DEVELOPMENT OF AN EFFECTIVE TECHNOLOGY TRANSFER MECHANISM FOR THE TEXTILE AND APPAREL SECTOR OF BANGLADESH BY INNOVATIVE CAPACITY ANALYSIS

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Abstract

Textile and apparel sector is the major industrial sector of Bangladesh and the economy is highly dependent on the development of this sector. The sector needs to develop its technological fundamentals and embrace continuous innovation for sustainable development in the future. But unfortunately, in spite of being the major industrial sector of the country it is still running with a combination of low, medium and high technologies haphazardly and there is no study what so ever in terms of its innovativeness and technological development.

The objective of this research was to analyze the current practice of the industries, find out the gaps and develop an effective technology transfer mechanism. As the indigenous capability of the industries and institutes to create new technology is very poor in this country, the development of technological fundamentals of industries highly depends on the transferred technologies. Hence, the need of an effective technology transfer mechanism is indispensable.

The method used in this research is a qualitative approach with quantitative analysis of the survey data. The methodology includes survey in the industries with appropriate questionnaire and data analysis on the industrial innovative capacity and the current technology transfer practices of the industries. Rationale study of the technology transfer mechanisms from the literature was done to create the theoretical foundation of the study.

The outcome of this research creates a new concept of technology transfer mechanism and opens a wide scope for cross-fertilization of knowledge in technology management in the textile and apparel sector of Bangladesh. The major implications of this research is identified as a reliable guideline for industries to assess their individual innovative capacity and develop their technological fundamentals by adopting the new concepts of technology transfer mechanism. This research also can be used as a background document in institutes to design Technology Transfer Office (TTO) dedicated for the textile and apparel sector of Bangladesh.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

ADB	Asian Development Bank
BCS	Bangladesh Cadre Services
BTMA	Bangladesh Textile Mills Association
BGMEA	Bangladesh Garments Manufacturers and Exporters Association
BKMEA	Bangladesh Knitwear Manufacturers and Exporters Association
CEO	Chief Operating Officer
CM	Cost of Making
CCI&E	Chief Controller of Imports and Exports
DoE	Department of Environment
EPB	Export Promotion Bureau
ED	Executive Director
FDI	Foreign Direct Investment
FOB	Free On Board
ICI	Innovation Capacity Index
ITMA	International Textile Machinery Association
JICA	Japan International Cooperation Agency
NITER	National Institute of the Textile Engineering and Research
NV	Normalized Value
RMG	Ready Made Garments
ODA	Official Development Assistance
TTO	Technology Transfer Office
TNC	Trans National Companies
UNIDO	United Nations Industrial Development Organization
UD	Utilization Declaration
UP	Utilization Permission
WCED	World Commission of Environment and Development

Chapter 1: Introduction

1.1 Background

The background behind undertaking this thesis topic came from realizing the need for technological development of the textile and apparel sector of Bangladesh for maintaining sustainable economic growth. Textile and apparel sector is the major industrial sector of the country earning most of the foreign exchange for the economy and accounts around 80% of the total export. The industry is also leading globally as it is now the second biggest ready-made garments exporter of the world. Cheap and abundant labour has been the major backbone of the textile and apparel industry. But as the cost of labor and resources are getting higher day by day, the industry has started facing a great challenge to remain competitive. Hence, product diversification, value addition, resource optimization and quality management have become really vital for the sector to survive in the dynamic global textile and apparel market. To achieve these, industries must have to become innovative and improve their technological fundamentals. But unfortunately there is neither a specific roadmap for technological development nor any study or policy in this regard is existent. In this circumstance a proper technology management strategy is a call of time. Industries must develop an effective technology development strategy to improve their production, quality, marketing and other business operations. For this there is no way but to become more innovative and adopt a proper technology transfer mechanism so that the industries can acquire the right blend of technology, manpower and information to remain competitive.

1.2 Research Need Assessment

The need for technological development of the textile and apparel sector of Bangladesh is irrefutable for maintaining sustainable economic growth as more than 80% export earnings comes from this sector. The apparel industry of Bangladesh is known for delivering large volume of orders of low end products like basic knit-wears. undergarments, baby-wears, woven shirts and trousers. The textile industry is supporting the export oriented apparel industry with fabrics, yarns and finishing services. Although the apparel industries are labor intensive industries, textile

industries are more technology oriented and requires a huge investment in capital machineries and infrastructures. The textile industry is now capable of providing 90% fabrics for knit products and around 35-40% fabrics for woven products. However, the apparel industry is gradually losing its competitiveness as the profit margins are shrinking due to increased wages and business operational costs. As most of the exported items in the product mix are low FOB price items, the apparel industry needs to start manufacturing more high end items like, sports-wear, fashion wear, jackets, suits and functional apparels to retain enough profit to remain competitive in the upcoming days. The textile industry also requires to transform itself so that it can provide required sophisticated yarns and fabrics for manufacturing high end apparel products. But the textile and apparel industry is unable to do it due to lack of appropriate technology and skilled manpower. And unfortunately there is no concrete study on how to develop the technological fundamentals of the industry. In terms of technology management, the current scenario in the textile industry is that most the industries have modern technologies but they are unable to utilize them. This is due to the lack of technology management knowledge and skills to adopt the technologies. As the indigenous capacity to develop technology is very poor in the country all the technologies are transferred from outside sources. But as there is no mechanism in the industries on how to properly adopt these technologies and full-fill industrial needs, the investments in purchasing technologies are not justified with adequate profit generation and wealth creation. A huge amount is spent to hire the expert services to use the sophisticated functions of the machines and develop new products. But most of the industries gradually loose the automations and are using only the basic functions of the transferred technologies, which results in huge opportunity loss. So there is a huge gap in this area which is to develop a comprehensive framework for the technological development of the textile and apparel sector gradually and develop an effective mechanism so that the transferred technologies are properly adopted and the highest benefits can be generated.

1.3 Objectives

The modes and mechanisms of technology transfer are diverse. But the effectiveness of the transferred technology relies on the socio-economic-industrial framework and the Innovative Capacity of a particular sector. Innovative Capacity refers to the indigenous capability to produce or introduce technology by academia and research institutes and the ability of the industrial sector

to absorb it. According to a research from Harvard Business School the Innovative Capacity has a linear relation with GDP growth of a country. For designing a sustainable technology transfer mechanism a clear idea on the Innovative Capacity of the sector is undeniable. The theme of this study is to determine the Innovative Capacity of the sector and relate it with the socio-economic and industry variables to develop an effective technology transfer mechanism for the sector.

The specific aims can be grouped as followed:

- To determine the innovative capacity of the textile and apparel sector.
- Rationale study of the potential technology transfer mechanisms.
- To develop an effective technology transfer mechanism for the sector.
- To design a model of Technology Transfer Mechanism to sustainably perform knowledge and technology transfer from academia to industry.

1.4 Scope of the Study

The study has a wide ranging scope both inside and outside the industry. This study brings valuable insights about the internal mechanism of the textile and apparel industries in Bangladesh in terms of technology transfer practices and also the interaction of the other stake-holders outside the industry. The study also reveals the innovative capacity of the industries in terms of the four critical innovative factors which opens a huge scope for improvement in the innovativeness of the industries. It finds out the synergy between the industrial innovative capacity and technology transfer to develop an effective mechanism for the industries so that the industries can continuously develop their technological fundamentals. The mechanism also opens opportunity for the stake holders like the industry association, academic and research institutes to develop their capacity in idea generation and technology development.

1.5 Outline of the Study

The study is comprised of six chapters. The first chapter is the introduction where the objectives and the background of this research is outlined. The next chapter is the literature review. The literature section encompasses the essential theoretical knowledge and information about

technology, technology transfer, transfer mechanism, innovation and innovative capacity and about Bangladesh textile and apparel industry. The third chapter, is the methodology section where the method and design of the research, the sampling technique, questionnaire design and the scoring method of the industries has been described. The survey data section in chapter four shows all the data collected from the industries under investigation and their analysis. Chapter five describes the development of an effective technology transfer mechanism for the textile and apparel sector of Bangladesh. In this chapter a conceptual model of the technology transfer mechanism is outlined and described. The sixth chapter depicts about the recommendations for the industry in terms of sustainable technology development and the conclusion.

Chapter 2: Literature Review

2.1 Introduction

In this chapter definition and explanation of the concept of technology and technology transfer is discussed from journal papers. A brief overview of the Textile and Apparel sector of Bangladesh including its growth, development and innovation pattern that is relevant to this research is also discussed. The concept of innovative capacity is introduced and how the innovative capacity of the industries can be measured is explained. The fact is also discussed about why innovativeness and technological development is a must for the sustainable development of the textile and apparel sector. The literature review section makes a theoretical foundation of the topics under study for this research so that the information collected from the industries can be analyzed with a view to develop an effective technology transfer mechanism for the textile and apparel sector of Bangladesh.

2.2 Concept of Technology

2.2.1 Definition of Technology

In the contemporary world, technology is deemed as the most important factor of production and industrial competitiveness. Interestingly, defining technology in one sentence is not an easy task; hence, scholars have been defining technology in different ways and from different perspectives [1]. The definition of technology varied according to authors and context of discipline [2]. One of the earlier definitions given by Arrow that says technology is an information that is generally applicable and easy to reproduce and reuse [3]. In contrast in another definition, Tihanyi and Roath said technology can include information that is not easily reproducible and transferable [4]. Sahal viewed technology as ‘configuration’, observing that the transfer object (the technology) relies on a subjectively determined but specifiable set of processes and products [5]. So, from the earlier definitions an explicit and clear view of technology is not evident. However, from scrutinizing the ancient definitions given by different scholars from different backgrounds Sazali and Raduan has concluded that there are two basic components of technology that can be identified: 1) ‘knowledge’ or technique; and 2) ‘doing things’ [6]. And the modern definitions are primarily based on the

concepts of Sazali and Raduan that deals with knowledge or techniques to produce products and services. A complete definition can be quoted from Tarek Khalil as he says technology can be defined as all the knowledge, products, processes, tools, methods and systems employed in the creation of goods or in providing services [7]. That is, technology is the way we do things. It is the practical implementation of knowledge gathered from scientific theories and models.

The concept of technology is getting richer day by day as its importance is felt by the users of technology in different sectors more and more. For long man, machine and materials have been the factors of production in the industrial sector but today the concept has changed quite a bit as only the development and optimization of the mentioned three factors cannot ensure competitiveness anymore. Time and technology are the two new and undeniable factors of production today as the success mostly depends on how quickly, how efficiently and effectively products and services are delivered to the consumers. To be efficient and effective there is no option but to adopt management of technology; to find, adopt and optimize or develop the appropriate technology for a particular business mix.

2.2.2. Technology as a Factor of Production

To have a clear idea on what technology is all about is very important for this particular study. As long as textile and apparel or any other industrial sector is concerned, technology at first is a vital factor of production. Factors of production are the inputs that an industry requires to produce its goods or services; the output. According to Adam Smith there are three basic resources or factors of production: land, labour, and capital [8]. Again Sullivan and Sheffrin identified entrepreneurship as another vital factor of production [9]. But now days, due to the importance of technology as a major contributor of production and something more than capital, Micheal Parkin in his study introduced technology as another individual factor of production [10]. And today time has also become a vital issue for the manufacturing world as prompt production solution is a must to remain competitive in the fast global market. Especially in the era of fast fashion the lead time for production in the apparel industries and subsequently in the textile industries as the backward linkage has been shortened significantly [11].

So to facilitate the study on the textile and apparel industries of the country the factors of production can be identified as: Land, labour, capital, entrepreneurship, technology and time. However, only the technology factor will be explained and studied further for this particular research.

2.2.3. Components of Technology

To general people, technology means only the machineries or the hardware part of the production tools. But in reality technology is actually something beyond only machineries. So when study on technology transfer is in concern, it is very important to characterize the technology appropriately. Sharif and Ramanthan divided technology into four components. They distinguish between engines, microchips and software packages. Technoware refers to the physical manifestations of technology. Infoware denotes the articulated knowledge concerning the physical manifestations. Individual technological skills are included in the term humanware, whereas the organizational skills related to technology are called orgaware. The orgaware component manifests itself in organizational routines and processes [12]. Professor Dr. M. Kamal Uddin has given a more industry oriented definition of the technology components illustrated in Table 2.1. as hardware, skill-ware, facts and figure ware, and the procedure ware [13].

A complete transfer of technology is characterized by the transfer of all those four components of technology. Any missing component can lead to poor performance of technology. A common practice in the industries is evident that when a technology is under consideration, only the hardware or the physical machine is given the most of the attention. Less emphasize is given in transferring or developing the skill-ware and the other components of the technology which leads to under-performance of the transferred technology in many cases. In some cases, additional costs are associated with hiring skilled persons from outside in order to properly operate the newly transferred technology. As long as textile and apparel sector is concerned they are the most labor intensive industries, and all the other components along with the humanware has great influence on production.

Table 2.1: The Components of Technology

Component Title	Component Title	Description
Technoware	**The Hardware**	a. It is the machine and tools that are physically present in the industry. b. the hardware component of an industry. c. Facilities that consists of tools, capital goods, intermediary goods, products, physical equipment, machinery, physical processes.
Humanware	**The Skillware**	a. The labour or work of people; skill to operate the hardware part of technology. b. Abilities of humanware consisting of understanding capacity for systematic application of knowledge, know-how, human capability, specialized ideas, problem solving capacity etc. c. If the humanware is not enough skilled to run the machineries and tools for production efficiently and effectively the technoware is valueless.
Infoware	**The Facts and Figure ware**	a. Document or record embodied component of technology. b. Fact and figures about the technoware, knowledge about physical relationships, scientific and/or other form of organized knowledge, principles of physical and social attributes, technical information, standards, computer software that are essential for the sustainable operation of a technology.
Orgaware	**The Procedure ware**	a. Organizational behavior towards a technology or organizational framework requirement for the smooth operation of a technology. b. The procedure of adopting and running a technology in an organization. c. The behavior of an organization to control any technology as a factor of production.

2.3 Technology Transfer

2.3.1. Defining Technology Transfer

In general words, technology transfer represents the expression of a choice of someone or some organization or a country to import or purchase technology rather than develop it or acquiring it by any other means. It is a process that opens the door for wide application and utilization of technologies in any part of the world irrespective to the origin of technology.

Even though technology transfer is not a new business phenomenon, the considerable literature on technology transfer that has emerged over the years agrees that defining technology transfer is difficult due to the complexity of the technology transfer process [14]. The past literatures offer several definitions from several point of views. Interestingly, the definitions depend on how the user defines technology and in what context [15]. It is defined initially as the process whereby technology is moved from one physical or geographical location to another for the purpose of application toward an end product [16]. This transfer can take place either domestically from one sector or firm to another or, it can take place across national boundaries, from one country to another, which is generally accepted as international technology transfer. According to Behrman et. al, technology transfer is a process by which technology developed for one purpose is employed either in different application or by a new user [17]. Ramanathan similarly says, the term technology transfer can be defined as the process of movement of technology from one entity to another. The transfer may be said to be successful if the receiving entity, the transferee, can effectively utilize the technology transferred and eventually assimilate it [18]. The movement may involve physical assets, know-how, and technical knowledge [19]. Kayak has defined technology transfer as transition of know-how to suit local conditions, with effective absorption and diffusion both within a country and from one country to another [20]. Another scholar defines technology transfer as the utilization of an existing technique in an instance where it has not previously been used [21].

Derakshani defines technology transfer as the acquisition, development, and utilization of technological knowledge by a country other than that in which this knowledge originates [22]. This definition is similar to that presented by Van Gigch. He believes that technology transfer

involves the acquisition of "inventive activity" by secondary users [23]. It shows that technology transfer may not always involve the transfer of machinery or physical equipment. Knowledge can also be transferred through training and education, which could include training on how to effectively manage technological processes and changes [24]. These definitions strongly admit the transfer of knowledge and know-how along with the machineries or physical tools as an integral part of technology transfer. Again Chenais defines technology transfer as the transition of the capability to manufacture a product or process from firms in one country to firms in another [25]. He argues that this transfer includes not only the technical knowledge needed to produce the products, but also of the capacity to master, develop, and later produce autonomously the technology underlying these products. So Technology transfer also indicated the transfer of operating, exploiting and developing capacity of the technology. Larsen et. al. defines technology transfer as the process by which technological innovations are exchanged between individuals and organizations who are involved in R&D on one hand, and in putting technological innovations into use on the other hand [26]. According to Larsen existence of R&D activities is key for technology transfer. Again Meissner says transfer of technology is the act of sharing know how by such devices as consultancy, joint ventures, gifts, licenses, franchises and patents [27]. Meissner identifies the modern channels of technology transfer that relocates technologies from developed to the developing countries. Another definition made by Agarawal on the other hand views technology transfer as the communication, adaptation and use of the technology from one place or economic region into second region. He adds that this technology has to be adapted to local conditions by receiver to fit to its social, political, cultural, economic and educational environment [28]. Aggrawal emphasizes the importance of technology diffusion for the successful technology transfer process. However, there is a clear distinction between technology transfer and technology diffusion. Some scholars like Rogers and Shoemaker has defined technology transfer in the context of diffusion of innovation that may lead to confusion where many researchers, and even practitioners, refer to the terms technology transfer and technology diffusion interchangeably [29]. The literature on technology diffusion, in general, suggests that the term refers to the spreading, often passively within a specific technological population, of technological knowledge related to a specific innovation of interest to that population. Technology transfer, on the other hand, is a proactive process to disseminate or acquire knowledge, experience and related artefacts [30]. Technology transfer is intentional and goal-oriented, though is not a free process [31]. Transfer

also presupposes agreement and therefore involves agreement, unlike diffusion [32]. So the fundamental characteristics that can be derived from the above definitions of technology transfer are:

Technology transfer is a dynamic process: Technology has many components and dimensions and almost always involves more than one element of technology. The components interact with each other as if they constitute a system. In addition, as conditions change in the recipient's environment the technology package must be periodically re-evaluated with the advancement of the project cycle and as new information becomes available. So the transfer involves with transferring the full system and it is dynamic in nature.

Technology transfer requires adequate infrastructure: Effective technology transfer requires an adequate infrastructure, which may include scientific institutions, R&D facilities, vocational, technical and management training institutes and skilled personnel of different specialization within the recipient country. A dedicated one-stop center for technology transfer is a common thing in the research universities in the developed countries. In the industries the R&D departments must acquire proper knowledge on technology management so that they are able to do the required modifications of the newly transferred technologies or technology components.

***Technology transfer often requires considerable modification and innovation at the plant level*:** Technology developed in a specific context can hardly ever be introduced into a new environment without at least some degree of modification. Modification and further development of technology are thus very often an integrated part of transfer. This often involves changing the scale of a production process and the adaptation of products to local or target market characteristics. A new process introduction often involves considerable problem solving and some innovation at the plant level. According to Tyre the degree of changes in the technology is affected by the attributes and business environments of the units involved in the transfer [33].

2.3.2. Technology Transfer Classification

As technology transfer is a dynamic process, classification of technology transfer can be done from various aspects. The simplest classification can be viewed as per the transfer demographics.

Internal technology transfers; that indicates transfer within countries and International technology transfer; indicating technology transfer beyond the national and political boundaries. Internal technology transfer usually are the transfer of technologies, know-hows from internal R&D institutes and universities to the local industries or sometimes firm to firm transfers. But for the LCDs as the indigenous technology capacity is very poor, most of the technologies are sourced from the developed countries. Hence, international technology transfer carries more significance for countries like Bangladesh. Mansfield classified international technology transfer into material transfer, design transfer and capacity transfer [34].

Material Transfer: Material transfer consists of the transfer of materials, final products, components, equipment, and even turnkey plants. In brief, this is a transfer of the technological artefact itself. It is not so much a transfer of knowledge as it is the transfer of the results of knowledge. The receiving country is merely a passive consumer of the knowledge produced by others which cannot be produced by itself.

Design Transfer: Design transfer basically involves the movement of designs, blueprints, and the know-how to manufacture previously designed products or equipment. The major objective here is to provide the basic information, data, and guidelines needed to create a desired capability. In other words, foreign items are imported in order to copy their designs and the recipient nation begins to produce domestically the artefact formerly imported in the material type of transfer like reverse engineering. Nevertheless, it still remains dependent upon technological knowledge produced elsewhere.

Capacity transfer: Capacity transfer includes provision of the know-how and software not simply to manufacture existing products but, more importantly, to innovate and adapt existing technologies and products, and ultimately design new products.

Brooks describes another classification of technology transfer as vertical transfer and horizontal transfer [35].

Vertical transfer: Vertical transfer refers to the transfer of technical information within the various stages of a particular innovation process, i.e., from basic research to applied research, from applied research to development, and from development to production. In other words, it is the transition from principle to practice, or from pure scientific theory to its practical application. Since vertical

technology transfer entails technological progression from science to completed product, it requires organizing rigorous R&D.

Horizontal transfer: Horizontal transfer occurs when technology is developed and used in one place, organization or context and is transferred directly to another place. In horizontal transfer rigorous R&D is not a must but ability to undertake plant level modification and adaptation is essential for the recipient.

2.3.3. Technology Transfer Modes

The understand the difference between technology transfer modes and technology transfer mechanisms is essential for this study. The two terms have been described in many literatures. According to the work of Hayami and Ruttan the term "mode" is used in many places actually as the classification of technology transfer described in the previous paragraph [36]. Hayami and Ruttan again classifies the modes of technology transfer as material, design and capacity transfer. Souder refers to the vertical transfer described by Mansfield as internal technology transfer and the horizontal technology transfer as external technology transfer in his study of new product innovation [37].

However, the above technology transfer concepts were put in perspective by Amsden and Habibie in their research. Amsden identified that technology transfer follows reciprocal modes in developed and developing countries illustrated in figure 2.1 [38].

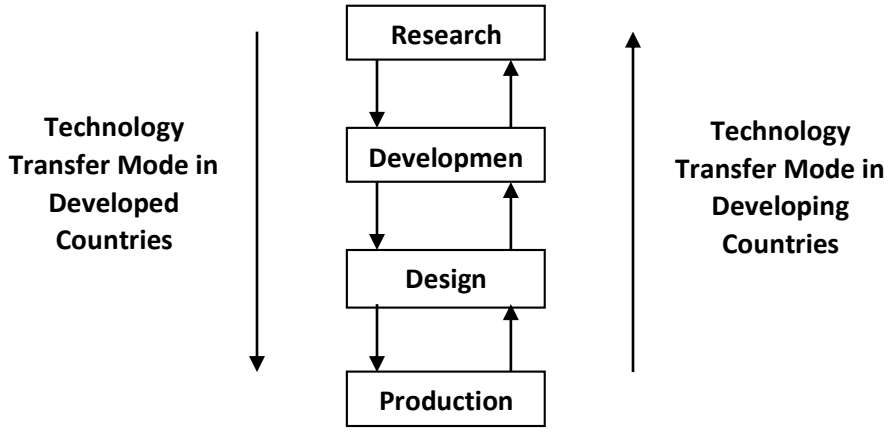

Figure 2.1: Technology Transfer Mode in Developing and Developed Countries

According to Amsden the developing countries are more of learners and they do not usually innovate as they have to compete initially on the basis of low wages, state support, quality and productivity. The mode that must thus be pursued should be based on transfer, absorption, and adaptation of existing technology. This viewpoint fits in with the material, design, and capacity transfer progression described by Mansfield. Again Habibie reinforces the statement as he states "technology receivers must be prepared to modify their manufacturing plans on a step-by step basis in order to achieve the value addition obtained by the technology transferring firm" [39]. He refers to such an approach as "progressive manufacturing" and popularized the slogan, "begin at the end and end at the beginning" implying that a transferee firm should start with production and move backwards to research as also pointed out by Amsden.

All the above ideas about technology transfer modes has been combined by Steenhuis; he created the concept 'the technology building' [40]. The technology building has two wings; the innovation wing consisting of the research, development, production, and distribution stages of the transferor; and the exnovation wing that consists of the distribution, production, development, and research stages of the transferee. The innovation and exnovation wings refer to the technology development stages of the transferor and transferee respectively in accordance with the Amsden and Habibie models of technology development. Steenhuis points out that transfer of technology can take place between the stages of both wings of the technology building in a variety of combinations.

As the term innovation and exnovation has other operational meanings that will be exploited in the later part of this research, thus, in this study the technology development stages of the transferor and transferee will be referred to as "technology generation" and "technology assimilation" respectively. The combinations stated by Steenhuis is the procedural arrangements in different stages of the generation of technology at the transferor's entity to the assimilation of technology at the transferee's entity. The same model is described by Ramanathan in his study on 'A Taxonomy of International Technology Transfer Modes' [41].

According to Ramanathan's study he has classified the technology transfer modes in four categories as: Sales intensive, manufacturing intensive, development intensive and research intensive. It is derived from the technology generation stages and technology assimilation stages described by Steenhuis illustrated in Figure.

