effort to measure the effectiveness of the whole Technology Transfer projects. The present study has investigated the Technology Transfer projects from technology characteristics perspectives : process related, product-related and management related and the impacts each type plays in the Technology Transfer activities. Utilising the complex/teachable, explicit/tacit typology, we can create a framework of process related, product-related and management related technologies as explicit, tacit or some kind of combination. The environment of Technology Transfer, i.e. the sender and receiver factors, plays significant role as Nonaka (1994) and Nonaka and Takeuchi (1995) have noticed that the success of a Technology Transfer project relies on the the willingness and intention of the sender and the receiver.

In this research, three areas of Technology Transfer are investigated: product-related, process-related, and managerial-related technology and its impact on Technology Transfer effectiveness from international market to the health sector of Bangladesh. Using the complex/teachable, explicit/tacit dimensions, we can conceptualise product-related, process-related and managerial related as complex or teachable, as explicit or tacit or combination of both. However, it should also be noted that there is an interaction effect between the package of Technology Transfer, the sender willingness to transfer and recipient‘s learning intent and absorptive capacity. Nonaka (1994) and Nonaka and Takeuchi (1995) observe that knowledge is created, organized, and transferred by the willingness and motivation of the sender and its recipients. The above discussion leads us to the following research question for the empirical investigation in the health sector of Bangladesh.

- **What kind of technology is being sent to Bangladesh health sector and are the impacts and effectiveness of these technologies?**

3.3 Senders willingness to transfer technology

Sender's willingness plays a far more dominant role than has been acknowledged in the existing empirical studies. Szulanski (1996), Simonin (1999), and Gupta and Govindarajan (2000) gave us some examples in this respect. Van Wijk *et al*., (2008:830), in an assertive way, tells that most of the TT projects has remained outside of research undertaking and we possess a very little

understanding of it. The may be attributed to the emphasis on the receiver's perspective, while not taking sender's points into account, limiting our knowledge of what sender could play in the TT program.

As of the present time, the scholars have been mostly focused on the recipient firm's learning intent and absorptive capabilities as the fundamental bases of successful TT projects(Hamel, 1991; Cohen and Levinthal, 1990; Gupta and Govindarajan, 2000), labelling a firm's acumen for choosing and picking the appropriate technology as the main pillar of TT success (Zahra and George, 2002). These studies have overlooked the sender's factors, causing a gap in our understanding and the sender's factors remain unexplored. (Martin and Salomon, 2003). Setting the health sector of Bangladesh as a backdrop, we strive to show that sender's willingness plays a significant role in the transfer of critical knowledge to the recipient. If the technology owners come to teach the Bangladeshi companies, the local firms will be equipped with exploitative and exploratory innovations as well as organisational depth and breadth learning. Anchored to these premise, the questions posed are:

- **What are the mechanisms that have been used in TT in Bangladesh?**
- **Have the mechanisms been useful?**
- **To what degree and extent the technology senders are willing to transfer different kind of technology (product, process and managerial-related) to the Bangladeshi suppliers?**

3.4 Recipients learning intent

The literature on knowledge transfer suggests that recipients‘ learning intent is one of the key factors in enhancing, or jeopardizing, the knowledge transfer project. For example, scholars have found that motivation to learning positively impact the degree of knowledge transfer (Gupta and Govindarajan, 2000; Tsang, 2002), and a lack of motivation on the recipient‘s end leads to stickiness‘ in the knowledge transfer process (Szulanski, 1996). Moreover, we can argue that if the recipients are genuinely motivated to acquire technology possessed by the buyers, they will be better equipped to understand the technology that is being transferred to them and the sender will be more willing to transfer the technology. As Simonin (1999:409) puts it “learning intent captures the degree of desire for internalising a partner‘s skills and competencies”. In this study, we also expect the learning intent of the recipients related to Technology Transfer from their technology senders to be positively linked with the Technology Transfer effectiveness. As, Pérez-Nordtvedt *et al*. (2008), point out recipient‘s learning intent is a critical factor to knowledge transfer success. Therefore, in this research, we will investigate the recipient side learning intent factor to get a better idea about the interactions affect of learning intent with the willingness of the sender. The above discussion leads us to the following research question.

- **Does learning intent influence critically Technology Transfer and its effectiveness?**

3.5 Recipient’s absorptive capacity

A host of organisational issues ranging from strategic matters to international business and technology management have been explained through the application of the concept of absorptive capacity (Zahra and George, 2002), defined by Cohen and Levinthal (1990:128) as a

company's degree of insights in choosing the right external technology and applying it for its own business perspective.

Mowery et al. (1996) see this as a long-term Knowledge accumulation investigation, path dependant by nature as the effective utilisation of foreign Knowledge is largely the outcome of an organisation's ability to choose, pick, bring in and adept to the targeted skills and ways of doing. In the public health sector of Bangladesh, as the argument goes, the absorptive capacity is strongly correlated to the success of TT. However, considering discussion above, there remains questions regarding the idea of absorptive capacity and its scope and nature- potential or realised, and which one deserves our attention in the TT success evaluation, leading us to the following question.

- **What role does recipient's absorptive capacity play in the lead up to the process of Technology Transfer and its efficacy? How an organisation build up absorptive capacity from its own perspective?**

3.6 Inter-organizational dynamics (social ties and trust)

This part will figure out the role of inter-organisational dynamics relating to social ties and trust. The past researchers have emphasized either on social ties to the technology owners or the trust milieu existing in the operation projectiles (Adler and Kwon, 2002; Dhanaraj *et al*., 2004; Levin and Cross, 2004; Szulanski *et al*., 2004). We, contrarily, put the proposition that a TT project occurs in joint account of the sender and the receiver and any exploration of the impact of social ties and trust should be understood as a whole, under the rubric of inter-organisational dynamics to get the better picture in the sense of term.

3.6.1 Social ties

The inter-organisational dynamics built on the realm of social perspective is explored in this part with special emphasis placed on the societal ties transpiring between the sender and the receiver. The various levels of interactions, presumably, in the form of interpersonal and non-technological ties exert considerable role in leading up to an effective TT. Some scholars have emphasized strong ties as catalysts for successful TT, others have seen weak ties as rendering useful knowledge to recipient. (Hansen, 1999; Levin and Cross, 2004).
Social ties play immense impact in the uncertain environment by protruding the technology owners to diffuse novel invention (Rogers, 2003), expediting the access to resources, technology and organisational learning for the receiver (Reagans and McEvily, 2003). McDermott and Corredoira (2010), for example, have noticed the few social ties between the international technology owners and local auto parts suppliers to have benefited in the product and process upgradation. The things discussed above shows the value of exploring the influence that social ties - strong, weak or informal ties- play in the TT context. Therefore, the following question has been worded.

- **What extent do social ties play in promoting Technology Transfer and effectiveness from senders to their Bangladeshi recipients?**

3.6.2 Trust

Due to its importance in the knowledge transfer activities, trust is considered as a distinguished dimension in the inter-organisational dynamics (Doz, 1996; Dodgson, 1993) defined by Mayer *et al.* (1995:712) as the willingness of an organisation to compromise its secrecy sensitivity to the other party. Trust influences the sender to what degree it should share technology, whereas the lack of trust creates confusion among the parties (Powell, *et al*., 1996). So, the presence of trust relationship fosters more transfer of knowledge as no one feels threat from the other's opportunistic behaviours. (Jarillo, 1988; Blau, 1964).

The institutions, we strongly argue, of the developing countries are weak for certain reasons, forcing the technology senders to rely substantially on trust to stay guarded from opportunistic behaviour and predatory activities of the receiving party. The important role of trust has also been noticed for performance outcome in volatile markets (Luo, 2002) and environmental fluctuations (Aulakh, Kotabe, and Sahay, 1996). In the event of trust relationship prevailing in the environment, the sender shows more willingness and cooperation to give away valuable technology, including tacit knowledge(Dhanaraj *et al*., 2004; Levin and Cross, 2004) and entertain the risk of technology spillover effect to the potential candidates (Dyer and Singh, 1998). The role of trust in the health sector TT in Bangladesh deserves notable emphasis, since Bangladesh is a developing country with weak legal capacity to solve disputes, if necessary. Through the discussions above, we articulate the following question.

- **What is the role of trust in Technology Transfer and its effectiveness?**

3.7 Technology Transfer effectiveness

The resource-based view of the firm holds that technology which is difficult to copy renders sustainable competitive advantage for the firm (Barney, 1991) and Knowledge dimension of the technology has come to dominate the competitive advantage issues (Grant, 1996; Gupta and Govindarajn, 2000; Kogut and Zander, 1992). The TT process with Knowledge focus gives the receiver the lifeline of competitive advantage in the area of performance and Innovation capacities (Dhanaraj *et al*., 2004; Kotabe, *et al*., 2003; Lyles and Salk, 1996). The past researches saw TT effectiveness in terms of time, cost, and budget and the usefulness of the technology to the recipient (Levin and Cross; Szulanski, 1996), speed (Zander and Kogut, 1995), the aggregate of transferred Knowledge (Gupta and Govindarajan, 2000), or the value generation for the upstarts (Yli-Renko *et al*., 2001).

As useful as the above mentioned measures, they don't give us the full account of the TT effectiveness in its fullest sense. This is why scholars in the past recent (Bhagat *et al*., 2002; Van Wijk *et al*., 2008) have been urging relentlessly to resort to more fine-tune measures. Because of such inspiration, we have considered TT effectiveness as the receiver's dynamic capabilities to breadth and depth of learning as well as the exploitative and explorative innovations. We perceive an interaction effects emanating from the owner's willingness to send technology, typology of technology and the recipient's absorptive capacity and learning intent. Thus, we arrive at the following research question to address all the issues addressed above.

- **What extent Technology Transfer was effective in terms of breadth, depth of learning and exploitative and exploratory innovations and what are the determinant factors, which influence Technology Transfer effectiveness?**

3.8 The Conceptual Framework

By combining the quests to find the answers of the above questions, a conceptual framework can be designed. The designed conceptual framework is shown in the figure below

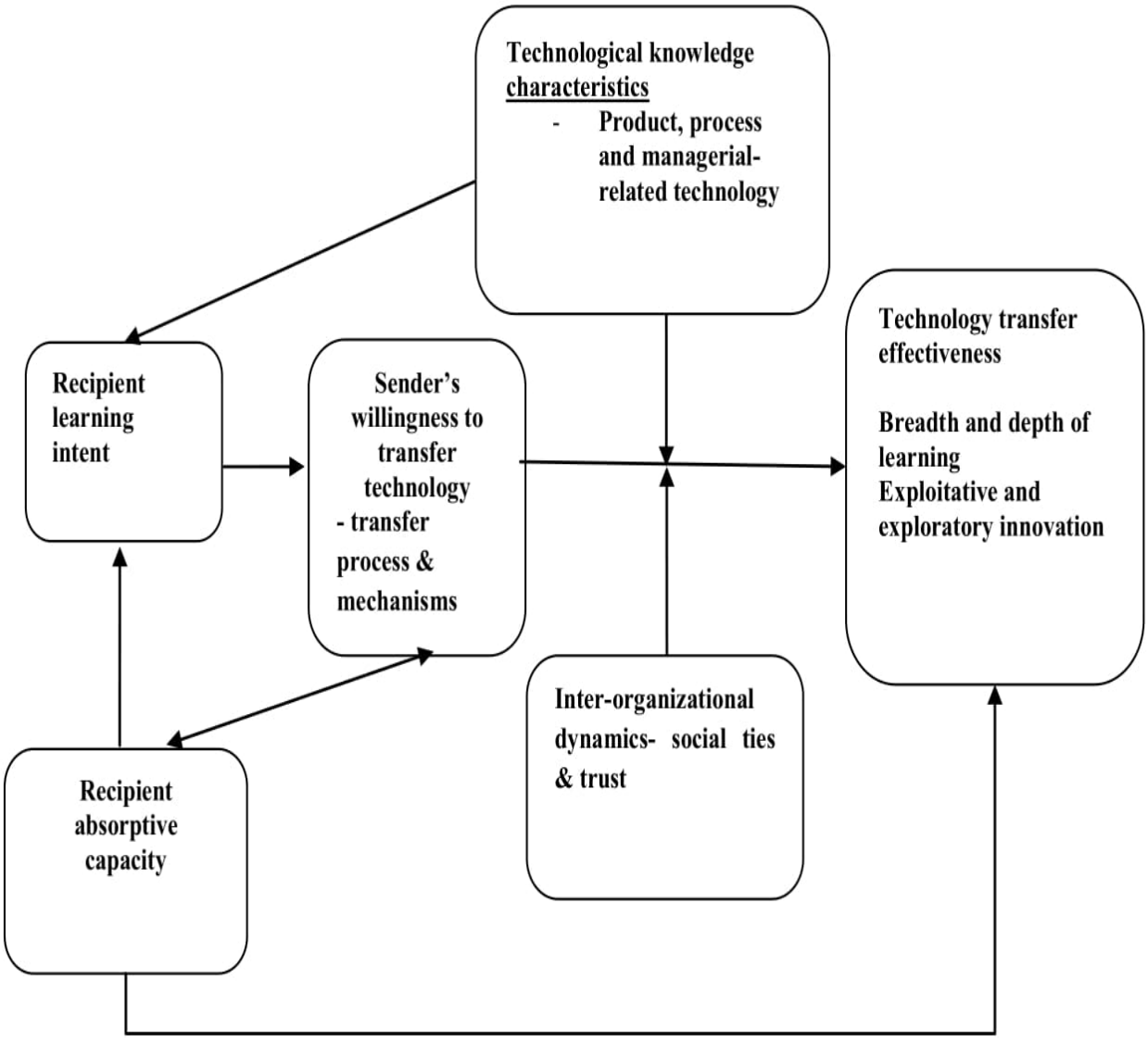


Figure 3.4: Conceptual Framework

CHAPTER 4: CURRENT SCENARIO OF THE HEALTH SECTOR OF BANGLADESH

The present study endeavors to shed critical light on the efficacy of Technology Transfer project channeling to the public health sector of Bangladesh from the supplier operating in the international market, making it imperative to look briefly at the situation in the global health sector and that if Bangladesh in a longitudinal fashion to elicit a context of the research. This will be followed by an exploration into the genesis of health sector of Bangladesh, the chronological development with the passages of time, as well as the policies and regulatory compliance issues brought about by successive governments to meet the demand of time, coming from both the local and international perspective. The focus will then shift to the global healthcare technology suppliers from an evaluating perspective to measure their compatibility with the condition of Bangladesh health care market.

4.1 Present Status of the health sector of Bangladesh:

The sheer importance of nation being healthy is universally acknowledged, due primarily to the economic functions and role that healthy citizens in the wider context of national production and output. Intergovernmental organisations around the world has given tremendous focus on raising the health level of the nations enlisting health care as the most recognised agenda in order to bring about meaningful and sustainable socio economic development. This is particularly evident in the declaration of the third Sustainable Development Goals by the UN, which, acknowledging the importance of health, has emphasized health by ascertaining 'Good Health and well Being" around the globe.

Having achieved remarkable success in the MDGs, Bangladesh has stated express will in its dedicated to the commitment enumerated in the SDGs as the goals of SDGs come in consonance with those of Bangladesh to leapfrog the economic ladder in the world stage. As the government is dedicated to the SDG commitment, the present government has been optimally focused on raising the health level of the nations with serious consideration by enshrining several crucial policies and regulatory measures in its shared vision of Digital Bangladesh and a prosperous nation with 2041. The Vision 2021 entails several parameters to make sure a healthy population free from disease and infirmity by reaching health care opportunity at their doorstep. Since independence about 5 decades ago, the achievement of Bangladesh in the field of child mortality, sanitation facilities development, awareness in the physical well-being, infant mortality is well recognised globally. (Balabanova D, McKee M et al., 2011).

There have been more noticeable gains in several indicators than its neighbors, which have been a particular attention to the social workers and expertise alike. For example, with lower per capita GDP than those of India and Pakistan, Bangladesh did better in reducing child mortality, ensuring drinkable water, immunising children from Diphtheria and other fatal disease as well providing better sanitation to the citizens. The decades between 1990 and 2010 saw a noticeable decrease in the under-five mortality reducing dropping by 60% while infant mortality has been cut by half in the time period, making far better headways than those of India and Pakistan (World Bank Annual country report, 2016).

In addition, Bangladesh has achieved enormous breakthrough in the improvement of maternal and infant health through numerous health initiatives with maternal mortality rate declining by 70% in the last 3 decades. The maternal mortality rate, according to present statistical report, stands at about 176 per 100000 cases of giving birth. The country has also ensured phenomenal melioration in the health of infant and neonatal babies as manifested in the slump of vast reduction in related death cases with child mortality rate cutting by more than 75% in the 3 decades. The infant mortality rate, as the statistics goes, is 31 cases of deaths among 1000 live births. While there can be no question to the massive changes in the sector of public health, particularly in nutrition development and maternal health improvement, the country has a lot to do to reach the global health context which would have contributed positively in ascending the upper middle class status in the offing. The sector is still plagued with immense inefficiency and utter mismanagement, as well as the absence of effective policy standards. One major cause that stymies the sector's healthy growth is the inadequate allocation of funds in the national budgetary framework, lagging the sector behind the expected goals. The matter is even complicated by mismanagement and poor state of technology importing by the funds allocated, expediting the cases of proverbial technology failure in the most cases of Technology Transfer, if not all which will be elaborated shortly. The frequent media report and publications is a testament to that point, pointing to the improper or outdated technology procurement and importation.

Lacking of sufficient allocation for the sector aside, the public health context of Bangladesh is beset with a range of problem, scarcity of doctors and medical workers, for example, is a noticeable one leading to cause unintended hazardous consequence for the patients, who are forced to take medication and diagnosis from pharmaceutical personnel, ward boys, nurses, hospital attendants and village frauds. Quality of the healthcare services is often undermined due to the absence of expert and specialised doctors as well as the unbound commercialisation of medical facilities around the country with outdated technologies and trained professionals. Finding no other alternative or perceiving the sorry state of quality treatment, many patients chose to fly abroad to get better services, costing Bangladesh valuable foreign currencies, and indirectly hindering the sector to grow, reflected in a report which tells that patients of Bangladeshi origins contribute to 90% revenue earnings of Thailand's health tourism. Therefore, in the context of Bangladesh's stated commitment to SDGs and the government's steadfast allegiance to improve the health sector of Bangladesh, it's binding that the country eliminate the inadequacy and inefficiency in the sector by guarantying untrammeled access to safe drinking water, sufficient nutrition and food staples, medical facilities for all for the thorough development in the sector.