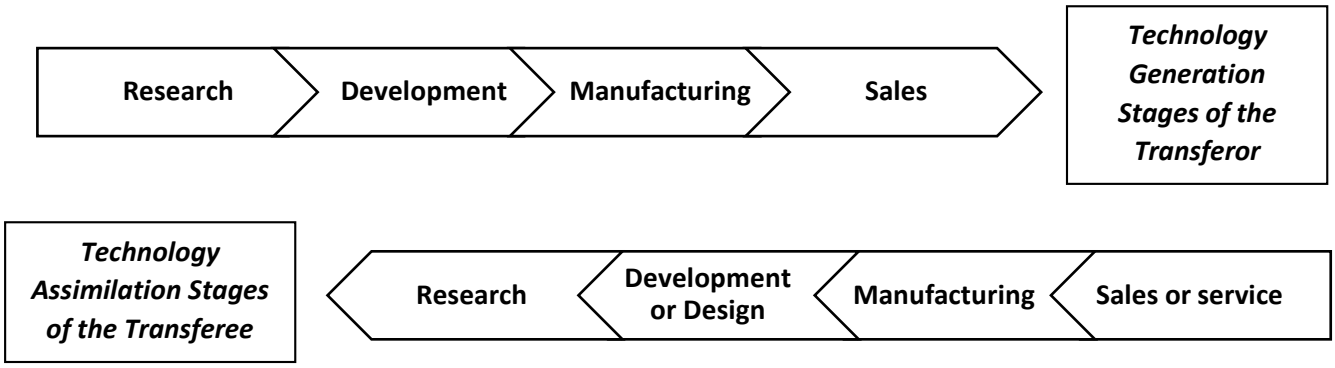

Figure 2.2: Technology Assimilation and Generation Stages

The generation stages start with vigorous R&D in the transferor's place, generally R&D institutes and universities followed by the development or design of the idea, manufacturing of the product and selling it to the one who needs it. In the contrast the transferee only receives or buys the product or technology to provide service or sell it to the consumers directly. For the transferee the technology assimilation stages are manufacturing some parts of the product brought or the modification of the product or technology to adapt with the transferee's actual business, market and environment. There are cases where firms do new developments and designs over their products and technologies transferred initially from the original manufacturer. Sometimes these development leads to further research in order to improve the adaptability of the product/technology.

The simplest form of technology transfer could be said to take place when an owner of technology (the transferor) transfers the technology needed by a business partner (the transferee) to sell and service a product produced by the owner. This may be depicted as an [S: s] mode of transfer. The representation within parentheses implies that a product at the end of the "generation" stage is simply being sold by the transferee. The technology likely to be transferred here is that needed by the transferee to sell, repair, and provide other elements of after-sales service to customers buying the product. The objective of the transfer is to effectively maximize the sales of the product in the region managed by the business partner. Another possible variation is [M: s] if the transferee is the sole distributor of the product made by the transferor. These two types of technology transfer arrangements with a predominantly sales focus may be referred to as a "sales intensive mode" of technology transfer. The possible variation in transfer mode and the associated transfer mechanism are grouped by Ramanathan [41] as follows:

Table 2.2: Different Transfer Mechanisms for Different Transfer Modes

Technology Transfer Modes		Possible Transfer Mechanisms
Sales Intensive	[S:s] or [M:s]	Sales and service agreement either as an agent or sole distributor
Manufacturing Intensive	[M: m,S] or [M:m,s] or [D:m,S] or [D:m,s]	Subcontracting, original manufacturing arrangements, production licensing and joint ventures
Development Intensive	[R:d,M,S] or [R:d,m,S] or [R:d,m,s]	Original design manufacturing, production licensing, joint ventures
Research Intensive	[R:r,D,M,S] or [R:r,d,M,S] or [R:r,d,m,S] or [R:r,d,m,s]	Joint R&D and production, university – industry licensing, government R&D institute-industry licensing

The term "mode" here, is used to refer to the transfer links between the phases of the technology development chains (generation and assimilation) of the transferor and transferee while the term "mechanism" is used to describe popular business arrangements that are deployed to transfer technology.

2.3.4. Technology Transfer Channels

Technology transfer channel and technology transfer mechanism have been specified in a methodical overview with no major distinction [31]. The technology transfer mechanism has been defined as any specific form of interaction between two or more social entities during which technology is transferred, and a technology transfer channel as the link between two or more social entities in which the various technology transfer mechanisms can be activated [42]. So transfer mechanism is the formal business arrangement or informal means that creates the channel for the technology to be transferred.

According to different literature, there are numerous channels of international technology transfer [43]. As a net importer of technology, in Bangladesh new technologies mostly gets through following channels illustrated in Table 2.3.

Table 2.3: Technology Transfer Channels

Formal Channels of Technology Transfer	**Explanation**
a. Foreign direct investment (FDI);	An investment made by a company or individual of one country in another country in business interests. The investment can be in the form of either establishing business operations or acquiring business assets, such as ownership or controlling interest in a foreign company.
b. Technology (technical) licensing agreements;	Agreement whereby an owner of a technological intellectual property (the licensor) allows another party (the licensee) to use, modify, and/or resell that property in exchange for a compensation (consideration).
c. Import of capital goods;	Imports of machineries, tools and any other capital goods embedded with technology
d. Foreign education and training;	Higher education of students in a technologically advanced country (universities and institutes); on the job and off the job training of employees.
e. Turnkey projects;	A contract under which a firm agrees to fully design, construct and equip a manufacturing/ business/ service facility and turn the project over to the purchaser when it is ready for operation for a remuneration
f. Technical consultancies	Instances when experts, professionals visit as consultants and share their knowledge, skill and expertise.
g. Joint ventures	A commercial enterprise undertaken jointly by two or more parties that otherwise retain their distinct identities
Informal Channels of Technology Transfer	**Explanation**
a. Reverse engineering	It is the process of extracting knowledge or design information from anything man-made and re-producing it or re-producing anything based on the extracted information.
b. Participation in world trade fairs	Participating in different world trade exhibitions and symposiums where new technologies are introduced.

Like in other developing countries, the bulk of international technology transfer to Bangladesh takes place in the private sector, that is from private firms of the advanced countries to private Bangladeshi firms, although occasionally also from advanced country firms to Bangladeshi state-owned enterprises. Another channel for international technology transfer takes place in the public sector through official development assistance (ODA) programs which usually also contain a technology transfer component specifically in the form of technical assistance or manpower training programs provided by the technical assistance agencies of individual donor countries, such as the Japan International Cooperation Agency (JICA), the GIZ of the German government, or by

multilateral aid agencies, including the World Bank, the Asian Development Bank (ADB), and the United Nations Industrial Development Organization (UNIDO). In general, however, technology transfer through the public sector is less important than what takes place through the private sector.

FDI inflow always had a positive trend towards Bangladesh due to government's friendly policies and also due to different free and customized trade agreements with EU and some other developed countries. In fact, the fiscal year 2016 saw the highest FDI inflow ever to the country surpassing 2 billion USD for the first time [44]. The FDI inflows in Bangladesh in the past ten years is showed in the figure 2.2.

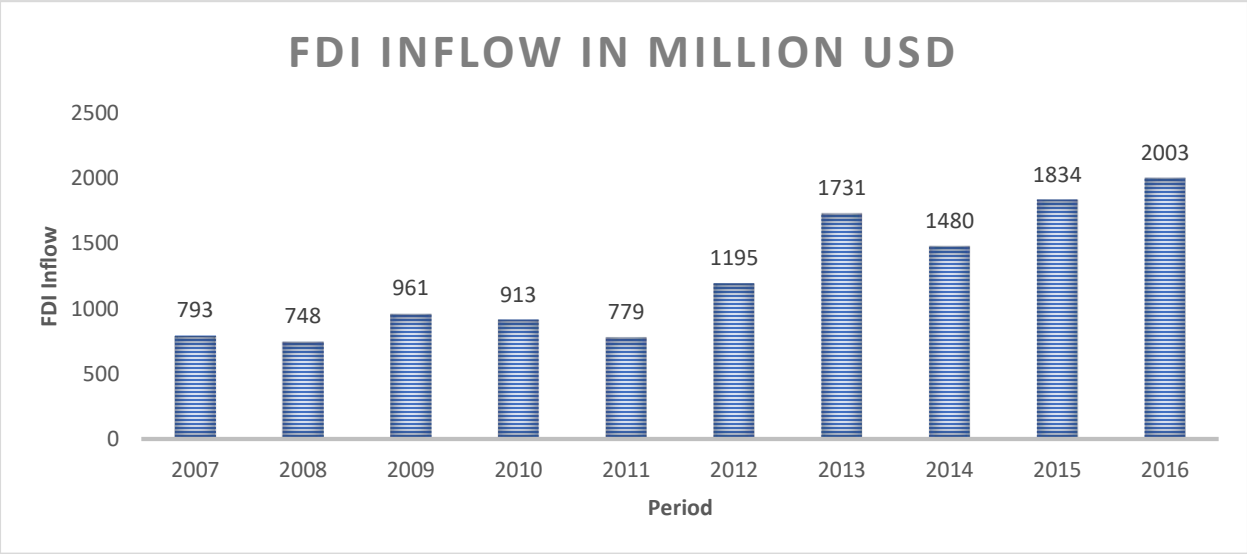

Figure 2.3: FDI inflows in Bangladesh from 2007 to 2016 fiscal year.

According to the Bangladesh Bank report, country's power, gas and petroleum sector have received highest FDI of $574 million followed by textile and apparel at $443 million, telecommunication $255 million and banking $310 [45]. Other than direct investments, technology is also transferred in the textile and apparel industries through importation of capital goods, machineries and tools. The country's imports on a cost and freight basis stood at $42.92 billion, according to data from Bangladesh Bank. The overall imports grew 5.45 percent year-on-year in fiscal 2015-16 owing to an uptick in capital machinery and industrial raw material deliveries. The import of capital machinery rose by over 14 percent to $3.53 billion [46]. Technology in the form of both machine and tacit form is transferred to the textile and apparel sector of Bangladesh through the channels mentioned above especially through FDI and imports of capital machineries. But only

a physical transfer of technologies does not ensure the effective dissemination of the technologies in the recipient's sector. Most of the technologies are transferred from Trans National Companies (TNCs); in many cases they do not have an interest in transferring knowledge to and supporting innovation in foreign affiliates beyond what is needed for their production process or product. UNCTAD has analyzed the factors affecting technology transfer and dissemination in the developing countries from the TNCs where it depicts that the TNCs are not interested to transfer the complete knowledge and skills underlying any new technology to the transferee unless it is required for their production purpose. In the case of joint ventures or other arrangements with foreign firms, transfer of knowledge to local firms and dissemination in local economy would be even more limited unless local firms have a long history of using the foreign technology and accumulating such technology through license agreements or other technology use arrangements. Government support to facilitate the acquisition or use of such technology and process of learning foreign technology is critical [47].

Technology is transferred to the textile and apparel industries through direct investments, joint ventures, import of capital machineries and some turnkey projects as formal channels but there is no study what so ever about how effective this transfers are. The effectiveness of technology transfers mostly governed by the complete adaptation with all the four components of technology and the ability of the firms to operate, modify and develop the transferred technology according to change dynamics in the industry and market. Technology transfer channels are only the route through which a new technology enters in to the transferee premises, but the effectiveness of the transfer rather relies on the mechanism adopted by the transferee to assess, adopt, operate and develop the technology according to the industry need.

The mechanisms of technology transfer are institute specific, which have their origin in institutional structure, mandate, objective, area of research, controlling rules and laws on technology transfer, institutional culture, leadership in the institute, attitude of scientists and researchers, opportunity for involvement of technology developer and transferrer, firm's behaviour towards institute and it's technology, available expertise on technology transfer with institute, IPR policy, structure of TTO, overall national science and technology policy and available funding. The TT mechanism also depends on interactions and communication between research institutes and technology consumers. Technology transfer has good scope when both parties have mutual

beneficial situation. The technology transfer is symbol of benefits to the parties engaged in interaction, but after all it depends on effectiveness of technology transfer mechanism.

2.4 Technology Transfer Through EPZs

EPZs are vital economic drivers of our country. In order to stimulate rapid economic growth of the country, particularly through industrialization, the government has adopted an 'Open Door Policy' to attract foreign investment to Bangladesh. The Bangladesh Export Processing Zones Authority (BEPZA) is the official organ of the government to promote, attract and facilitate foreign investment in the Export Processing Zones (EPZ). The primary objectives of an EPZ is to provide special areas where potential investors would find a congenial investment climate, free from cumbersome procedures. Although, the EPZs immensely contributed in exports and foreign currency earnings, the long term benefits as a host country in terms of technology transfer and development of spill overs is a matter of debate.

Companies in the EPZs often bring in foreign technology, knowledge, skills and work practices that can be transferred to the rest part of the country. Specially the MNCs set up manufacturing and R & D facilities that employ domestic scientists and engineers who, in turn, develop new products and processes in conjunction with expatriate R&D personnel. As MNCs maintain higher quality of products, they call for higher level of skills (supervisors, production engineers, etc.). In fact, quality seems to be the driving force for technology transfer not only through MNEs themselves but through backward linkages as they suppliers also must meet the quality requirements set by the world market [48].

As long as EPZ companies are freely allowed to buy from and sell to the local market, technology and knowledge transfer will happen over the entire value chain, and the country as a whole will benefit. The workforce will follow suit by learning new skills and technologies, and ultimately becoming more competitive in the global market. Apart from the training and development of a skilled labor force in a technology-intensive industry, there is the transfer of actual capital equipment, and the subsequent transfer of skills required to maintain as well and eventually develop indigenous versions of the same manufacturing technology.

But unfortunately, Bangladesh is being unable to gain the benefits to a significant level due to following reasons. [48] [49]

a. Most of the MNCs which are supposed to bring in R&D intensive industries in the EPZs typically contribute the R&D part in their home country. As a result, it becomes difficult for the engineers and supervisors working in the factory in the EPZs of the host country to learn the actual know-hows and technicalities.
b. The transfer of technology of the tacit variety is very low, given the labor intensive and low value added activities undertaken by the investing companies in Bangladesh EPZs to capitalize the benefits from inexpensive and abundance of labor force.
c. The development of spillovers is also not significant as the domestic firms do not have the similar level of technology that of the MNCs operating in the EPZs. MNCs are also not interested going in long term contracts with the domestic suppliers as they prefer sudden exits due to their internal policy.
d. The tendency of the host government economies to insulate the domestic industries from direct exposure to the MNCs operating in the EPZs also limits the scope of skill transfers.

2.5 Technology Transfer Process

The technological development has no boundary and only is limited by the developer's capacity. But industries are still far away from this limits and they are much more likely to come up with their practical and technological limits. This is why the technology transfer process starts with the identification of the need or opportunity of the technological development. Researchers are devoted to narrow the gap between the current technology and their target technology and identify whether the gap is physical or practical. This gap is called the Technical Potential of Technology [50]. This gap is often very big that makes developing new technology so difficult. These gaps may be just big enough for people to become unable to see the benefits of the new technology. The following factors are identified that may hinder in the way of adopting new technologies and discarding the old ones: a. Incorrect perspective of technical limits, b. Inability to measure technological progress, c. Faulty interpretations of market signals, d. Misinterpreted customer needs, e. Culture and f. Gap between old and new technology is too big.

The initial step in the transfer of technology process is the recognition of a need. This need must be satisfied by current technology applied differently, or it must be satisfied by new technology. A research suggests that needs can arise from any of the following [51]: a. Scientific changes, b.

Competition, c. The market, d. Legislation, e. Human inquisitives and f. Innovation and company policy.

Scientific changes can bring about new products utilizing new technologies. Competition together with the market may be one of the greatest initiators of the need to transfer new technology. The market is becoming increasingly fragmented and more sophisticated. This means that an organization's products or services must be tailored to address the specific needs of individuals. If an organization does not have the technological capability to do so, it will lose that market to its competitors. Technology can give a business the competitive advantage it needs to secure its position in the market. Legislation may also create a need that has to be met by obtaining new technology. In dyeing industries in general there are, for example, restrictions on the pollution levels generating from the effluents. This legislation disqualifies using harmful dyes and chemicals or imposes the use of effluent treatment plants. Human inquisitiveness together with innovation ensures advances in technology.

After defining a need an organization must search for appropriate technology that will best satisfy this need. There are several strategies that can be followed and they can be divided into two major groups. The first is developing the technology within the organization and the second is looking for the technology outside the organization.

Information plays a big role in the search for new, or the most applicable technology. Organizations are particularly interested in information on products, research activities, finance and patent information. One of the successful sources of information and co-operation is higher education institutions in the form of universities. Partnerships with these institutions help companies to: a. Access new technologies, b. Keep abreast of new technologies, c. Access consultancy skills and d. Develop new technologies jointly.

The next stage in technology transfer process is the information management and monitoring the transfer process. Before a technology can be identified that may satisfy a newly identified need, senior personnel (managers and above) must have accurate knowledge of not only the company's technological position but about the market and their competitors. The indigenous transfer mechanism of a particular industry comes to play here. This mechanism will ensure a well-organized approach in obtaining new technology. Cooke and Mayes identified two prominent roles found in companies concerning the knowledge of technologies. The first is the ***godfather***. This is

the person, usually in a senior position in an organisation that watches over the technology transfer process. This person often introduces other senior staff members to the idea of new technology. This is the person that is up to date with the latest developments in his field or market segment, although it is not part of his work description. The role of the godfather may be limited to the development phase of transfer project or even just the role of initiator. The role might however continue throughout the whole transfer project.

The second role found in companies is that of ***champion***. The champion is often found at the mid-level management level. The people in this role are often very skilled and will most probably oversee the implementation of new technology, i.e. the programs initiated by the godfather. The role of champion may eventually mature into the role of godfather. The champion has excellent knowledge on internal politics and skills. The person in this role also has great people skills and is a good communicator.

Out of these two roles it is seen that the godfather's role has knowledge on the internal state of technology, but even greater knowledge on the external state of technology. If a need arises this is often the person to go for, to ask, "How to solve this?" A person can fulfil the godfather role in an unofficial capacity, but with organizations, which realize the importance of technology and the acquiring thereof, this is very often an official role. Where the godfather's main role is over-seeing the transfer process from the external environment, the role of the champion is mostly concerned with the internal environment. His role does not include the identification of new technology, but he is an excellent evaluator of chosen technology because of his knowledge of internal affairs. The champion will be able to comment on the appropriateness of the technology. Again, the champion's role can be official or unofficial. The role of the champion can be seen as that of a gatekeeper, who not only has excellent technical knowledge, but also has great people skills and excellent leadership qualities [51].

For organizations that are concerned with keeping up to date with technology, it is important to identify people who might unconsciously fulfil these roles of champion and godfather and exploit their capabilities. It might even be feasible to give these people official capacity in an organization to fulfil these roles. The technology transfer process can be simplified as shown in the Table 2.4.

Table 2.4: Stages in Technology Transfer Process

Stages	Underlying Activities
Recognition of technological development need	a. Identifying technology gap b. Interpretation of market signals c. Managing customer needs
Searching for appropriate technology	a. Available options of development b. Local suitability c. Operational changes/ training required
Managing information and transfer process	a. Initiating the transfer process b. Overseeing the implementation of new technology
Using the new technology	a. Satisfying the technology development need b. Using the technology in gaining competitive advantage

2.6 Technology Transfer Mechanisms

Technology may find a way to the user through different channels but the transfer process takes place via certain technical transfer mechanisms. The technology transfer mechanism are mostly chosen according to the form and domain of technology to be transferred [52]. Technology in the form of knowledge, skill and equipment can be conveyed through the following mechanisms shown in the Table 2.5.

Table 2.5: Different forms of Technology Transfer Mechanism

Forms	Technology Transfer Mechanism
Knowledge	a. In print through technical journals b. In print through learned journals c. Scientific magazines d. Patents e. Orally at conferences f. Orally at learned societies g. In discussions with colleagues h. In discussions with acquaintances i. In discussion with consultants j. On television or radio k. Courses l. Service bulletins m. Data packs n. Specifications

Skills	a. Watching someone doing something b. Watching a video of someone doing something c. Demonstrations at courses d. Hands-on training
Equipment	a. Products b. Trade exhibitions c. Trade conventions d. Sales representatives e. Advertisements f. Contacts in other companies

Now most of the technology transfer happens between companies. In textile industries especially technology is transferred in the form of hi-tech machineries and the success of transfer lies in effectively transferring all the components of the technology (the skill-ware, info-ware and orga-ware along with the techno-ware). According to Mogavero and Shane all technology transfer models can be divided in two major categories. The first category is passive and the second is active. This classification refers to the level of activity in applying the technology in the transfer process. If the technology transfer mechanism presents the technology to the potential user without assistance regarding its application, then the mode is called passive. In the passive mode only the knowledge part of technology is transferred, the skills surrounding the technology are not transferred. These mechanisms can include presentations in a report. If, on the other hand the provider of the technology assists with the application of the technology then the mode is called active. The boundaries between passive and active are not that easy to define and therefore a semi-active mode is also defined by Mogavero and Shane.

2.6.1 The Passive Mode

The most widely used mechanism in the passive mode is the instruction manual or "cookbook" approach illustrated in the figure 2.5. This is the only contact between the originator of the technology and the user. Millions of products are made and sold with transfer occurring in this form. These self-teaching manuals used in this mode have one thing in common: they presume that the user has some level of knowledge and competence in the specific technological area. It is

an important point in this mode of transfer. The skill resting in the user of the technology must be clearly defined by the originator, and the user must have some level of competence in using the technology. If the technology is transferred to someone in a passive mode who does not know how to use it to achieve organizational goal, the transfer process will not be successful.

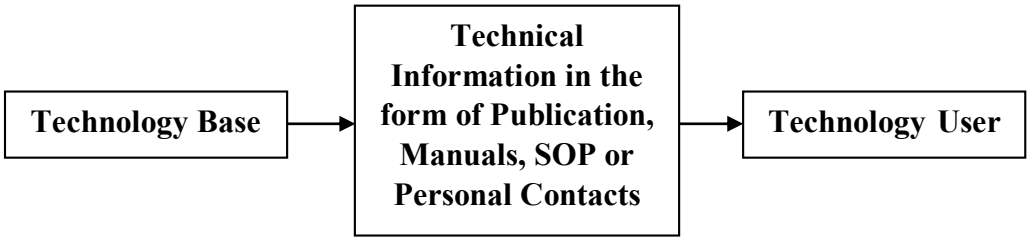

Figure 2.4: Passive Mode of Technology Transfer

2.6.2 The Semi-Active Mode

In the semi-active mode there is third party intervention in the transfer process. This is usually in the form of a transfer agent. In the semi-active mode, the role of the transfer agent is limited to that of adviser. Very often in the semi-active mode, the transfer agent only screens information in the relevant field of interest and passes it on to the final user. As the agent is supposed to have prior knowledge about the technology, he therefore ensures the relevance of the information with the user's needs. The role of the transfer agent is therefore one of communicator between the technology and the user. The process is illustrated in figure 2.6. If his role is beyond the capacity of a transfer agent, then the mode of transfer becomes active.

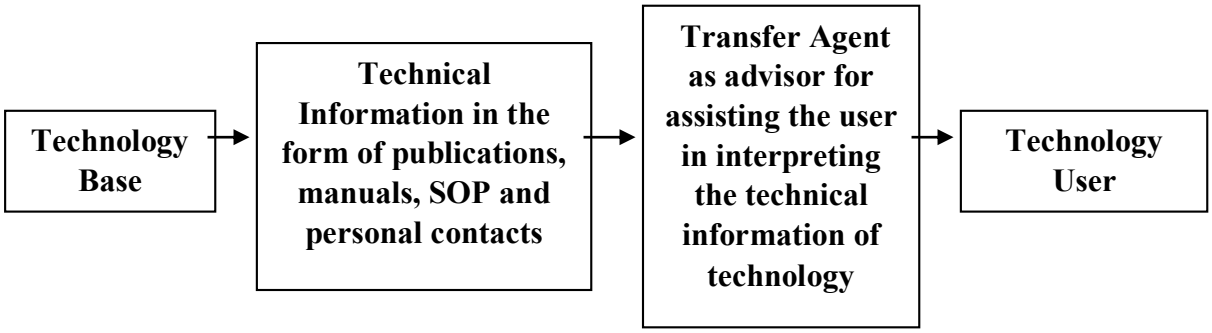

Figure 2.5: Semi-Active Mode of Technology Transfer

The semi-active mode is a mechanism involved when technical information supplied with the technology in the form of manuals or publications are too detailed and the user feels it as an overwhelming task and a time consuming effort to read and understand. In these cases, the task is outsourced to third party technology transfer agents. The agent will then be responsible for identifying relevant information and transferring it to the user. The transfer agent can be in the form of one or several people working in a team, each within their own field of expertise. An additional benefit of using a transfer agent is that the user of the technology may have interpreted the problem incorrectly due to lack of time as they have other mundane responsibilities in the organization like production, operation and this could lead them on the wrong path in the search for a solution. Here the agent can be of help, because of his knowledge of the user's needs.

The passive and semi-active modes are therefore recognized by the fact that no third party participates in the application of the technology. Only limited assistance in identifying relevant technologies is experienced in the semi-active mode [52].

2.6.3 The Active Mode

When a completely new technology is transferred or when all the components of a technology is transferred, only the handbook, manuals or even assistance from a transfer agent may not be enough. In these cases, active mode of technology transfer is required. In the active mode not only knowledge is transferred, but also the process is carried through to an actual demonstration of the technology. In this mode of transfer not only words and pictures are transferred, but a working system is installed and demonstrated to the users thereof. The transfer process even goes further than this. The user is trained to use the technology. It is clear that the technology transfer agent plays a key role in this transfer mode.

The agent does not only identify relevant technologies but also helps in identifying the most appropriate technology. He then also helps with the implementation of the new technology and the training of personnel that will be using the new resources. In order to do this successfully; the agent must have a clear understanding of what the user's needs are. The agent must also have a very good understanding of the technology or must be able to quickly familiarise himself with the technology. The agent must be able to interact with the nontechnical and/or technical user on the one side, and the very technical orientated developers of the technology on the other side. The

agent is no longer a feeder of information as in the semi-active or passive modes. The agent has become a technologist, seeking, evaluating and implementing technology in order to satisfy a need or solve a problem. Thus the transferring agent actively involves with the *godfather* and the *champion team* identified by Cooke and Mayes to transfer and implement the technology successfully. In fact, the godfather himself may act in some cases as the technology transfer agent and employ the champion team to facilitate the complete transfer and successful implementation of the new technology. The active mode of transfer involves all the parties concerning in the transfer mechanism to ensure the transfer process is sustainable and effective.

Organizations who have problems implementing technical solutions themselves, and who are struggling to bridge the gap between technology and the ultimate application thereof benefit most from the active mode of technology transfer is most likely to be found. Organisations like small businesses that do not have their own R&D departments have to consult a third party on introducing new technology to satisfy their needs. If they do not consider themselves experts in the field of the new technology and in implementing it, they may also seek the help of the transfer agent.

The transfer agent will also be able to customize the technology in order to be user-friendly in the environment it is to be implemented. The transfer agent is expected to understand each aspect of the technology, while the user is only expected to understand aspects of the technology in order to use it successfully. The success of the active mode of transfer is measured by the degree the ultimate user of the technology is satisfied. As technology transfer is a continuous process and not a one-off endeavor, it's great to have personnel like a godfather identified by Cooke and Mayes [51] in the organization who has comprehensive knowledge on the organizations current technology base, the development need and the capability to train and operate a champion team to implement the new technology successfully according to the organization's environment.

Again, Mogavero and Shane [52] have identified seven minimum aspects that must be present in order to assure the success of the transfer process. These are: a. Firm statement of user needs, b. Clearly stated and understood boundary of solutions, c. Firm commitment by the user to remain actively associated during and after the transfer, d. Participation of representatives of influential interested organisations, e. Market analysis, f. The manufacturer and g. The champion

In the active mode a firm commitment is needed by the user to remain actively involved in the transfer process. There must be certain flexibility in the thinking of not only the user, but also the transfer agent. Pursuing one solution may bring forth-another solution and both parties must be aware of this. Both parties cannot allow a setback to deter them from finding a suitable solution.

The user must also ensure beforehand, that the search and implementation of the new technology is well accepted by organisations within the user's environment. These include labour unions, management associations', etc. The more actively these organisations can be involved in the transfer process, the greater the probability of success. The user must show how the implementation of the new technology will benefit all concerned. If this is not done, a group can derail a transfer project that would have brought major benefits to the user.

One of the factors that may have the most negative impact on a transfer process may be something that lies outside the process. This factor is market acceptance of the new technology. Every aspect of the transfer process may be executed to perfection to bring forth a solution, but if the market does not accept the solution, all the effort is in vein. This is the reason why a good market analysis should form part of any good transfer process. The effect of the technology on the market place can therefore not be ignored. Another big role player in the transfer process is the manufacturer or developer of the product or solution. It is important to identify and consult him/her as early as possible in the transfer process, for they play an important role in the development of the ultimate solution. The last of the seven aspects is the champion. This is the motivator for the whole project from the user's side. This is the person that gives direction to the project and keeps people motivated to see the project through [52].

Again in another research Mafias [53] corroborates this, presenting the different technological innovation strategies adopted by companies, such as: offensive strategies, defensive strategies, imitative strategies, opportunistic strategies and traditional strategies. The offensive strategy is adopted by companies that want technical and market leadership, to be achieved through new product launches; they invest a fair amount in research, planning and development, and are quick to explore new opportunities. Major companies can be considered to this profile.

The defensive strategy has the same aims where research, planning and development spending is concerned, but it differs from the former in that it explores opportunities that have already been

discovered, thus avoiding high risk. In other words, a defensive strategy capitalizes on the mistakes and achievements of others.

The imitative strategy, which calls for little investment in research, competes in the market by offering the consumer the alternative of low-cost products, whereas the opportunistic strategy aims at identifying opportunities in the environment, taking over market niches, with no investment in research, planning and development. These two profile types are typical of small and medium-sized companies. Last, a traditional strategy, whether explicit or implicit, according to the author, is adopted by companies in mature markets, in which technical changes occur slowly; in this case, the need for innovation is not felt. Here the technological changes boil down to simple design changes applied to existing products and new packaging sizes.

2.7 Innovative Capacity

2.7.1 Innovation and Innovative Capacity

The economic development of the developed countries has been led by continuous technological inventions. But for countries like Bangladesh, invention is not the appropriate tool; rather Bangladesh should go for innovation of technology. Developing indigenous capability to produce new technologies overnight is too optimistic for Bangladesh; hence proper adaptation, utilization and optimization of the available technologies should be the strategy for development. This is what innovation is all about. Surge in the economic growth of Bangladesh is highly dependent on the industrialization and effective industrialization relies on appropriate innovation. This innovative capacity of the industries will be the key factor for Bangladesh in the next decade for effective economic growth.

Innovation is termed as the most effective mechanism for the technological and economic development of the developing countries. The capacity to innovate is termed as the innovative capacity of an industry. The more the innovative capacity the more the opportunities for business rise. Innovative capacity is a parameter used by economists to compare countries in terms of their capacity to innovate new technology. At the national level the National innovative capacity is the potential of a country (both as a political and economic entity) to produce and commercialize a

flow of innovative technology at a given point of time. As such, national innovative capacity depends on an interrelated set of fundamental investments, policies, and resource commitments that determine the extent and success of innovative effort in a country over the long term [54]. This national innovative capacity can be analyzed to determine a firm level capacity that is the industrial innovative capacity. Industrial innovative capacity will lead to find the answer 'why some firms are more innovative than others?' Al though this is really a complex thing to understand or determine, still it clearly demonstrates a picture of the industries on their capacity for innovation. Theories of firms, literature on organization studies and the economic geography; all have a great influence in determining the innovative capacity of industries [55].

2.7.2 National Innovative Capacity & Bangladesh

In the Innovation for development report 2010-2011 showed in figure 2.6 a new index was introduced named Innovation Capacity Index which is a methodological tool that examines a broad array of factors, policies, and institutions that have a bearing on strengthening innovation in a large number of countries [56]. Innovation Capacity Index, in particular features a tool for assessing the extent to which countries have succeeded in developing a climate that will nourish the potential for innovation.

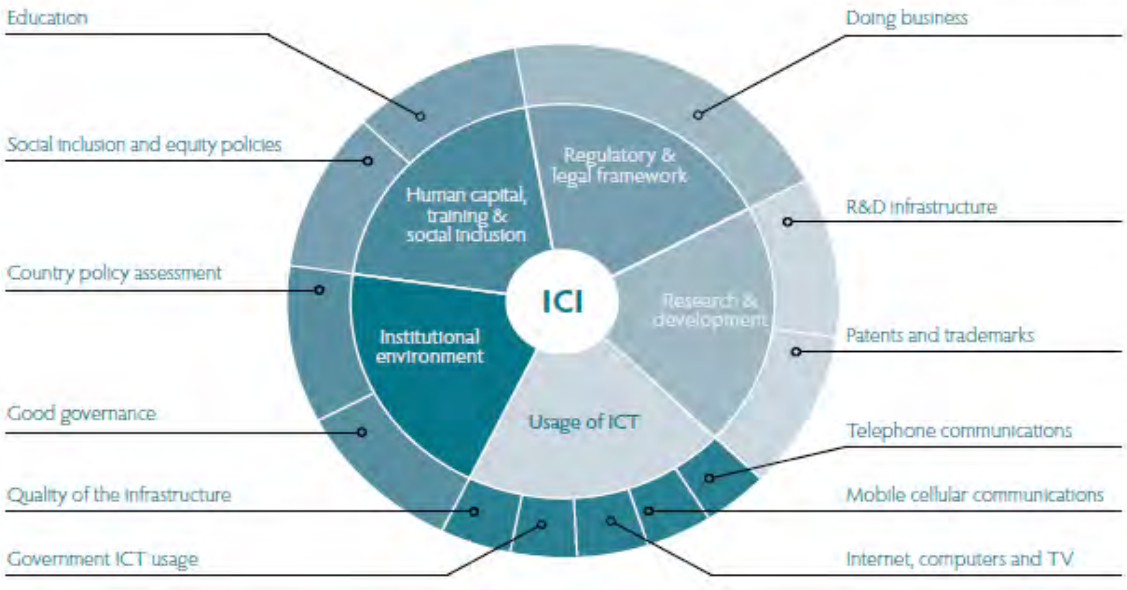

Figure 2.6: Innovation Capacity Index published in Innovation for Development Report 2010-2011 by World Bank

Countries are grouped into categories and ranked according to scores obtained in the Innovation Capacity Index (ICI) [57]. The complex indicators considered in making the ICI are: a. Human Capital, training and Social Inclusion, b. Institutional Environment, c. Regulatory & Legal Framework, d. Research & development and e. Usage of ICT.

These factors used for the construction of the ICI is believed to affect the capacity of innovation of a country. A large number of factors which are grouped under the above five categories to make the complex indicators of innovation was used to rank 131 countries.

In this study Bangladesh is grouped with the low income countries like Cambodia, Ethiopia, Ghana, Haiti, Kenya, Madagascar, Malawi, Mali, Mozambique, Republic of Nepal, Senegal, Tanzania, Uganda and Zambia [58]. Among the listed 15 countries Bangladesh lies on rank 11 with an ICI score of 38.6. A study with all the 131 countries also depicts a laggard position of Bangladesh in terms of innovative capacity. For the sake of stress-free comparison, the following list is made from the original study (with original ranking) showing countries industrially important to Bangladesh.

Table 2.6: ICI Rankings of Countries Industrially Important to Bangladesh

Country	Ranking	ICI Score (100)
United States	*5*	*74.8*
Canada	*7*	*73.6*
Taiwan	*9*	*72.5*
Rep. of Korea	*11*	*72.1*
Hong Kong	*13*	*71.4*
UK	*14*	*71.3*
Japan	*16*	*70.3*
Thailand	*45*	*54.8*
Turkey	*62*	*50.2*
China	*64*	*49.9*
Vietnam	*74*	*47.1*
Indonesia	*77*	*46.0*
Philippines	*81*	*45.3*
Sri Lanka	*86*	*44.4*
India	*88*	*44.2*
Pakistan	*102*	*40.8*
Ethiopia	*108*	*39.2*
Bangladesh	*110*	*38.6*
Cambodia	*113*	*37.4*

From the table it is clear that Bangladesh lies behind all the countries who are the industrial competitors including Turkey, China, Indonesia, Philippines, Vietnam, India and Pakistan. Following is another chart in figure 2.7 constructed to facilitate the comparison of the Asian countries with Bangladesh in terms of their position according to six major factors influencing innovation capacity. From this analysis a clear view can be depicted about the relative positions of the countries in terms of good governance, education, ease of doing business, R&D infrastructure, no. and quality of patents and trademarks and the extent of ICT usage. All these indicators are believed to have a significant contribution towards developing an environment for better innovation.

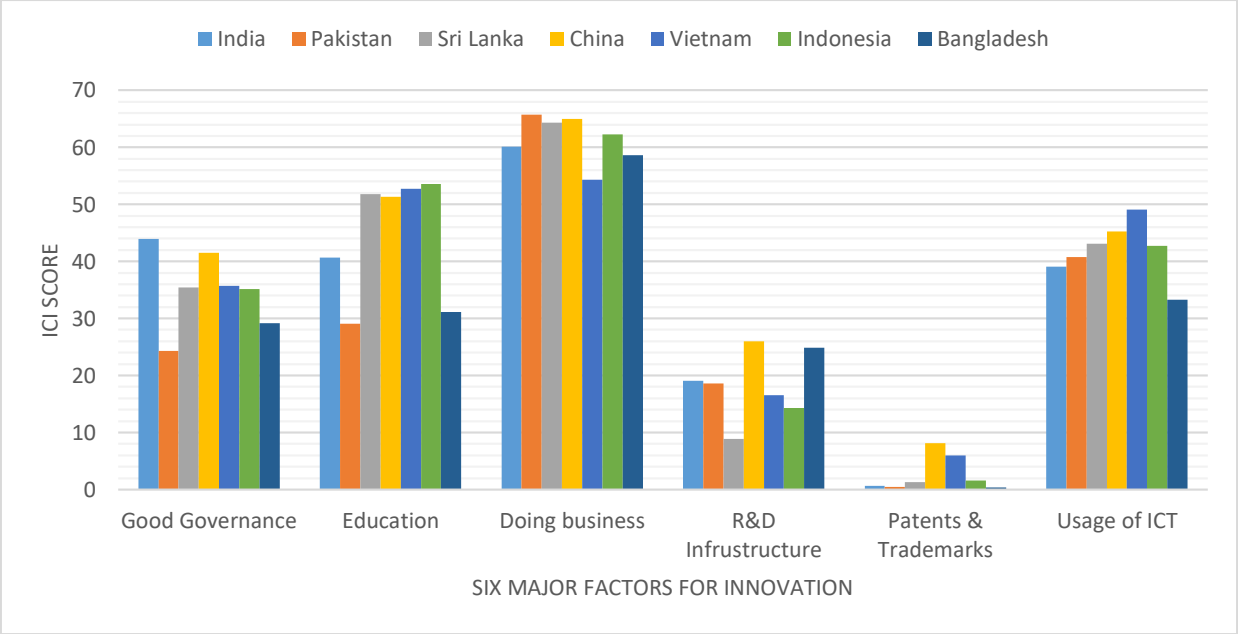

Figure 2.7: Relative Comparison of Bangladesh with the Asian Countries according to Six major factors influencing Innovation Capacity

Among the emerging Asian industrial powers Bangladesh looks to have a better governance and education than only Pakistan. In terms of ease of starting a new business Bangladesh is a better place than Vietnam but worse than other Asian countries. But they are quite close in terms of opportunities of doing business and rightly so as the Asian market is a golden track for investment for the western countries. In terms of R&D infrastructure Bangladesh is poised at a good position only behind China. But this is only because of the continuous R&D investments in the agricultural

sector of the country. Performance of the Asian countries in terms of the Patents and Trademarks are very poor when compared to the developed countries and Bangladesh have very little contribution towards innovation from indigenous patents, copyrights or trademarks. Bangladesh also lags behind in terms of the ICT usage compared to the Asian countries as well.

This indicator can act as the primary indications on what factors to improve to create an environment friendly for innovation. Still question lies on the extent of impact of the mentioned factors on the innovative capacity of a nation but it is fairly acceptable that the development of this factors as a whole will contribute towards making an innovation prone industrial sector.

2.7.3 Industrial Innovative Capacity

The concept of the national innovation capacity is analyzed to determine the capacity to innovate at the firm level, which is the industrial innovative capacity. This is important to come to a conclusion about industrial organizations on why some firms or industries are more innovative than others? That is, what it takes for an industry to outplay other competitive industries in terms of innovation.

Innovation reflects the tendency of a firm to lend its support to new ideas, novelty, experimentation and the creative processes that may result in new products, services or technological processes [59]. Under current market conditions, characterised by rapidly saturated demand, one firm's competitiveness relative to others tends to be determined more by its innovative capacity than by its productivity [60].

In view of the contemporary challenges firms face, innovation is seen as an increasingly key factor in the competitiveness of firms; as a result, the more detailed study of the factors that encourage and limit innovative capacity of firms is crucial [61] Besides the importance of understanding whether firms are or are not innovative, and identifying which factors contribute to the development of innovative behaviour, the ways in which innovative behaviour influences firm’s performance also needs closer analysis [62].

Every industrial organization is endowed with a set of resources, but to be innovative, management must enact the right organizational culture, develop and optimize the resources and capabilities

constantly and harness links with external environment for new ideas. A similar explanation of Industrial Innovative Capacity can be drawn from the following definition given by J. Hill as *'Innovative capacity of a firm is its internal potential to generate new ideas, identify new market opportunities and implement marketable innovations by leveraging on existing resources and capabilities'* [63]. So a decision can be drawn about the four factors that constitutes the innovativeness of an industry shown in the figure 2.8.

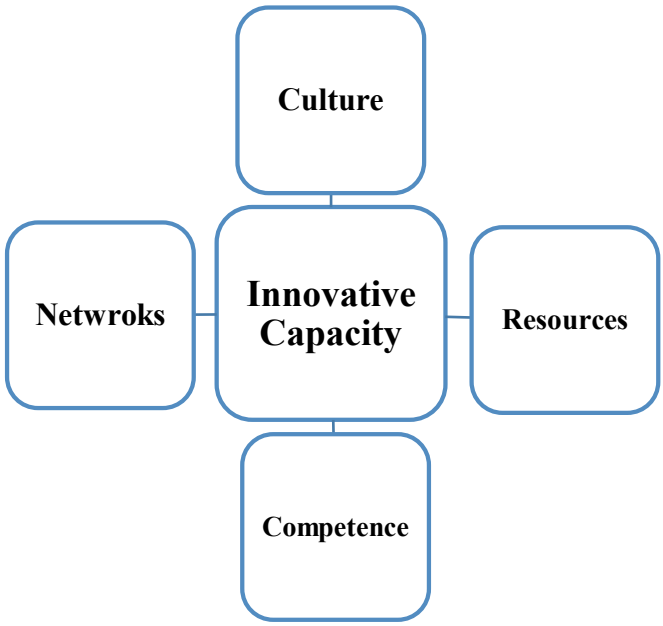

Figure 2. 8: Four Factors that Constitutes Innovativeness in an Industry

Culture

Here, Culture corresponds to the extent to which a firm support innovation. This indicator can be measured by six items including strategy, leadership and support, company style, risk-taking, measurement systems and incentives systems. Another study can be stated where analyzing the influence of the innovation culture in innovation performance of products and processes in the textile industry has been done by researchers in Brazil. They proposed a model that provides an initial vision to improve understanding of the variables that influence the dimensions of innovation culture. The proposed model is divided into five determinants: strategy, structure, support mechanisms, behaviors that encourage innovation and communication [64].

Resource

Resources relate to four categories, financial, intellectual, human and physical. The questions probed for the extent to which there is sufficient resources in place to support innovation initiatives. Financial resources' endowments towards research and development, employee training and technological development are key indicators of innovativeness. Conceptualization of what the components of intellectual capital are can be attributed from the study done by Dr. Patricia where he reported a system of measuring and reporting knowledge based resources of any organizations. [65] In his report he accumulated general literatures on intellectual resources and identified three sub-phenomena that constitutes the concept of intellectual capital. Human Capital, relational capital and structural capital. According to [66] human capital represents the individual knowledge stock of an organization as represented by its employees. It is accumulated value of investments in employee training, competence and future [67]. Relational capital represents the relationship with internal and external stakeholders, customers and strategic alliance partners [68]. The concept of structural capital refers to the value of what is left when the human capital – the employees- has gone home. Database, customer list, manuals, trademarks and organizational structures [67].

Dr. Patricia's report identifies two indicators as human capital and physical resource [65]. Human capital is characterized by employee profile, staff turnover, education, commitment and motivation and physical resource is characterized by infrastructure, customer support, administrative processes, innovation and quality improvement.

Competence

Competencies are for the most part responsible for the number of new products and services developed by the industry [55]. Competencies are defined as a set of skills needed to coordinate and allocate company resources towards the fulfillment of tasks. competencies provide evidence of how the firm uses its capacities to carry out processes. Of the countless processes executed by a company, some stand out as more characteristic of innovative organizations, such as: the capacity to generate and pick up on ideas; management of a project portfolio; formulation, communication, and management of corporate strategy, through the use of indicators; and the capacity to manage, develop and make use of all knowledge presented to the company by employees [69].

Networking

Networking ability of an industry is measured by the connections to consumers, connections to suppliers and the horizontal connections with the external environment through partnerships and alliances [69]. these connections can be a source of substantial knowledge to guide the development of the company's technological assets.

Again, another study depicted innovative capacity or innovative behavior of firms to include a number of dimensions of a firm's innovation process, namely product innovation, process innovation, market innovation and organizational innovation [70]. Another study concluded that the influence of firm or industry, the entrepreneurs and the external environment is inevitable in a firm's innovative capacity [71]. This study was done on the Portuguese SME industries to determine the innovative capacity of the firms. The size, age, level of training and life cycle of the firm; age and entrepreneurship skills of the owner of the industry; the openness of the organization towards external environment and partnership or collaborations of the company, all are considered as the networkability of an industry.

2.8 Relation between Technology Transfer Mechanism and Industrial Innovative Capacity

According to the definitions described above technology transfer mechanism is the formal business arrangements or informal means that creates the channel for the technology to be transferred. In other words, technology transfer mechanism is any specific form of interaction between two or more social entities during which technology is transferred and the transfer channel is the link between the social entities. It implies, whatever the TT channel is, there must be a mechanism that will ensure the adaptation, modification and optimization of the transferred technology so that the transfer process is effective. This mechanism can be industry and firm specific as industries vary in terms of culture, resources, skill competencies, management thoughts and networks.

In the contrast, industrial innovative capacity is the firm level capacity of industries to innovate; that is the capacity of a firm to adopt/adapt, modify or optimize a new technology that makes the technology transfer process effective. Hence, the technology transfer mechanism in the industry level must be designed according to their innovative capacity; or in other way the industrial

innovative capacity analysis of an industry has significant importance in developing an effective technology transfer mechanism. The relation can be more clearly depicted from figure 2.9.

An effective technology transfer mechanism is the most important aspect as long as the transfer process is concerned as transfer not only retains its defined meaning of moving something to another location, but also includes the use of the transferred item. Technology transfer therefore means the movement of technology, consisting of knowledge, skills and equipment, from an originator's environment to a user's environment [50]. No transfer has however taken place unless the moved technology is used. And to ensure the complete usage of the transferred technology in order to accomplish the transfer need of the transferring entity, an effective technology transfer mechanism is required. Now the effectiveness of the technology transfer mechanism relies on different factors mostly on the intrinsic industry environment, culture, networks and skill levels; that is the capacity of the industry to innovate.

The relation between innovative capacity and the technological fundamentals of an industry can be drawn from Luis Suarez-Villa [72] where he states, innovative capacity of industries has the following implications in its development, a. Improving the technological leadership of economic activities, industries or specific organizations, b. Helping nations, regions or local areas become sources of new technology, c. Finding a diagnostic indicator to register changes in technological potential and d. Creating infrastructure that can support invention and technological innovation.

The global market has become so competitive that industries are always under pressure to make enough profit to run their business and create wealth. So industries are in need of productivity improvement, cost reduction and product development and diversification in a continuous manner to remain competitive. Hence, updating the production process, machineries and manpower skill has become a never ending journey for the industries. All of these particulars are holistically the technological fundamental of an industry. So industries need to keep updating their technological fundamentals continuously. For countries like Bangladesh technology transfer is the appropriate way to do so as indigenous capability to develop new technology is not there. It can be concluded that the industries that are innovative in nature can do effective technology transfer to remain competitive in the market.

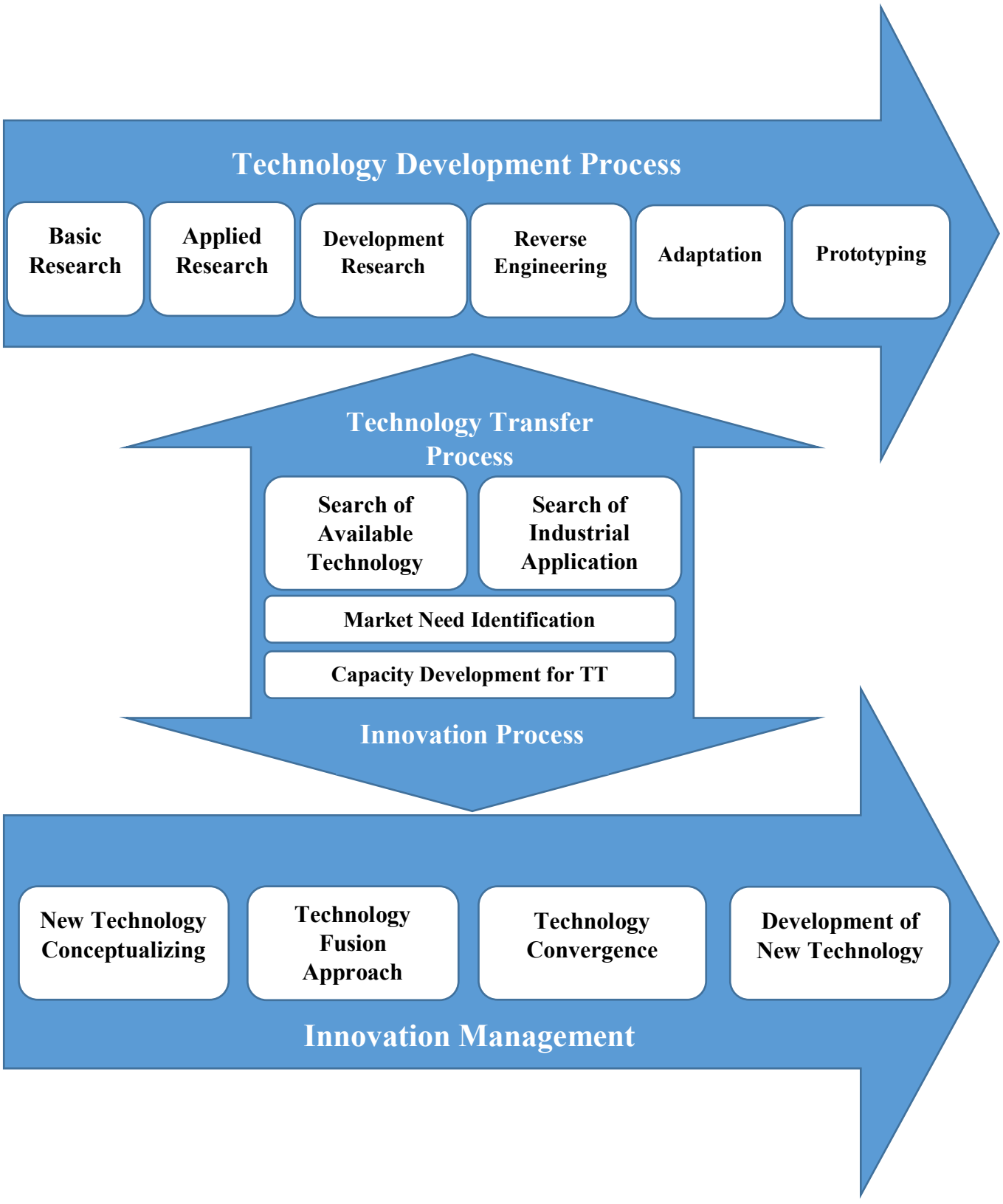

Figure 2.9: Interaction among Innovativeness, Technology Development Process and Technology Transfer Process

2.9 Overview of Bangladesh Textile and Apparel Sector

2.9.1 Introduction

The textile and apparel sector of Bangladesh is the largest industrial sector of the country earning the highest amount of foreign revenue from exports. The industry has grown to an enormous size since last decade, established substantial influence on the economy, alleviated unemployment considerably and produced hundreds of success stories for a country that was historically distressed with poverty. The contribution of the textile and apparel industry to the overall GDP of the country and impact on the social wellbeing have changed the scenario of Bangladesh all together. Today Bangladesh is one of the fastest growing economy of the world riding on the back of a rising textile and apparel industry. If the textile and apparel industry is taken away the government's target of transforming to a middle-income country becomes obsolete [73].