4.2 Health system governance in Bangladesh

Providing the citizens with basic medical services is a duty of government as stipulated in the constitution (IGS, 2012). Article 15 of the Bangladesh binds the government with ensuring fundamental provisions of life, clothing, food, education and medical care for the citizens of the state. Moreover, article 18 of the constitution obligates the state to take measures to increase the level of nutrition and public health as its fundamental duties and responsibilities. In conformity to the supreme legal framework of the state, the Ministry of health and Family Welfare has carried out projects and programs in light of the polices and regulatory measures undertaken by the sector. Even though the health sector is the sole responsibility of the government as the

constitution demands, private sector plays a significant role in providing health care to the people, thus creating a parallel system of government and private healthcare providing mechanism. Having grown as an entrepreneurial system, the private system dispenses medical facilities according to the economic condition of the service seekers, making it hard for the poor to afford agreeable service, at least, in practice. The system is a pluralistic too, as being inhabited by multiple actors each playing role and offering services as per their selling point. However, all the actors can be subdivided into 4 groupings in the broad context of the country's health sector: namely, Government, the private sector, NGOs and donor agencies. The three sectors are involved in the delivery of service, dispense of financing, and recruiting and staffing health workers and personnel, while the donor agencies, the last actor, contribute to the designing, planning and financing of the sector. On top policy making and regulatory functions, the public sector is heavily engaged in delivering health care opportunity and financing the salary of the staffs, as well as monitoring and controlling the function and activities of the public, private and NGOs employing acts and legislations through the employment of doctors, nurses, pharmacist and health workers countrywide.

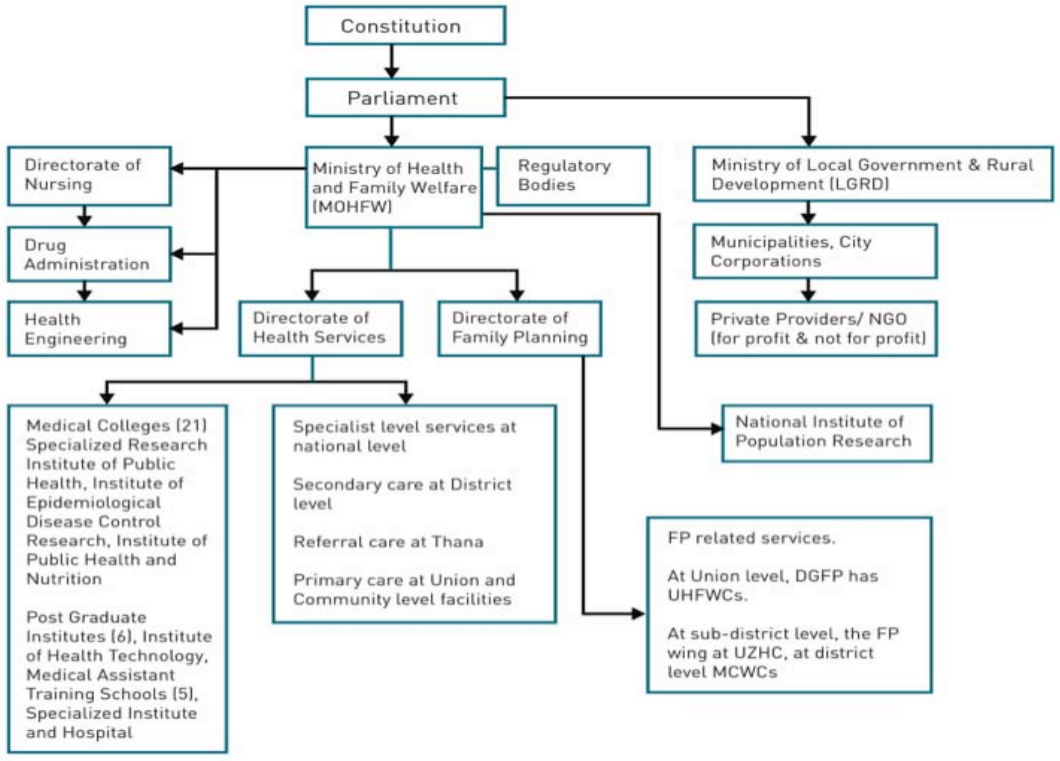
Public sector deals with health care services, as curative, preventive, promotive and rehabilitative services, while the private sector involves in profit-inducing curative care and charitable future services in a limited purview nationally and locally. The NGIs are mostly engaged in providing care to marginal people preventive and basic in nature. With a pool of traditional therapist, unqualified village doctors, and recognised doctors employed in the public services, the private sector boasts of more healthcare providers than the public sectors. NGOs are traditionally known for offering services for the most poor section of the society, The regulatory measures relating to the public and private sectors are accomplished by the Ministry of Health and Family Welfare, which, as per the schedule 1 of the rules of business and central body, is endowed with the tasks of policy formulation and implementation, monitoring and controlling the drug marketing and supplying, management of medicine institutions and many more. With its two segments, Health and Family Planning, the Ministry supervises the entire health sector, from central management initiatives to the rural health activities, from the national level to the local level in all its manifestation. Despite the Ministry being the directive in the institution-based health-care services at the national level, the basic healthcare services in the township and semi-urban areas are overseen by local governmental institutions working at the behest of Ministry of Local Government, Rural Development and Cooperative. Private sector facilities are confined to medical colleges, diagnostic centers, clinic and traditional healers with more service catchment than that of public sector.

4.3 Administrative structure of the statutory health system of Bangladesh

The Ministry of Health and Family Welfare conducts health programs and services by means of several implementing and monitoring authorities. Five Directories- the Directorate General of Health Services (DGHS); Directorate General of Family Planning (DGFP); Directorate General of Drug Administration (DGDA); Directorate of Nursing Services (DNS) and the Health Engineering Department come under the control of the implementing authority. The DNS and DGDA are connected to the Ministry of Health and Family Welfare's health wing. DNS is tasked with providing nursing education; DGDA enforces drugs related regulatory measures. A number of executive bodies engaged in carrying out important function of the ministry are Transport and

Equipment Maintenance Organization, National Electro-medical and Engineering Workshop, and the Essential Drugs Company Limited. The organizations, executing regulatory activities, include the Bangladesh Medical and Dental Council (BMDC), Bangladesh Nursing Council (BNC), State Medical Faculty (SMF), the Ayurvedic, Homeopathy and Unani Board, and the Bangladesh Pharmacy Council.

Several public sector institutions within the authority of Ministry of Health and Family Welfare conduct scientific research activities in medical studies. To create professionals and personnel on medical field, the country has around two dozens of medical colleges, half dozens postgraduate facilities as well as three specialised institutes, two health technology institutes etc. To bolster research efforts, two institutions of BMRC and NIPORT play critical role in the national level. Some other mentionable research institutions may include the Institute of Epidemiology, Disease Control and Research (IEDCR), Institute of Public Health (IPH), Institute of Public Health and Nutrition (IPHN) and National Institute of Preventive and Social Medicine (NIPSOM). Besides, some national and regional level research initiatives and institutions, such as the the Urban Primary Health-care Services Delivery Project (UPHCSDP) have extended their services to all city corporations and municipalities of Bangladesh (UPHCSDP, 2014), aiming to raising the urban people's health level by ensuring modern, efficient and affordable health services.



Source: Asia Pacific Observatory on Health Systems and Policies

Figure 4.1: Organizational structure of health system in Bangladesh

4.4 Health technology assessment

The country is yet to come up with an assessment of what kind technology it should bring from abroad for use in the public and private healthcare facilities with the exception of DGHS participating in regional conferences, and some handful NGO initiatives having research on the technology assessment (Sivalal, 2009).

4.4.1 Information technology

The health sector of Bangladesh is fast moving to technology integration in their management and operations level through the implementation of projects of HPNSDP (2011–2016), (HIS) e-Health and Health Information System (HIS) (MOHFW, 2012) which will gather data automatically from all national to local level facilities by affording them internet access in an effort to build up a health database to perform better management activities. The e-Health will, with the aid of cellular phone services, will setup a call center combining UHCs and hospital through which people from the catchment area will be able to connect to the doctors to seek prescription and medical advices without any cost. Later, the system will absorb the community clinics. Telemedicine service, a pilot initiative found in 2011, offers medical services from nine different hospital and health facilities, by utilising video conferencing system, to the far remote country area previously beyond specialist services, which will gradually include all community clinics by providing laptops and internet access as well. At present, MOVE-IT, an internet based health initiative, is going to create a database by taking inputs of all medical inputs, including pregnancy, maternal health, mortality, births, deaths, disease control, etc. being implemented by the government in partnerships with an NGO and WHO.

4.5 Technology failure

The landscape of Technology Transfer cases in Bangladesh is rife with tantamount cases of failure or utter mismanagement; to the degree of technology obsolescence even before the installation or operations begin, resulting in the enormous waste of taxpayers' money and inefficiency in the health sector.

4.5.1 Technology Failure: Cases 1

It's no surprise that many high-priced medical machineries purchased a decade earlier might never go into operation on account of insufficient manpower or not being able to forecast the technology disruption. A recent investigation, conducted by the Hospital Management Systems (HMS) of DGHS, uncovered more than 100 types of valuable medical equipments, purchased around 2996-2011, laid waste in the backyard of about two dozens medical hospitals, most of which were never unboxed, owing primarily to the shortage of appropriate place, or the unavailability of trained installers or operators. The investigation report states that most of the equipment, purchased between 2006 an 2011 by the Central Medical Store Depot (CMSD), could not be installed either due to shortage of space or because there were not enough trained operators or because of the negligence of the suppliers.

The price tags of the unused item could range from several hundred thousand Tk. to several million, a staggering amount considering the degree of economic status of the nation. The HMS probe also unearthed a whole slew of pricey sophisticated medical technical instruments, trashed in the storeroom of 250-bed Sadar Hospital of Sunamganj, the cause of which, the authority reasoned, was space crisis. Another Sadar Hospital of Thakurgaon oversaw the waste of an anesthesia machine, an overhead projector and a 60KVA generators laid packaged for more than a decade or so. In many cases, the suppliers went carefree after the payment had been cleared, contributing to the squandering of valuable technology. Experts have pointed out a couple of loopholes in the government procurements, such as the absence of infrastructure consideration, technology assessment, skilled and need-specific trained operators, and inadequate justification of the suppliers, who dilly-dally the supply, and compromise the quality (Dhaka Tribune, 2015).

4.4.2 Technology failure: cases 2

National Institute of Traumatic and Rehabilitation Hospital (NITOR), popularly known as Pongu Hospital, absurdly started purchasing of medical instruments and materials, such as MRI, Citi Scan, two lifts, a 500 KV generator system, worth 125 crore out of a project allotment of 169 crore earmarked for the construction and procurement of a twelve-storied building demolishing a dilapidated 3 storied one, high-priced medical systems and diagnostic machineries. Querily enough, the hospital completed the procurement of 75 crore of medical instruments and other equipment, long before the construction of the building had started. Such enthusiastic purchase initiative could only be explained by the rampant corruption and financial benefits to be realised to the interested parties, in expense of the public money. The already brought equipments will lie idle in a backward corner of the hospital for many years, until they will be put to use or condemned in a fine morning. The project director will retire from duty within a year, which is, as in the air, the prime cause of such enthusiasm. The surreptitious nexus between the hospital authority and the suppliers, common to most of the cases studied, hardly considers the types of technology, product related training, availability of skilled personnel while chalking out the Technology Transfer process, since personal interest takes center stage in such hefty dealings (editorial, Jugantor 2015).

In a more shocking report of the daily Prothom Alo, the leading newspaper of the country, more than 500 pricey medical devices and instruments have been found either unused or lying idle for years, some of them never unboxed ever since. Most of these dust-ridden, badly damaged, uncared machineries have been purchased in the present government's tenure, since 2009, to be precise. In response to such wild disregard for the costly machineries, several Civil Surgeons have eschewed responsibility, passing the blame on the CSMS (Central Medical Stores Depot), who, without requisition, sent machineries and instruments to the hospitals. In a scathing remark, Mr. Shahid Uddin Ahmed, Civil Surgeon of Netrokona District, complained against the allotment of 5KV generator equipment, which cannot be installed in the hospital premises and he has not been given any fuel cost for that matter. During 2003 to 2011, CMSD delivered 24 generators (40KV to 60KV) to District and sub-district level hospitals, out of which none has been found in operation, costing a huge loss to the public, depriving the citizens from sufficient health care. Machines and equipment found wasted includes anesthetic equipment, hydraulic OT Table, delivery table, incubator, hot air bath, emergency bulbs, etc., which would be useful for daily medical cases (Prothom Alo, Dhaka 2015).

CHAPTER 5: RESEARCH METHODOLOGY

5.1 Empirical Setting and Context

The observational basis and setting of the study is public health of the country the focal point of which is the tertiary level hospitals, the end users of Technology Transfer, as well as the effectiveness arising from exploratory innovations. This chapter details a discussion of the industry for many reasons following:

- The sector requires diverse technologies with expansive supply chains.
- Having endowed with extensive backward and forward integration and considerable multiplier factor, it's recognised as a key industry.
- The sector is a regular recipient of Technology, and suffers, as reported in government investigation, the highest cases of technology failure among all the sectors.
- Successful Technology Transfer will bear extensive and direct health impact upon the larger section of the population.
- About half of a hundred mediums to large-scale health instruments and technology suppliers take part in the medical sector of Bangladesh.
- The tertiary level health facilities attract maximal attention as prime technology receiver.
- Focus is on the top tier tertiary hospitals of the country as the main recipients of technology.

Apart from the causes stated above, concentration on a single Industry is useful to maintain a narrow research focus.

5.2 Research Philosophies and Paradigms

The term 'paradigm' refers to the development and progression in the scientific investigation grounded in the philosophical orientation and dictation people enjoins to their surroundings and epistemic scope. Qualitative and quantitative undertaking to research draw assumptions from different paradigmatically perspectives as researchers perceive the ontological and epistemological factors of philosophy from different realisation and worldviews (Collis and Hussey, 2003). Ontology, the assumption of knowledge, seeks to define knowledge of reality from objective viewpoints- nature as embedded in its own settings, or subjective viewpoints- phenomenon as socially constructed. The other assumption, epistemology, explains the essential qualities of knowledge, and the relationship that exists between Knower and the known. The two assumptions have had researchers follow two different paradigmatically approaches to research problems, namely positivism and interpretivism (Morgan and Burrell, 1979; Patton, 1990) described in the following section.

5.2.1 Positivism Paradigm

Researchers for positivistic paradigm consider reality as separate and independent from the interference of the researchers, advocating for the use of natural science methods to enquire into the social phenomena (Behling 1980; Schon, Drake and Miller 1984; Burrell and Morgan 1979), which strongly positively correlates to quantitative approaches to social phenomenon. The

paradigm, in short, applies natural science's hypothetic-deductive method and the formal logic to fulfill the four demands of logical consistency, falsifiability, relative explanatory power and endurance (Lee, 1991:343).

5.2.2 Interpretivism Paradigm

Proponents of this paradigm contend that social phenomena pertains nature, different from natural phenomena, thus, nullifying the scientific method and calling for a approach altogether. The interpretivism views human action from cultural construction entirely separate from the realms of scientific observation and studies people from their own settings employs international method as the main thrust of the research methodology. The preceeded discussion clearly explains the different viewpoints and methods, used in studying social phenomena with respective merits and demerits. The study, therefore, has combined elements from both approaches so as to elicit a comprehensive view and condition of Technology Transfer effectiveness and its successes in the public health sector of health sector of Bangladesh. The combination approach is supported by Perez-Nordtvedt et Al (2008) who appreciate the amalgamation to capture the richness and complicated picture of Technology Transfer in the developing countries. Further complementing the methodology mix, Guba and Lincoln (1991) stress the need for utilising both approaches to acquire desirable results. Bryman and Bell (2003), and Shah and Corley (2006), in a similar vein, argues for the importance of methodology combination for management studies. To fulfill the objectives, enumerated in the first chapter, the hybrid approach methodology, supplemented by multi-purpose and multiple sectoral inputs with focused heavily on qualitative approach, will be a suitable research strategy to study the public health sector of Bangladesh.

5.3 Quantitative and Qualitative Research Approaches

Qualitative and quantitative approaches have been recognised as major data collection procedures (Bryman and Bell, 2003; Bernard, 2006). The selection of approaches is of considerable importance, since the choice of the approaches influences the outcome of the study in a significant way (Denscombe, 2003; Saunders *et al*., 2000), minding that there is no set approaches to research as objectives can be accomplished through combination of a range of methods. Quantitative method, in conformity to positivistic approach, employs experimental settings and survey design to put hypothetico-deduction to test, studying phenomena objectively and focusing on measurements and analytical tools to compare between and among variables (Denzin and Lincoln, 2000).

Qualitative approach, as Denzin and Lincoln (2005:3) conceive, is a kind of situated activity, putting the researcher into the real-world settings, combining interpretive and material practices to make sense of the things studied. Formulated to observe social realities and phenomenon in their natural process, the approach produces non- numerical data like words, symbols, cultural context, etc. which, Pope and Mays (1995) maintain, can't be derived otherwise. Instead of quantifying the complex realities, the process attempts to capture the whole realities- cultural artefacts, dynamism of social life, intricate social networks and institutions- in a conversational styles, allowing the researchers to contribute to make sense of the realities as much as possible with detailed description and analysis whenever.

5.4 Rationale for the choice of methods for the current study

As indicated above, the research seeks to have a blend of qualitative and quantitative methods with a qualitative stress, drawing data from a wide range of sources, the justification of which is that there has hardly been any research conducted on Technology Transfer in Bangladesh, not to mention the health sector. Hunnerinta-Peltomdki and Nurnmela (2004:162) opine that the mix of approaches help absorb the whole picture in its natural setting, eliminating the chance to miss out important details that would be left out otherwise. Research methods don't offer any inherent benefit to achieve the objectives, rather, their efficacy depends, to a great extent, on how effectively and calculatedly they are utilised, as reflected in the argument of Creswell (1994) which prompts the researchers see methods as means, not as an end. Keeping all these scholarly views in focus, the present study has emphasized the coordinated mixing of semi-structured, qualitative interviews, expert opinions, real-time survey methods and observations of particular fields, effective usage of these methods will boost the richness of data to be gathered and help the researchers triangulate among diverse set of data (Eisenhardt, 1999; Yin, 2003). The added benefit as accrued is the offsetting of bias, arising from any particular method, thus ensuring much validity of the data and that of findings (Nick, 1979).

5.5 Methods Used in this Study

The ongoing study has obtained data from semi-structured interview questionnaire survey and employed the documentary evidence in the total length of the research process, which will be elaborated in the subs-sections following.

5.5.1 Qualitative semi-structured interviews with Technology recipient

Qualitative interviews typology generally includes structured-standardised interviews, un-structured interviews and semi-structured interviews (Denscombe, 2005; May, 1997; Yin, 1994). Cultural and ideology related behaviours are well-elicited through semi-structured interview (Lindlof, 1995: 165–166), providing the study with contextual and subtle data, as well as helping the researchers shed light on all the topics and guiding him/her as the research unfolds, giving the structure response time to adjust whenever necessary. The present study has engaged in semi-structured interviews with a wide range of incumbents in the health sector, including particularly the director of several hospitals, technology suppliers, Health workers and officials from Ministry of Health and Family Welfare, following an interview guide having topics related to health issues and Technology Transfer process, given in the Appendix A and described, in short, in the following section.