But reaching in today's position has not been a stress-free path for Bangladesh. Back-breaking hard work of the apparel workers at the lowest pay of the world, enthusiastic entrepreneurs' never-stopping spirit, and government's supreme assistance led the way. Incidents like the fire in Tazreen Garments in 2012, Rana Plaza building collapse and Standard Group fire in 2013 halted the progress of the industry. But the ultimate strength of the industry proved to be to over-come all the odds every time. As the 2nd largest knitwear exporter of the world, Bangladesh is moving fast making 'Made in Bangladesh' a well-desired label for the apparel consumers.

The export oriented apparel or readymade garments (RMG) sector in Bangladesh started its modest journey as a small non-traditional sector of export in late 1970s. After the liberation especially from the 90s the apparel industry started to grow at a commendable pace as the country was gaining political and social stability. Within three decades, the apparel industry has transformed itself as the country's highest revenue generating sector, contributing 82% (USD 28.094 billion in FY 15-16) of country's total export according to the Export Processing Bureau of Bangladesh (EPB). Today Bangladesh has the highest numbers of apparel industries compared to other strong competitors. The textile industry has also grown substantially to support the apparel as backward linkage. According to reports from BTMA and BGMEA there are more than 1500 export oriented textile industries and more than 6000 (4000 under BGMEA and 2000 under BKMEA as of 2015-16 FY) RMG industries operating in the country. All these industries make Bangladesh the second

biggest exporter of apparel after China and the market is growing at a good rate. Around 4 million workers of which more than 80% are women are directly employed in those industries making apparels for most of the countries of the world. From 1984-85 to 2004-05, in 20 years the export market of apparel rose 200 folds, whereas the total export from all sectors surged only by 10 folds. It clearly depicts the impeccable growth of the RMG industry. In the last decade form FY 2005-06 to 2015-2016 the industry again rose 3 folds to a staggering 28 billion according to the BGMEA Statistics, 2016. Following is the sector profile of the Bangladesh Textile and Apparel Sector in Table 2. according to BTMA annual report 2012.

Table 2.7: Sector Profile of Bangladesh Textile and Apparel Industry

Textile and Apparel Industry Metrics	Bangladesh (as of 2015-16 FY)
Export value	$28.094 billion
Capacity- no. of factories	6358
Capacity- no. of textile mills	1500
Product types	Knitwear, Denim, Kids-wear, woven tops and bottoms, jackets, sweaters
Export markets	Global (major EU and USA)
Worker availability	Abundance of unskilled worker, shortage of skilled labour
Management skills	In-efficient mid-level management
Contribution to the GDP	16%
Labour rates- minimum legal wage	$68 (5300 taka) basic rate per month
Speed to market- lead time	120-140

The size of the textile industry is also growing as there is an increasing demand from the export oriented garments industries. There are 1500 units of textile processing (spinning, weaving, knitting, dyeing, finishing) units operating in the country to supply and process the materials for the export oriented apparel sector.

But the textile industries still have scopes to improve in terms of quality of products and compliance. Especially the dyeing and finishing units are known to be polluting the inland water base of the country by draining effluents and pollutants directly to the canals and rivers. But the situations are improving as awareness of the owners, stake-holders and the government has increased.

The textile industry supplies around 90% of the knit fabric demands and around 45% of the woven fabric demands to the RMGs [11]. Indigenous capacity in weaving is also increasing specially in denim sector as around 80% of the total demand of denim is supplied from the local denim industries. The development of the textile base is really important for the apparel industries to be sustainable and profitable.

2.9.2 Global Position of the Bangladesh Textile and Apparel Sector

Though Bangladesh has the second largest apparel exports only after China, still the difference between the two country's export shares is immense; 45% and 5% of the global market respectively. Apart from China, Vietnam, India and Cambodia are the biggest competitors when apparel export is in concern. Product portfolio, average FOB price, wage, trade agreements, speed to market, workers' availability and skill domain, quality of product, maturity in mid-level management and compliance are the metrics that set apart the country's apparel sectors. A summary is shown in table 2.8 about the comparative position of Bangladesh apparel industry against the competitors [74].

From the table 2.8 it can be seen that the product portfolio is more or less similar but Bangladesh is still not a favorable place for the buyers to source high-end garments and only a few industries manufacture items like suits, sportswear and fashionable apparels. India and China are more capable of manufacturing fashionable items then Bangladesh. Vietnam of late has gained a great fame by capturing USA market. Due to the blessing of cotton availability and versatile textile industry China, India and Vietnam are more favorable place to manufacture high-end and fashion items.

According to the statistics of BGMEA and BKMEA the number of apparel industries in Bangladesh is 6538 in total. Though India has the same number of industries but the average capacity of the Indian industries is comparatively smaller in size. Consumer apparel buyers like

H&M prefers Bangladesh due to its large size factories able to customize price in terms of economies of scale. China has around 1,00,000 industries and produces almost half of the total consumption of apparel of the world. But they are gradually transforming to medium and hi-tech products as they are no more suitable place to manufacture low-tech items with the highest worker wage around. The FOB price of a basic garment is also the highest among them.

According to the operational efficiency Bangladesh still lags behind of all as the mid-level management are un-skilled and inefficient compared to India, China and Vietnam. The lead-time is another matter of concern for Bangladesh as China and India can complete a shipment in two-third the time Bangladesh needs.

Workers are available in abundance in all of the countries but due to the demographic difference, Chinese, Indian and Vietnamese workers are more efficient and intelligent then Bangladeshi workers. Matter of fact is that it is becoming difficult to attract workers in India, China and Vietnam to the apparel industries as there are other better options like electronics, telecommunication and FMCG products. Whereas, in Bangladesh still the prime industrial sector are the textiles and apparel and most of the employment comes from these two sectors.

Incidents in Bangladesh like Rana Plaza collapse, Tazreen fire and other safety disasters, the compliance risk in the apparel industries became the concern for all. But due to the concentrated effort from the government, accord & alliance and the RMG owner's authority the situation has improved dramatically. Accord & Alliance Audit report safety assessment by global buyers' platform has found less than 2% factories risky to workers' safety, which have already been closed.

Considering all the parameters described here Bangladesh is still a preferable place for the western buyers for consumer products like basic knit-wears, shirts, trousers, pull-overs, kids item and basic women wear due to the industries unique ability to produce at the cheapest rate. Lead-time and the compliance issues are the things to look for.

Table 2.8: Comparative Positioning of the Apparel Exporting Countries

Metrics	Bangladesh	Vietnam	Cambodia	China	India
Product type	Knitwear, Denim, Kids-wear, woven tops and bottoms, jackets, sweaters	Knitwear, woven-wear, jackets, suits, skirts, swim wears, all range of apparel	Knit and basic woven	All types of products	Knit, woven, delicate fabrics' variety of products
Complexity of product	Low-medium	Low-medium	Low-medium	Medium to high	Medium to high (in the North), low-medium (in the South)
Avg. FOB price for basic garments	$4	$4	$4.25	$5	$4.5
Minimum wage (USD)	$68 (5300 Taka)	$89-$140	$80	$195-$228	$63-$87
FTA, GSP with major markets	EU, Japan, Australia, Canada	TPP, US-led trade pact involving 12 countries – including big markets like Australia, Canada, Japan, and Malaysia,	EU,US, Japan, Australia, New Zealand	Canada, Japan	Canada, japan, EU
Lead-time	120-140 days	60-95 days	120-140 days	60-120 days	60-120 days
Avg. operational efficacy	38-40%	50-55%	32-49%	55-57%	44-46%
Capacity (approx. no. of RMG units)	6358	2400	447	100,000	6000
Worker availability and skill domain	Abundance of labour with basic skills	RMG is not the first choice for workers, known to be literate young and intelligent	Limited pool of workers due to population size	Abundance of labour but difficult to attract workers to the RMG industry	Abundance of labour but difficult to attract workers to the RMG industry
Quality of Product	Delivers quality on basic products	Delivers high quality on basic and high-end items	Delivers quality on basic and simple products	Delivers high quality on wide range of products including complex products	The North delivers high quality complex products, the South delivers quality simple products
Compliance risk	Extremely high- factories are aware of code of conducts but not properly implemented	Medium to high	High- factories are aware of code of conducts but not properly implemented	Medium to high	Medium to high

2.9.3 Sustainability and Qualitative Issues of the Bangladesh Textile and Apparel Sector

Only increasing in numbers without the development of the qualitative indicators cannot be sustainable. As long as the textile and apparel industry is concerned, real development can only be realized if the income generated from the industry is improving the living standards of the people and there is no exaggerated impact on the environment and society in the process. That is what a sustainable industry is all about. Sustainable development is formally defined by the World Commission on Environment and Development (WCED) as "development that meets the needs of the people today without compromising the ability of future generations to meet their own needs tomorrow". Therefore, sustainable development refers to a shared commitment towards steady economic growth, given that this economic growth does not compromise the satisfactory management of available environmental resources. Textile industries are known for one of the most polluting and environmentally hazardous industry. Hence, the extent of natural resources that is endowed in the textile industries and the extent of hazardous impact the industry has on the environment must be considered as the qualitative indicators for the real development. So the aim is to control the resources, protect the environment, produce efficiently, pay ethically and develop gradually so that economic development is gradual and sustainable. Sustainability will be achieved by ensuring both qualitative and qualitative development of the industry. All these should bring equity in the society, in which all people within a specific society or isolated group have the same status in certain respects. All the stake-holders starting from the owners to the workers should be equally benefitted according to their level culminating a happy living for all.

2.9.4 Currency Retention and Value Addition

The fiscal year 2015-16 yielded 28.09 billion USD exports from the RMG industry. But the matter of fact is that the actual currency retention is not significant. A big portion of the resources (specially fabrics) for the apparel industries (cotton and yarn for textile industries) have to be imported from abroad which costs more than half of the income. As a result, net income becomes considerably less compared to the total net export.

Table 2.9: Currency Retention Data, January to June, 2016

Product		Period	
		Jan-Mar 2016	Apr-Jun 2016
Export	Knitwear and woven-wear	5203	5102
Import	Textiles and textile articles	2171	2213
Currency Retention (approx.)		3032	2889
**Values are in million USD (Bangladesh Bank Data)*			

The table 2.9 shows the amounts in USD that was earned from knitwear and woven-wear exports and the corresponding imports of textiles and textile-goods in two periods. As the data depicts more than 40% of the currency earned is spent through back to back LC to source fabrics, accessories and other textile goods. In other words, 40% more value could have been added in the industry if it was possible to supply the textile and textile articles that were sourced from abroad.

Table 2.10 depicts the actual products of import and import values in fiscal year 2014-15 and 2015-16. It shows a staggering $11.7 billion and $12.2 billion USD imports of materials that are directly used in apparel manufacturing for exports. The bottom line is that the backward linkage is not strong enough. In spite of being a $28 billion export industry, the currency retention is only $15-16 billion in reality. In other words, there lies an opportunity of a $12 billion worth textile and allied supply industries in Bangladesh only to manufacture raw materials for the export oriented apparel industry. Exports of apparel grew 300 times in 20 years only from the EPZs, but the imports of textile and textile articles also grew simultaneously. It clearly depicts that, in spite of better opportunity to transfer technology in the EPZs most of the industries are still low-technology oriented apparel industries.

If the exports items are tallied according to the export HS Code showed in the table 2.11, it can be easily depicted that both knitwear and woven-wear products ranges only within the basic apparel items. The production of such items are less technology intensive and more labor intensive; productivity depends on the appropriate application of production management systems. The Average FOB price ranges from as low as less than $1 to $10-$15 for the basic apparel items. And most of the products are manufactured upon imports of raw materials which reduces the currency

retention considerably. So the crux of the story is that, though the apparel industry is a great success, the textile industries must be developed to make the success effective and sustainable.

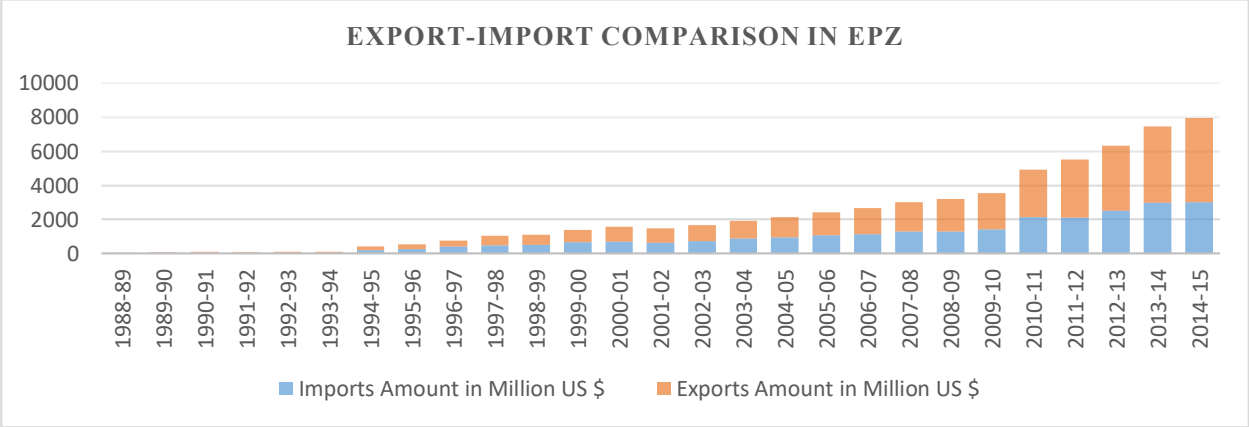

Figure 2.10: Export-Import Comparison of Apparel in EPZs of Bangladesh

Table 2.10: Major Commodity Wise Export Data

Major Commodities		2015-2016		2014-2015	
		Amount		Amount	
		Taka	USD	Taka	USD
1	Cotton,(all types) cotton yarn/thread and cotton fabrics	43483.7	5554.2	41927.5	5397.8
2	Man-made staple fibres	7367.4	941.4	6538.3	841.8
3	Man-made filaments; strip and the like of man-made textile materials	5169.1	660.4	4678.4	602.3
4	Organic chemicals	4855.3	620.3	4617.2	594.4
5	Knitted or crocheted fabrics	4355.6	556.7	3855.2	496.4
6	Tanning or dyeing extracts tannins and their derivatives, dyes, pigments, and other coloring matters, paints and varnishes, putty and other mastics, inks	4271.9	545.8	4312.3	555.3
7	Articles of apparel and clothing accessories, not knitted or crocheted	1992.3	254.5	2187.8	281.6
8	Imports of EPZ	24413.3	3118.6	23473	3021.8
	Total imports against textile and RMG sector	95908.6	12251.9	91589.7	11791.4

Table 2.11: Apparel Export Product Name according to the HS Codes

	HS Code	Product Name
Knitwear	6109	T-shirts, singlets and other vests
	6110	Jerseys, pullovers, cardigans etc
	6105	Men's knitted shirts
	6104	Women's suit dresses, trousers etc
	6103	Men's suits, jackets, trousers
	6108	Women's slips, panties, pajamas, bathrobes
	6107	Men's underpants, pajamas, bathrobes
	6106	Women's blouses & knitted shirts
Woven-wear	6203	Men's suits, jackets. Dresses etc
	6204	Women's suits, jackets, dresses, skirts etc
	6205	Men's shirts
	6206	Women's blouses shirts
	6212	Brassier, griddles, corsets. Braces, suspenders etc
	6201	Men's overcoats, capes, wind-jackets etc
	6207	Men's singlets, briefs, pajamas, bathrobes
	6208	Women's singlets, slips, briefs, pajamas
	6209	Babies garments and clothing necessaries
	6210	Garments made up of fabric

2.9.5 Trade Issues and Market Diversifications

The world is a globalized village now and market diversification is as important as product diversification. Dependence on a single market is risky and uncertain. For long Bangladesh has been exporting apparel only in the EU-region and USA but thankfully in the last five to ten years the market has been significantly diversified and the export to the new emerging markets are growing fast. Still the biggest share of exports is destined towards Europe and USA, the next big market can be China and Japan as the export to these two destinations are increasing. However, the last year's data depicts a slight decline in the exports growth to the emerging market due to the political mishaps in the running year. According to BGMEA report apparel exports to non-traditional markets were $3.907 billion against $3.598 billion in the previous fiscal registering growth of 8.60%. Growth was registered at 20.99% in the previous year, 2013-14 and 28.75% in

2012-13 [75]. Export Promotion Bureau along with garments manufacturer's associations are undertaking rigorous activities to penetrate Bangladeshi RMG products in the emerging economies of the world like China, Japan, India and South Africa especially. However, the effort from the government in terms of managing the bilateral and multi-lateral trade issues are not significant. Trade agreements like the TICFA, Trans-Pacific Partnership and GSP issues has challenging effects on the export markets due to immense competitiveness. Table 2.12 shows the Rules of origin (RoO) for preferential tariff that Bangladesh is enjoying at the moment.

Table 2.12: RoO for Preferential Tariffs to Bangladesh

Country	Tariff Year	Processing stage/Value addition requirement
India	2012	30% value addition
Australia	2011	50% value addition
Canada	2010	40% value addition
European Union	2011	single stage processing
Korea Rep.	2010	50% value addition
China	2011	40% value addition
Japan	2011	two stage processing

Technology, Innovation, Education and Training

Bangladesh is not a technology producer. Hence, all the technology, methods and engineering systems used in the textile and apparel industry are imported or adopted. The education and research in the universities and institutes are not up to the standard to produce indigenous technology. However, the appropriate adoption and transfer of technology itself is a big task and Bangladesh should go for effective technology transfer in near future as new technology development is too optimistic for the current education system.

Management of technology in the industries and developing technology development and modification capacity in the institutes and research centers is key for sustainable development of the sector. This is what innovation is all about [76] But unfortunately, University education is still not mature enough to conduct proper research work and the indigenous capacity for innovation and technology development is poor. In fact, only Bangladesh University of Textiles, which is a full-pledged university for only textiles, apparel and allied education has a set-up to start research oriented education. The university is still very young and it will take time to start effective research

and development. There are some other institutes conducting education in textile engineering in different levels but only National Institute of Textile Engineering and Research (NITER) is mentionable as far as research capacity is concern. However, there are still scopes to enhance the industry-academia linkage at least in order to start the innovation process effectively.

Figure 2.11: The Industry-Academia Innovation Chain

In the developed countries it is realized that there is an effective innovation chain (figure 2.10) running among the industries and academic institutes. The institutes do independent research and the outcomes are immediately embraced by the industries. And as the industry starts getting benefit from a particular research or innovation, it motivates the research entity for further development. So, there is always a win-win situation and the universities are never deficient in funds. The innovation chain in one way is helping the universities to develop state of the art laboratories, research facilities and hire the most talented students/researchers; and in another way it is helping the industry being provided with cutting edge technologies continuously to be more efficient and profitable.

The aim is to gradually transform the industry from a low tech labor intensive, resource intensive and low profit making industry to less labor and resource intensive, productive and high profit making industry. For that the intellectual base of the industry that is the education, training, R&D infrastructure has to be strengthened.

Chapter 3: Methodology

3.1 Introduction

The research methodology of the study basically includes literature review and industrial survey to collect information required to meet the objective of the study. The objective is to develop an effective technology transfer mechanism for the sector according to the findings from innovative capacity analysis of the industries. The key factors that constitute the innovative capacity of industries are selected through literature review. The survey in the industries is based on a 3 point Likert scale so that the industries can be classified in to two classes as high innovative capacity and low innovative capacity industries. The reasons behind classifying the industries are due to the fact that the obligations and constraints in terms of innovation are different in high innovative capacity and low innovative capacity industries. Research suggests technology transfer processes differs across industries and the differences apply especially to the use of certain types of transfer mechanisms relative to others [77].

So the primary set of data is collected through the questionnaire. Interviews and interactions in the industry and inputs from academic scholars have been taken in developing the concepts. The secondary source of data are online sources, books, journals and relevant references for the literature review. Fifty industries have been selected randomly using the snowball technique. Among them 41 industries provided the data for the research. The outline of the methodology can be stated as followed:

1. Literature review on technology transfer and innovative capacity of the industries to find out the key factors for data collection.
2. To form questionnaire to collect appropriate data from the selected industries to draw an idea about their technology transfer practices and innovative capacity.
3. Collection of data through questionnaire.
4. Statistical analysis of the collected data with scatter diagram and bar-charts.
5. Development of a conceptual model of effective technology transfer mechanism and detailed discussion.

6. Validation of the conceptual model and formulation of expert recommendation with Delphi method for the sustainable technological development of the industries.

3.2 Sampling of Industries- Snowball Technique

To assess the innovative capacity of the industries and their current method of technology transfer practices, the sample size is taken until it reaches a point of theoretical saturation. That means after collecting data from a certain number of population a consistent pattern is reached which is not changing considerably with the addition of each sample data. Theories on qualitative sampling depicts that the average number of sample size for qualitative interview based research should be on average 30, minimum 15 and not more than 50 [78]. The sample size is kept small so that it allows in-depth exploration and understanding of phenomena under investigation.

For choosing samples from the large population a mixed approach of convenience sampling and snowball sampling has been followed. The first industry was selected according to the ease of accessibility. The next samples were selected through the snowball technique of sampling. Snowball technique identifies samples of interest from people who know people who know what cases are information-rich, that is, who would be a good interview participant. Thus, this is an approach used for locating information-rich cases. For example, one would ask for nominations, until the nominations snowball, getting bigger and bigger. Eventually, there should be a few key names that are mentioned repeatedly [79].

There are more than 1500 textile and apparel industries under Bangladesh Textile Mills Association (BTMA) in operation. For this particular research approach was made to collect survey data from 50 industries. Among the 50 industries being approached 41 industries participated in the survey. Among the 41 industries 19 are composite industries in which both textile and garments units were available.

3.3 Questionnaire Design, Scoring and Data Representation

The survey is done in 41 industries in the form of a 3 point Likert chart. Every question has three options to choose from as Disagree, Agree and Strongly Agree. The respondents select their

answers according to their observation of the industry and every answer is assigned points from 1 to 3 respectively.

Judgement	Points Allocated
Disagree	1
Agree	2
Strongly Agree	3

The questionnaire is divided into four sections. The first section depicts the objectives of the survey and instructions about how to participate in the survey. The second section is about the respondents' detailed personal information. The industry name, location, type of industry, number of years in operation, number of employee and total yearly turnover of the industry are in the information collected about the industry. Name and designation of the respondents, age, qualification, no. of years' experience are the data collected about each respondent. In terms of selecting a respondent, it is ensured that they have at least 5 years of experience in a particular industry so that having an in-depth perception about the culture, resources, competencies, networks and technology transfer and innovation practices of their industry. In section three there are questions designed to culminate information about the four factors of innovative capacity- culture, resources, competencies and networks of an industry. Every respondent had to choose one answer from three options: Disagree, Agree and Strongly Agree. If the respondent selects 'Strongly Agree' that means the industry is strong in that particular area. If the respondent selects 'Disagree' that means the particular area is not developed in the industry and needs to be taken care of. The middle option 'Agree' denotes that the particular area is developed in the industry but still needs improvement. The fourth section is about the current innovative capacity or technology innovation practices of the industries, that is the firm's innovative performance. There are questions with multiple answers listed in checkboxes so that a respondent can choose more than one answer if applicable. This section of the questionnaire is unscored. The collected information is plotted in bar-charts to demonstrate the comparison of industries in different categories in terms of their technological innovative capacity.

The results are represented statistically in the form of graphs and diagrams. The points associated to the industries are unified as normalized value where 1.00 is the benchmark. A national average

or standard is assumed which is the arithmetic mean of the points obtained by all the industries for every factor. The formula used to calculate the normalized value (N_V) in equation (i) and the national average in equation (ii) is stated below:

$$N_V = \frac{\Sigma(x_1, x_2, \ldots\ldots\ldots\ldots x_n)}{n} \ldots\ldots\ldots\ldots \text{(i)}$$

Where,

N_V= Normalized Value

x = is the points obtained by the industries against each questions under the sub-factors of Culture, Resource, Competencies and Network

n = maximum points attainable in total against each sub-factors of Culture, Resource, Competencies and Network

$$\text{National Average} = \frac{\Sigma(Nv_1, Nv_2, \ldots\ldots\ldots\ldots Nv_m)}{m} \ldots\ldots\ldots\ldots \text{(ii)}$$

Where,

N_V = Normalized Value obtained by each industry against each of the factors of innovative capacity i.e. Culture, Resource, Competencies and Network

m = total number of industries under investigation which is equal to 41

Every graph represents how far is the industries from the national average and also from the benchmark in terms of their culture, resources, competencies and network that constitutes their innovative capacity to transfer technology effectively. Separate scatter diagrams are also generated to identify the position of industries in terms of elements that associate the four critical factors. These diagrams depict the strength and weaknesses of the industries and identifies the areas they need attention to improve their innovative capacity.

3.4 Questionnaire for Innovative Capacity

The questionnaire for determining innovative capacity of the selected firms have been designed according to the idea developed from different research papers on the factors that constitutes the innovativeness of an organization. Hii and Neely suggested four critical factors that constructs the innovative capacity of firms namely: Culture, Resources, Competencies and Networks [63].

3.4.1 Culture

Padiha and Gomes describes the attributes of culture that forms the innovativeness of companies in the textile industry [64]. The first generic factor, Culture is characterized by the following four attributes: Strategy, Leadership and Support, Company style/ Structure and Measurement & Incentive Systems.

Strategy: This factor implies how an industrial organization is strategically concerned for innovation. The industry's organizational objective, plan for development and its mission toward gaining competitive advantage are important factors to become an innovative organization. Mission and vision of an organization, when well defined, influence the creation of a strong culture, guiding the behaviors and actions of organizational actors [80]. Organizational objectives and goals express the organization values and may encourage or hinder innovation [81]. In the observation form for determining innovative capacity of industries the mission and vision of the organization, their determination for undertaking innovative activities and the organizational influence for strengthening the innovative culture of the organization are the selected factors for data collection.

Leadership and Support: Innovation requires visible and vocal top management commitment, supported by aligned resources and incentives. Once leaders give their signal of support for innovation, they open a call for innovation to all. At the same time, leaders must find some people with core competencies in innovation to lead specific efforts to integrate innovative pursuits [82]. An organization that wants systemic commitment to innovation will want to recruit, train, nurture, and reward innovative behavior of staff and leaders.

Company Style/ Structure: The size of an organization is one of the factors that influence in its structure and in its innovation process. Large organizations have some advantages, such as greater availability of resources. However, they may be more bureaucratic and less flexible [83]. So it is

the company's style of work that influences the innovation capacity more than only its size. The freedom and flexibility in work [84] and the risk propensity of the organization are important factors constituting innovating culture.

Measurement and Incentive Systems: Rewards and incentives systems are believed to compose the culture of an organization to create an environment with conditions for stimulating creativity and innovation. [85] Rewarding success and considering the failures causes the facts to be remembered, and people may learn from mistakes [86]. Organizations that has a system to measure the success and failure and rewards and recognizes the effort of the employees are more innovative in nature and culture.

3.4.2 Resources

The second critical factor for innovative capacity is the resource domain of an organization. The resource of an organization is characterized by financial, intellectual, human and physical or structural resource.

Financial Resource: A widespread conception in the literature is that financial resource supports creativity and innovation [87]. Again one of the most common indicators used to evaluate the commitment of an organization with the R&D is the level of expenditure dedicated to this activity [88]. An organization's investment in R&D is an evidence of its innovativeness. Organizations that are known for ground breaking innovations have R&D budgets as their prime financial investment. Another notable thing is the innovation skills of the employees which needs comprehensive training and development [89]. Financial investment or budgets for employee training so that they become more creative and innovative is another indicator for innovative capacity.

Intellectual Resource: The individual knowledge stock of a company and the intellectual property in the form of patents, trademarks, manuals, rich database and customer lists have a positive influence on the innovative performance of the company. Economists assert that intellectual capital (IC) is a vital asset that helps organizations to create value in present economic syndrome and enables the organization to be more innovative [90].

Human Resource: Educational and professional background of the employees of a company is a factor for its innovativeness. Employees' commitment and motivation level towards innovative activities and their long term presence in the company is a must for a company to become innovative. Companies with high employee turnover turns to be less innovative and productive. Concentrated training programs to encourage and train employees for innovative activities is a major factor behind a company's innovativeness.

Physical and Infrastructural Resources: Infrastructure is a must for development. Lack of proper infrastructure may lead to low productivity and development in the industries. Infrastructure that allows industries to expand, involve in research and development is a must for innovativeness. Developed infrastructure leads to technological developments that leads to innovations and research. Knowledge is transferred from new researches and the cycle continues to develop the innovativeness of the industries [91]. The infrastructure includes the industries administration and how efficient they are to process works as well. Different accreditations and certifications are also considered as infrastructural strength of a company that leads to innovativeness.

3.4.3 Competencies

To make proper use of the resources the competency and skill to use the resources is essential. This one area especially in developing countries are weak, as they are unable to exploit their resources effectively. Lack of competency to use the resources is a bigger problem than lack of resources and infrastructure in the industries. In this research five key competencies are included for survey deemed as important for innovation.

Idea generation: Every innovation starts with an idea. Idea generation is a characteristics of creative minds. Idea generation is a competency that encourages employees to be innovative. Role playing among departments, dedicated idea incubation programs, collaborations and expert engagement are some of the ways through which industries can generate idea. Strong idea generation skill of the employees has become a key factor for the overall industrial innovativeness.

Project Management: Project is a one-time endeavor and project management is a competency that is essential to materialize any industrial innovation. Experienced organizational support for projects enables a company to successfully accomplish technological innovation projects [64]. Availability of project management tools and proper training of the employees to use the project

management tools enables the company to undertake innovation projects in the shortest possible time. So stronger in project management is stronger in technological innovativeness.

Technical Knowledge: To be technically sound is the first requirement for technological innovativeness. Technical knowledge and know-how of the technologies in use in the industry must be very sound for an employee to be innovative. If one is not knowledgeable about the existing technologies used in the industry, it is difficult to think for further technological development through innovation. Technology innovation process involves with the analysis, assessment of different technology options that requires expert product and process knowledge on the specified field [89].

Soft Skills: It is proved from different studies that the success of employees is more reliant on their soft skills rather than their technical skills. An employee will not be able to communicate or express his opinions and decisions properly if he is not strong in communication and linguistic skills. Interpersonal skill is required to be able to work in a team with harmony. Moreover, as this is the era of IT and internet it is very difficult to do innovations without proper IT and computer skills of the employee. As a result the soft skills of the employees of a company is a great factor for their innovativeness [63].

Experimentation and Problem Solving Skills: Industries are problem ridden and if a root-cause analysis is done of innovations it will be found that it all started from looking for a solution of a problem. So the willingness and the ability of the employees to look for problems and their solution is a prerequisite of innovativeness. The employees must be diagnostic minded so that they can exert high level of energy and effort to find new solutions for prevailing problems in the industry [64].

3.4.4 Networks

Relationship: The world has become a global hub. Especially with the proliferation of the information technology everything has become very open to all. As a result, it is very difficult for industries to develop alone. Rather relation with the customers, suppliers and even competitors is a vital issue for companies' innovativeness. Maintaining relationships and exchange programs with competing industries in the same market, relationship with the customers for authentic

feedback of products and services and also relationship with the strategic alliance partners is becoming important for the contemporary companies to become innovative [81].

Communication: Communication in and outside the company ensures that the flow of information is smooth and effective. It has been seen that companies with great communication practices are more innovative than the others [81]. As a result, it is necessary to examine how an industry is using their communication tools among the staffs and also outside the company to analyze their innovativeness. Proper communication among the employees ensure that their emotional state of the staff in the company is safe which is prerequisite for innovativeness.

Collaborations: Proper communication within and outside the company results in effective collaborations. And effective collaboration leads to potential innovations in the company [89]. Collaboration opens new the gateways for new ideas and solutions to problems. So collaboration is considered as a prerequisite for a company to become innovative.

3.5 Questionnaire for Technology Transfer Practices

A separate questionnaire was designed to draw data on the current innovative performance of the industries under investigation so that a general idea of the innovativeness of the textile and apparel sector of Bangladesh can be portrayed. Industries were asked to answer five questions. The first question was asked about whether there was introduction of any new technology or technology component that form the firm's viewpoint, was significant for the industrial development in last five years. This question was aimed at drawing information on the number of technology or technology components that were newly innovated in the company and that have played a role in their respective industrial development.

The second question was on the technology transfer channel to analyze which channels of technology transfer are being used for the technological innovation. FDI, licensing, imports, foreign education and training, technical consultation, joint venture, reverse engineering, participating in international trade fairs and exhibitions are the channels technology comes through to the textile and apparel industries of Bangladesh.

The third question was on the technology modes used for the technology transfers. There are three usual modes for technology transfer from a foreign source to the industries. One mode is to adept the technology through practicing using it. Tacit component of the technology or the skill-ware component can be transferred through the mode adept. Another mode is to adapt the technology through training. Is this mode there must be a third party to train the technology user on how to use the technology. In many cases the technology suppliers or the exporters take the responsibility to train up the technology users in the user's premises so that they can adapt the new technology. The third mode of technology transfer is the adoption mode where a complete new package of technology is introduced through consultation and foreign expert services. In these cases, an external agent is appointed to do the necessary staff regarding the transfer process. In many cases they are hired consultant expert in the specialized field of interest and experts in technology management services. The aim of this question is to analyze the trend of the industries to consider different transfer modes for different types of technology and technology components.

The fourth question of this section was about the consequence of the technology transfer on the industries' overall development. A new technology or technology component must play some role in the development of the company otherwise there is no point of transferring or innovating new technologies. Now the development of any company or a new technology must play roles in any one of the following development characteristics: a. The firm launched new products in the market, b. The firm incorporated new features in their product mix, c. The firm gained in its productivity, d. The firm was able to gain cost cutting or e. The firm was able to reduce negative impact on the environment.

This question is aimed at analyzing the intent of the industries for technology transfer. For what specific purpose the industries are targeting new technologies or technology components. This information will eventually help afterwards for developing an effective technology transfer mechanism for the textile and apparel sector.

The fifth question is a general question on the satisfaction level of the industries. It is asked to analyze the percentage of the industry who are satisfied with the consequences of the technology/ technology component transfer or not. The information collected from this section of the questionnaire on the firm's current innovative performance will lead to develop an effective technology transfer mechanism for the textile and apparel sector of Bangladesh.

3.6 Delphi Method for the Rationale Study of the Conceptual Model

The Delphi method, a methodology used for obtaining expert consensus on a particular topic, was developed in the 1950s by the Rand Corporation to forecast the impact of technology on warfare. [92] In the modern days this method is extensively used in validating conceptual models and formulating expert recommendations for which there is no other way to reach consensus for [93].

The Delphi technique typically involves the recruitment of a panel of experts on a specific topic. Each expert independently responds to questions designed to elicit opinions, estimates, or predictions regarding the topic. Responses are then aggregated, tabulated, summarized, and returned to the experts in a series of data collection rounds. A crucial aspect of conducting a successful Delphi study is the selection of the expert panel or the respondents. Much care was consequently taken in recruiting the panel. The number of respondents were selected as seven as Dalkey and Helmer refers seven as the suitable minimum number of panelists in Delphi study [92]. As the validation of the conceptual model is required, in this study the panelists are being selected from different areas of the stakeholder so that their opinion is wide spreading and consisting insights of all the concerned departments significant in ensuring effective technology transfer. However, it is ensured that the panelists are recognized experts in their area and have a minimum 15 years of experience (table 3.1) in their offices working on the different stages of technology transfer, and technological developments in the textile and apparel industries.

Table 3.1: List of Expert Panel Members Participating in the Delphi Method

Panelists	Name	Designation	Experience
Panelist 1 (Academician)	Professor Md. Monirul Islam	Professor, Department of Textile Engineering Management, Bangladesh University of Textiles	Over 30 years of academic experience and over 10 years of experience as a consultant in the industry. Conducts the Management of Textile Technology course in postgraduate level in the University
Panelist 2 (Researcher)	Dr. Md. Rezaul Hasan	Researcher, North Carolina State University, USA.	Over 10 years of working experience as a Production Leader in multinational textile company and more than 7 years of experience as a researcher in UK and USA on the area of sustainability, technology management and supply

			chain management in the textile industry
Panelist 3 (Government Official)	Md. Maniruzzaman Chowdhury	Assistant Director, Department of Textile, Ministry of Textiles and Jute, GoB	More than 10 years of working experience in the government set-up in assisting policy development.
Panelist 4 (Consultant and Trainer)	Engr. Abrar Ahmed Apu	Advisor and Lead Trainer AAA-Control Ltd. and	More than 15 years of experience working as a consultant and trainer in the industries in the areas of innovation management and sustainable development of the textile and apparel industry.
Panelist 5 (Industry)	Engr. Md. Kawser Alam Sikder	Chief Operating Officer, Asrotex Group	More than 25 years of experience working as a plant head of textile composite industry, certified in lean six sigma and total quality management. Recognized expert in industrial project setup and textile technology.
Panelist 6 (Textile Machinery Supplier)	Engr. Mamun Ur Rashid	Executive Director, Texco Tech	He has a long experience working as a spinning technology expert, machine and technology suppler in the textile industries.
Panelist 7 (Industry Owner)	Md. Fozlul Haque	Ex-President, BKMEA and Managing Director, Plummy Fashions Ltd.	Two term president of the Bangladesh Knitwear Manufacturer and Exporters Association (BKMEA), entrepreneur, owner of one of the most high-tech and green textile composite industry in Bangladesh.

The traditional Delphi technique usually begins with an open-ended questionnaire followed by two to four rounds of feedback and modified questionnaires. A modified technique has been used in many studies to improve initial-round response rate. The modified technique begins with preselected items drawn from various sources including synthesized reviews of the literature to provide a context for responses. The number of rounds may be decreased to as few as two if experts are provided with a list of preselected items. The outline of the process is illustrated in figure 3.1. In the majority of Delphi applications, consensus is achieved when a percentage of opinions and the inter-rater agreement among experts is 70% or greater [94]. From the statements in consensus by the panel members, decisions are taken on the validation of the conceptual model and formulate recommendations.

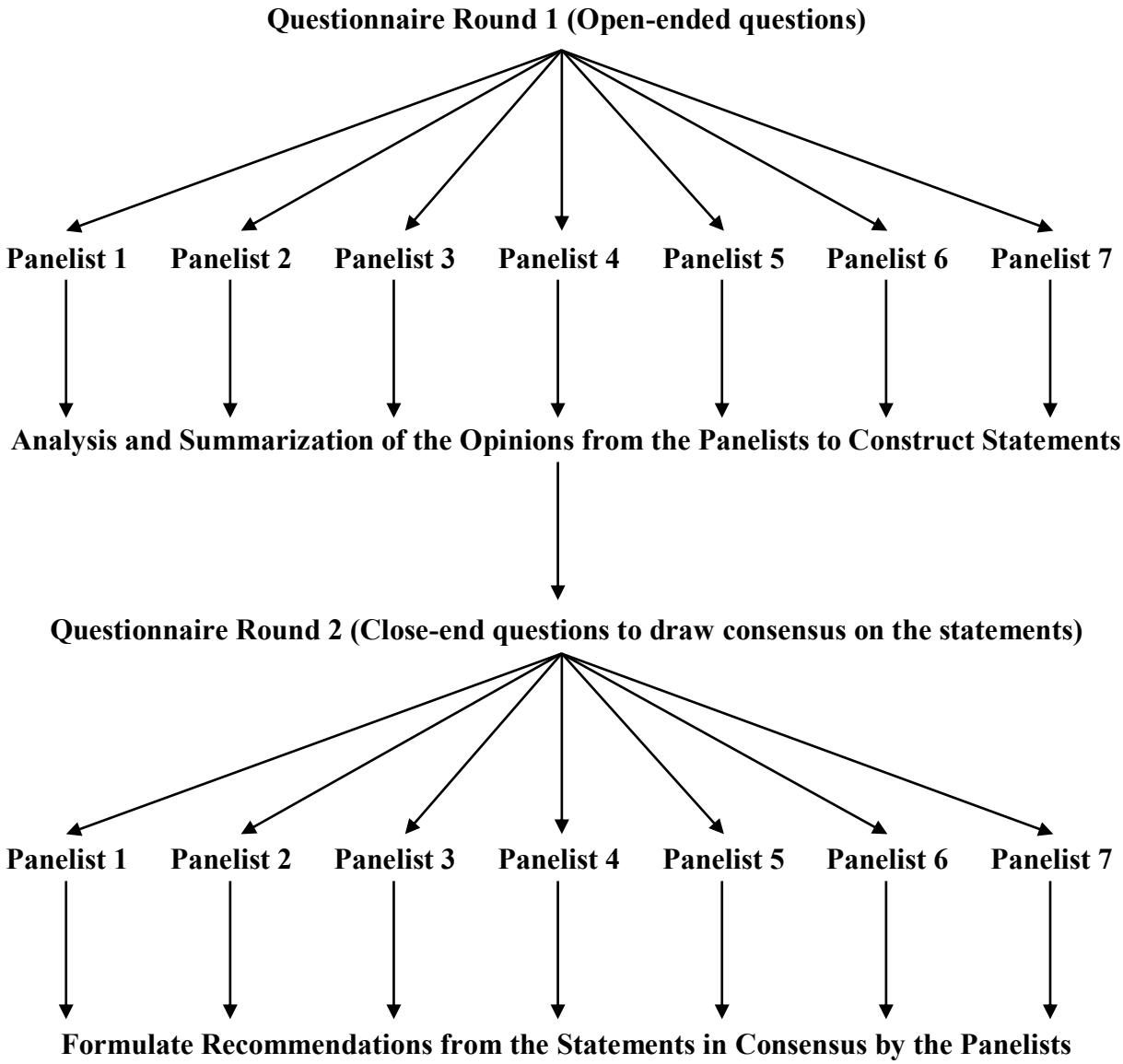

Figure 3.1: Outline of the Delphi method for Model Validation and Recommendation Formulation

Chapter 4: Analysis of Survey Data

4.1 Introduction

The data collected from the questionnaire is plotted in scatter diagram and bar-charts. The scatter diagrams demonstrate the comparative positioning of the industries in terms of national average and in terms of the benchmark. The bar-charts identifies the areas the industries have to improve to increase their innovativeness. A classification of the industries is done as high-innovative industries and low-innovative industries according to their points obtained below national average and above national average respectively.

The second set of questionnaire brought valuable insights from the industries on their current technology transfer practices. The results here are shown in bar-charts depicting the number of occurrences against different transfer channels and modes to portray the current trend of the industries technology transfer practices. The data on implication of the technology transfer depicts the outcome of the technology transfer projects and how the industries are being benefitted. All these findings are analyzed to formulate an effective technology transfer mechanism for the textile and apparel sector of Bangladesh.

4.2 Analysis of the Four Critical Factors for Innovative Capacity

The four critical factors for innovative capacity are culture, resources, competencies and network. Each industry is analyzed considering all the four factors individually. The industries are plotted in horizontal axis and the normalized values of the points obtained by the industries for each factor are plotted in the vertical direction of scatter diagrams to depict the position of the factories and to demonstrate how far the industries are from the standard. This depicts a comparative position of the factories in terms of the extent of the factors vital for their innovativeness.

4.2.1 Graphical Representation of the factor 'Culture'

The positioning of the industries in the scatter diagram in figure 4.1 shows that most of the industries are residing far from the baseline. The average score obtained by the industries is 0.78.

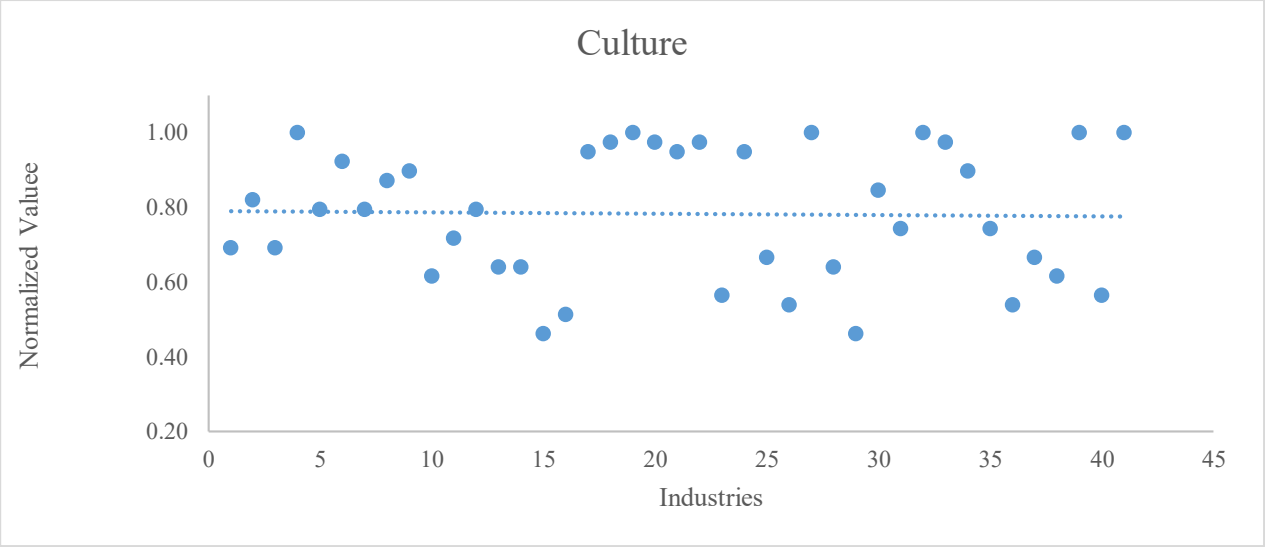

Figure 4.1: Industry positioning in terms of the factor 'Culture'

The diagram depicts that the culture in the textile and apparel industries are yet to mature enough to support and promote innovative activities that leads to technological innovation and development. Half of the industries scored lower than the average score obtained by the industries which means half of the industries are still residing in a lower position than the national standard in terms of practicing innovative culture in the industries.

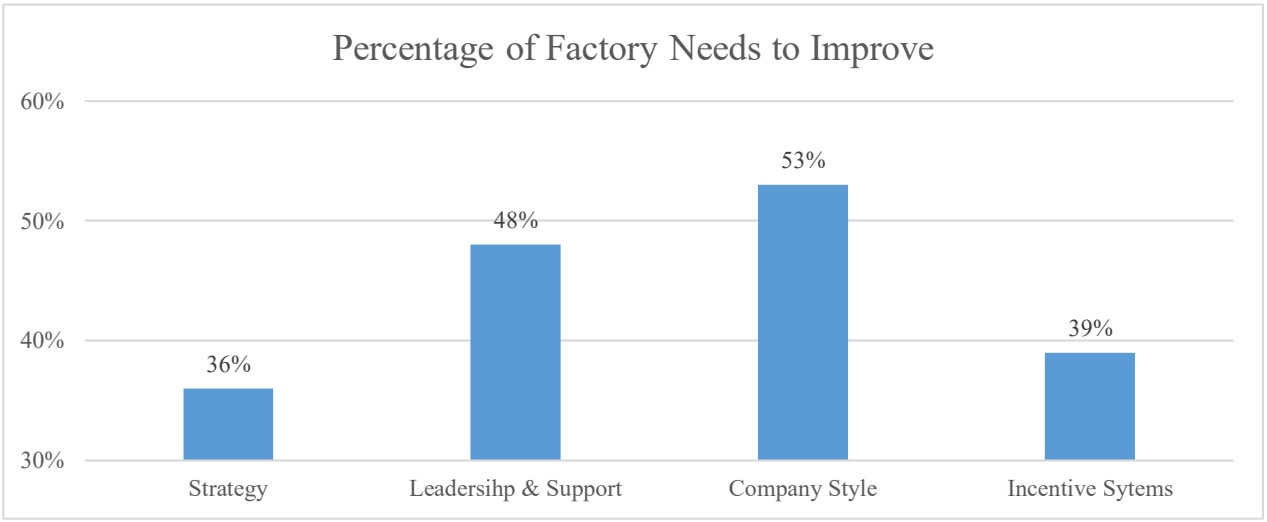

Figure 4.2: Percentage of industries needs to improve in the respective sub-factors of Culture

The bar-chart in figure 4.2 shows the percentage of industries weak in the respective sub-factors that constitute the innovative culture of an industry. It depicts that 53% industries are weak in company style which means they are vulnerable in decision making and there is no freedom of work. Too much reporting culture consumes the man-hour that could have been spent in more productive activities. These type of companies are also resistant to change their behaviors towards employees, customers and suppliers and their risk propensity is found to be very high. 48% of the industries are found to weak in leadership and support programs. That means the leadership quality of the top management is not good and they are reluctant to endow the necessary resources for innovation. This type of industries are unable to provide enough support to the innovative and creative personnel and there is no integrated program to train, recruit and nurture innovative people. 39% of industries are found weak in incentive systems and 36% industries found weak in their strategy.

So a final conclusion about the textile and apparel sector can be drawn from the above analysis that many of the industries has a clear mission and vision for innovation but many of them are unable to innovate technologies for overall industrial development due to lack in leadership, training and support programs and proper incentive systems in the industry operation.