5.5.1.1 Interview guide

As indicated in the preceding section, semi-structured interview could be accomplished through the use of an interview guide with a set questions and enquiring statements, prepared in advance of the interview (Denscombe, 2003; Oka and Shaw, 2000) which guides the researcher deal with interesting and pertinent issues, popping up naturally while conducting the interviews (Flick, 1998), checking the researcher around the particular topics, as well as maintaining a standard operating procedures in all the interview cases (Burgess, 1984). For the present thesis, two guides were prepared- one for the technology suppliers and another for the adaptors, intending to

minimise bias by having data from both the stakeholders. This also helped the researcher triangulate data comparing the authenticity of the data produced thereof. The interview format is given here in Table 5.1

Table 5.1 Semi-structured interview guide

Topic areas	Questions
Technology Transfer Process	What was the procedure of Technology Transfer process from senders to your company?
	How was this procedure begun?
	Who started the Technology Transfer process?
	What kind of initiatives was implemented to aid the Technology Transfer process?
Technology Transfer Mechanisms	What technical steps were utilised to transfer the technology?
	Why did you follow those steps and did those fulfill your requirements?
	What have been the steps you found useful and for what types of technology?
	How do differing systems or modes affect the exchange of various kinds of technology from the supplier to your company?
Type of Technology Transfer	What sort of Technology did you purchase from the sender and why did you go for those?
	Why did your supplier show reluctance to transfer a particular technology?
	What were the gains your firm thought it would realise from sending technology knowledge to your receivers?

Table 5.1 evinces a crucial point that an interview guide prepared previously helped the researcher maintain a continuing focus on the research objectives, which, in turn, contributed to sustain consistency in data collection, applying by which the researcher can, as Alvesson et al. (2000) contends, interpret the data in a consistent fashion. In contrast to questionnaire, the interviews, semi-structured in nature, last longer, having varied lengths between 60 to 90 minutes, some even extending up to 2.5 hours, providing the researcher with adequate space to get into the minds of Bangladeshi people, who, unless cozy environments made, don't open up for critical discussion. Thus, the cultural context plays role in setting the interview length and duration of the procedure.

5.5.1.2 Sample selection for semi-structured interviews

With regard to sampling in the qualitative approach, no hard-&-fast rules usually apply, with many scholars arguing against random sampling as a befitting process to follow in the qualitative studies. (Danscombe, 2003; Glasser and Strauss, 1967; Ritchie *et al*., 2003). Random sampling offers every entity of target group with an equal propensity to be nominated. Non-random sampling, in contrast, proposes a set of rules for the samples to be accepted, being called by the scholars as theoretical sampling, anchored at a definite criteria (Bryman and Bell, 2003; Danscombe, 2003; Ritchie *et al*., 2003). The sample selection criteria for the technology recipients are as follows:

1- The Ministry of Health and Family Welfare and the Bangladesh Association of Medical equipments suppliers have provided the basis for the sampling framework. Secondary and Tertiary level public hospitals of Dhaka, Medical Technology suppliers, employing at least 40 employees and having door-to-door business with the government were selected for the sampling.

2- Applying this criteria, 25 hospitals, 21 suppliers were earmarked for further procedure as well as an introductory letter briefing the study addressed to the Director/MD/ CEO of the firms/hospitals, requesting them to provide with the focal contacts of the companies, managing the relationship with the Ministry.

3- The efforts were followed by personnel from 18 hospitals concerned with medical technologies, in the hospital, expressing willingness to cooperate with details of a manger to contact. From supplier side 14 firms expressed their willingness to participate in the survey. Another letter was addressed to the contacting manager about the research objectives, promising that the company secrecy will not be compromised and they will be given a copy of the research summary. The research project was able to interview the 50 stakeholders from technology recipients side of 18 hospitals and MoHFW, 14 personnel from 8 technology suppliers firms, leaving the rest in, for logistics and time issues.

5.6 Semi-Structured interviews with the three technology owners

As detailed in the section 6.2, eleven international medical technologies providers having engaged with the health sector of Bangladesh were interviewed, the goal of which was to cross-check the responses elicited from the local firms interviewed previously, in an effort to boost reliability and validity of the research.

5.7 Interviews with the Ministry of Health and Family welfare, Bangladesh

The semi-structured interviews were also conducted, along with the suppliers and technology senders, with officials of MOHFW and the directorate of Health, intending to collect data on institutions agreement and understanding between the senders and the receivers of the Technology Transfer process. The information sought from MOHFW, who is duty-bound to develop the health sector policies and to exercise monitoring authority, was to supplement the data derived from other sources as well as to triangulate data collected from numerous sources and methodological approaches. The interview questions were concentrated on the problems,

prospects and opportunities facing the health sector of Bangladesh, referring to especially development issues and Technology Transfer processes. How the TTs could be implemented more effectively and efficiently, what are the future challenges of the health sector, etc., what should be the appropriate policies in response to TTs dominate the questionnaire.

5.8 Data Analysis-Qualitative Phase

Dealing with analysing the semi-structured interviews, the steps prescribed in the extant literatures have been complied, as shown in the following: (i) summing-up the data to have a brief overview (ii) codification of data (iii) demonstration, evaluation and by drawing the conclusions. Coding and analysing were accomplished following suggestions Miles and Huberman (1984) proposed, so as to point out the major themes and patterns in the data. Microsoft Excel 2007 spreadsheet, an effective tool to sort, classify, tag, label and arrange the data, was utilised to divide the data into working categories and typology. It also raised the efficiency level of data analysis and is helpful to arrive at the research objectives defined (Yin, 1984), as well as the Technology Transfer procedure, type of Technology Transfer, thrust building, social factors etc. Crosschecking and referencing have also been used extensively to checkout database, existing between interviews data, and primary and secondary methods of data collection.

5.9 Questionnaire Survey with the technology suppliers

The questionnaire survey was carried on, as already mentioned in the chapter, to fill up any gap left by semi-structured interviews, bolstering the scope and reliability of the overall objectives achieved. The questions, set up in the questionnaire, expand into a wide variety of issues relating to Technology Transfer, including Technology Transfer procedures, Technology Transfer mechanisms to implement the procedure, benefits of the process, trust, social factors, vertical and horizontal integration mechanism, institutional forms of the receiving party, educational status of the receiving end, technical qualification and efficacy of the entire operations. (See Appendix, B). Each item was then quantified along a nominal scale of Yes/No, apart from the questions to measure the intention to establish business ties, and technological capabilities, which have been marked on 1-3 and 1-5 scales, respectively. In the 1-3 scale, 1 and 3 signify 'very important' and 'not important' respective, while 1 and 5 in 1-5 scales refer to 'basic technological capabilities' and 'advanced technological capabilities' respectively. The measurement criteria have been outlined, drawing insights from literature review and the semi-structured interviews.

5.9.1 Sample Size and Selection

In survey-based research, sampling is considered as a key component, with random sampling often found desirable such research type to draw statistical inference. The study, however, didn't follow the random sampling, because of time constraints and resource consideration, and for the sustenance of trust among the managers of the technology suppliers, the sampling followed that of interview sampling. This has rendered benefits: (1) the researcher worked out trusting rapport

with the manger in the study process (2) effective and workable response rate (3) the identification of deceptive data, ensuring data reliability.

5.9.1.2 Survey Approach and Administration

Survey-based study, conducted through phone conversation, Email, online system, Skype or other means of social media, has often been stymied by diminished response rate, the requested ones negligent to the survey papers. In doing survey research, the present study considered the factors of time, resource and response rate, choosing the months of August and September 2019 for optimal response. We selected the most accomplished and experienced people for the survey, includes CEOs/Directors, Technical Managers, Technology Transfer expert for the most relevant information and data so as to giving maximum reliability to the data collected this way. The survey was occasionally conducted through sit-ins of managers across the sector, which reduces the data bias. (Huber and Power, 1985; Kumar, Stern, and Anderson, 1993).

5.10 Data Analysis-Questionnaire Survey

The quantitative data derived from questionnaire systems provides a lot of numbered data, which can be ordered, sorted and analysed by graphical presentation, such as bar charts, graphs, etc. Advanced data analysis techniques of multiple regression, chi-square test, partial least squares are employed to find out the relationship pattern among and within the variables studied. The study has used Excel 2010 for simple analysis, using data with regard to Technology Transfer, trust, social ties, the firm's capabilities, etc. (Chapter 6), maintaining that the presentation of findings in the form percentage and graphs are aimed not at testing the theoretical grounds, but to gather added information to support the data sought from qualitative undertaking. To identify possible path relationship between factors, structural equation modeling has been done on some of the identified variables (section 6.10)

5.11 Comparative multidimensional matrix analysis

A multidimensional matrix with comparative focus has been applied to order, analyse and exhibit the data, looked at critically from different dimensions, for instance, receiver's learning intents, absorbing capacity, sender's intention to transfer technology, etc. The data from interviews and discussion have been marked 1- 5, 1 indicating the lowest and 5 highest while the responses shown with percentage denomination. Dealing with questions like importance and effectiveness, 1-5 scale indicates the least important to most important. The reliability and validity of the studied data is elaborated in the section 5.12

5.12 Reliability and Validity

Despite the complexities of applying reliability and validity to qualitative cases, it still warrants justification to evince the representation of qualitative data for the phenomenon researched (Lee, 1999). The study's combined usage of data sources, data collection method mix makes has been directed at gaining a comprehensive narrative with the optimum use of the quality, reliability of the data, instead of some slashed, whipping endeavour to arrive at a hazy conclusion.

CHAPTER 6: FINDINGS

6.1 Technology Transfer process

This section deals with the questions related to the Technology Transfer procedure from the international technology providers to the receiver of the public health sector of Bangladesh. The interview data points out three-tiered Technology Transfer in the health sector of Bangladesh, namely: (1) Qualifying Stage, (2) Evaluative Stage and (3) Interactive Stage of Technology Transfer, which contrast the findings of Szulanski(1996), who spoke of four stages in Technology Transfer process. This might be due to the differences that exist among industries, as well as to type of technology transferred.

6.1.1 The Qualifying Stage

The stage begins with the selection of a number of prospective technology suppliers, who could satisfy the customer's requirements, by a pool of multidisciplinary experts involved in setting the technlogy requirements and potential candidates for Technology Transfer. Being contacted, the sender transmits encrypted and codified drawings, as per the technlogy requirements, to the local firms, who, based on the drawings, develop a prototype. The prototype, being qualified in the test, works as the basis for business relationships between them. Worth mentioning hereby is that the stage itself is divided into several distinct phases having little communication between the parties.

6.1.2 The Evaluative Stage

In the stage, the business relationships formed, the technology owners communicated the technology specifications, quality dimensions, advice on machineries etc., to the technology suppliers. The stage concludes with the manufacturing of the tailor-made product specified by the client. Of the health sector of Bangladesh. The distinguishable phases of the stage includes elaborate product specifications, expected quality provisions, and the development of the end customised product.

6.1.3 The Interactive Stage

The Interactive process, the concluding stage, was attained through the interviews of 50 respondents, out of which 39 (78%) informed that their staffs and managers had been provided with quality related training, as well as visits to the sender's factories. The fact is further strengthened by the sender's added willingness to work enthusiastically with the capable recipients who could act efficiently. The relational ties, along with the business dealings, become more and more pronounced, in the relationship trajectory, in giving the receiver access to the technology, the interview data points out. Moreover, the senders have been found to provide communication channels to the local firms to get assistance from the parent company working elsewhere. 9 out of 50 respondents were given technology assistance cooperation agreements and

the sender firms played a major role in the whole process of installation and completion of the projects. The three phases given above of the Technology Transfer process are summarized in Figure 6.1. *Note: Bold text indicates distinct phases in the Technology Transfer process*.

Technology Transfer Process Phase 1:

Qualifying Stage

- **Prequalification/Selection of the key suppliers**
- **Provided parts drawings to the recipients (Explicit knowledge)**
- **Suppliers develop the customized prototype**
- Testing of the technology (with customization, if have any)
- **Selected suppliers join the business relationship with recipients**
- Little social interaction
- Little communication

Technology Transfer Process Phase 2:

Evaluative Stage

- **Owners provide technology detail specifications(Explicit knowledge)**
- Quality parameters
- **Technology owners provided some technical information, tools and advice on equipments**
- **Suppliers develop the final localized component (part)**

Technology Transfer Process Phase 3:

Interactive Stage

- Technology owners provided quality related training to recipients‘ staff
- **Suppliers’ management get more training and factory visits to the technology owners home country (tacit & explicit technology)**
- **Mediator and facilitator role**
- **Relational ties developed (social interaction and communications developed)**
- Regular audits

Figure 6.1 Three phases of Technology Transfer process from technology owners to their recipients.

6.2 Type of Technology Transfer

The type of technology, being transferred to Bangladesh, constitutes a major issue in the Technology Transfer process, with around 90% local firms indicating of having received some kind of technology in the last couple of years. The following table provides a list of the key technologies received by the Bangladesh health sector, based on UNCTAD, 2001 technology typology.

Table 6.1 Type of Technology Transfer to Bangladesh's recipients (50 respondents)

Type of Technology Transfer	Yes	No	No Response
1. Product related			
(a) Provision on product designs and technical specifications	41(82%)	7 (14%)	2(4%)
(b) Provision, seeking advice, or financial assistance to gain elemental materials and ingredients	28(56%)	12(24%)	10(20%)
(c) Continuous feedback on product performance to better the existing product-related technology	35(70%)	10 (20%)	5 (10%)
(d) Technical consultations on product characteristics to master new product technology	2(4%)	42 (84%)	6 (12%)
(e) Arranged R&D-collaboration efforts in product-related arena	0(0%)	48 (96%)	2(4%)
2.Process/Production related technology			
(a) Provision, advice, or financial assistance to gain new machinery, instruments and equipment	2(4%)	45 (90%)	3(6%)
(b) Technical support to improve the current production technology	28(56%)	21 (42%)	1(2%)
(c) Technical consultations and advice on machinery operation to equip with new production technology	0(0%)	48 (96%)	2(4%)
(d) Advice on installation of technology plants and organisation	2(4%)	48 (96%)	0(0%)
(e) Assistance with regard to quality assurance systems (e.g., ISO certification, TQM, etc.)	9(18%)	37 (74%)	4(8%)
3. Training programmes for suppliers' personnel			
(a) In-plant training for managers/ technicians at the local supplier site	35(70%)	10(20%)	5 (10%)
(b) Training for managers/ technicians at technology owners site	0(0%)	49(98%)	1 (2%)
(c) In-plant training for employees at the supplier site*	35(70%)	10 (20%)	5 (10%)
(d) Training for employees at technology owners site	0 (0%)	49(98%)	1 (2%)
4. Managerial related technology			
(a) Market know-how	0(0%)	47(94%)	3 (6%)
(b)Financial Planning & Management	2 (4%)	47(94%)	1 (2%)
(c) Project Management	0 (0%)	49(98%)	1 (2%)
(d) Inventory control	0 (0%)	48(96%)	2 (4%)
(e)Manufacturing cost control and delivery systems	0 (0%)	46(92%)	4 (8%)

Source: Author's Survey.

* Mainly quality related training programs.

The table 6.1 makes it clear that the international suppliers, operating in Bangladesh health sector, are mainly focused on supplying product related technology, with process and management related technology receiving scant attention, reflected in the 82% (or 41) firms'

receiving explicit knowledge, particularly product specifications and designing. More than half of the companies were provided raw materials, medical testing reagent and medical equipments, while around a three quarters were afforded support services to improve product performance. So, there is a conspicuous point as to the absence of Technology Transfer cases in the management related technology to operate the hospitals more efficiently.

The interview data also evinces the sheer evidence for a combination package of three areas of technology, instead of any one area, which restricts the company's growth and future prospective, as well as the opportunity to enter the standard of global health care service as confirmed by 85% of the firms interviewed. While evaluating the merits, as the interview suggests, one must consider all the types of the technlogy. We can divide the technology package into three types, based on the interview data.

- The elementary package includes specifications, design and drawings of the product.
- An intermediary package constitutes the features of the product design, specifications, ISO certification, training on product quality, consultative services on machineries. (product+process related technology)
- An advanced package combines product, process and management related technology.

6.3 Technology owners' Willingness to Transfer Technology

The degree to which the technology providers have been willing to trade their technology with the local customers is of particular attention to this ongoing study as the sender's willingness is considered essential and critical success factor [as described in the works of Szulanski (1996), Husted and Michailova (2002), Michailova and Husted (2003), Ko *et al*. (2005), and Becerra *et al*. (2008)] to implement a successful Technology Transfer. From the interviews with the technology providers and the local partners active in the health sector of Bangladesh, only three globally acclaimed parent corporations have been found inclined to deliver low-to-medium technical instruments and technology knowledge to Bangladesh. No advanced technological transfer has ever occurred, as Technology Transfer, so far, has been limited to provide the hospital with basic supplies. 40 respondents, out of 50, have confirmed that the technology senders are hardly willing to pass moderate to advanced technology knowledge, while favourable to procure standard and labor intensive parts and much willing to transfer related technology transfers. The international firms, as a whole, are extremely reluctant to give away the advanced technology to the local clients, let alone the hospital or mid-level medical facilities. The table below enumerates the technology transferred by three main international suppliers to the health sector of Bangladesh (Siemens, GE, Fresenius).

Table 6.2 Technology Contributed by the three International direct Suppliers

International technology owners	Technology contributed to local (Bangladesh) recipients
A-01 (International technology owners)	40-60% of transferred technology is of high precision parts.
	Good technology base in the small-medium compact size medical equipments. Has been established in the local market since the 1980s.
A-02 (International technology owners)	Low-medium tech parts technology (25-35%) of parts are localised.
	Excellent Production System and technology base. Has an excellent premium global presence.
	Established in Bangladesh‘s market in the 1990s. Views Bangladesh as a good potential market.
A-03 (International technology owners)	Low tech parts (10-25%) of parts are localised. Good technology base in highly tech shabby medical plants.
	Global network of around 507 subsidiaries.
	Local presence since the 1990s.

Source: Author’s interviews

The MNCs reluctance to share advanced technology emanates from several reasons, including the Bangladesh public health market size- not big enough to count into MNCs profitability, and the nature of the product part, the knowledge of which varies, from easy to enormously complex. For the advanced Technology Transfer transfer to take place, a whole lot of issues, such as budget consideration, biomedical research ability, time, willingness etc., are required from both senders and receivers. The strategic decision making process of the technology providers are also a decisive factor in this regard. The next section deals with the mechanism exploited by Technology Transfer parties.

6.4 Main Mechanisms used for Technology Transfer

Suppliers and parties in the Bangladesh health sector have sought different method to implement Technology Transfer, the interview finding suggests, from the international suppliers to the local firms, and then to the hospital authority. Face-to-face sit-in, video conferencing, documents communication such as drawings, layout, installation blueprints, seminars, factory visits, expert opinions consultation have been primary mechanism to expedite the Technology Transfer process. In some cases, technical committee was formed to spearhead the projects between the parties, they were previously agreed upon the terms to do the transfer. Almost all the companies (96% to be specific) received the transferred technology through documential procedures, in which the sender companies sent only the technology products, instead of sending skilled engineers along with the products, which, according to the interviewed firms would be more fruitful for more efficient in Technology Transfer process, particularly in complex cases requiring high degree of cooperation and intense engagement. The key mechanism and their advantages to the local firms are elaborated in the following table 6.3.

Table 6.3 Main Mechanisms for the Technology Transfer to Bangladesh's Health Sector

Mechanisms	Yes	No	No response	Useful mechanism (Yes/No)
Face to Face meetings	45 (90%)	2 (4%)	3 (6%)	Yes
Documents	48 (96%)	0	2 (4%)	Yes
Engineers Transfer	0	48 (96%)	2 (4%)	Yes
On-the-Job Trainings (OJTS)	33 (66%)	13 (26%)	4 (8%)	Yes
Seminars/presentations	35 (70%)	12 (24%)	3 (6%)	No
Vendor's conferences	40 (80%)	5 (10%)	5 (10%)	No
Overseas Correspondence*	15 (30%)	28 (56%)	7 (14%)	Yes

Source: Author's interviews and Survey data

* recipient's own initiated mechanism

That direct meeting and documents have been the key mechanism of the Technology Transfer in the health sector is quite obvious from the table, as the technology suppliers didn't escort their technology with engineering personnel to the local firms. A substantial portion of technology knowledge, opined many scholars, is rooted with a great many individuals, sending of which would facilitate the Technology Transfer process by huge portion (Argote and Ingram, 2000).

6.5 Trust

The crucial role of trust, a basic element of organisational relationship, is quite apparent in the present study. The evolution of relationship between the Technology Transfer parties is largely dependant on the strength of the trust between them, as trust increases, so told the local firms' high officials, the arena for mutual cooperation and and fosters speedy transfer of knowledge. In most cases, the final outcome of the Technology Transfer process heavily depends on the willingness of the senders and the sender firms have dictated the terms and conditions of the process, occasionally even pressurising the local suppliers into sales commission cuts. Around half of the recipients interviewed have complained about no-assistance from their parent international technology partners.

Table 6.4 Level of trust of recipients have in their technology owners

Measures of trust	Yes	No
You (recipients) think that the technology sender will always care for your benefit and interest	13 (26%)	37 (74%)
You (recipients) think that the technology senders would preserve your interest in any situation.	12 (24%)	38 (76%)
You felt like your suppliers (technology owners) become worried at what happened to you	10 (20%)	40 (80%)
You trust that your technology providers will treat you fairly	24 (48%)	26 (52%)
You assume that the technology senders have a persistent goodwill for trust building (dedicated to promises and commitments) across the industry.	12 (24%)	38 (76%)
Given the chance, you assume that the technology senders will avail unfair advantage of you	22 (44%)	28 (56%)

Source: Survey Questionnaire

The table above makes the point the local recipients enjoy a very low level of trust among the parent technology ventures. A huge portion of 80% stated that their technology supplier would hardly care for their hospital operations if technology fails or inoperative, while 30% owners feel satisfied with their suppliers. About 72% held that technology owner would capitalise any undue advantage whenever presented with. 76% of the respondents complained about the international firms of not being sincere enough on their promises and commitment. Interviews with the technology owners stressed the importance of trust and reliance for meaningful Technology Transfer completion.

6.6 Social Ties

The research took special effort to measure the role of social ties in Technology Transfer implementation in the Bangladesh health sector, for which the suppliers and receivers often gather in social arrangements, the interviews suggested. Of the 50 respondents interviewed, 11 informed us about social gatherings, foreign excursion trips, recreation festivals, among the staffs of both parties as well as their family held, to facilitate speedy communication and sound business environments. For attaining critical knowledge and technology, social relations and connections play important roles.

6.7 Recipients' Learning Intent

Recipient's learning intents and capabilities are of particular significance from the receiver's point of contribution to make the Technology Transfer successful. Scholars studying management speak of differing motives for organisation-wise partnership building (Faulkner, 1996; Kauda, 2002), but this doesn't automatically translate into learning acquisition for the receiver, unless accompanied with the readiness to learn and the necessary resources to support the process (Inkpen, 2000). In the Technology Transfer context, the self-desire and willing of a firm to learn from the sender is reflected in the degree of learning intents (Hamel, 1991). From the perspective of Bangladeshi recipients, the achievement of technological know-how has been the prime mover to access to foreign sender.

Table 6.5: Main motives for Bangladeshi technology recipients in forming business relationships with technology owners

Main Motives	Very important	Important	Not important
Acquiring technical know-how	47 (94%)	2 (4%)	1 (2%)
Entering into global value chains	46 (92%)	3(6%)	1 (2%)
Learn about global motive best practices	40 (80%)	6 (12%)	4 (8%)
Sharing the risk of new product development	30 (60%)	8 (16%)	12 (24%)
Develop technological capabilities	45 (90%)	3 (6%)	2 (4%)

Source: Author's survey and interviews

The table 6.5 points out acquiring technology know-how as the fundamental inceptive to come to terms with the technology suppliers, as well as to ride the sender's back to access global

networks. 90% firms sought the partnership for upgrading their technological acumen and skills, as reflected in the table showing technology know-how as the sticking point with the technology owners. Perez Nordtvedt et al. (2008) stressed upon the criticality of learning intents in the run up to a successful Technology Transfer project. The next section shows the importance of recipient's absorption capacity.

6.8 Recipients' Absorptive Capacity

Maximum exploitation of the foreign technology is largely incumbent upon the recipient's capacity to absorb the knowledge, which has been emphasized by a number of scholars from the management studies on issues of Technology Transfer (Lane *et al*., 2001; Gupta & Govindarajan, 2000; Lyles and Salk, 1996). The recipients interviewed in the study showed a moderate level of absorbing capacity with almost all 97% of them recognising the importance of having in-house ability to acquire the knowledge brought in.

Table 6.6 Linkages with local institutions and benefits for components suppliers

Local institutions	Benefits for suppliers
(R&D centres, Universities, Associations)	❖ Repositories of technology knowledge and information ❖ Low search costs for a technological knowledge ❖ Intense collaboration efforts and a workable combination of resources

The data shows that only 22% were able to import absorbing capacity from the senders through weak institutional means and linkages, not healthy enough to do more. The following table presents the state of institutional rendering and cooperation with regard to the technology knowledge providers.

Table: 6.7 Institutional support and linkages the recipients have with sender (50 respondents)

Institutional Linkages	Yes	No
Your firm received support for R&D initiatives from local institutions	4(8%)	46 (92%)
Your employees were afforded specific training programs by localised academic institutions, including those of Government-run skills development institutions	11(22%)	35 (70%)
Your firm advantaged from academic institution research activities	2(4%)	48 (96%)
Your firm held collaborations with any Government R&D institutions	0	50(100%)
Your firm has internship arrangements with the local institutions	6(12%)	44 (88%)
Your firm has received assistance in technological knowledge development efforts from local academic institutions, including Government- run institutions	5(10%)	45 (90%)

Source: Author's Survey

The table above presents the extent and degree of institutional support of the sender for the recepients, with only 22% respondents were found to have received development training through local arrangements and government-run technical support centers (Rund by DGHS). A

tiny percentage (8%) of the firms afforded support for R&D initiatives and only 4% had linkages with the local training providers which is not surprising, given the very low level of integration between training providers and recipients in the country. There is hardly any firm to engage the government in R&D initiatives and 12% offered some kind of internship opportunity with local institutes. 10% firms received technlogy knowledge from the government institutions. All these results suggest a very low degree of programs and initiatives in raising the recipient's absorption capacity.

6.9 Technology Transfer Effectiveness

The responses to the question of Technology Transfer effectiveness from technology senders to receivers in the health sector of Bangladesh reveals different results, interviewed receivers contending that receiving a technology is just a basic step in the overall context as many other issues come up along the value chains. There have been, as the interview data reveals, multiple types governance relationship between the parties in Technology Transfer, which exerts influence in the Technology Transfer process in a substantial basis. 84% recipients have been following contractual or purely business agreements, with the technology owners dominating the terms. The owners can pull out from the business within a moment's notice.

6.9.2 Breadth and depth of technological learning

The breadth and depth technlogy adaptation, term coined by Zahra et al., (2000), of the Technology Transfer process occuring in Bangladesh health context has also been explored in the study, touching upon multifaceted areas of learning novel experience (Teece, Rumelt, Dosi, & Winter, 1994), which involves acquiring sophisticated technology knowledge mirrored in firm's ability to reach upon new conclusion and stitch together technology across technological types (Huber, 1991). Out of the 50 respondents, 37 recipients told that they had been provided with elemental technology knowledge, particularly documents and drawings, which was narrow I'm focus, limiting the scope for learning from a broad context. The owners' continuous support and assistance, the data evidenced, play a vital role for efficient learning to take place. Looking critically at the interview data it becomes obvious that the local technology recipients have, so far, received rudimental and primary technology as the technology owners have been willing to transfer only the standard to low medium technology, rendering them a low-level of capability development. The personal ties, social relations, mutual understanding, etc., have been influential in the development of advanced technologies for the receiving party, which could be complemented by the presence of in-house training facilities. While eliciting the respondent data, we relay the respondents about the meaning and significance of marks 5 to 1 - representing deep/advanced level learning and shallow/Basic level learning.

Table 6.8 Technology Transfer effectiveness from owners to recipients - Breadth and Depth of Learning

Technology Transfer effectiveness in terms of:	Narrow	Broad	No Response
Breadth of technological learning			
What extent your company has acquired technology knowledge and information, or acquired skills or technological capabilities from the technology owners in:			
(a) designing and drawing of new products/processes	37(74%)	9(18%)	4 (8%)
(b) to prototype new customized products/processes	34(68%)	11(10%)	5 (10%)
(b) Timing new product/processes introduction	28(56%)	20 (40%)	2 (4%)
(c) Sequencing new product/processes	31(62%)	18(36%)	1(2%)
(d)Customising (reverse engineering) for local situation	31(62%)	1(2%)	18(36%)
(e) Manufacturing	39(78%)	1(2%)	10(20%)
(f) Organising the R&D function	44(88%)	4 (8%)	2(4%)
(g) Staffing the R&D function	43(86%)	7 (14%)	
(h) Determining R&D spending level	38(76%)	2(4%)	10(20%)
(i) Managing the R&D process	42(84%)	4 (8%)	4 (8%)
(j) Co-ordinating R&D with other firms and organisational units (functions)	48(96%)	2(4%)	
Depth of technological learning	**Shallow**	**Deep**	No Response
How well (depth and quality) your company has garnered or achieved mastery of new skills from your technology sender in each of the areas which are listed below:			
(a) designing and drawing of new products/processes	21(42%)	22(44%)	7(14%)
(b) to prototype new customized products/processes	38(76%)	2(4%)	10(20%)
(b) Timing new product/processes introduction	32(64%)	16(32%)	2 (8%)
(c) Sequencing new product/processes	36(72%)	14(28%)	0
(d)Customising (reverse engineering) for local situation	37(74%)	9(18%)	4 (8%)
(e) Manufacturing	47(94%)	3(6%)	0
(f) Organising the R&D function	40(80%)	6 (12%)	4 (8%)
(g) Staffing the R&D function	30(60%)	8 (16%)	12 (24%)
(h) Determining R&D spending level	39(78%)	1(2%)	10(20%)
(i) Managing the R&D process	39(78%)	1(2%)	10(20%)
(j) Co-ordinating R&D with other firms and organisational units (functions)	32(64%)	16(32%)	2 (8%)

Source: Author's survey (based on Zahra et al.2001)

The results regarding the breadth and scope of technological learning, presented in the table above, indicate that about 74% recipients have acquired a few to some basic technology knowledge, notably in the fields of designing and drawings, and 18% spoke of gaining deeper or intimate knowledge. Out of the 50 respondents, around 68% received very shallow level technology knowledge on prototyping new products, while 80% respondents informed that they received shallow knowledge on fresh skills or capacity with regard to build up training programs and quality building initiatives through R&D activities. Under the discussions above, we see a very limited breadth of transferred technology.

Table 6.9 Important factors for Technology Transfer effectiveness across recipients (n=50)

Factors	Very Important	Not Important	Illustrative quotes
Learning intent	97%	3%	"As quite obvious in the present perspective, to learn sender's technology we must have to possess firm commitment to learning and dedicated resources to make use of this technology"
Absorptive capacity	96%	4%	"even if my Technology Transfer partner sends simple technology, it won't come to use if we lack the capability and commitment to receive and learn this technology"
Trust	94%	6%	"you exchange knowledge or secret with your business associates who you think will not turn their back upon you"
Social ties	97%	3%	"we have understood the importance of personal connections and it is generally taking the person in your inner quarters to talk if you are having any issues and getting the timely feedback"
Senders willingness and intention to transfer technology	100%	n/a	"the client shares us the technology for medium and low tech products type; for the advanced and tacit high tech parts technology which are reluctant to give away this knowledge" "We would like to find new markets in China, India and even Latin America which will supply hubs, but we require the advanced technology and the willingness and capability of our technology owners matters, as without their intention we cannot afford the know-how"
Package of technology (Product, Process and Managerial technology)	100%	n/a	"we want to acquire the complete package of technology and manufacturer state of the art product technology which we could export or sell to other international makers"

Note: 1-5 scale 1= not important; 5= very important

Table 6.9 is furnished with respondent quotes, illustrating the role the sender's intention to handover technology, management learnings, social relations in a successful Technology Transfer Project. More than 95% firms have rated those points as having most critical influential weight in Technology Transfer effectiveness.

6.10 Numerical Analysis Variable using Structural Equation Modeling

6.10.1 Instrument

The instrument of this study consisted of a 37 Likert- item or converted to Likert questionnaire, which was designed to assess the Technology Transfer effectiveness in terms of the importance of Technology Transfer Effectiveness (TTE) success variables. The 37 variables were categorised into six dimensions or latent constructs and measured using the different scale, later converted or fitted to five-point scale ranging from “extremely unimportant” to “extremely important”. The 37 variables are denoted by V1 through V37 are shown in the appendix E.

6.10.2 Data Analysis

The sampling frame of this study consisted of 50 respondents from health sectors of Bangladesh. The surveys were conducted using self-administered structured questionnaires. The research questions of this study were analysed using Statistical Packages for the Social Sciences (SPSS) package. Two levels of data analysis are conducted: a macro-level analysis of aggregate, surface characteristics of the respondents and a micro-level analysis of deeper, fined data methods. The macro-level was concerned with the aggregate measures of the descriptive statistics, where as the micro-level, there was the evaluation of the measurement and structural model of the Technology Transfer Effectiveness (TTE) traditional methods such as Pearson correlations, Regression as well as fine grained methods such as Structural Equation Modelling (SEM). The following sub section presents a brief overview of one such method, Structural Equation Modelling.

6.10.3 Structural Equation Modelling (SEM) Approach

The structural equation modelling (SEM) approach consists of two parts, the measurement and structural model. According to Cheng (2001), the structural model stage of analysis involves the evaluation of the relationship between the latent constructs, developed. The measurement model involves parameter estimating and model testing which is used to test the fitness between theoretical specifications and the empirical data set (Fan and Hsu, 2004). The following sub section presents the measurement model estimation.

6.10.3.1 Measurement Model Estimation

To strictly test the critical success factors of technology transfer, a global model comprising of the structural the measurement models are illustrated through equations 1.0 to 2.0 using the second order approach.

SECOND ORDER APPROACH (SOA)

Structural Equation = G? + S *Equation 1.0*

(6 x 1) = (6x1) (1x1) + (6x1)

The structural equation links the six Technology Transfer Project constructs to the latent success factor "Technology Transfer Effectiveness " ?. These six factors are shown in Fig 6.2. as Learning Intent (LEI), Absorptive Capacity (ABC), Trust (TRS), Sender's Willingness (SWL), Technological Package (PCK) and Social Tie (STI). The 37 variables are shown in the Appendix E.

FIRST ORDER APPROACH (FOA)

Measurement Equation:

$$y = ?? ? + e \qquad \text{Equation 2.0}$$

(37 x 1) = (37 x 6) (6 x 1) (37 x 1)

The measurement equation links observed indicators y to their respective hypothesized quality factors *?*. First order factors are given by ?**?** while second-order factor loadings are given by G

Global Model = Structural Model + Measurement Model

The hypothesised overall TTE-SMART model (Chileshe and Haupt, 2005) is portrayed in Figure 2.0 in Structural Equation Modelling (SEM) notation. The single headed arrows leading from the second-order of TTE (F11) to each of its underlying first order factors (F1, F7; F2, F7; F3, F7; F4, F7; F5; and F6, F7) are regression paths that indicated the prediction of the TTE Learning Intent, (F1), TTE Absorptive Capacity (F2), TTE Trust (F3), TTE Sender's willingness (F4), TTE Technological Package (F5), and TTE Social Tie (F6) from a higher order TTE factor.

They also represent second-order factor loadings results denoted as q11 through q61 and presented in Table 6.10 There is also a residual disturbance term associated with each first-order factor (D1, D2, D3, D4, D5, and D6). These represent residual errors in the prediction of the first-order factors from the higher order factor of Technology Transfer. The loading on the first variable (LEI) in Figure 1.is fixed to 1.0 to scale the latent variable. With this loading fixed, the one factor model has 12 free parameters, including 5 remaining factor loadings and 11 variances (of 6 measurement errors denoted as e-1 through e-6 and latent variable). With 6 observable variables, there are [6(6+1)]/2 =21 observations, thus the degrees of freedom (df) = 21 - 12 = 9. Where 21 are the number of distinct sample moments and 12 is the number of distinct parameter to be estimated.