4.2.2 Graphical Representation of the factor 'Resource'

Resource is the second component for industrial innovative capacity. The resource factor is composed of four sub-factors namely financial, intellectual, human and infrastructural resources. The average score obtained by the industries under investigation is 0.76.

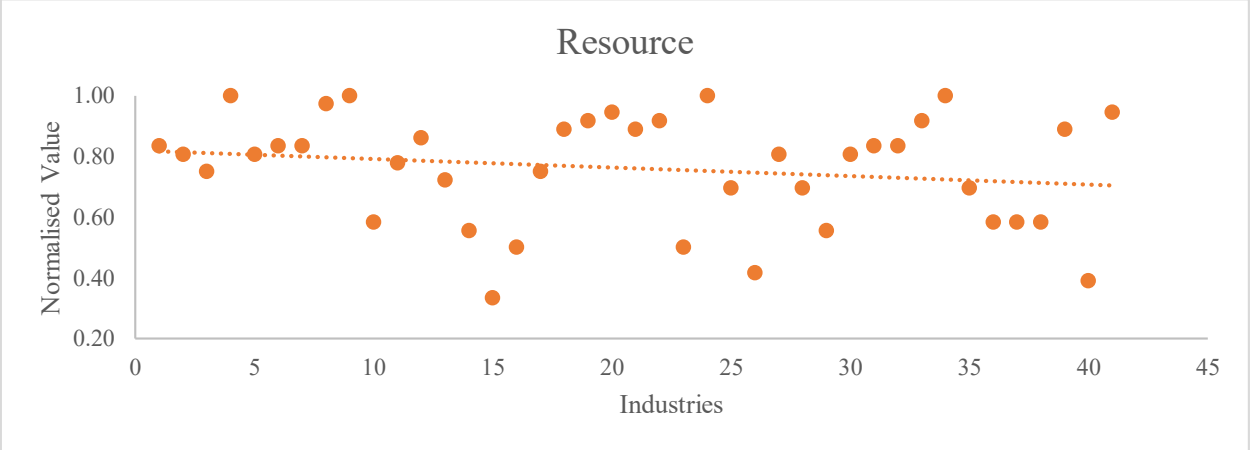

Figure 4.3: Industry positioning in terms of the factor 'Resource'

The scatter diagram in figure 4.2 depicts the industry positioning in terms of the normalized value of the obtained scores by the industries. Around 45% of the industries scored lower than the national average that means 45% of the industries are yet to reach the national standards. This statistic shows that around half of the industries are not innovative because they do not have the right resources. The comparative positioning of the industries in terms of the sub-factors that constitute the resource factor can be analyzed form the bar-chart in figure 4.4.

From the bar-chart it is apparent that 48%, 51% and 53% industries need to improve respectively in financial, intellectual and human resources and only 29% of the industries need to improve in infrastructural resources. That means around 70% of the industries are sufficient in infrastructural resources required to be an innovative company but it is becoming difficult for them to innovate continuously towards industrial development due to the lack of other supporting resources.

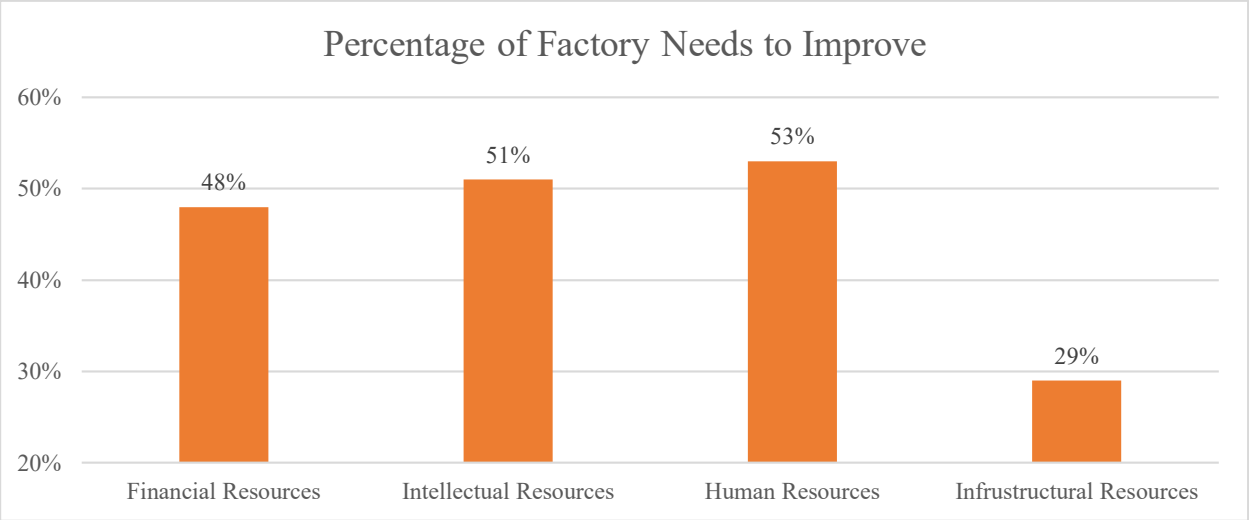

Figure 4.4: Percentage of industries needs to improve its Resources

As long as textile and apparel industry of Bangladesh is in concern, industry owners are known to make good profit due to the cheap labor cost. A good share of this profit is re-invested in the industries resulting in infrastructural development. But due to lacking in intellectual and appropriate human resources the infrastructures are not being capitalized properly. As a results some industries in spite of having adequate infrastructure are not found to be innovative enough to utilize its resources for industrial development. The infrastructure or physical resources here meant to be the structural assets like buildings and offices, lab and equipment, machineries; efficient administrative process; certifications and accreditations. 53% industry needs to improve

in human resources which implies that the employee profile is not rich and they are not adequately motivated and committed towards innovation. These phenomenon results in high employee turnover which is a big obstacle for innovation, because continuation in idea generation and commitment towards work is a must for innovation. Intellectual resource refers to the knowledge stock of the employees and the intellectual property assets like trademarks, manuals, database, customer list and in high-end cases patents. 51% industries happen to be weak in intellectual resources. 48% of industries are lacking in adequate finance eg. finance in R&D, training and technological development.

So a final conclusion about the resource factor can be made from the data demonstrated above is that, the industry is good in infrastructural resources but not that good in other resources like financial, human and intellectual resources. Without appropriate manpower and proper training and motivation it is impossible to capitalize the available physical resources to convert it to profitable business. As a result, many industries are there who has adequate infrastructure to do rigorous R&D and innovation but due to lack in rich employee profile and knowledge stock and know-hows they are unable to capitalize the opportunities. In other hand there are some other factories where there are no sufficient financial resources to start innovation. So the two types of industries must follow a different mechanism for technological development.

4.2.3 Graphical Representation of 'Competencies'

Apart from the academic and technical knowledge stock of the employees there are some specific competencies found in the employees of innovative companies. So Competencies are the third factor for innovation in this research. The competencies are idea generation, project management, technical knowledge, soft skills and experimentation and problem solving skills.

The scatter diagram in figure 4.5 shows the industry positioning in terms of the competencies. Here the average score obtained by the industries under investigation is 0.70 that is lower than the first two factors culture and resources. According to the obtained statistics 66% of the industries are residing below the national average score which is the highest comparing to the other innovation factors. It depicts that only around 34% of the industries have the competencies to innovate whereas 66% of the industries lack the critical competencies for innovation.

The bar-chart in figure 4.6 shows that there are two sub-factors of competencies where more than 80% of the industries needs to improve: Project Management and Experimentation and Problem Solving Skills. Around 51%, 51% and 60% of the industries need to improve the other three competencies respectively: Idea generation, Technical knowledge and Soft Skills. Every event of technological innovation is a one-time endeavor as every time transfer of technology comes with new challenges and new set of problems. Technology innovation and transfer process is also bound by time, budget and quality. As a results every event of technology transfer is like a new project and competency to handle new projects is crucial for success. From the study it is found that most of the industry does not have experienced organizational support structure for projects. They are not well trained to use the project management tools and there are no training options on project management. Only 20% of the industries are found acquainted with the project management terms and tools and the other 80% of the factories didn't. Another big lacking was in experimentation and problem solving skills. Employee's willingness to identify and diagnose problems and look for potential solution is a prerequisite for innovativeness. The ability to test and run new solutions of problems is a must competency for innovative companies. 83% of the industries unfortunately doesn't have this competency. 60% of the companies also opined not to have strong soft skills. Linguistic, computer and IT skills and the spirit to works in a team is lacking in the employees. 51% of the industries also lack in idea generation practices and technical knowledge domain which are the fundamental requisites to be innovative in a specific field.

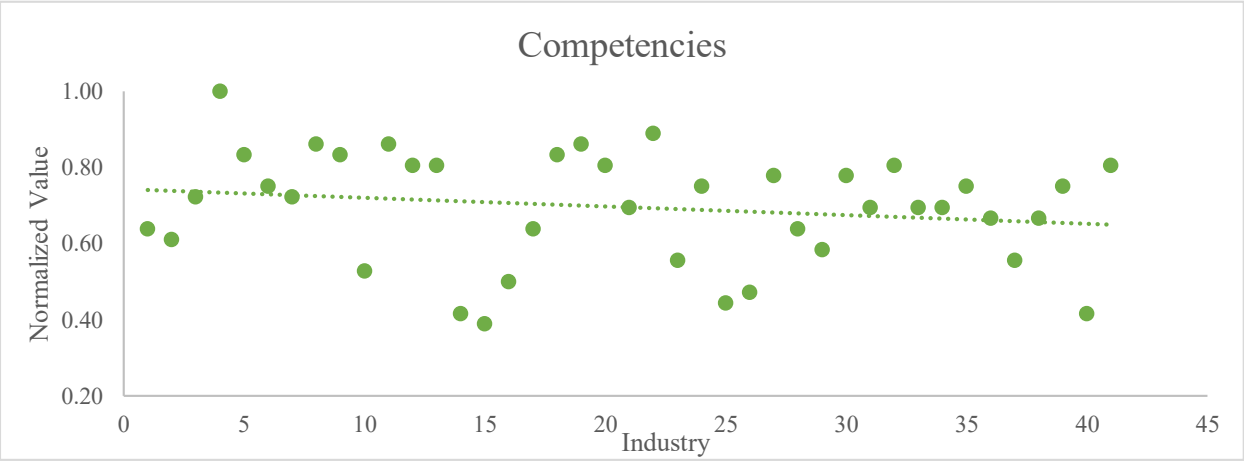

Figure 4.5: Industry positioning in terms of the factor 'Competencies'

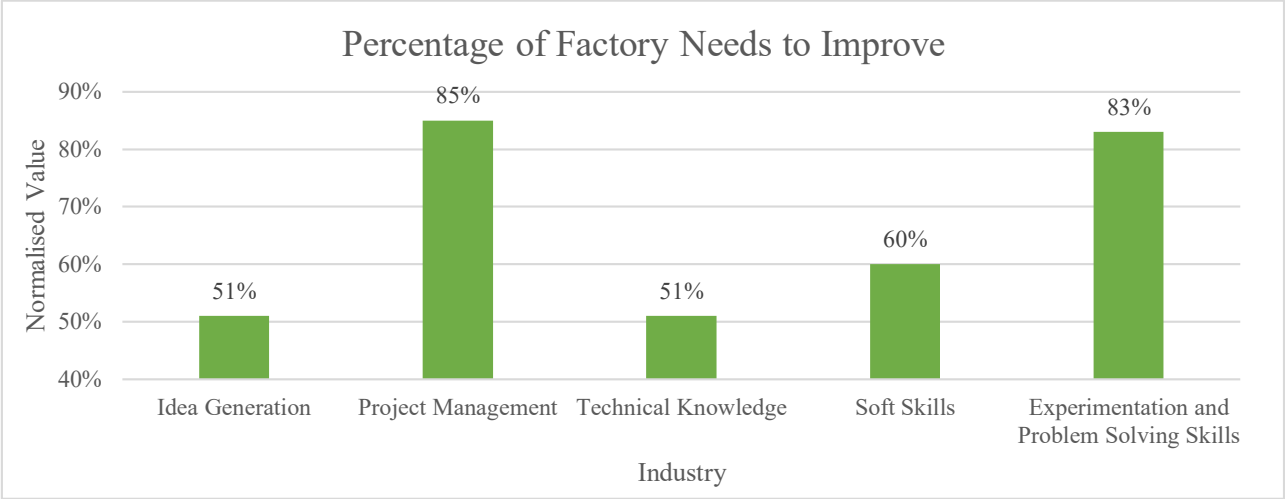

Figure 4.6: Percentage of industries needs to improve in Competencies

So a final conclusion can be made from the above analysis that the textile and apparel industry is weak in the competencies required for innovation. Among the competencies required for being innovative around 80% industries are weak in project management and experimentation skills. This is due to lack of education on project management and proper training and motivation program for increasing the experimentation and testing skills. The technical knowledge of the employees is average but due to the lack in other soft skills like interpersonal and presentation skills and skill to use the IT and computer it becomes difficult for them to communicate well and interpret problems appropriately. Improvement in those domains can surely improve the innovativeness of the companies and help develop technologies through effective transfer mechanism.

4.2.4 Graphical Representation of 'Network'

The last factor that is considered for innovativeness of the industry is their networking. This domain consists of three sub-factors namely: Relationship, communication and collaborations. Networking ability of the employees are constituted of the relationship with customers, competitors and stake holders, communication skills and their emotional state and collaboration inside and outside the industry. The average score obtained by the industries under investigation is 0.77.

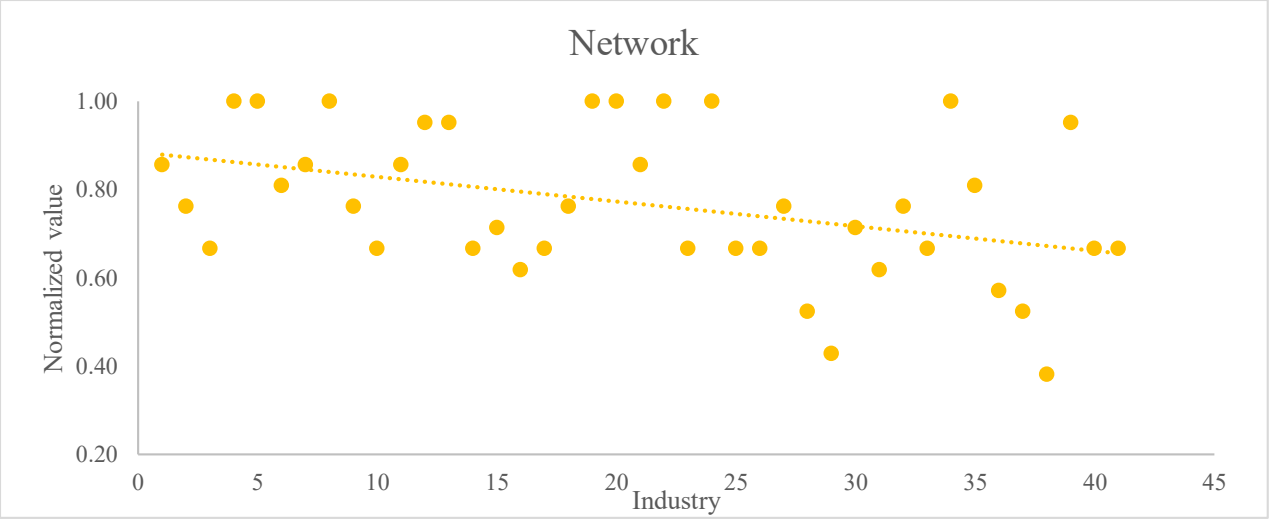

Figure 4.7: Industry positioning in terms of the factor 'Networks'

The scatter diagram in figure 4.7 shows the industry positions in terms of points obtained in the network factor. Here, 52% of the industries are found to reside below the national average line. The scatter diagram suggests a visual representation of the industries which shows how far the industries are from baseline.

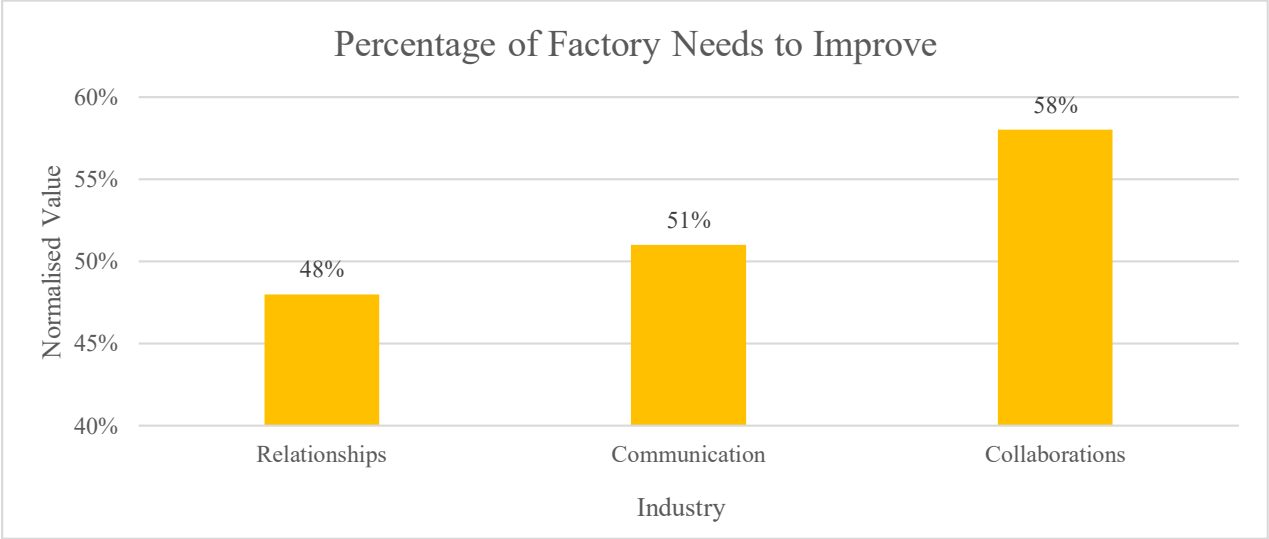

Figure 4.8: Percentage of industries needs to improve its Networks

The bar-chart in figure 4.8 suggests that 58% of the industries needs to improve in collaborations whereas 48% and 51% of industries needs to improve in relationships and communications. The matter of fact is that the networking process starts with relationships which leads to collaborations if proper communications is maintained. So if an industry is weak in collaboration, it indicates that it is weak in maintaining good relationships with their customers, competitors and strategic alliance partners. So on average it is found here that 52% of the industries are not good in networking. They are not communicating well with their colleagues inside and outside the company. Proper communication also vents the frustration of the employees and improves the team spirit which motivates to create more collaborations inside and outside the organizations.

So it can be depicted that around half of the industries under investigation are found to be networking properly and half of the industries have the networking capability that translates into innovating capability. Collaborations with technology partners or the potential technology users can be a way to improve effective networking that will lead to the improvement of innovativeness of the industries. The networking information of the industries under investigation will help developing an effective technology transfer mechanism of the industries both strong and weak in networking.

4.3 Analysis of Technology Transfer Practices of the Industries

Analysis of the innovative performance of the industries under investigation is done according to the data collected on the technological innovation practices of the industries. Data was collected from the industries on their technology transfer channel, the associated innovation process and the technology transfer implication. This analysis was aimed to portray the current technological innovation trend of the industries so that an effective technology transfer mechanism can be developed accordingly.

4.3.1 Technology Transfer Channels

Technology transfer channel is the link between entities involved with the technology in which the various technology transfer mechanisms can be activated. The industries were asked to point out the formal channels through which the technology is innovated or transferred in their factories. The result is showed in a bar-chart in figure 4.9.

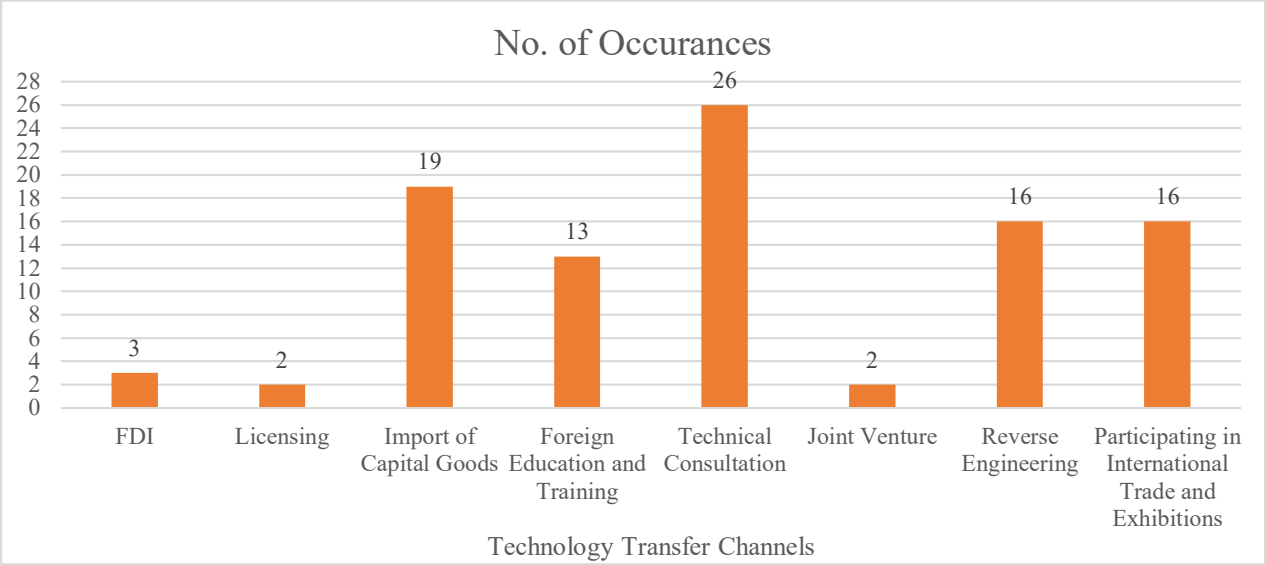

Figure 4.9: Technology transfer channels used by the industries under investigation

The bar-chart depicts that most industries used the technical consultation as a channel for technology transfer. There are 26 occurrences when a technology or technology component has been innovated or transferred through technical consultation services. It can be assumed from these statistics that these industries do not have the technical expertise required to innovate the technology or technology components. The next highest occurrence was import of goods. In 19 cases it was found that a new technology or technology component was innovated in the industry by importing new machineries from abroad. Reverse engineering and participation in the international trade fairs are the next highest transfer channel being found. Reverse engineering is done mainly in the apparel industries where new designs are being developed from the product itself through reverse designing and engineering. Most of the hardware and machineries of the textile industry are being adopted from international trade fairs and exhibitions that take place every year in different countries. Technology manufacturers exhibit their new technologies and new version of textile machineries and provide transfer services to the industries as well. Only 2 to 3 occasions were found where a technology was developed through Foreign Direct Investment (FDI) or Licensing in our investigation which depicts that these two channels are not being such effective for the industry compared to channels like technical consultation and imports of capital goods. This trend of transfer channel when coupled with their innovative capacity, renders valuable

insights from which an effective technology transfer mechanism can be developed. This discussion is illustrated in the subsequent chapter.

4.3.2 Technology Transfer Modes

In different researches technology transfer mode has been described as material transfer, design transfer and capacity transfer as the classifications. Mode also has been described as the horizontal and vertical technology transfer classifications mentioned already in the literature section. Now material, design and capacity cannot be adopted in the same mode as the implication of the three are different. Material is the results of knowledge, whereas the design and capacity are components of knowledge. To put simply, one cannot practice a product rather must practice the process of the production of the product. On the other hand, when a design or capacity is to transfer, only practicing will not be enough as it is the know-how on the production and design of the product. This is why in this research the mode of technology transfer is divided in three types as Adept, Adapt and Adoption.

Tacit component of the technology or the skill-ware component can be transferred through the mode adept. Another mode is to adapt the technology through training. In this mode there must be a third party to train the technology user on how to use the technology. In many cases the technology suppliers or the exporters take the responsibility to train up the technology users in the user's premises so that they can adapt the new technology. The third mode of technology transfer is the adoption mode where a complete new package of technology is introduced through consultation and foreign expert services. In these cases, an external agent is appointed to do the necessary staff regarding the transfer process. In many cases they are hired consultants expert in the specialized field of interest and experts in technology management services. The aim of this question is to analyze the trend of the industries to consider different transfer modes for different types of technology and technology components. The bar-chart in the figure 4.10 shows the number of occurrences industries were following the three transfer modes.