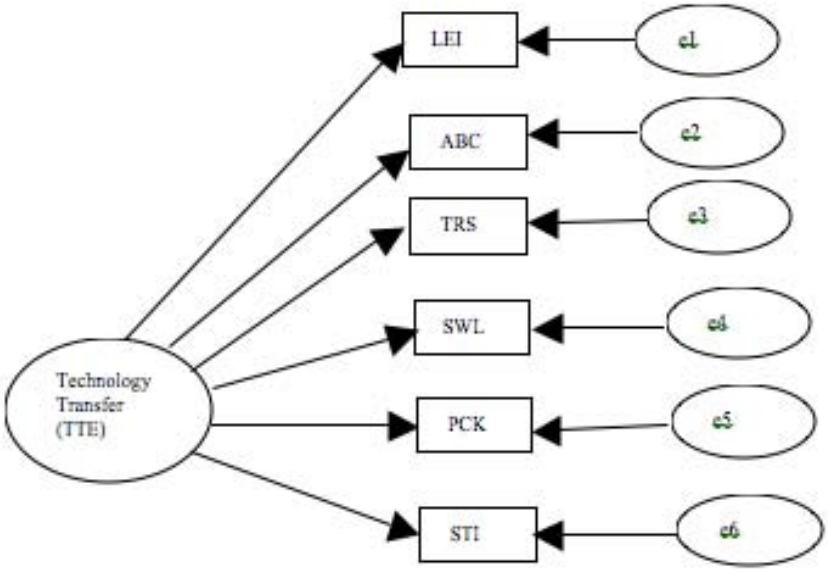


Figure 6.2: Model of 2nd Order Confirmatory factor analysis

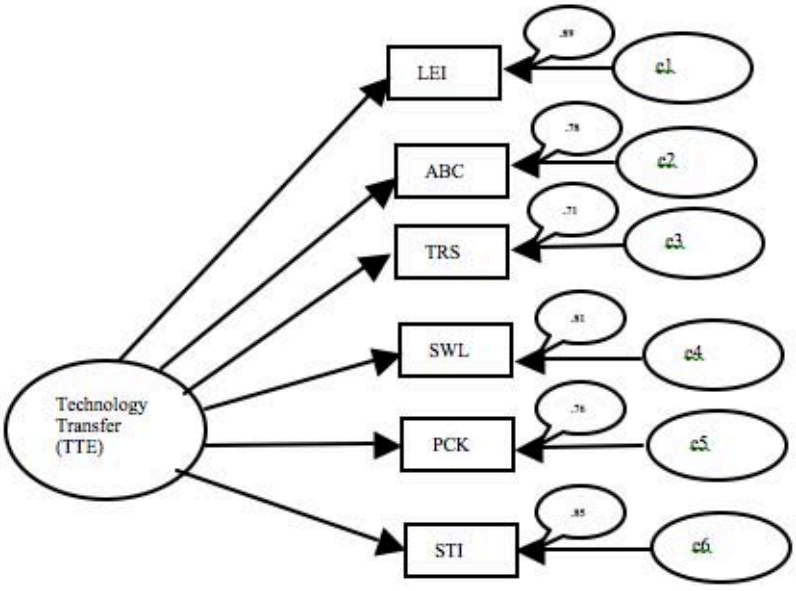


Figure 6.3: Result of the 2nd Order Confirmatory factor analysis (Full Sample n=50)

This approach draws heavily from Curkovic (2003) as used in examining a four factor model of Environmental Responsible Manufacturing (ERM). F1 through F6 are constructs from success factors of technology transfer, which are approximated units, which by their very nature cannot be observed directly. In testing the theory, the researcher is testing a statement of a predicted relationship between the units observed or approximated in the real world. Thus constructs (h1 to h6) are related to each other by propositions, while variables are related by hypotheses. Expressed more formally, the Second Order CFA model portrayed in Figures 6.2 and 6.3 hypothesized a priority that

- TTE can be conceptualised in terms of the six factors
- each observed variable will have non zero loading for all other factors
- error terms (E1 through E6) associated with each observable variables will be uncorrelated
- The six first-order factors will be correlated

F_1 = Factor 1 = TTE Learning Intent Factor (1^{st} Order Factor)
F^2 = Factor 2 = TTE Absorptive Capacity Factor (1^{st} Order Factor)
F^3 = Factor 3 =TTE Trust Factor (1^{st} Order factor)
F^4 = Factor 4 = TTE Sender willingness factor (1^{st} Order Factor)
F^5 = Factor 5 = TTE Technological Packages Factors (1^{st} Order Factor)
F^6 = Factor 6 = TTE Social Tie Factor (1^{st} Order Factor)
F_7 = Factor 7 = TTE (2^{nd} Order Factor)
The results from structural analysis indicated that the minimum was achieved with a chi-square (?) of 28.225 and probability level of 0.001.

6.10.4 Model Testing

The modified TTE-SMART model is represented in Figures 6.2. and 6.3. according to the Linear Structural Relationships (LISREL) notation. The ellipses contain the name of the latent variables while the rectangles contain the measure used to explain each construct (Forza and Filipini, 1998). For example the 'Learning Intent Construct' is represented by latent variable F1 while the measure used to explain this construct are indicated by variables V1 to V7 with their associated errors E1 to E7.

6.10.5 Output of Numerical Analysis of The Success Factors

Tables 6.10. and 6.11. present the results of the SEM, LISREL and Regression Approaches. The results in Table 6.10 are for the second-order factor loadings of TTE constructs, which can also be represented, in a graphical format as shown in Figure 6.3. The results are slightly different as the values used in the second order analysis took the average scores of the variables assigned to each factor. Table 6.3. contains the standardised coefficients for the structural relationships. All but one of the parameters shown in Figure 6.3 are found to be both of the hypothesized sign and statistically significant. Learning Intent (F1) appears

to be strongly linked to TTE ($?_{11}$ = 0.945). The equations, which comprise the measurement model of the LISREL (Linear Structural Relationships) notation with the coefficient mean, manifest variables and constructs corresponding to those used in the model are shown in Figure 6.3.

$X_1 = \quad ?_1?_1 + d_1$

$X_2 = \quad ?_2?_2 + d_2$

$X_3 = \quad ?_3?_3 + d_3$

$X_4 = \quad ?_4?_4 + d_4$

$X_5 = \quad ?_5?_5 + d_5$

$X_6 = \quad ?_6?_6 + d_6$

Where the values of the factor loadings are obtained from Figure 2.0 for the factors designated by the six constructs with their following factor loadings ($?_1$ through $?_6$) are as follows; $?_1$= 0.89, $?_2$= 0.78, $?_3$= 0.71, $?_4$= 0.81, $?_5$= 0.76, and $?_6$= 0.85.

6.10.6 Demonstration Of Inter-Factor Relationships Using SEM

The factor loadings or standardised regression weights as shown in Table 6.10 are also used to generate the inter-factor correlations, which are presented in Table 6.12. For example, from the factor loadings as shown in Table 6.10, the path from TTE to Factor 1 (Learning Intent Factor) and 2 (Absorptive Capacity) illustrated as $?_{11}$ and $?_{21}$ are 0.945 and 0.883 respectively. This can further be shown as follows;

TTE ? F1 = 0.945, TTE ? F2 = 0.883

Thus the path between F1 and F2 can be computed as follows; 0.945*0.883 = 0.834, and that between F2 and F3 can be calculated as 0.749 ($?_{21}$ * $?_{31}$ = 0.883 *0.848). This shows that the relationship between the TTE and its associated constructs at each level is stronger than within the constructs themselves.

Table 6.10 : Structural Equation Modelling Approach

Path	Factor Loading	Standardised Regression Weights (SRW)	Squared Multiple Correlations (SMC)
TTE - F1	q11	0.945	0.892
TTE - F2	q21	0.883	0.780
TTE - F3	q31	0.848	0.706
TTE - F4	q41	0.898	0.807
TTE - F5	q51	0.870	0.757
TTE - F6	q61	0.921	0.848

Table 6.11: Regression Approach

Model	Multiple R	SMC R2	Adjusted R2	St Error of the Estimate
1	.337(a)	.113	-.050	1.57986
2	.582(b)	.339	.070	1.48689
3	.637(c)	.405	-.029	1.56428
4	.764(d)	.584	.016	1.52965
5	.828(e)	.686	.057	1.49711
6	.893(f)	.798	-.135	1.64239

Table 6.12: Inter-Factor Correlations (F)

	F1	F2	F3	F4	F5	F6
F1	1.00					
F2	.834	1.00				
F3	.794	.742	1.00			
F4	.848	.793	.755	1.00		
F5	.822	.769	.731	.782	1.00	
F6	.870	.813	.774	.827	.802	1.00

Table 6.13: Goodness-of-fit indices for the initially hypothesised first-order TTE CFA Model

N	50 Respondents	Results
Number of latent variables	6	
Total number of observed variables	13	
Number of unobserved variables	7	
Degree of freedom (df)	9	
$?^2$ statistic	28.255	Acceptable fit
p-value	0.001	Acceptable fit
$?^2$/df	3.136	Acceptable fit
Bentler-Bonett normed fit index (NFI)	0.930	Acceptable fit
Bentler-Bonett non-normed fit index (TLI)	0.917	Acceptable fit
Comparative fit index (CFI)	0.950	Acceptable fit

The standardised parameters for the Multitrait- multi- method model are displayed in Figure 6.3. Each set of standardised measurement coefficient shows the relative influence of a concept variable and an error variable or a measured variable. The square of a standardised coefficient shows the proportion of observed variance to the specified causes, the error term. For example, TTE contributes 11.3% (0.337^2) of the unit variance of Learning Intent Construct. According to Cheng (2001), the structural model stage of analysis involves the evaluation of the relationship between the latent constructs. Table 6.12. presents the relationship among the first-order factors, which can be used to infer the relative strength of relationship among the success factors (variables) by their path loadings.

The highest correlation between 'Learning Intent' (F1) and 'Social Tie' (F6) as (F = 0.870) and each of the other constructs suggests that when Technology Receiving Firms exhibit acquiring technical knowhow, entering into global value chain, develop own technological capabilities; learn about global motive of best technology transfer practices. This finding is consistent with previous studies (Perez Nordtvedt et al. 2008). According to Cortina (2002), these structural coefficients in SEM are meant to represent the relationship among constructs. Nomological validity was assessed from the final instrument shown in Figure 6.3 using the inter- factor correlations. From Table 6.12, it is evident that all correlations were statistically significant and positive; also some of the correlations were very large.

As asserted by Curkovic et al (2000), the large correlations are hardly surprising as it was hypothesised a priori that these six factors are associated with a higher-order factor called Technology Transfer Effectiveness (TTE) as illustrated in Figure 6.3. The inferences to be drawn are that the absence of negative correlations among the TTE success factors indicates a high value on one factor and that the factors complement one another (Curkovic et al, 2000:779) As evident from Table 6.12 none of the correlations has a value that is close to 1 (>0.9 or even in the most exacting case, >0.809) which shows the presence of discriminant validity among the different concepts used in this research.

The overall fit measures, the multiple squared correlation, coefficients of the variables, and the signs and significance levels of the path coefficients all indicatethat the model fits the data well ($?^2_{(58)}$ = 28.255, p < 0.001; $?^2$ ratio = 3.136; NFI =0.930, TLI = 0.917 and CFI = 0.950). The residuals of the covariance were also small and centred around zero. A summary of the selected indices for the AMOS analysis is provided in Table 4. Presented with the findings of $?^2$ (58) = 28.255 and CFI = 0.950 for the first-order Technology Project Management CFA model, no further modifications were required to improve the model fit to acceptable levels. Based on the ratio of the Chi-square to the degrees of freedom (>2), this value should not exceed twice the degrees of freedom. Other ft indices also suggest a good fit; the CFI is high (.95) and the average off-diagonal standardised residual is low.

However, Curkovic et al (2000) argue that $?^2$ divided by its degrees of freedom, should be less than 3. As the value obtained for this model is 3.136, it can be concluded that the observed and estimated matrices do not differ considerably.

6.10.7 Regression Approach

In additional to the fined data analysis such as SEM, this study also employed the traditional methods such as Regression. For this study, the F-to-enter and F-to-remove values used were 0.05 and 0.01 respectively. Using a similar approach as adopted by Kontoghiorghes and Gudgel (2004) and Chileshe (2005), the generated regression models as shown in Table 2.0 were cross-validated by also calculating the Herzberg's adjusted R^2 value and comparing it to R^2 in order to determine shrinkage and the predictive power of the regression model. The objective of Table 2.is to verify whether or not the inclusion of the factors and latent constructs improves the fit of the model (Llusar and Zornoza 2000). The R square, the coefficient of determination, is the squared value of the multiple correlation coefficients and it shows that the model explains about 11.3% of the variation in the Learning Intent (LEI) Construct. Clearly this is a weak model as the threshold should be approximately 50%, thus requiring the multiple R to be greater than 0.7. The first model in Table 2.for the TTE only contains LEI as a construct and this can only explain 11.3 per cent of the variance. The following Table A-1. (Appendix D) summarise the change statistics of the R2 for the TTE model as illustrated in Figure 6.3

The adjusted R^2 value provides an indication of how well the model generalises. Ideally this value should be the same or very close to the value of the squared multiple correlations R^2 (Field, 2000). For model 6 in Table 6.11., the difference between the values is 0.798- (-0.135) = 0.933 (93.3%). This shrinkage means that if the six-factor model were derived from a sample, it would account for approximately 93.3% less variance in the outcome. As a further measure of the strength of the model fit, comparing the standard error of the estimate in the model to the standard deviation of the Learning Intent Construct reported in the change statistics Table A-1. (Appendix D). Though useful test of the model's test to explain any variation in the dependent variable, it does not directly address the strength of that relationship. The Analysis of Variance (ANOVA) showed in Table A-1, Appendix D tests the acceptability of the model from a statistical perspective. The significance value of the F Statistics is less than 0.05, which means the variation explained by the model is not due to chance. From Table A-1 (Appendix D), the regression row model displays information about the variance accounted for by the model. For example in the above table, Model 1 accounts for 11.34 % which is obtained by dividing the sum of squares for the regression model by the total values, in this case 12.132/106.978 = 11.34. From the regression model in row 1, it is evident that the regression and residual sum of squares are not equal, which indicates that about 88.65% (100 -11.34) of the variation is explained by the residuals. The model does for the residual, which displays information about the variation, not account for the second row. The inferences of the statistics are that ideally the regression values should be higher than the residual. Based on this assumption, examination of Table 6 reveals that Model 4 has the Regression value greater than the residuals (i.e. 62.521 > 44.457), which is supported by the higher value of the R^2 (>0. 584) in Tables 6.11 and A-1 (Appendix D).

6.10.8 Convergent Validity:

Convergent validity refers to the degree to which the different approaches to construct measurement are similar to (converges on) other approaches that it theoretically should be similar to. Three techniques are utilised for assessing convergent validity as follows;

- Statistical significance of the loadings at a given alpha (i.e. p=0.05)
- Average Variance Extracted (AVE)
- Reliability (standardised loadings)

Statistical Significance: The convergent validity analysis was performed in six stages using the stepwise regression method. In the first model only variables belonging to the Strategic Constructs were included. This was termed as Model 1. Test statistics showed that this model was inconsistent with sample data. The root mean square residual (RMSR) was very high (RSMR = 0.190). The residual sum of squares represents the total difference between the model and the observed data. (Field, 2000). All the models apart from No. 6 are insignificant (p> 0.001) and the F-ratio as indicated in Table 6.0 are not high values. The interpretation of this data is that it is difficult to predict whether an technology owner or university is effectively delivering the Technology or not. Furthermore from Table 6.11, it is evident that when only Learning Intent used as a predictor, this becomes a simple correlation between learning intent and implementing Technology effectively (0.337)

Average Variance Extracted (AVE): Discriminant validity is demonstrated if the average variance for each construct (within-construct variance) is greater than the squared correlations between constructs (between-construct variance). Discriminant validity among the six elements of TTE was examined using Fornell and Larcker's (1981) techniques. A six factor correlated model representing each of the six elements was used to examine discriminant validity, and is schematically shown in Figure 6.3 Convergent validity was supported as the entire factor loading ($?_{11}$ through $?_{61}$) for each individual indicator (Table 1.) to its respective construct was positive (greater than 0.50) indicating that all the 6 constructs were significant determinants of the TTE

Reliability: The cronbach values for the six constructs ranged from 0.6227-0.8248. A full listing of the final constructs and their scale reliabilities can be found in Table A-3 (Appendix E). Therefore, the reliability and convergent validity of the measurements are preliminarily secured and thus appropriated for further conduction of SEM (Peng, Fan and Hsu, 2004). The six models as examined in Tables 2 and 5 and based on the values of variances explained, the integrated 6 Construct Model (R^2 = 0.798) is a better representation of TTE than the separate models of LEI Constructs (R^2 = 0.113), the two factor model of Learning Intent and Absorptive Capacity (R^2 = 0.339) and the three factor model which includes the Learning Intent, Absorptive Capacity and Trust (R^2 = 0.405)

6.10.9 Comparison of result extracted from two approaches

6.10.9.1 Regression Approach

As shown in Table 6.11, the six stepwise regression models identified the stronger predictors of each of the TTE constructs. Interestingly enough, the strongest was the 6 construct model summary of regression analysis which included all the factors as shown in Figures 1.0 and 2.0. This reports the strength of the relationship between the model and the dependent variables. The multiple (R) correlation coefficients, is the linear correlation between the observed and model-predicted values of the dependent model. Its large value indicates a strong relationship. The interpretation of the Model 5 in Table 6.11 is that if the sample was drawn from the population, then the expected variance would be R^2 less than the adjusted R value, which would be 0.686 – 0.057 = 0.629. This means that the variance from the sample would be 21.3 per cent. As the R^2 states how much of the variance in Y is accounted for by the regression model from the sample, it can be concluded that the six-construct model as hypothesised is the better option, as it can explain above the recommended variance (> .70). The second model indicated in Table 6.11 includes the seven variables each for the learning intent factor as shown in Appendix E, V1 through V7 and the six variables for (V8 through V13) absorptive capacity. The value of the squared multiple correlations is (R^2 =.339), which means that learning intent factor and absorptive capacity, accounts for 33.9 per cent of the variation in delivering the TTE. As the two (thirteen) predictors are included in this model, the value increases from 0.113 or 11.3 per cent to 0.339 or 33.9 per cent, thus the inclusion of more predictors explains quite a large amount of variation. Furthermore the data collected found a strong association between the technology transfer and the independent variables. Table 2.0 and also (Table A-1, Appendix D) shows that the explained variation (R^2) improves from 11.3 percent for the strategic construct as the only one in the model to 79.8 per cent for a 6 construct model incorporating all the factors. The above result confirms that there is a positive relation between the implementation of Transfer technology effectively and adoption of the six deployment constructs as suggested by the R square value of 0.798 and adjusted value of -0.135.

6.10.9.2 Comparison Of Structural Equation Modelling And Regression Analysis

Table 6.12. also indicates that there are moderately large correlations among the three core dimensions of social tie, technology package and sender willingness to transfer technology. Table 3.0 provides a direct picture of the relationship between the various TTE practices. This helps give a better understanding about the positive fit among the practices. As supported by Woon (2000), where the correlation among the TTE constructs provides an indication of the extent to which they reinforce one another in the TTE effort. Based on Structural Equation Modelling using the AMOS Software, the structural analysis produced "factor loadings" that represented the strength of causal connection between the models independent and dependent variables (constructs). The factor loadings could be used to determine the unit contributions of each construct towards Technology project management. In additional to testing the validity and reliability of the TTE-SMART through Confirmatory Factor Analysis (CFA), the structural equation modelling (SEM) was utilised to verify the construct validity of scales and to test relationships among variables and unobservable variables. SEM was used to determine the relative influence of each of the six constructs on the Technology Transfer Project effectiveness.

6.10.10 Final Remarks from Statistical Analysis of Variables

This study has moved from present technology transfer situations and specific research hypotheses, linking the theoretical concepts of TTE to empirical indicants. The structural model in Figures 6.2 and 6.3 can be effectively used by decision makers to measure the levels of TTE in the health sector of Bangladesh. This is possible, as the critical weight factors or factor loadings established, highlights the importance of each of the constructs and their associated activities. Therefore, the conceptual framework conveys a message of how limited Technology Transfer resources should be allocated (Flynn and Saladin, 2001). Additionally, according to Tan and Wisner (2004), knowledge of the interactions among the six deployment constructs, can be a valuable diagnostic tool in addressing the effectiveness of each initiative alone to further enhance competitive success in delivering an effective and efficient Technology Transfer. One of the rationale of SEM usage is that, since science typically views theory validation as coming from predictive verification (Deductive Approach), of expected theoretically results based on empirical evidence, the SEM casual models used throughout the study provided an explanatory description of casual relationships among the TTE constructs, plus a manipulation capabilities for diagnosing the key changes necessary for system improvements, and for predicting the impacts of potential change actions (Anderson and Vastag, 2003).

One of the purposes of this study was to contribute to the Technology Transfer Project Management, theory-building efforts in knowledge transfer, particularly Technology. This was achieved in the following ways: This study contributes to the existing body of knowledge on TTE by answering some of the questions left unanswered both on the conceptual and empirical lines by various researchers. Filippini (1997) identifies these as the components of Technology project and their measurements, (SEM) and the relations between these. This thesis demonstrates the causal relationships between the six TTE deployment constructs through the factor loadings. The conclusion drawn from the regression analysis is that TTE is best implemented on a holistic approach rather than a piece meal approach.

One area found wanting in TTE research, that is the difficulty at arriving at a theory which highlights the various concepts of TTE by measuring them and then correlating theses concepts to quality performance. This can be achieved through the application of Advanced Structural Equation Modelling techniques as advocated by Williams et al (2003). This research further contributes to TTE knowledge by maintaining the convergent and discriminant validity of Technology Transfer Effectiveness. This extends the work of Loo, (2003) by empirically validating the model as developed for managers to assess their project and organization variables. Using the approach of Hackman and Wageman (1995) in assessing the TQM, this study raised the following question; "Is there such a thing as TTE"? In assessing the distinctiveness of TTE, the two comparison groups were considered, Academia and Industry within the developing countries Context, however, as foreseen by Hackman and Wageman (1995), despite passing the discriminant validity test, TTE is close to failing the test when one considers emerging initiatives as identified in this study, by organisations or universities which claim not to be delivering Technology Project Management as a discipline yet, address some principles and skills of TTE. On the other hand, it would be difficult to demonstrate the aforementioned through usage of traditional methods such a regression analysis.

CHAPTER 7: DISCUSSION & CONCLUSION

7.1 Technology Transfer process

The findings show that the Technology Transfer, an ongoing process, consists of the three stages of qualifying, evaluation and interactive, which resemble, in some respects, those of intra-firm transfer mechanism Szulanski (2000). While our study finds three stages of Technology Transfer, Szulanski (1996, 2000) speaks of four stages of intra-firm transfer of technology. Bresnan et al (1999) found two stages in the arena of international technology acquisition. The differing opinions related to Technology Transfer stages could be attributed to the variations in the industry and across nations following different mode of transactions. The cases of Bangladesh, on the other hand, show three distinct stages across the industry, which may be due to the fact the international players active in the Bangladesh health sector marketplace are well aware of the market and its dynamic.

Table 7.1 Summary and Overview of the Findings

Main Findings	**Managerial and Practical implications**	**Research implications**
Technology Transfer process: 1.Technology Transfer is an continuous undertaking and possesses clearcut phases in every stage of operation 2.By helping the local recipient link up with the international suppliers, International Technology Sender performs the role of mediator and facilitator. 3.Relational ties work as crucial conduits for successful Technology Transfer implementation and ties of this sort are occured at the latter stages of Technology Transfer projects.	1. To engage in the Technology Transfer process, to get acquainted with the Technology Transfer stages and the phases that lie within the each stage. 2. To utilize the MNCs social capital to involve in the wider reach of the nexus of technology knowledge.	1. The future research should focus on the distinct phases of Technology Transfer processes and investigate the importance of each process and the mediating and functioning role of MNCs.
Type of Technology Transfer: 1.Advanced technology	1. Relational and managerial level collaborative ties are required to get advanced	1.The future research initiative should integrate the complete package,

package, which combines the product, process and managerial process, is not usually transferred, and whole package is required get connected the global value chain.	technology and the whole package as well.	instead of investigating a separate type of technology in Technology Transfer cases.
Senders willingness to transfer technology: 1. The willingness and motivation of the sender is the most considerable element in the successful Technology Transfer completion, which depends on the intrinsic and extrinsic motivating issues. The main factors influencing the motivation and willingness are market size, type of the technology component, competitive pressures in the market, strategic decision making and the scope and nature of knowledge.	1. Technology transferring incentive must be built with the technology senders to get tacit knowledge and technology. 2.Long-term trusting relationship and and mutual collaboration has to be developed with the sender's technology.	2. Future research need to empirically enquire the market size, component related technology type, competitive pressure and strategic decision-making posing as central factors for the sender to trade complex technology. 3.The market size has to be formally appreciated as an important element when it comes to Technology Transfer decision.
Mechanisms for Technology Transfer: **1.**In the cases of explicit technology transfer, the owners have mostly relied on face to face meeting, email communication, documents exchanged in between, on the job training, video conference, etc. The efficacy of these methods varies according to the context while in the Bangladesh context, a combination of mechanism was used to	1.A combination of technology involving multiple mechanism should be strengthened to get tacit and advance technology. 2.The receiving party should encourage the engineers from the technology owner to come to the receiver's facilities, they have context related knowledge.	1.There is a critical need to enquire into these multiple mechanisms of Technology Transfer and the number of technology transfer occurred by each of the mechanism. 1.Future research and studies are required to shed more light on informal sort of mechanisms of Technology Transfer such as . overseas correspondence and communication as a useful medium of getting

implement the Technology Transfer process. Prior studies, regarding this, have raised concerns about issues preventing firms from applying the Technology Transfer process.		technology.
Trust: 1.Trusting relationship has been marked to be important for Technology Transfer initiatives. 2. The owner's level of cooperation with the technology recipient were seen as an important element of trust building. 3. Informal relationship and social ties were signs of developing trust between the Technology owners and the sender. 4.Fostering trust between the parties won't necessarily translate the transfer of knowhow for the receiver.	1.Concentrate on ways to develop trust by having shared visions and arranging in social relations, i.e. management level cooperation and ties to achieve technology know-how. Personnel exchanges and employees interactions with training and factory visits should be promoted and facilitated for the building of trust.	1.Future studies has to investigate trust building from the institutional level, and the role of the informal ties and commitment justifies additional attention.
Social ties: 1. Social ties and personal relationship have important implications for Technology Transfer effectiveness. 2.Lower level of social interactions limits the Technology Transfer to explicit technology. 3. Social ties become more effective, when a firm is equipped with in-house capabilities for technology development.	1.Strong personal ties and relationship has to be developed and promoted by arranging social events. 2.Inter-organisational communication and exchanges mechanisms has to be increased and promote for the sake of personal connections and getting technological know-how	1.Strong vs. low social connections and ties as well as their role with the characteristics and types of technological knowledge transfer have to be scrutinized.

Recipients learning intent: 1.Organisation's learning intents accompanying the commitment of organisational, physical and human resources were detected as the rudimentary elements of effective technology transfer.	1.Adequate resource allotment and emphasizing training programs facilitate employees learning intention, and therefore successful Technology Transfer. Strong learning intent of the receiving party will also give boost the owners of the technology to transfer more and more technology.	1.Commitment and dedication of resources to technology achievement and the amount of technology acquired and absorbed have to be empirically investigated.
Recipients' absorptive capacity: 1.The absorptive capacity of the local suppliers has direct consequence for the Technology Transfer successes. The three actors of the recipient, the sender and the Government play role in the absorptive capacity of the receiver. In the Bangladesh context, the local suppliers had little help from the sender and the Government.	1.Continuous improvement of absorptive capacity is crucial and local institutional connection has to be encouraged and sought with the cooperation from the government. Joint training programs and and R&D initiatives had to be propped up with local R&D ventures with the help of public-private partnerships (PPPs)	1.The interaction of three actors of technology senders of, technology recipients and government institutions in improving the absorptive capacity of the receiving party and the development of different kinds of absorptive skills by joint initiatives above has to be included in future research efforts. The construct had to be inclusive to to investigate the role of other actors appreciated and practically investigated.
Technology Transfer effectiveness: 1.The efficacy of Technology Transfer has implications along the value chain, with governance mechanism playing significant role in the respect. Contractual/commercial and technical relationship will present obstacles in the Technology Transfer	1.Collaborative efforts and ties with the technology senders and local government institutions has to be ensured for the development of exploratory/exploitative innovations, breadth and depth of organisational learning and technology acquisition. Long-term relationships needs to be	1.Advantages of benefits of building ties to local government and non-government institutions and technology senders and their impacts on the technology transfer efficacy needs further investigation and attention. The nature and scope of different governance

effectiveness when it comes to exploratory/ explorative innovation. 2. In exploratory innovations, Technology owner's strong support matters significantly. Informal relationship and the owner-lead problem solving meeting were helpful in this case. 3.The relation's strength and durability with the technology sender play vital role for exploitative Innovations. 4.Elemental technology transfering has caused a limited technology learning among the receiver. 5. Technology owners' continuous support and readiness to cooperate the suppliers were found to be crucial for the breadth and scope of technological learning. 6.Missing institutional support and set-up along with the lower level of assistance and cooperation of technology owners also resulted in basic and rudimentary (breadth) technological learning and acquisition. 7.Long-focus relationships based on mutual understanding, trust, and willingness of the technology sender to assist and personal	nurtured with with the technology owners.	mechanisms, suppliers and Technology Transfer success factors justify further investigation. 2.Instead of perceiving technology transfer success in terms of cost, time and speed, the building of exploitative/ exploratory innovations and invention, breadth and depth of organisational learning has to be formally appreciated and included in further studies on technological transfer effectiveness.

ties are of significance importance for developing breadth and depth of technological learning and advanced technological capabilities.		

The study findings show that the MNCs have been trading technologies of explicit and tacit in nature, following the three stages of Technology Transfer in the health sector. In the interactive process of Technology Transfer project, the tacit technology was crucially looked at. Echoing the findings of Duanmu and Fai(2007), the research has found the tacit technology to be transferred at the later period of Technology Transfer projects. The absence of transfer of tacit technlogy at the first two stages of Technology Transfer can be attributed to the lack of trusting relationship, social ties, managerial level communication and evolving relationship along the business dealings. This might emanate from the rudimentary Technology Transfer experience of Bangladesh in an informal Technology Transfer modus operandi.

Researches conducted previously on the Technology Transfer process threw weight to the inter-organisational communication and mutual understanding in ushering Technology Transfer successes, which appear crucial in all the Technology Transfer stages. The findings from Bangladesh Technology Transfer cases show that the technology senders don't send their technical personnel to the plant installation site of Bangladesh and a little interaction with regard to technological enrichment is reported. Previous researches have considered personnel exchanges among firms beneficial to Technology Transfer transfer projects, providing the receivers with tacit technlogy knowledge, not achievable otherwise. (Argote and Ingram, 2000; Song *et al*., 2003).

The study findings have also appreciated the roles of international technology owners to facilitate and expedite the Technology Transfer projects through endowing the receiver with access to international marketplace and channel to engage other firms in the global industry. Duanmu and Fai (2007), Dyer and Hatch (2006), Zhao *et al*. (2005) didn't mention the facilitating and mediating functions of the MNCs in Technology Transfer to developing countries. This thesis also holds the relational aspect and personal relationship act as major conduit in transferring Technology Transfer to the local suppliers. At the later stages of Technology Transfer projects, such relationship often forms as the parties come to build on trusting relationship. The transfer of tacit and complex technologies often begins with the personal and social ties, as confirmed by several scholars of Technology Transfer projects (Levin and Cross, 2004; Hansen, 1999). Interview data suggest that several Bangladeshi firms received tacit technlogy at the later stage when trust is the highest and company-to-company relationship at its peak. Thus

Proposition 1a: Technology Transfer is a continuous efforts which comprises of several stages (typically 3 to 4) with stages subdivided into distinct phases.
Proposition 1b: International technlogy senders might play the mediating and facilitating role in the Technology Transfer process by bridging the local firms to global value chain network.
Proposition 1c: Trusting relationship and ties function as conduit of tacit knowledge transfer, which develops in the later period of Technology Transfer projects.

7.2 Type of Technology Transfer

Foreign technlogy suppliers operating in the Bangladesh health sector are more concentrated in delivering product- related technlogy than managerial- or Process-related technlogy. (See table 6.1). The result stands in contrast to the findings of Sammarra and Biggiero (2008), who showed that collaborating firms engage in exchanging market, technlogy and managerial skills and experience in the course of their evolving relationship. Around 82% Technology Transfer, as the study finds, was done on product-related technlogy, the central cause if which is the variation of technlogy and industry, for example, reachable, explicit knowledge. Studies of Zhao and Anand (2009), and Duanmu and Fai (2007) maintain that marketing prowess and management related technlogy are more tacit and complex when compared to product-related technlogy. The MNCs don't usually involve in the R&D initiatives in the health sector of Bangladesh, for the leading technology owners do their research in their parent countries.

The research, in contrast to previous researches undertaken by Zhao and Anand (2009), and Duanmu and Fai (2007, finds three main technlogy packages, namely basic package, intermediate package and advanced package, indicating that an advanced package includes all three types of technology which hardly occurs in Bangladesh. The argument for the acquisition of whole technology packages, instead of a separate part, lies in the importance of multiple, multidisciplinary skills and knowledge, that come with the whole package in the forms of marketing knowledge, managerial skills and experience etc. crucial to the expansion the health sector's upward mobility. Apart from that, the local firms are in a constant pressure to upgrade their product and service quality to meet up the evolving market demand, which requires the assistance from foreign companies. Thus
Proposition 2: The whole package of technlogy betters a company more than any individual type of technology, and this helps the firm move upward the value chain in response to incessant market demand.

7.3 Senders' willingness and intention to transfer technology

The study findings indicate that the MNCs show a particular amount of selectivity when it comes to transferring technology to the local firms in the Bangladesh health sector, illuminating the fact

that the MNCs mainly give away the low to medium range medical instruments and supplies to the local firms and highly averse to dispense any high end technology, for that matter. The interview data as well as the questionnaire survey information reveal that the international technology owners are willing to provide the local firms with finished goods and supplies, instead of technology intensive high end technology (see table 6.2).

One particular interesting finding the present study entails is the component type of the technology, which highly influences the sender's technlogy transfer decision. Surprisingly, no other previous studies have touched upon the Rat's component factors (Dyer and Hatch, 2006; Zhao *et al*., 2005; Iversson and Alvstam, 2005, 2004; Chung *et al*., 2003; Duanmu and Fai, 2007; Young and Lan, 1997). The events of component based Technology Transfer might be an outcome of differing component across the technlogy world. Secondly, the nature of operation and market focus of a global company is important when seeking to know the causes of why companies keep their advanced technology home, rather than selling them country like Bangladesh. One reason, in this respect, might be that the companies don't just want disruption in their global operations and supply chain management and see a little profitability and long-term benefits in teaching Bangladeshi recepient on the knowledge-intense technology, particularly the complicated medical technologies.

Size of the market also impacts the decision making of the transfer of high end complex technology and the complete technology package. This finding contradicts the findings of previous studies (Sammarra and Biggeiro, 2008; Blalock and Simon, 2009; Simonin, 2004; Chung *et al*., 2003; Dyer and Hatch, 2006 and Zhao *et al*., 2004, 2005). The market size factor is a crucial and new finding as the previous researches didn't evaluate whether or not the size of the market play any role in the transfer of low-medium technology. In the Technology Transfer projects, the receiver is empowered with less bargaining power than the sender party, and thrown into a weaker position, which bars the receiver from getting any high end technology. This is reflected in the findings of Wong et al (2007), confirming more likelihood of technology transfer from the weaker party to strong party. The power nexus becomes more pronounced in the Bangladesh Technology Transfer cases, in which the local recipients hardly enjoy any bargaining power, capitulating to the terms and conditions of the MNCs.

The findings of the study bears strongly upon the organisational learning and the social relations theories in respect to the local firms of the developing countries, which, owing to limited bargaining power over their foreign technology providers, enjoy limited access to advanced technology despite being part of the broader international network. The future research, therefore, must address the issues of the technology owner's excessive power hindering the Technology Transfer process from the developed to the technology-starved countries. The lack of high competitive market in the public health sector of Bangladesh has caused the concentration of monopoly in the hands of three International parent companies, who feel little

need to transfer the advanced technology package to the local suppliers. Competitive market pressure has been marked in the FDI spillover literature (Blomstrom and Sjoholm, 1999; Blomstrom and Kokko, 2001) as an important factor in the transfer of advanced and complex technologies. So, research on Technology Transfer from senders to local recipients need to take the competitive pressure factors into account.

The slow pace of Technology Transfer implementation in Bangladesh results, as can be said, from avoiding numerous Government policies related to Technology Transfer. This is partially due to the fledgling institutions and the shaky institutional structure which occasionally present obstacles in the speedy transfer of Technology Transfer. This is reflected in the work of Hatani (2009), suggesting that the emerging economies with great prospects for Technology Transfer projects falter in Technology Transfer initiatives because of weak institutions and unfair regulations. Thus

Proposition 3: Sender's intention to exchange advanced technology to the recipient is incumbent upon the component type, market size and the power of the strategic decision making.

7.4 Mechanisms for transfer technology

The three multinational companies having lion share of the Bangladesh health sector rely on multiple channels to implement Technology Transfer to the local receivers. (See table 6.3). In the cases of explicit technology transfer, the owners have mostly relied on face to face meeting, email communication, documents exchanged in between, on the job training, video conference, etc. The efficacy of these methods varies according to the context while in the Bangladesh context, a combination of mechanism was used to implement the Technology Transfer process. Prior studies, regarding this, have raised concerns about issues preventing firms from applying the Technology Transfer process (Argote and Ingram, 2000; Inkpen and Crossan, 1995).
Face-to-face sit-ins, documents sharing, on-the-job training (OJT) have been proven more efficient than video conferencing and email communication. Resorting to standard Technology Transfer mechanisms without taking the local context into equation would come with with complexities, as suggested by the interview and survey data (see table 7.5). The Technology Transfer process becomes fruitful and effective when accomplished through the collective efforts of parties involving the local setting into consideration, instead of video conferencing or communication through fax. The result is supplemented by scholars like Hong and Nguyen (2009), stressing on the local knowledge rooted in the local environment rather than universal standard. Thus,
Proposition 4: Depending on a combination of mechanism and considering the local setting into account are of crucial importance for successful Technology Transfer project.

7.5 Trust

Trust deficit of trust (see table 6.4) existing between the Technology Transfer parties, the study suggests, has resulted in the transfer of elementary level of technology from the owners to local suppliers. The trust relationship is divided into two types: low level of trust and trusting

relationship with the owners, the first group complaining of receiving little technology such as documents, drawings etc and no ongoing support down the course of their relationship, while the latter expressing satisfaction with their foreign suppliers having substantial support in the form of training, continuous guidance, etc. One potential explanation for this finding could be that the technology owners have not fulfilled their promises to transfer the technological know-how to train the medical health technologist making fully confident to operate the technology. This non-implementation or sluggishness of government policies has also resulted in a low level of trust between the technology owners and some of their Bangladeshi recipients.