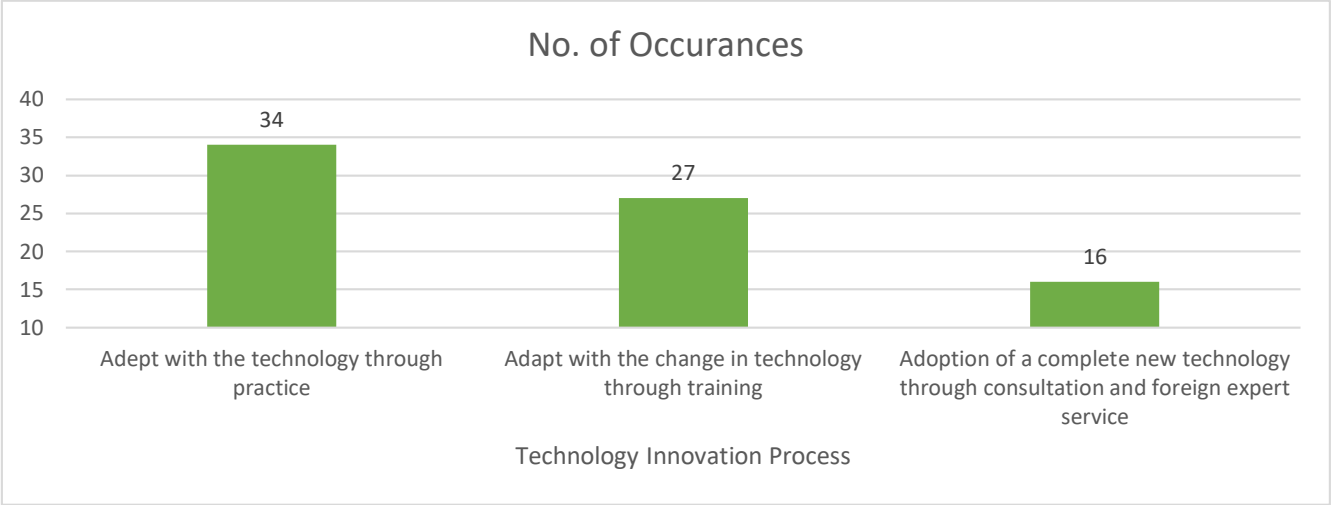

Figure 4.10: Number of occurrences when industries were following the three transfer modes

The analysis of the survey data in this bar-chart shows that there are 34 times when the industry is found to follow the adept mode where they are transferring the technology through practicing. 27 times it was found that the attempt was to transfer the technology through training and only 16 times it was found that the industry was following the adoption mode to transfer complete technology that is to transfer the capacity through foreign consultation services. This analysis depicts that the industry is more used to do the material transfer and not concentrated to capacity transfer which is more effective and productive in terms of technological development. An effective technology transfer mechanism must draw the optimal way different types of industries can upgrade their transfer modes from material transfer to capacity transfer.

4.3.3 Implication of Technology Transfer

Industries aim to transfer technology in a view to trigger development. How this development can be attributed, is a vital question. In this research five attributes of development that is achieved through technology transfer is outlined. E.g. a. new product development in the market, b. incorporation of new features in the product mix, c. improvement in productivity, d. cost cutting and e. reduce of negative impact on the environment.

So if the transferred technology or the component of technology is not resulting in any of the five attributes of development, then the technology transfer can be deemed as ineffective. The data on technology transfer implication of the industries under investigation is showed in a bar-chart in figure 4.11.

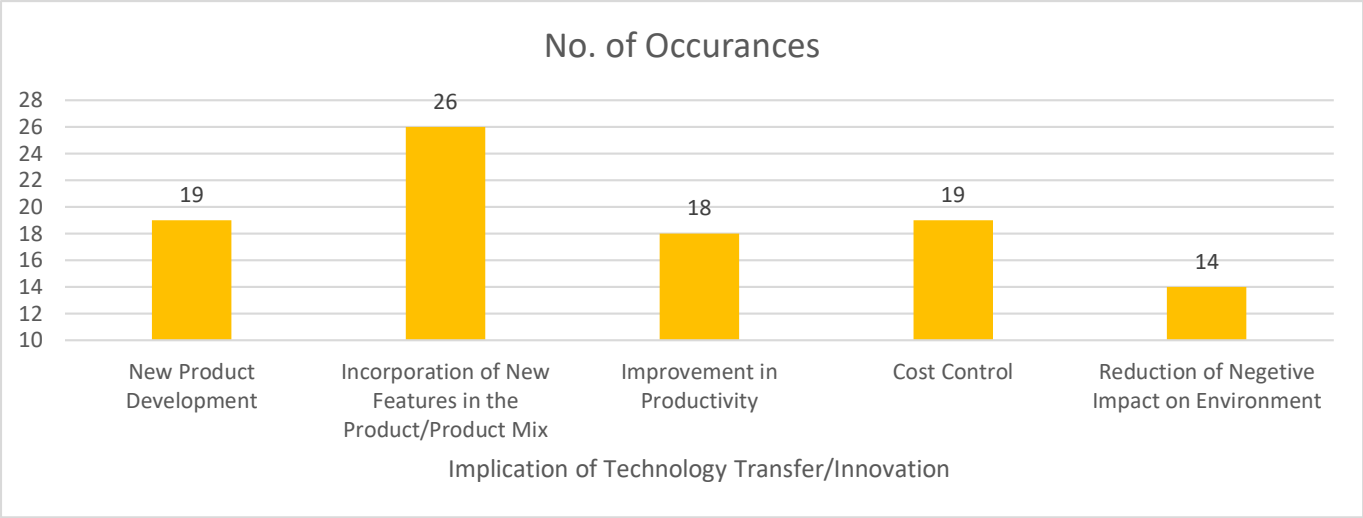

Figure 4.11 Number of occurrences in terms of the technology transfer implications

It shows that the most number of occurrences were found when industry transferred technology to incorporate new features in the existing product mix. 19 times it was found that new products have been developed with the new technology or technology components. Productivity improvement and cost control has been found 18 and 19 times respectively. It depicts that these factories targeted technology transfer only for process development and not product development. 14 times it was found that the technology transfer has a consequence with reducing the negative impacts on the environmental issues.

The industries' different modes of transferring technology provide valuable insight in developing an effective technology transfer mechanism for the sector. The industries looking for new product development, are considered as aiming for market and technical leadership; whereas the industries only targeting productivity and cost control are not trying for market leadership rather aiming at sustaining in the competitive market.

Chapter 5: Development of an Effective Technology Transfer Mechanism and Discussion

5.1 Introduction

The economic development of Bangladesh is mostly reliant on the industrial development. Textile and apparel sector is the largest industrial sector of Bangladesh and the development of this sector directly translates into the overall economic development of the country. As a result, the technological development of the textile and apparel sector is very significant. From this study it is proved that without proper technology management it is not possible to ensure a sustainable development and growth of the textile and apparel sector. Continuous and strategic technological innovation is a must for the industries. For that, the innovativeness of the industries must be improved. In this regard an attempt to measure the innovative capacity of the industry has been taken in this research. The current practice of the industries in terms of transferring technology and the innovativeness of the industries are analyzed to develop a technology transfer mechanism for the industry that will be effective and sustainable. Different mechanism is seen in different countries for technology transfer. Technology transfers to Mexico and Brazil are mainly related to the strong involvement of foreign partners and good technological capabilities. Besides a relative advantage with respect to these factors, the higher rate of international transfers in Mexico seems to be due to a sector composition effect. The involvement of foreign partners is less frequent in India and China, where investment opportunities generated by fast growing economies seem to play a more important role in facilitating international technology transfers through the clean development mechanism [95].

According to definition, the technology transfer mechanism is any specific form of interaction between two or more social entities during which technology is transferred, and a technology transfer channel is the link between two or more social entities in which the various technology transfer mechanisms can be activated. An ideal technology transfer mechanism involves with the identification, development / searching, assessment, transfer, customize and manage appropriate technology [50]. In the Ideal technology transfer mechanism illustrated in figure 5.1 the development, customization, implementation and managing is the crucial steps and the effectiveness of the transferred technology highly depends on these steps. As a result, the transfer

mechanism of the concerned industry must be developed in such a way that allows industry managers to be able to customize, implement and manage the transferred technology in such a way that the technology need is full-filled.

So it depicts that whatever the transfer channel is, every industry must have a mechanism to adopt the technology through the channel. As it is the social interaction of the entities involved in the technology transfer process, transfer modes and technology transfer strategy all are sub-sets of technology transfer mechanism. That means every industry must adopt a technology transfer strategy at first hand from which they will decide what type of technology they should aim and what will be the final implication of the transfer. This strategy must be according to their innovativeness and company characteristics. The transfer strategy will lead to select the appropriate mode of transfer. There must be an effective transfer process for all but the industries can modify the process according to need. And finally, there must be some personnel in the industry dedicated to take care of the complete transfer process. All these activities culminate in a technology transfer mechanism that can be suggested as an effective mechanism for the textile and apparel sector of Bangladesh.

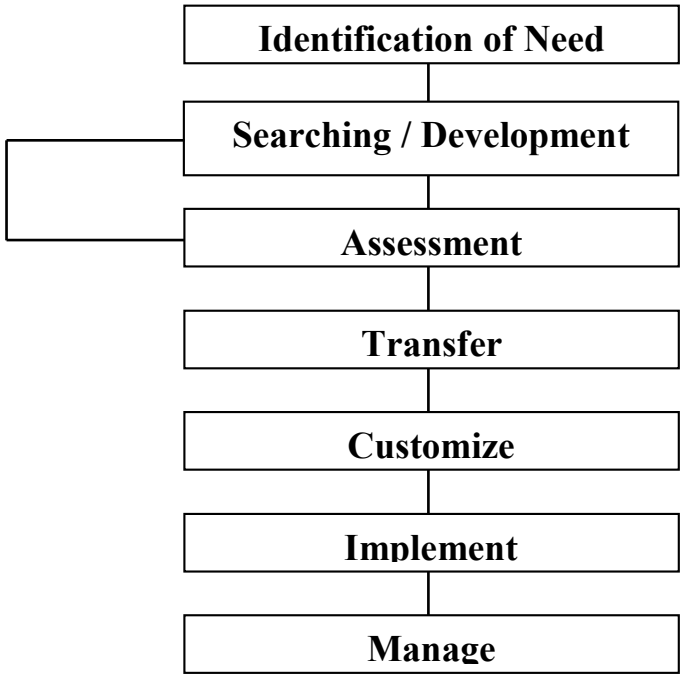

Figure 5.1: An Ideal Flow-chart of Technology Transfer Mechanism

5.2 Current Technology Transfer Mechanism in the Industry

Based on the information collected through the questionnaire and personal experience a model has been constructed in figure 5.2 depicting the current practice of the textile and apparel industries in terms of technology transfer. This model shows the current mechanism in the industries that take place when a new technology is in the transfer process. According to the investigation in the industries it is seen that they are completely reliant on external sources for technological support as well as transfer support. It can be easily recognized that proper functions of technology management are absent in this mechanism. In most of the cases the top management consisting of the managing director, other functional directors and senior functional managers takes decision about new technologies to adopt often with the advice from foreign consultants. In many cases it is seen that industries who are consistently upgrading their technological fundamentals, recruit foreign experts as their chief operating officers (CEO) or as executive directors (ED) so that their expert services on technology transfer are always at the industry's disposal. In most of the cases new technologies find route to the industries in the form of capital machineries. Industry owners frequently visit machinery exhibition events like the International Textile Machinery Exhibition Association (ITMA) every year where the latest technologies in textile and apparel are exhibited. Most of the cases it is seen that the machinery imports from this trade fairs are results of inspirations taken from the international trade fairs. In this way only the techno-ware component of the technology is transferred and in many cases the other components of technology are partially or fully absent.

The contribution of industry association like the BTMA, BGMEA and BKMEA in technology transfer is limited. They provide Utilization Declaration (UD) and Utilization Permission (UP) for export oriented industries. Association also take decision in their board meetings about the duties levied by the government on imports and tax at source for exports and communicate with the government officials. However, their contribution or engagement in constructing a road-map for technological development or in the technology transfer process is not significant.

The government provides the export and import registrations through the office of chief controller of imports and exports (CCI&E). The governments' contribution in technology transfer is limited to only providing permission. The Department of Environment (DoE) is supposed to provide the environmental clearance but the service is limited due to their limited manpower and corruption.

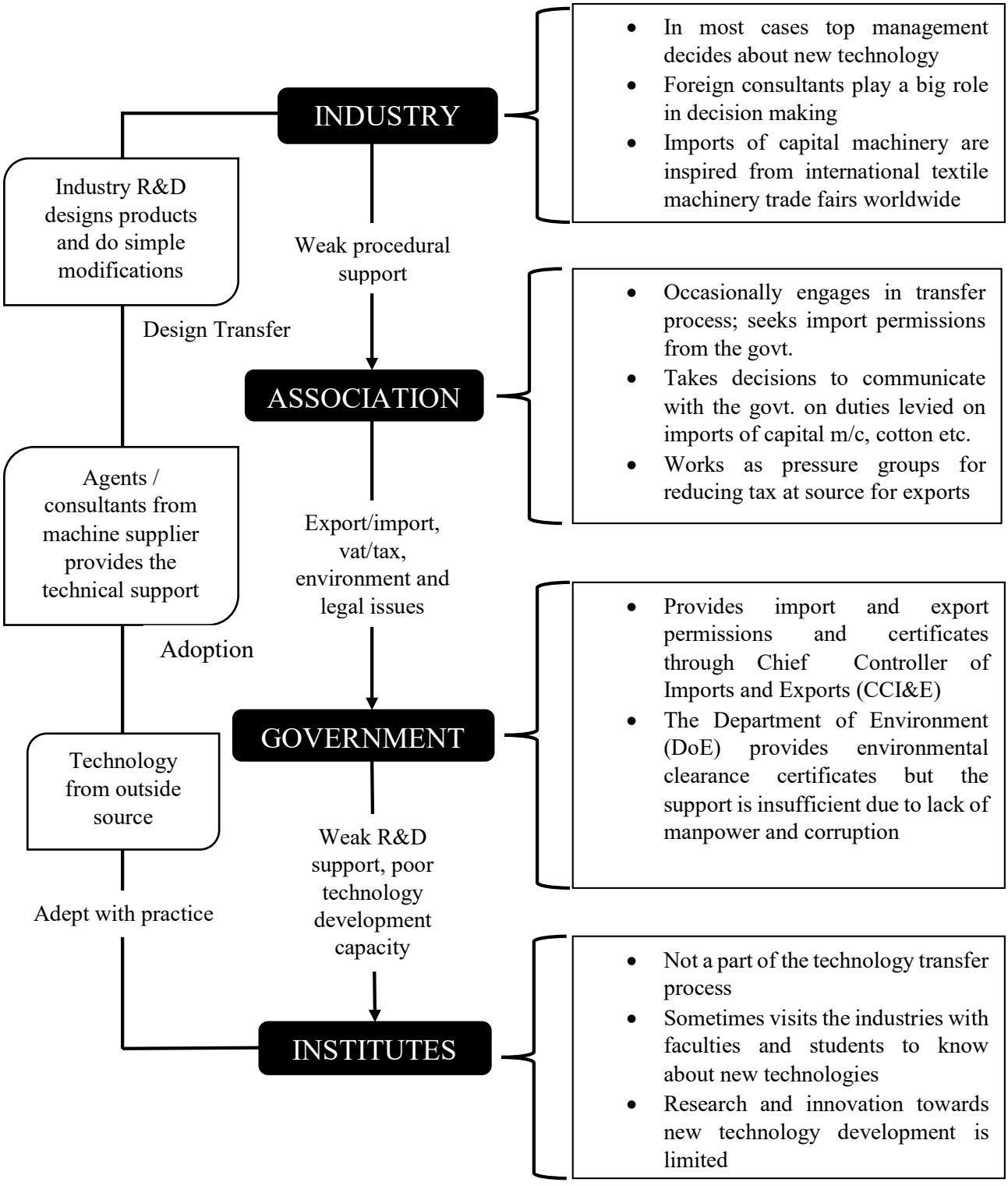

Figure 5.2: Model of Current Technology Transfer Mechanism in the Industry

The indigenous capacity of the institutes to carry on continuous research and innovation for technology development is very poor. The number of institutes providing education and training in textile, apparel and allied subjects are sufficient but all of them are providing primary and secondary level of education. Post graduate program is only available in very few institutes in the form of Masters of Science programs but there is no doctoral program available. There is no dedicated research center for the sector as well. So it can be said that the institutional capacity to produce or transfer new technology is not in satisfactory level. As a result, there is no contribution from the institutes in technology transfer process of the industries. In fact, they are completely reliant on the industries for the practical training of the students. Faculty members along with students are used to visit industries to know about new technologies.

The current model indicates the parties involved in the technology transfer process and their contribution. It is clearly evident that the knowledge on technology management and skill to transfer technology effectively is absent. In the industries the participation of the executives in the idea generation process of new technology is very poor. A clear gap remains in the current process in terms of transferring the skill to operate the new technologies. In many cases it is seen that a modern technology with multiple functionalities are adopted by industries but after a period most of the functionalities are abandoned due to lack of proper skill and organizational setup. This is one of the major gap of the current transfer mechanism where the development of the required manpower with proper skills to use the new technology for benefit. Managers are unaware about the current technological scopes and limitations and a concrete process of technological development starting from assessment, forecasting transfer and diffusion is absent. Another major problem in terms of technology transfer can be identified is the innovativeness of the industries. The knowledge and awareness on the importance of innovation is not evident in most of the industries. As a result, there is no study on the innovative capacity of the industries which results in ineffective decision making about technologies to transfer. The innovation process starting from idea generation, development and acquisition or development and facilitation is not apparent.

Another big gap identified is the weak procedural support from the industry association and the government offices. In the developed countries industry associations have significant contribution in developing sectoral roadmaps and policies. The association of the garments manufacturers association BGMEA along with the export promotion bureau (EPB) of Bangladesh set export

targets every year but there is no significant activity for a roadmap for technological development or policy development. The most unproductive thing about the government and ministry offices related to the textile and apparel sector is that the number of sectoral specialists is very few. As a result, the policies being made many times fail to fulfill the demands of the situation and many opportunities are being unable to capitalized. Due to lack of knowledge on sustainability, in many cases technologies which have negative impacts on the environment and society are adopted without proper monitoring from the government officials. The activity of the Department of Environment (DoE) which is the government body to monitor and control the industries using hazardous technologies is not up to the mark and there is always complain about manpower shortage and corruption. A more engaging and knowledge based contribution form the association and the government is a must for an effective technology transfer mechanism.

The importance of institution and research centers is also immense in developing the technological fundamentals of any industrial sector. Another huge set-back for the Bangladesh textile and apparel industries' development is the sub-standard quality of education in the institutes and lack of dedicated research centers. Technological innovation from local sources is next to zero as there is not enough facilities in the institutes to carry out good quality research. Only one government university conducts postgraduate masters course in textiles but the research output is not up to standards that can benefit the industry. The industry-academia collaboration as well is not strong. However, such collaborations in current situation is only meant to arrange visits of the students to the industries and for internship and training purposes. So the innovativeness and research capacity in the institutes must be improved in order to make sure a meaningful involvement and contribution in the technology development and transfer processes in the industries.

In conclusion it can be said about the current technology transfer mechanism of the textile and apparel sector of Bangladesh that, the technology transfer process is not complete and contribution of the stake-holders are not evident due to lack of capacity. The low innovative capacity in the industries lead to poor exploitation of technology. There is no knowledge based approach in the industries to improve the technological fundamentals and the technology transfer process.

5.3 Development of an Effective Technology Transfer Mechanism

The proposed technology transfer mechanism is an attempt to develop a system considering all the learned theories from the literature and observed gaps in the current transfer mechanism and the innovative capacity of the industries. This mechanism will open scopes for industries so that a particular industry can assess itself in terms of their innovative capacity and choose the elements of transfer mechanism described in this research. As described in the introduction the proposed technology transfer mechanism consists four elements. They are: a. Transfer Process, b. Transfer Strategy, c. Transfer Mode and d. Transfer Personnel

5.3.1 Transfer Process

5.3.1.1 The Ideation Stage

In this research an attempt is made to develop a comprehensive technology transfer process that starts from identifying industry's technology need and finishes with full-filling that need and reporting. According to literature the need is identified from the gap between current technology and the target technology. This gap can be perceived due to scientific change, market competitiveness, company policy or continuous innovation. Now, the fact is every need is not full-fillable through technology transfer; the transfer decision must be based on the company's innovative capacity and the extend of gap between the current technology and target technology. This is why update on the global technology innovation trend and technology assessment is an essential element of the technology transfer process. After gathering sufficient knowledge on the target technology and the global trend about the technology every industry individually must develop their own idea and strategy for the technology. This customized idea will allow the industry to specifically identify the components of the target technology that to be transferred. As technology transfer is a process associated with considerable cost, it is not a good idea to transfer technology components which are not required or do not directly help full-filling the industry need. For this reason, the first step in the transfer process is proposed as the Ideation stage where every industry develops an initial idea, interprets the idea with the senior and concerned staff and finally validates and optimizes the idea so that effective transfer process can be initiated.

5.3.1.2 The Transfer Stage

The transfer stage is the second step in the proposed transfer process. This stage starts with initiating the actual transfer of technology or technology component. Transfer of technology does not always mean a transfer of capital machinery or equipment. In many cases, skill transfer or information transfer can also be a part of technology transfer process depending on the need of the industry set at the ideation stage. Again as technology transfer is an innovation, consciousness and appropriate knowledge building about the transfer process in the industry during the transfer stage is important. All the users of the technology in the industry must be well aware about the info-ware component (manuals, SOP or handbooks) of the transferred technology so that they are able to use in different production needs. This program can be arranged in the form of seminars or round table meetings providing enough information to the executives concerned with the target technology or technology component so that they are mentally and socially prepared to face the new changes. This stage also includes the training of the personnel involved with operating the new technology.

5.3.1.3 The Facilitation Stage

The third stage is the facilitation stage. This stage ensures the implementation of the transferred technology or technology component. The aim of this stage is to make sure the gap between current technology and the target technology is significantly minimized and the need that was identified earlier is met. This stage optimizes the orga-ware that is the organizational change management required to adopt a new system or technology. In this stage the personnel responsible for the technology transfer ensures all the logistic support so that the transfer process is successful and the industry need is met. Analysis and reporting of the transfer process is done in this stage to identify the actual implication of the new technology or technology component. The information from this stage can be further used to increase efficiency of the later transfer processes. The outline of the proposed transfer process is illustrated below:

Ideation Stage
Identification of industry's technology need
Technology assessment and update on global technology innovations
Development of idea or strategy
Interpretation of the idea or strategy to the senior staff
Validation and optimization of the idea or strategy
⇩
Transfer Stage
Initiation of transfer process
Knowledge generation and consciousness building on the transfer process
Interpretation of the info-ware component (manuals, SOP, handbooks)
Training of executives
Facilitation Stage
Implementation of the complete transferred technology
Facilitation of the complete transfer process
Fulfillment of industry need or solution of the technological problem
Report

Figure 5.3: Illustration of Transfer Process in a Flow-chart

5.3.2 Transfer Strategy

The proposed transfer strategy is an element of the ideation stage of the transfer process. As it is said earlier that every industry must develop their own idea or strategy according to their innovative capacity and actual need; the strategy becomes so important. The decisions are derived from the characteristics of the company, innovative capacity factors attributing the technology transfer and the target implication of the target technology or technology component. This concept is adopted and modified from Mafia's (1993) technology transfer mechanism. The transfer strategy is illustrated in table 5.1. In the proposed mechanism four transfer strategies are proposed: a. Offensive Strategy, b. Defensive Strategy, c. Imitative Strategy and d. Conservative Strategy.

5.3.2.1 Offensive Strategy

Industries which are found very strong in all four factors of industrial innovative capacity should target for technologies that help them to develop new products for market and technical leadership. This type of industry is rich in financial resources and have the ability to invest extensively in research and development. This strategy is proposed as the Offensive Strategy. They are also very strong in networking, problem solving and experimenting with new things. The number of industries in this category is very few who are strong in all innovative parameters. In this research only 21% of the industries are found such. This mechanism proposes that these 21% industry should adopt the offensive strategy. These industries are found to be well off as long as their resources and competencies are concern. They should make comprehensive strategy to develop new products that will increase the value addition of the industry. These type of textile industries are found to be composite industries comprising all the textile process departments like knitting, dyeing-finishing, printing, garments and merchandising. These industries have huge orders from foreign buying houses and found to make medium to high cost of making (CM) products like fancy shirts, jackets, pull-overs, sweaters, denim etc. So the next step for development should be to target smart textiles and performance apparels which are more value added and associated with high-end technologies. As these companies have already proved to work efficiently with medium-to high end technologies now they should take strategy to develop technology for technical textiles like geo-textiles, medical textiles, automobile textiles etc. or high-end performance apparels. It will take a huge investment in R&D and technology purchase which they are capable of as they have the resources and competencies. This will lead to market and technical leadership and new products development in the sector which translates into a sustainable development of the industries.

5.3.2.2 Defensive Strategy

The second strategy is stated as Defensive Strategy which is proposed for industries that are not very strong in the innovative parameters like the 21% of the industries stated before but strong enough to start developing technologies for gaining market and technical leadership. In this study

it is found that 46% of the industries can be grouped in this category who are not very strong in innovativeness but they are on the way to become a very innovative industry and gain leadership in the competitive market. The defensive strategy proposes that the industry should target technologies that incorporates new features in their existing product or product mix as development of a complete new product is a bit too optimistic for them. Introducing new quality features and variety in product mix also needs vigorous R&D but lesser than the offensive strategy. This type of industry can do design transfers to improve their product design and technology components that are used to improve the product features. Like, improving yarn quality or introduction of high count yarns for spinning industry; introducing quality management tools to reduce defects; reducing dyeing reworks with a better dyeing technique, introducing new wash processes or embroidery technology in the garments section, these are some examples how industries can adopt the defensive strategy where they are not investing extensively in infrastructure and R&D but considering selected investments in different areas of its supply chain to improve their products and processes to gain more profitability and market leadership.