Continuous connection and support relationship such as product improvement, quality related issues solving, training assistance program, etc. between the recipient and technology owners are considerable elements in the trust building relationships between foreign technology suppliers and local receivers. Trusting relationship goes beyond Technology Transfer transfer as it helps the parties to implement further successes in their collective action as expressed in the positive correlation between between successful Technology Transfer and trust (Inkpen and Pien, 2006; Levin and Cross, 2004; Lui, 2009; Park, 2010; Yli- Renko *et al*., 2001). The semi-structured qualitative interview data suggest that trusting relationship helps the local suppliers win the transfer of technical know-how and technological capabilities in the form of tacit knowledge exchange from the owners, which finds similarity in many previous researches (Becerra *et al*., 2008; Inkpen and Tsang, 2005; Li *et al*., 2010; Nielson and Nielson, 2009;). Thus:

Proposition 5: Ongoing support and continuous assistance, social ties and relation, trusting relationship will help the parties forge trust and will increase the transfer of tacit and advance technologies, with varying degrees of efficacy depending on the component type of technology.

7.6 Social Ties

That social ties and personal communication is of serious consideration for the delivery of technology constitutes an important finding. Ties of this type is begun and evolved through arranging different socialising events at different occasions, helping consolidate relations and interaction the parties. The strength of social ties is shown by the owner's willingness to cooperate with the local suppliers along the business relationships. Different types of social ties, suggest Uzi and Lancaster (2003), foster different types of technology transfer. Complementing the findings is the assertion of many scholars (Inkpen and Tsang, 2005; Reagans and McEvily, 2003; Rowley *et al*., 2000; Yli-Renko *et al*., 2001) that social ties helps grow greater Technology Transfer.

In the context of Bangladesh health sector, the potential of social ties is all the more evident in the cases of hospital: with ties and without ties. The first group of hospitals has large medical hospitals and colleges with international connection in the form of seminars, invitation of doctors and consultants from abroad, hosting scientific conference etc. These activities help the hospitals to gain valuable social ties, thus attracting the attention of the global technology giants, which helps the hospital receive unusual technology with relative ease and comfort. The other group, focused on diagnosis and treatment of the patients, doesn't look beyond the horizon, getting limited to their ordinary businesses. They can't simply win the valuable connection or links, for that matter, to engage with international players or personalities. Thus, they find it quite hard

when bit comes to procure tacit technology from abroad. However, there are exceptions in a couple of cases, where the hospitals with sophisticated training and technical facilities can bring improvement without assistance from abroad, for example, the BSMMU hospital. Thus:

Proposition 6: Social and personal connections will strengthen the Technology Transfer process with the receiving party having in-house training capabilities. The recipient, who have lower level of personal and social relations will end up getting limited to medium level technology.

7.7 Recipient's Learning Intent

The receiver's learning intents, as the general findings of the study suggest, is a key factor to accomplish a successful Technology Transfer project completion. The result shows the acquisition of technology know-how has been the prime motive for the local firms to team up the foreign technology owners (See table 6.5), which has also been assured by many scholars (Inkpen, 2000; Park and Ghauri, 2010; Perez - Nordtvedt *et al*., 2008; Simonin, 2004; Tsang, 2002; Wang *et al*., 2004) who identified organisational learning intents as the key determinant of technology transfer. The employees dedicatedly attended the company arranged and owner supported training program, which play a vital role in the spreading of required knowledge and the utilisation of transferred technology to the fullest extent. Getting technology through Technology Transfer and not encouraging the learning would result in the "not invented here" syndrome (Govindarajan and Gupta, 2001), resulting in the decline of learning intents in the company, often leading to a called "stickiness" (Szulanski, 1996). Thus:

Proposition 7: The greater commitment accompanying physical, organisational and human resources and the employee's dedication to learning will lead to more effective Technology Transfer process.

7.8 Recipient's Absorptive Capacity

Along with the learning intents, the local firms' absorptive capacity can be recognised as a key factor for successful and, subsequently, flourishing Technology Transfer process. Mentioning three Technology Transfer actors of Bangladesh- technology owners, receiver, and the Government, the study holds that combined efforts of all the actors will help increase the firm's absorptive capacity. The causes of low level absorptive capacity among Bangladeshi suppliers can be attributed to no-assistance from the sender and weak linkages between the receiver and local government institutions (see table 6.6). Many studies have supported the role of the firm's absorptive capacity to make successful Technology Transfer(Blalock and Simon, 2009; Gao *et al*., 2008; Minbeava *et al*., 2003; Phene and Almeida, 2008; Song and Shin, 2008). Thus:

Proposition 8: Absorptive capacity of the recipient plays a critical role for Technology Transfer and the three actors of technology sender, the government and technology receiver are important in this regard.

7.9 Technology Transfer Effectiveness

The research finds that effective Technology Transfer process depends on the value chain, especially pertinent to the Bangladesh health sector context, indicating that governance types and

mechanism have direct bearing upon the Technology Transfer process. The existence of commercial relationship among the parties precludes the Technology Transfer effectiveness and organisational learning and breadth and scope in the event of exploratory innovations. The findings echoes , to some extent, the contention that recipients capacity to technology reverse engineering and skills often depends of the type of relationship and collaboration they maintain across the industry (Dyer and Hatch 2006; Helper *et al*., 2000; McDuffie and Helper, 2006). This directs our attention to tier segment variables as a good way of judging different Technology Transfer types. Technology owners have shown selectivity while transferring differing technology to differing types of recipients. The study also indicates that health sector recipients in Bangladesh having calculated technical governance get quality inducement training from the owners.

Regarding the technical governance, we see the technical governance mechanism to have played an important contribution in aiding the local recipients to receive continuous support from the technology sender. For exploitative Innovations, the technical/collaborative mechanism have been proven particularly useful as reflected in the studies of many scholars (Dyer and Hatch, 2006; Helper and Kiehl, 2004; Li *et al*., 2010; McDermott and Corredoira, 2010; Mesquita *et al*., 2008) suggesting that collaborative efforts existing between the Technology Transfer parties contribute to the transfer of tacit technology knowledge. In the events of exploitative/explorative innovation and breadth of the organisational learning, the recipients show a diversity, indicating that the firms with exploitative/exploratory innovations will get more technology than those with commercial technology engagement with the international sender. The study findings point out that the firms with in-house technological facilities or capabilities will benefit from exploitative or exploratory innovations. Only 4% respondents, the study finds, were engaged in the this sort of arrangements and mechanism.

For the resource-focused and organisational learning theory, this findings corroborate significant implications as the contemporary research indicates that ambidextrous firms are more likely to build competitive advantage(Ahuja and Lampert, 2001; Colbert, 2004; Gibson and Birkinshaw, 2004; Hamel and Prahalad, 1993; He and Wong, 2004; Jansen and Volberda, 2005; Levinthal and March, 1993). The Bangladeshi farm's relationship strength and length with their foreign suppliers were reported to have played a crucial role the successful completion of Technology Transfer projects, extending the views of Kotabe et al. (2003) that long-term relationships increase the degree Technology Transfer success. The Technology Transfer cases in Bangladesh health sector context , which were limited to low to medium technological equipment in the form of documents and email communication, have contributed to the narrow technological learning for her local firms with study results further indicating that the owner's continuous assistance for the local firms is a crucial component of successful Technology Transfer implementation and in the cases of breadth of organisational learning. The findings are also reflected in the several studies which dictate that personal and social ties can help the local firms gain important knowledge from the MNCs (Giuliani *et al*., 2005; Moran *et al*., 2005). Thus

Proposition 9a: *Different governance mechanisms are utilised in transferring different types of technology and the contractual/commercial technical governance mechanisms have been harmful for Technology Transfer effectiveness, whereas collaborative/relational technical governance mechanisms will expedite the transfer of explicit/tacit technology and are closely*

linked to Technology Transfer effectiveness.

***Proposition 9b**: The technology owner's intention to trade technology and providing linkages with training programs and R&D institutions along with recipients' technological capability have played critical role for exploratory innovations.*

***Proposition 9c**: Social relationship and personalised ties with the technology owners and the technology receiver's in-house technological facilities , and the owner's lead problem solving meeting are beneficial to explorative innovation.*

***Proposition 9d**: strength and the length of relationship between the Technology Transfer parties is crucial for exploitative Innovations.*

***Proposition 9e**: Long-focused relationship depending on mutual trust building and personalised ties are helpful for the local receivers for promoting breadth na depth of technological learning.*

7.10 Conclusion

The study brings in fresh insights in the Technology Transfer circumstances of Bangladesh, with special focus on the health sector, which has, until now, had a little exposure in the research area. The research, in continuation of the previous studies, stresses the worthiness of Technology Transfer from a general viewpoint and sheds light on the effectiveness of Technology Transfer projects in the arena of Bangladesh health sector, which, apart from some scattered studies, has remained largely unexplored. It also brings enrichment in the fields of resource-oriented view of the company, the knowledge-oriented view of the company, organizational skills learning activities and social relations theories by critically examining the role of the technology owners and receiver as well as the contribution of the local government for a successful Technology Transfer project. Scholars who give much weight to the internal resource-based view (RBV) of the companies in acquiring competitive advantage, often undermine the importance of external resources. Social capital scholars, much like the RBV experts, stress on the role of organizational structure, cognitive, and social ties, while downplaying the role of actors in Technology Transfer implementation. Knowledge based view (KBV) scholars focus on the nature of knowledge of the firms in explaining competitive advantage, rendering limited attention to the owner's willingness to pass on a technology. Scholars arguing for organizational learning theory put importance in the firm's absorptive capacity for learning, while not taking the relations between the patients into account. The roles of this four distinct approach have been demonstrated in the research.

Setting the Bangladesh public health sector as a pertinent perspective, we have elucidated the role of the each stage of the transfer mechanism, considering the Technology Transfer as a whole process and a package from the context of the receiver, not just a module-like single technology that the RBV and KBV researchers see as the source of competitive advantage. We have focused that it's not just the tacit knowledge, but rather the whole elements of technology, both tacit and explicit knowledge which matter in effective Technology Transfer learning and upward

mobility. The thesis holds that the senders hardly trade the complete package and, therefore, stresses on the Resource Based View aspect, maintaining that knowledge-hard to imitate- gives substantial competitive advantage and the companies are less willing to transfer such knowledge. The study expands our knowledge on how emerging nations with fledgling institutions can learn from inter-organizational dynamics, including trust relations and mutual understanding. Social ties, which develops and revolves around the relations between the parties involved, contributes to how the firms will start trusting each other down the pathways of technology and knowledge exchange and will perceive the other party's needs in a subtle way. Even though Technology Transfer effectiveness is a complicated thing to measure, many studies have sought to quantify, applying quantitative methods, the efficacy of Technology Transfer projects in terms of time, cost, input, output, employee reduction, economic benefits, turnover growth, market penetrations, budget, recognized benefit and the satisfaction of the customers. The present research, however, not being satisfied with the traditional methods of measurement, has resorted to fine-grained methods and criteria to evaluate the Technology Transfer effectiveness, encompassing a wide range of issues previously ignored. These include, but not limited to, organizational skills and behavior, exploratory analysis, diversity of technology owners and receivers, and the length and breadth of organizational learning etc.

7.10.1 Theoretical Insights and Reflections

We hold that the research, providing pertinent insights and information to the present literature of Technology Transfer from the owners to local recipients in the health sector of Bangladesh, an understudied subject, contributes to an overall, clear cut understanding of the Technology Transfer in the broader technology context and arena, focusing mainly on the whole package of Technology Transfer. The research, in a straight distinction to the previous ones, highlights the three factors of product, process and managerial capacities in explaining the Technology Transfer efficacy instead of looking at just one type of technology. The study has scrutinized from a wide perspective, combining issues of sender's flexibility to give away technology, the receiver's intention to adopt the technology, the recipient's learning intention and absorptive capacity, to provide a comprehensive narrative of the Technology Transfer system from the aspects of trust building and social ties. The sharp focus and scrutiny of the above factors give us a better understanding of the Technology Transfer effectiveness. Instead of previous studies measuring Technology Transfer success in terms of time, cost and budget related issues, the present thesis focuses on comprehensive and encompassing variables, making the research a broader one in context and scope of understanding. Hence, the research bears an impact on knowledge based view of the companies, the Resource Based View aspect of the companies, organization-wise learning theory and social relations capital in a sophisticated way

First, the well-marked phases, found in every Technology Transfer stage, call for special attention to give on the distinct phases, as the existing literature lacks, Van Wijik *et al.* (2008) remarks, treatment of the distinct phases. This research, therefore, emphasizes the need to recognize phases academically and suggests future researches to work on those issues vigorously.

Shedding adequate focus on the diversity of technology receivers with different technology needs, social nature, organizational buildup, the research contributes by pointing out the influence of relations among diverse groups of owners and stakeholders to wind up a successful Technology Transfer project, contending that amalgamation of companies and firms is an ample basis successful Technology Transfer undertaking, particularly in the cases of technology brought from different sources (Szulanski, 1996; Simonin, 2004).

By elucidating empirical cases of social ties and trust relations in the Technology Transfer context, the research enriches the social capital and organizational behavior theories, corroborating the needs of the local suppliers and the international owners in the relational perspective. Scholars and theorists of organizational learning (Argote, 1999; Wijk *et al*., 2008; Bhagat *et al*., 2002) have argued for broad investigation of learning output, which could insert values and consciousness of effort to the firms. By looking deep into Technology Transfer critical success factors we took a direction focusing on the breadth and depth of the firm's learning, thus contributing to literature of Technology Transfer in this field.

The research shares contribution relating to Resource Based View and knowledge based view through eliciting the roles of boundary spreading decision making and technology transfer. Strategic decision making plays significant role in cases like transferring technology complex and complicated to transfer, in which organizational bondages are extremely important. Apart from all these, the research has been endowed with several critical findings (See Chapter six) which could be very effective for the future research. Some of which are stated below:

1- The each stage of Technology Transfer entails clear-cut, distinct phase, which warrants attention and investigation in the coming researches in this field as well the role of the MNCs in facilitating the Technology Transfer process to the resource-starved poor countries.

2- The understanding and evaluation of the technology, being transferred, requires identifying the diversity of receivers and how they will engage the parties from a wide range of industries which matter a lot in successful Technology Transfer.

3- Technology Transfer cases with regard to component to component substantially depends on the technology owner's way of delivering technology knowledge and information, bearing that social ties and trust building efforts don't add up much to high-end technology transfer.

4- Social relationship and personal level bonding don't necessarily accompany achieving of critical, hard-to-copy technology.

5- The technology owners usually commercialize and trade the technology which have sizable market and profitability.

6- The absence of high competitive pressure will result in the transfer of low to medium level complex technology transfer to the recipient.

7- The organizational power, skills, and control over a technology have been found crucial in the decision making of complex technology transfer which should be incorporated in the future research undertaking.

8- The receiver's capacity to absorb new technology doesn't just depend on the receiver (Zahra and George, 2002). It also depends on other players and factors extant in the setting, namely the sender, the recipient and the institutional government setting of the receiving country. This should be included in the future research consideration as well.

9- A combination of ties and relation with the local socioeconomic institutions, the technology owners and diverse government and non-government functionaries have been found to be important in escalating explorative innovation, therefore warranting further attention.

10- The type of government mechanism and the influence they perform on the Technology Transfer process is a new findings of the study which should be scrutinized in the future studies.

7.10.2 Managerial and Practical Implications

The research extends several learning points for the director and manager on Technology Transfer process in the health sector of Bangladesh, described in the following. Firstly, the managers and all others involved in the Technology Transfer process must be acquainted with the Technology Transfer process and the stages therein. For a host of technology is transferred, the managers have to cultivate social relations and utilize those in the evolving relationship to access to the MNCs knowledge and technology.

Second, the core advantage of technology is manifested in the many forms of technology and the offshoots that come naturally, not just in a particular type or segment. That's why it's a necessity for the firms to stay alert and aware to build up social ties and relationship, as well as collaborative efforts with the technology owners, so as to rip dividends in the long run focus. Third, the most crucial defining factor, as the study findings show, in the successful Technology Transfer completion is the owner's willingness and intention to share its technology with the receiver. That's why the managers must be watchful about the sender's willingness.

Fourth, the receiving of tacit, complicated technology necessitates a practical amalgamation of transferring mechanisms. The receiver must establish multiple connections to the sender through multiple channels to get case specific technical know-how and support.

Fifth, the research findings point out trusting relationship as an important aspect in the lead up to a successful business relationships and Technology Transfer transfer underscoring the need to engage the sender through various channels and mechanism. Management level ties, in this respect, are the basis of the social ties.

Sixth, it is found that social ties and personal connections are important for Technology Transfer and its effectiveness. Low social interaction results in the transfer of explicit technology in the form of documents. This finding underscores the necessity for managers and practitioners to develop and promote strong personal connections with the sender of the technology by attending social/cultural functions/trips.

Seventh, receiver's leaning tendency and intents are no less important: dedication to learning, organisational arrangements and flexibility to be open to new learning, and resource allocation and mobilization are the most important matter here.

Eight, along with the learning intent, the receiver's capacity is well-placed to successful Technology Transfer process, regarding which three main factors are pronounced: local government policies and practices, the local firms, and the technology sender, all of which play a

combined role in the Technology Transfer process and are equally important to consider. The study suggests little help from the government of Bangladesh in its institutional settings. The sender was not having adequate linkages with the receiving party, due to institutional difference and lack of calibration efforts. Managers must maintain and forge relationship with the local government for this respect.

Finally, the thesis maintains that Technology Transfer efficacy is reflected in the value chain pathway as difference management mechanism and policies have affected the process in a diverse manner, underlining the importance of forging ties with local institutions- government or non-government, and the technology owners for advanced and up-to-date technology and knowledge to operate, as well as to increase exploratory capacity and organisational learning. Thus, maintaining a long-term relationship with the actors and the players across the horizon is an obligation for a firm with futuristic ambition.

7.10.3 Policy Implications

The study also provides policy suggestions for the top brush policy makers of the country, particularly the health sector. Given that the technology owners will hardly allow complete access to the whole technology package, the research urges the local institutions and facilities to come unison to develop the required technology through in-house initiatives. Only a handful of companies with in-house capacity development arrangements have been able to rip the dividends from social tie-up and personalised relationship. Against this backdrop, the research present the following measures:

1. For a Technology Transfer initiative to be successful, the local firms must forge social relationship with the technology owners and must itself with in-house capacity capability development program.

2. As well as the buildup of in-house training program, the firms must increase public-private collaboration to tap into the high-priced technology.

3. The recipient should beef up effective collaboration measures between the industry and the academics by placing a number of expertise from the high-valued academic institutions into its technology installation site for s period of 1-2 years, which will equip both recipient and university with hands-on experiences, furthering the traditional knowledge base.

4. The Government should bring all the training and research facilities into an integrated core by establishing an oversight institution, Technology Transfer Center- for example, to enhance synchronisation among all to streamline Technology Transfer efforts.

5. The Government should expedite the training centers in the efforts to acquire modern machinery and ensure intimate coordination among them through legislations.

6. Bureaucracy and legal institutions have to be chimed with the technology and knowledge of the 21st century so that they can readily measure efficacy of any technology in no time and guide the local recipient with appropriate knowledge.

7. The Government should step up efforts to support innovative companies and firms by means of funding and taxation advantages, which will inspire them to get more modern technologies.

7.10.4 Limitations and future research directions

The study, nonetheless, suffers some limitations, which could provide appropriate avenues for the future research efforts to deal effectively.

Firstly, although the interview and questionnaire data has been collected from first tier firms and recipient, and the Ministry of Health and Family Welfare rendered crucial methodological viewpoints, the embedded political bias can't be ruled out. The future research, therefore, should incorporate data from the 2nd and 3rd tier recipient to make research data more inclusive.

Second, the research has been confined to a single industry of Bangladesh health sector, concentrating to a unidirectional Technology Transfer process wherein from the technology suppliers to the technology recipient. The future research efforts, therefore, could consider incorporating multiple industries and countries to produce more fruitful insights and information.

Third, since this study focuses on structural and relational dimensions of social capital, future research may examine the impact of cognitive dimensions of social capital on Technology Transfer effectiveness.

Fourth, we did not test the relationship between different variables exhaustively (trying every possible combination of relation between/among variables), for example, the durability of relationships helps in exploitative innovations, or the impact of different governance mechanisms on Technology Transfer effectiveness. Future studies may need to statistically test the relationship to see whether the relationship between these variables is significant or not. Therefore, the results of this study should be interpreted with caution because we cannot rule out the influence of other factors on Technology Transfer effectiveness.

Fifth, the study focused on exploratory and exploitative Innovations, breadth and width of technological learning to scrutinize Technology Transfer effectiveness. The future research works could include performance data, sales increase and market penetrations.

Sixth, although the research gives us fresh insights into Technology Transfer efficacy from the technology sender to their recipient, it didn't take leadership role in consideration in the attempt to increase the learning process and bolstering exploratory and exploitative capacities, which would be beneficial to take on longitudinal research to understand the role of leader in Technology Transfer effectiveness.

Seventh, the comparative analysis findings show that the receiver, having ties with more than one technology suppliers, emails more absorbing skills than those procuring from a single technology suppliers. Thud, it would be point of research for the future researchers to invest which conditions expedite the absorbing capacity.

Eighth, the comparative data analysis also reveals that getting technology from one or multiple owners doesn't translate into receiving the package of technology. Further research could investigate to determine the factors having role in this regard. The limitations apart, the present study, we hold firmly, has answered questions relating to theoretical, managerial, and down-to-earth implications by giving new insights and understanding the process of Technology Transfer, which was long unexplored.

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APENDICES

APPENDIX A : Interview Guide – Technology Recipients

The purpose of this study is to find out the process of Technology Transfer to your organization from international technology owners and its effectiveness. All the information provided will be kept confidential and will not be shared with any third party. The information collected from your company will be strictly used for the sole purpose of Master research. Your support and cooperation will be much appreciated. I will ask you a number of questions, which will take around 45 to 60 minutes of your time. Thank you very much for your co-operation.

Introductory questions

Name & Position of Interviewee, date of interview.

When was your hospital established?

Technology Transfer related questions.

- What types of knowledge your employees need for their routine jobs?
- What sources and channels had been most useful and effective in acquiring the knowledge?
- In the past 1-2 years have you received any technological knowledge from your technology suppliers?
- What benefits did your organization see in understanding and learning the technology supplied to?
- Which type of technology you have received recently?
- What was the process of Technology Transfer from technology owners to your company?
- Are there areas of knowledge and technology that the technology supplier does not want to share and why this may be the case?
- What sort of learning, R&D or technological activity your firm was doing before you enter into this business partnership with your technology supplier?
- Does your company collaborate with any Bangladeshi science, technology. R&D institutions that help your firm adapt or absorb the knowledge/technology from your supplier?
- Who participates in the Technology Transfer process and how do they participate in the transfer process? How does your technology suppliers organize activities for effective technology/ knowledge transfer and sharing?
- What you do think are the distinct phases in the technology/knowledge transfer process from your technology suppliers to your company? How much time was required for this process of Technology Transfer?
- What were the mechanisms/modes used to transfer this technology? How would you rate these mechanisms?
- What kind of transfer mechanisms were adopted for each type of Technology Transfer, i.e., product -related, process- related and managerial- related?
- Does your technology supplier have a socialisation team with your company employees?
- The technology, that was transferred from your supplier, was complete enough that you

were able to become proficient with it?
- ❖ Was the transferred technology well understood within your company?
- ❖ How has the Technology Transfer resulted in improving your products/services in the local market or abroad?
- ❖ Any other information would you like to add or any comments about the interview questions.

Thank you for your time.

APPENDIX B: Interview Guide- Technology owners

The purpose of this study is to find out the process of Technology Transfer from your firm to your technology recipients and its effectiveness. All the information provided will be kept confidential and will not be shared with any third party. The information collected from your company will be strictly used for the sole purpose of Master research. Your support and cooperation will be much appreciated. I will ask you a number of questions, which will take about 40 to 60 minutes. Thank you very much for your co-operation.

Introductory questions

- ❖ When was your company established? (How many years have you been in business?
- ❖ What are the major motives behind your investment or operation in Bangladesh?
- ❖ Number of employees.
- ❖ Major products.
- ❖ What kind of products your firm is sourcing from local Suppliers/Vendors?
- ❖ What is the long- term strategic plan and competitive advantage of your firm?
- ❖ What is the business plans for the next 2 years?

Technology Transfer related questions

- ❖ What type of technological knowledge/technology has your firm transferred to your recipients?
- ❖ What was the process of this Technology Transfer from your firm to your recipients?
- ❖ Who initiated this transfer process?
- ❖ How many people were involved?
- ❖ What were the benefits your firm saw in transferring technological knowledge/technology to your recipients?
- ❖ How different mechanisms or processes influence the transfer of different types of technological knowledge from your firm to your technology recipients?
- ❖ Does your firm provide training to your technology recipient's employees on regular basis? What kind of training you firm has provided to the recipients' employees?
- ❖ Who participates in the knowledge transfer process and how do they participate in the transfer process?
- ❖ How does your firm organise activities for effective technology/ knowledge transfer and sharing to your recipients'?
- ❖ Are there areas of knowledge and technology that your firm does not want to share with the recipients' and why this might be the case?

- What are the major barriers/problems that your firm is facing in regard to Technology Transfer to your recipients? And why this is the case?
- How often do your employees communicate with the recipients? On a daily, weekly or monthly basis. Does this take place at senior, middle or production line management level?
- Does your firm have socialisation team with your recipients‘ employees?
- What kind of ongoing support has your firm provided to your technology recipients during this transfer?
- In your opinion, what are the main factors the make the Technology Transfer more effective from your firm to your recipients?
- In your opinion, are your recipients willing to learn your technological knowledge?
- What do you think about your recipient‘s competencies? Have recipients possessed the necessary skills to absorb and implement your firm‘s technological knowledge?
- Is your firm business relationship based on mutual understanding or contract?
- How would you describe the nature of your business relationship with your recipients?
- Do you ever have the feeling of being misled by your local recipients? Why?
- How is conflict handled between your company and your recipient/s?

Any other information would you like to add or any comments about this interview

Thank you very much for your time.

APPENDIX C: **Questionnaire Survey**

Technology Transfer effectiveness from International Technology Suppliers to the health sector of Bangladesh. Please indicate what type of technology your firm has received from your technology owners. If a particular technology was received, select YES OTHEWISE NO. Your responses will be strictly used for the purpose of a Masters research, and this information will be kept confidential. Please complete all parts of this questionnaire.

PART 1 General Information:

Year of Establishment: **No of employees:**

1. **Product related technology**

(a) Provision on product designs and technical specifications. YES NO
(b) Provision, advice, or financial assistance to obtain technology. YES NO
(c) Regular feedback on product performance to improve existing product technology. YES
(d) Technical consultations on product characteristics to master new technology. YES NO
(e) Organized R&D-collaboration in product-related areas. YES NO

2.Process/Production related technology

(a) Provision, advice, or financial assistance to obtain machinery and equipment. YES NO
(b) Technical support to improve existing production technology. YES NO
(c) Technical consultations on operation to master new production technology. YES NO
(d) Advice on production layout and organisation. YES NO
(e) Assistance with quality assurance systems (e.g., ISO certification, TQM, etc.). YES NO

3. Training programs for suppliers’ personnel

(a) In-plant training for managers/ technicians at the supplier site. YES NO
(b) Training for managers/ technicians at assembler‘s site. YES NO
(c) In-plant training for workers at the recipients’ site. YES NO
(d) Training for workers at technology owners‘ site. YES NO

4. Managerial related technology

(a) Market know-how. YES NO
(b)Financial Planning & Management. YES NO
(c) Project Management. YES NO
(d) Inventory control. YES NO
(e) Manufacturing cost control and delivery systems. YES NO

PART 2 Mechanisms used to transfer the technology

(a) Face to face meetings. YES NO
(b) Documents transfer related to component design or improves process. YES NO
(c) Engineers transfer. YES NO
(d) On the Job trainings. YES NO
(e) Seminars/presentations. YES NO
(f) Vendor‘s conferences. YES NO
(g) Overseas Correspondence. YES NO

PART 3 Trust

(a) You (recipients) assumed that the technology owners would always look out for your interests. YES NO
(b) You (recipients) assumed that the technology owners would go out of her way to make sure you were not damaged or harmed. YES NO
(c) You felt like your suppliers (technology owners) cared what happened to you. YES NO
(d) You trust your technology owners to treat you fairly. YES NO
(e) You think that the technology owners have a reputation for trustworthiness (following through on promises and commitments) in the recipient‘s community. YES NO
(f) If given the chance to your technology owners, you perceive that the technology owners will take unfair advantage of you. YES NO

PART 4 Main Motives for Bangladesh’s recipients for forming business relationships with Bangladesh’s based medical Technology owners. Indicate the below motives on a 1-3 scale. 1= Very important; 2= Important; 3= Not Important

(a) Acquiring technological know-how.	1	2	3	4	5
(b) Enter in the global value networks.	1	2	3	4	5
(c) Learn global motive best practices.	1	2	3	4	5
(d) Sharing the risk of new product development.	1	2	3	4	5
(e) Develop Technological Capabilities.	1	2	3	4	5

PART 5 Indicate the institutional support and linkages your firm have with local Institutions on a YES or NO scales.

(a) Your firm received support for R&D activities from local institutions. YES NO
(b) Your employees received specific training by local academic institutions, including

Government-run skills development centres. YES NO
(c) Your firm received benefits from academic institution research activities. YES NO
(d) Your firm collaborate with any Government R&D Institutions YES NO
(e) Your firm has any internship programs with the local universities. YES NO
(f) Your firm has received support in technological knowledge development activities from local institutions, including Government-run centres. YES NO

Your firm technological capabilities on a 1-5 scale. 1= Basic; 5= Advanced 1- Product Engineering

How specialized your firm's capability is in terms of:
(a)Your firm possess the capability of assimilation of product design, minor adaptation to market needs.
(b) Product quality improvement, licensing and assimilating new imported product technology.
(c) In- house product innovations and basic research.

2- Process Engineering

(a) Debugging, quality control preventive maintenance, assimilation of process technology.
(b) Equipment stretching, process adaptation and cost saving.
(c) In-house process innovation.

3- Project Management

(a) Successfully completion of project on time, schedule and budget.
(b) Allocation of required resources on a project.

4- Manufacturing

(a) Understanding of manufacturing processes and capability to improve that processes.
(b) Manufacturing flexibility.
(c) Low operating costs.
(d) Components manufacturing.
(e) Supply chain management and production scheduling.
(f) More efficient production system.

5- R&D and Design

(a) Skill in conducting applied R&D.
(b) Ability to transform R&D results to products.
(c) Ability to upgrade existing products.
(d) Ability to improve the overall design and functionality of the components.
(e) Ability to frequently enhance product quality.

PART 6

Technology Transfer effectiveness

1. Exploratory Innovations

Technology Transfer resulted in:

(a) In the last 1-2 years, have your firm designed new parts for the new customers or emerging markets. YES NO

(b) On the basis of the technology, which your firm has received from your technology owners, resulted in open up new markets. YES NO
(c) Technology Transfer resulted in the introduction of new generation of products. YES NO
(d) Technology Transfer resulted in extending the product range for new customers or emerging markets. YES NO
(e) Your firm invents new products and services. YES NO
(f) Your firm frequently utilise new opportunities in new markets. YES NO
(g) Your firm commercializes products that are completely new to your firm. YES NO

2. Exploitative Innovations

Technology Transfer resulted in:

(a) In the last 1-2 years, have your firm introduced improved, but existing products for your local technology owners or local market. YES NO
(b) Technology Transfer resulted in improving the existing products quality. YES NO
(c) Improve production flexibility. YES NO
(d) We frequently refine the provision of existing products. YES NO
(e) We regularly implement small adaptations to existing products. YES NO
(a) We improve our provision‘s efficiency of products. YES NO
(g) We increase economies of scales in our local market. YES NO
(h) We expand products for our existing clients. YES NO

Thank you for completing this questionnaire.

APPENDIX D: Regression Approach

Table A-1 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of The estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.337(a)	.113	-.050	1.57986	.113	.694	7	38	.676
2	.582(b)	.339	.070	1.48689	.225	1.817	6	32	.127
3	.637(c)	.405	-.029	1.56428	.067	.485	6	26	.813
4	.764(d)	.584	.016	1.52965	.179	1.170	7	19	.365
5	.828(e)	.686	.057	1.49711	.101	1.209	4	15	.348
6	.893(f)	.798	-.135	1.64239	.113	.638	7	8	.717

Table A-2: Analysis of Variance (ANOVA)

Model	**Sources of Variation**	**Sum of Squares**	**Degrees of Freedom (df)**	**Mean Square**	**F-Statistic**	Sig.
1	Regression	12.132	7	1.733	.694	.676(a)
	Residual	94.846	38	2.496		
	Total	106.978	45			
2	Regression	36.232	13	2.787	1.261	.286(b)
	Residual	70.746	32	2.211		
	Total	106.978	45			
3	Regression	43.357	19	2.282	.933	.555(c)
	Residual	63.621	26	2.447		
	Total	106.978	45			
4	Regression	62.521	26	2.405	1.028	.484(d)
	Residual	44.457	19	2.340		
	Total	106.978	45			
5	Regression	73.358	30	2.445	1.091	.444(e)
	Residual	33.620	15	2.241		
	Total	106.978	45			
6	Regression	85.399	37	2.308	.856	.656(f)
	Residual	21.580	8	2.697		
	Total	106.978	45			

Explanation Of The ANOVA Table:

Consider the final row of information "Total ….45….106.978" The value 106.978 is referred to as the total sum of squares. There are 46 resulting values from the sample and corresponding degrees of observation in the ANOVA table is 45, one less than the number of observations. The ANOVA procedure seeks to decompose the total sample variance into corresponding sources of variation. The first model address the amount of variation between the "strategic factor" (the seven factors V1 through V7) with respect to the variation within the skills and attributes (denoting the error)

Sources Of Variation:

For the first model, if a relatively large portion of the variation is explained by the "Learning Intent" factors, there is evidence that the 'Learning Intent' factor has an effect on the response variable of the TTE. The sum of squares for the learning intent factor is 12.132. There roughly a tenth of the total variation is explained by this effect. Note that this fraction (12.132/106.978 = 11.34%) is the most widely used R2 value

Appendix E Table A-3 Communicating The Importance Of Factors

Item Means, Reliability Analysis-Scale (Alpha)

Success Factors		Mean (1-5)	Std. Dev	CV %	RII	Rank
LEI= LEARNING INTENT (Cronbach a = .6227)		4.2173	2.3811	56.46	.843	2
V1	= Acquiring technical Know How	3.7544	.7146	19.02	.751	
V2	= Entering into global value chains	4.4821	.5391	12.02	.896	
V3	= Learn about global motive best practices	4.1071	.7788	18.96	.821	
V4	= Sharing the risk of new product development	3.7679	.8088	21.46	.754	
V5	= Develop technical capabilities	4.3750	.6759	15.45	.875	
V6	= Familiarity with Technology Management	4.1786	.6355	15.21	.836	
V7	= Initiative to reverse engineering	4.3929	.5618	12.79	.879	
ABC = ABSORPTIVE CAPACITY (Cronbach a = .6642)		4.2500	2.5987	61.15	.850	1
V8	= Firm receive R&D support from Local Institution	4.0357	.6596	16.34	.807	
V9	= Employees were trained from local institutions	4.3929	.6790	15.68	.879	
V10	= Firm has linkage with local academic institution	4.3214	.7162	16.57	.864	
V11	= Firm has collaboration with Gov. R&D Institution	4.3036	.7115	16.53	.861	
V12	= Firm has internship arrangement with local Institution	4.1607	.7574	18.20	.832	
V13	= Firm receive assistance in tech knowledge devlpmnt	4.2857	.7062	16.47	.857	
TRS = TRUST (Cronbach a = .6284)		3.7061	3.1326	84.53	.741	5
V14	= Recipient think technology owner care their benefits	4.4000	.6555	14.90	.880	
V15	= Recpnt think Tech. owner would preserve thr interest	3.2182	1.0127	34.22	.644	
V16	= Recpnt thing Tech. owner worried at tech disruption	4.0182	.9127	22.71	.804	
V17	= Recpnt think Tech. owner will treat them fairly	4.0727	.7901	19.40	.815	
V18	= Recpnt think Tech. owner has persistent trust goodwill	3.2182	.9755	30.31	.643	
V19	= If get chance, Tech. owner will avail unfair advantage	3.3091	.9001	27.20	.662	
SWL = SENDER WILLINGNESS (Cronbach a = .7791)		3.7015	4.0464	109.31	.740	6
V20	= Technology Market Size	3.8571	.8186	21.22	.771	
V21	= Type of Technology Component	4.0893	.7205	17.62	.818	
V22	= Competitive pressure in the Market	4.0000	.8739	21.85	.800	
V23	= Strategic Decision Making Power	3.3571	.9616	28.64	.671	
V24	= Scope and nature of knowledge	3.5357	.9528	26.95	.707	
V25	= Recipient's Ability to Conduct counter Research	3.1250	.9547	30.55	.625	
V26	= Financial capability of the Recipients	3.9464	.8617	21.83	.789	
PCK = PACKAGE OF TECHNOLOGY (Cronbach = .7150)		4.0833	2.3401	57.30	.817	4
V27	= Product Related Technology (5 sub factor combined)	4.1228	.7808	18.94	.826	
V28	= Process and Production Related Technology (5 sf)	3.9649	.8230	20.75	.793	
V29	= Training Programmes for Recipient's employee (4 sf)	4.0877	.8511	20.81	.818	
V30	= Managerial Related Technology (5 sf)	4.1579	.7268	17.48	.832	
STI = SOCIAL TIES (Cronbach Alpha = .8248)		4.1811	3.4667	82.91	.836	3
V31	= Strong ties and Personal Relationship	4.1071	.7288	17.74	.821	
V32	= Inter-organization Communication and Exchanges	4.3214	.6355	14.70	.864	
V33	= Social Events	4.2857	.6527	15.23	.857	
V34	= Trust and Honesty	4.5714	.5987	13.10	.914	
V35	= Ability to Resolve Conflicts and Disputes	4.0714	.7350	18.05	.814	
V36	=Supervisory Skills and Ability to Train Others	4.0714	.7594	18.65	.814	
V37	=Negotiation Skills	3.8393	.7811	20.34	.768	