5.3.2.3 Imitative Strategy

The third strategy is for industries that are not strong in innovative capacity, low in resources and infrastructures and do not have a defined strategy and culture for development. This is stated as the Imitative Strategy. Around 21% of the industries under investigation in this research was found to be in this category where there is no significant vision of the top management for innovation, rather they are more concerned with day to day operational tasks to remain competitive in the business. These industries are found to be producing low-end items like regular knit and woven fabrics, normal dyeing and finishing of fabric in the textile industries and T-shirts, polo-shirts, shorts, baby clothes in the garments industries. As there is not much fund allotted for research and development and the staff dedicated for R&D are very few and are engaged mainly in sample developments they often work around low-tech products, copy design and reverse engineering products. For this type of industries aiming for product development or quality improvement is very tough task. So these industries should aim for the imitative strategy where they should look for technology or technology components that will help them to do design copying, reverse

engineering of products so that they can remain competitive in the low-cost product market. Their aim is not to gain leadership but to survive in the competitive market and gain confidence for further transformation in the future. For this they need to concentrate more in productivity improvement and process improvement as their margin for profit is very narrow. Improving production planning, introducing industrial engineering tools for production management, strengthening online quality inspection system, improving inventory and logistics systems are some of the example of technology or technology component that can be adopted in the imitative strategy. This is a strategy where industries will target technology or technology components that will help them improve production process, productivity and cost control and try develop their resources continuously so that they can transform to higher strategies in future. Here industries imitate the design and products from others so that there is no additional cost in R&D which allows them to concentrate more in productivity improvement and cost cutting.

5.3.2.4 Conservative Strategy

The fourth strategy here is the Conservative Strategy which is for the industries which are toiling hard to survive in the competitive market and have no investment in R&D what so ever and very weak in human resource. In this survey we found 12% of the industries can be considered in this category who should adopt the conservative strategy for their development. These type of industries are reluctant to change their practice and behavior primarily because of their lack of proper knowledge. They tend to prefer quantity over quality and try to take bigger orders with simple designs which are easy to make. These type of industries are found to have no proper leadership that is necessary for transformation. This strategy is named as conservative because it requires no or very little investment in R&D. Cost control is the primary target for these type of industries as costing is a major factor for them. Examples can be the improvement of management information systems, better production planning with integrated software, reduction of defects and reworks by proper training and motivation programs etc. These are all tacit components of technology that can be transferred and adopted in these industries to control the cost and improve productivity so that the industry remains competitive and increase profitability. The conservative strategy will allow the industries which are weak in innovation adopt simple technology

components that will help them control cost, improve productivity and gain more profit from the same setup.

Table 5.1: Transfer Strategy

Transfer Strategy	Company Characteristics	Innovative capacity factors attributing technology transfer	Priority based technology transfer implication
Offensive Strategy	Technical and market leadership	Very strong culture of leadership and support,	New Product Development
	New product launches	Very strong in competencies like idea generation, product knowledge	
	High investment in planning and R&D	Very strong in financial and intellectual resources	
	Explores new opportunities	Very strong in networking, problem solving and experimenting skills	
Defensive Strategy	Technical and market leadership	Strong culture of leadership and support	Incorporation of new features in the product / product mix
	New product launch/ modification	Strong in competencies like idea generation, product knowledge	
	Fair investment in planning and R&D	Strong in financial and intellectual resources	
	Explores opportunities that have already been discovered	Strong in networking but weak in experimenting and problem solving skills	
Imitative Strategy	Compete with low cost product	Weak in leadership and support	Productivity and cost control
	Design copy, re-engineered product	Weak in idea generation, product and process knowledge	
	Little investment in planning and R&D	Weak in infrastructure and financial resources	
Conservative Strategy	Reluctant to change, quantity over quality	Weak in leadership and support	Cost control and productivity
	Low end products and reworks	Weak in idea generation and product knowledge	
	No investment in R&D	Weak in financial and infrastructural resources	

5.3.3 Transfer Mode

As described in the literature section transfer mode is depicted differently by different researchers. One classification can be noted as the Material transfer, Design transfer and Capacity transfer. This classification is also interrelated with the Vertical and Horizontal mode of technology transfer. The question arises as long as technology transfer mode is concerned, how the industries are receiving the technology? In the survey section it is seen that there are 44% cases using the Adept mode; that is technology or technology component is transferred only through practicing to use a new machine or tool or process. 35% cases are found when industries transferred a new component through the mode Adapt; that is by training the concerned employees. And 20% cases are found where there has been a complete adoption of new technology or technology component through the mode Adoption; that is through consultation with experts.

So a common point can be noted here that every technology or technology component need some modification in the user's premises so that the new technology can be completely facilitated in the new organizational framework. Some industries are able to take this modification to a higher level of research to create their own styles and designs. Some only can design new versions of product from the new technology. Some cannot do any modification of the technology rather uses as it is transferred form the technology base for production and manufacturing.

This phenomenon matches the concept described by Hayami and Ruttan (1985) and Amsden (1989) where they identified four stages in technology generation and assimilation in the transferor's and transferee's premises. They are: research to development to design to production. But in the developing country like Bangladesh the process goes in the reverse direction like: production to design to development to research. This is because the stages in generation and assimilation of technology depends on the innovative capacity of the industries. Generation of technology requires a high R&D capability whereas industries with low R&D capability assimilates technology rather than generating it. Again, in terms of technology transfer two cases can be prevalent, some technologies may not require any change or modification and readily can be adopted whereas some technology may require adequate modification according to the industry framework before it can be properly adopted. In such different cases, different modes of transfer must be followed.

5.3.3.1 Static Transfer Mode

The static transfer mode is for technology or technology components that does not require any modifications or change management before adopting in the industry. There are technology or technology components that can be readily adopted in the industry after the transfer process. In such cases it is not required for R&D departments of the industry to modify the technology or go through any change management for proper adaptation. After the ideation stage in the transfer process the technology need is identified and the information is transmitted directly to the production and operation department. The technology is directly transferred from the technology source to the production department where the implementation and facilitation of the new technology is ensured. Technologies for which the human-ware, info-ware and orga-ware are already present in the industries and may only need the techno-ware as a machine or tool or equipment can be transferred in the static mode. Industries with low or medium innovative capacity going through only material transfers can adopt the static mode of technology transfer as it doesn't require any intervention from R&D for proper adaptation of the transferred technologies.

5.3.3.2 Dynamic Transfer Mode

Technology transfer is a dynamic process as most of the technology requires adequate modifications before it can be adopted in the industry. In this transfer mode after the idea finalization the technology need is transmitted to the technology supplier. Before the technology adoption the R&D department of the industry is required to optimize the technology according to need. The optimization process may include the training of the concerned employees and workers, awareness building on the safety and maintenance issues regarding the technology or may be getting used to with the new interface and functions of the new technology. In some cases, major modifications may be required before the complete adoption. In such cases the technology will be transferred in active mode where a third part agent who is a technical expert or consultant comes into play. The technical expert or consultant will closely with the technology officer so that the information are clearly interpreted and the functionalities of the technology is clearly understood. The technology officer will engage potential employees and operators who are likely to operate

the technology. In the dynamic transfer mode, it is ensured that all the components of the technology are properly adopted in the industry after required modifications and optimizations of the transferred technology has been done.

Considering all the concepts and classification of transfer modes and the innovative capacity of the industries under investigation in this research the following mode of technology transfer is proposed in table 5.2.

Table 5.2: Transfer Modes according to Innovative Capacity

Innovative Capacity	Transfer Mode	Transfer Classification	Remarks
High innovative capacity industries	Research to Development to Design to Production	Capacity Transfer (Dynamic Transfer)	Very high investment in R&D, Vertical transfer of technology, Adoption of new technologies through consultancy and expert services
Medium innovative capacity industries	Production to Design to Development to Research	Capacity Transfer / Design Transfer (Dynamic Transfer)	High investment in R&D, Emphasize in new product design and development from same technology source, Adapt new processes through employee training
Low innovative capacity industries	Production to Design	Design Transfer / Material Transfer (Static Transfer)	No or low investment in R&D, Horizontal transfer of technology, Adept new processes by practicing new things

This proposal of transfer mode depicts that industries with high innovative capacity should go for the Adoption mode where they follow the typical innovation process that starts from basic research to applied research, to idea development, product design and production. This route takes a huge investment in R&D which is only possible by the high innovative capacity industries as they are endowed with adequate resources to invest in R&D, infrastructure and technology purchase. These industries are able to do capacity transfers which is associated with the know-how and software

not simply to manufacture existing products but, more importantly, to innovate and adapt existing technologies and products, and ultimately design new products.

The industries which are not very strong in innovation but have medium innovative capacity should adopt the reverse transfer mode that starts form production then to design, development and research. This is because operating basic research is not possible for these type of industries due to lack in their R&D infrastructure and proper human resource. But as they have moderate innovation capacity they should be able to do the necessary modifications. This is why this mode starts form production and goes through up to research. The aim of this mode is to analyze the transferred technology component so that it can be modified to make new designs and developments of the products and processes. Even if it is needed to do some indigenous research so that a new implication of the technology can be brought out is possible in this transfer mode. In this mode it is possible to do design transfers but it is not possible to do capacity transfers in this mode as it requires extensive R&D and highly intellectual knowledge base.

The third one is for industries who are really weak in innovative performance and completely rely on low end products and reworks and have no investment in R&D. These type of industries generally depends on practicing new processes. That is the Adept mode which is becoming used to a new process or technology by using it several times. Only material transfer is possible in this mode. The concept of horizontal technology transfer also matches with this type of transfer mode. So industries with very low innovative capacity can follow this transfer mode to facilitate the transferred technology effectively.

5.3.4 Transfer Personnel

The observation from the industries depict that no industry has designated position like a technology manager to take-care of the technological fundamentals of the industry. That means there is no personnel uniquely assigned to think about the technological fundamentals. It proves that the textile and apparel industries of Bangladesh are not considering technology as a major factor of production and business as they are considering their product quality and productivity. From the literature it was evident that technologically innovative industries used to have dedicated staff to think about the technology used in the industry and how it can be upgraded in order to

make more business. An idea can be noted from Cooke and Mayes (1996) where they suggested two dedicated personnel in every industry to take through the technological innovation and transfer processes smoothly. He proposed two positions namely, *Godfather* and *Champion*. In this research two technology transfer personnel is also proposed adopting the idea given by Cooke and Mayes (1996). These two personnel will be dedicatedly assigned to manage all the technological fundamentals including all four components of technology (like, technoware, skillware, infoware and orgaware) and must be accountable to the top management for any issues regarding the overall technological development of the industry. The two personnel are named as Technology Manager and Technology Officer. The Technology Manager must be from a top managerial post and the Technology Officer can be from mid-level managerial post or executive post. These two persons will be assigned to take decisions and manage the elements of the transfer process. Industries must develop these two positions completely dedicated to develop the technological fundamentals. In the table 5.3. the functions and responsibilities of technology manager and technology officer is illustrated.

Table 5.3: Functions and Responsibilities of Transfer Personnel

Position	Level of Employee	Function and Responsibility
Technology Manager	Top Level Manager	• Work as a technology gatekeeper, like a watch dog to keep stay updated about the latest innovations • Interpret industry needs and introduce new ideas to the senior staff members for validation • Initiate the transfer process • Start creating consciousness about the transfer process among the executives
Technology Officer	Mid-Level Manager	• Implementation of the transfer process initiated by the Technology Manager • Develop knowledge on the new transferred technology • Manage the internal affairs regarding the transfer process • Ensure the complete adoption and use of the transferred technology as per the plan of the Technology Manager

It can be easily noted that the technology manager and the technology officer are the two key persons who will be managing the technology transfer process. The technology manager works as a technology gatekeeper, keeping update of the global technological innovations in the company's field. He is the one who develops strategy and a concrete idea considering the industry's need and their innovative capacity discussing with the concerned functional managers. He is the one who initiates the transfer process which later is facilitated by the technology officer.

The technology officer is responsible for implementing the technology in the industry. The role of Technology Officer may eventually mature into the role of a Technology Manager. The person in this role should also have excellent knowledge on internal politics and skill-set of his company as he has to build knowledge and know-hows with the concerned people. The person in this role also has great people skills and is a good communicator because he has to manage the internal affairs regarding the transfer process. He is the one who will ensure the transfer process is complete and the industry is full-filling the needs for which the technology has been innovated and must be accountable to the technology manager. At the end the officer also must prepare a report identifying the difficulties faced by the transfer process and also the actual implications of the transferred technology.

Now there are cases when only the technology management personnel of a company will not be sufficient for complete transfers. This is where contribution of a third party agent is required who will work closely with the technology manager and the officer to facilitate the complete transfer process. The transfer process can be classified into two categories according to the involvement of the transfer agent. The first category is passive and the second is active. This classification refers to the level of activity in applying the technology in the transfer process. If the technology transfer mechanism presents the technology to the potential user without assistance regarding its application, then the mode is called passive. In the passive mode only the knowledge part of technology is transferred, the skills surrounding the technology are not transferred. These mechanisms can include presentations in a report. If, on the other hand the provider of the technology assists with the application of the technology then the mode is called active. These mechanisms include training. The boundaries between passive and active are not that easy to define and therefore a semi-active mode is also defined. Table 5.4 following defines the three modes of

technology transfer and also show the extend of responsibility taken by the technology manager, technology officer and transfer agent.

Table 5.4: Passive, Active and Semi-active Mode of Transfer

Active Mode	**Technology Manager**						**Transfer Agent**				**Technology Officer**
Semi-Active Mode	**Technology Manager**						**Transfer Agent**	**Technology Officer**			
Passive Mode	**Technology Manager**						**Technology Officer**				
Functions	Identifying user's technology need	Update on global technology innovations / technology assessment	Generate / develop idea	Interpreting the idea to the senior staff	Validation and optimization of idea	Initiate transfer process	Consciousness / knowledge building on the transfer process	Communicating the manuals / SOP / handbooks of the technology to the user	Training of the executives	Implementation of the transferred technology	Facilitate the complete transfer process	Ensure satisfaction of the user's need / solution of problem and reporting

It can be seen that in the passive mode the transfer process doesn't require any assistant from a third party transfer agent. The transfer strategy and concept here is developed by the manager and implemented by the officer. In the active mode there is the transfer agent specialized in the target technology who is responsible for the knowledge building about the technology and the transfer process; that is to supply the manuals or instructions to the concerning party, interpreting them and training the employee of the company. He is also responsible to work closely with the technology transfer personnel of the company to implement the complete transfer process.

In the semi-active mode, the role of the transfer agent is limited to that of adviser. Very often in the semi-active mode, the transfer agent only screens information in the relevant field of interest and passes it on to the final user, therefore ensures the relevance of the information, about the user's needs, but also because of his knowledge about the technology. The role of the transfer agent is therefore one of communicators between the technology and the user. If his role is beyond this, then the mode of transfer becomes active.

5.4 Conceptual Model of the Proposed Technology Transfer Mechanism

The aim of this research is to develop an effective technology transfer mechanism for the textile and apparel sector of Bangladesh so that sustainable economic growth can be ensured from the industrial sector. As technology transfer is an innovative process it was evident from literature that the industrial innovative capacity is a vital issue for ensuring effective technology transfer process. In this regard an attempt was made to measure the innovative capacity of the industries. A set of questionnaire was developed from ideas taken from previous similar researches and advices from scholars in this field. Around 50 industries were targeted for survey and 41 industries participated in the investigation. The industries were selected randomly in snowball technique so that there is no biasness in industry selection. The information and data collected from the survey supplied valuable insights of the textile and apparel sector of the country in terms of their innovativeness and technological fundamentals. With the information collected from the survey combining with the related literatures an attempt was made to develop an effective technology transfer mechanism for the textile and apparel sector.

There are different scholars describing different technology transfer modes and mechanisms in the literature but there was none specifically defined for the textile and apparel industries. Although, it's not a proven concept to develop specific technology transfer mechanisms for specific industries but in this research a specific technology transfer mechanism is proposed for the textile and apparel industries keeping in mind the significance of this industry on the overall economy of Bangladesh. It's a novel concept where a linkage between technology transfer mechanism and industrial innovative capacity was established. So the first objective of this research which is to determine the industrial innovative capacity, has been full-filled by a questionnaire survey and analysis in the industries under investigation. This survey rendered insights in terms of the culture, resource, competencies and networks of the industries. In short, it was found that 21% of the industries were highly innovative, 46% of the industries were on the way of becoming innovative, 21% of the industries were low innovative and 12% of the industries were not innovative.

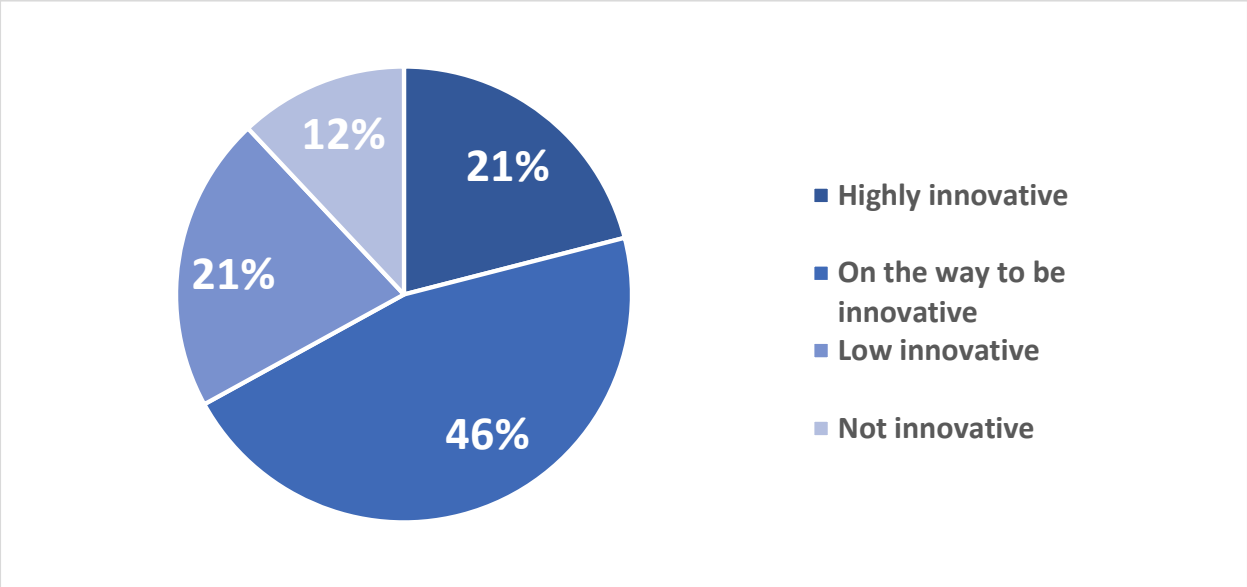

Figure 5.4: Pie chart depicting the innovativeness of the textile and apparel sector

This innovativeness translates into the effectiveness of the technologies transferred to these industries respectively. The second objective was to make rationale study on the technology transfer mechanisms established in different theories which has been done in the literature section. From the study it was found that technology transfer has been classified as the material transfer,

design transfer and capacity transfer in one research whereas in another research it is classified as horizontal and vertical transfer. However, it was discussed that the underlining theory behind the two classifications are similar where industries adopt transfer mechanisms according to their strength in innovativeness from material transfer to capacity transfer or from horizontal transfer to vertical transfer. In terms of the transfer mode, it was discussed that there are two stages called technology generation stage and technology assimilation stage which takes place in the transferor's and transferee's premises respectively. Developed industries and under developed industries has different approach towards this stages as stated in the research of Ramanathan [41] that the highly innovative industries take the route research to design to develop to manufacture and the low innovative industries adopt the other way around. This phenomenon can be linked with the horizontal and vertical transfer classifications [35]. The vertical transfer takes the typical route starting from basic research to applied research to product development and manufacturing and the horizontal transfer refers to transferring technology or technology components from out-side sources. In terms of transfer channel, it was discussed that the channel is the link between the entities involved in the transfer process whereas the transfer mechanism is the interaction between the entities. So without proper interaction between the entities it is not possible to ensure effective transfer of technology whatever the transfer channel is. From the survey it was found that most of the technologies comes through to the industry by import of capital goods and technical consultation services. But in terms of mechanism there was nothing concrete. Discussions were also made in the literature section about the different transfer modes and transfer process the concepts of which are modified for the proposed technology transfer mechanism.

The third objective of this research was to develop an effective transfer mechanism for the textile and apparel sector. Transfer mechanism, as defined in different literatures as the interaction between the two entities involved in transfer process is more related with the thought process, operation practice and management principles of individual industry. Hence, it can be said that there is a linkage between the innovativeness of the industries with the effectiveness of their transfer mechanism. So a transfer mechanism was developed according to the study of the previous literatures and considering the survey data accumulated through the questionnaires which consists four elements eg. Transfer Process, Transfer Strategy, Transfer Mode and Transfer Personnel. This proposed mechanism can act as a reliable guideline of the industries for technological development. Any industry that has a fair understanding of their innovativeness can select their

technology transfer strategy and transfer mode to improvise the technology transfer process from this proposed technology transfer mechanism. Industries highly concentrating in technological development cannot do this without proper manpower allocated for the very cause. This is why the Transfer Personnel is an important element in this transfer mechanism. However, industries can authorize other functional managers to do the same job as an additional duty if hiring separate personnel is not feasible for them or appropriate candidates are unavailable. But the transfer process will not be sustainable if the domain of technology management as a separate division of operation in the industries is inevitable. The involvement of all the stake holders starting from the industry, industry association, government, institutes and research centers is vital in the technology transfer mechanism. A conceptual model of the technology transfer mechanism according to the findings from this research is created in figure 5.5 for better visualization of the complex transfer process.

In this model the inclusion of the government, industry association and concerned institutes has been considered as they are supposed to be essential partners of technology transfer process. According to the investigation in the industries it is seen that they are completely reliant on external sources for technological support as well as transfer support. One of the reason behind, is the poor indigenous capacity of the institutes to do independent research and create technology and technology components for the industry. So the flow of information is rather from the industries to the institutes. In this model the government and the industry association is also included for proper assessment and vetting of the technologies to be transferred and for indigenous capacity building of the stake-holders.

According to the proposed model the ideation stage is carried out by the industry people as per the industry need. An effective transfer strategy must be developed keeping in mind the need and innovative capacity of the industries. The technology manager will come to action here as a technology gatekeeper who have the knowledge on the current innovation in respective technology areas and also on the technology development need of the industry backed by organizational goals. In this stage the technology need (or the idea) can be forwarded to the industry association for further suggestion and procedural support. The association like the BGMEA, BKMEA or BTMA will play a big role here by advising the industries regarding the most efficient way of developing or transferring the target technology or technology component. Specially in terms of developing

systems regarding compliance issues, these associations will work as a catalyst providing information and support services. In many cases associations will work as a pressure group to force the government in policy making, in tax and duty issues and for communicating with potential new markets in a political level. Additional function of the association will be to provide the procedural support to the industries by arranging necessary certifications and registrations, communicating with the government agencies for import permissions. Associations can also make collaborations with technology suppliers so that the industries can get their services in a continuous and hassle free manner. The involvement of the association is significant in a view that they can stay up to date about the technology need arising in the industries and the trend of technology development which in time will help them to make a road map for the industry.

The government will also be associated with the transfer process through a technology transfer cell, or may be through an office of the concerned ministry. The function of the cell here would be to assess the technology needs of the industry or industry association and take proper steps in budgeting, providing loans and incentives and policy making so that industries can to develop new processes, products and services with the new technologies. The technology transfer cell will also function as an innovative institute which will motivate, train and develop industry people to embrace more innovative ideas and develop their technological fundamentals so that sustainable development goal can be achieved. Another important function of the technology transfer cell will be the proper assessment and vetting of the technology to be transferred. The cell here will be responsible for assessing the technology whether it has any environmental or social impact and proper mitigation plan.

The next stake-holder in the proposed transfer mechanism are the universities, academic institutes and independent research centers. Because involvement of the academicians is a must for capacity building of the graduates who will eventually lead the industries in future. The institutes here can support the industry with knowledge based services in terms of technology assessment, forecasting and the complete adoption process. The engagement of the academicians in the transfer process will ensure the capacity building of the institutes and open windows for further cross-fertilization of academic knowledge regarding the transferred technology and transfer process. With academicians, students will also get opportunity to access newer technologies and their operation

in the industries. As a whole it will help in building the capacity of the institutes for further research and education.

These three stake-holders will help the industry in finalizing the best technology idea and strategy to start the transfer process. Meanwhile, by participating in the technology transfer mechanism the stake-holders will also build their capacity in assessment, adoption, training and research. The conceptual model shows how the industry can be interlinked with the stake-holders in terms of decision making and strategy development. The first priority should be to develop the technology or technology component locally, may be in the industry R&D or with the help of academic institution R&D. If it is not possible then the industry need is communicated to the potential technology suppliers. The technology transfer decision and the supplier selection must be done according the innovative capacity of the industry. An effective channel will be selected to transfer the technology from the technology source to the industry. From the collected data, it is seen that in most of the cases outright purchase and technical consultation is the preferred transfer channel. The transfer can be in passive, active or semi-active mode as per the type of technology and the innovative capacity of the industry. In cases of only material or design transfer, technology can be directly transferred to the production people of the industry where production can be started straight away. The involvement of industry R&D is only limited to product designs in this process. But if it is a capacity transfer then the industry R&D will play a big role here by ensuring the proper adoption of the technology, training of the staff and managing the changes in operation, design and production. These roles will be coordinated by the technology officer which forms the facilitation stage of the transfer process.

After implementation of the technology or technology component it is to be observed that whether the technology need has been full-filled or not. According to the observation new needs will be generated and new ideas will be evolved with experience which will be fed to the mechanism again. In this manner new ideas will be incorporated with new technologies in the technology transfer mechanism. Reports on the transfer success and experience will be conveyed to all the stake-holders for maintaining database and improving their activities.

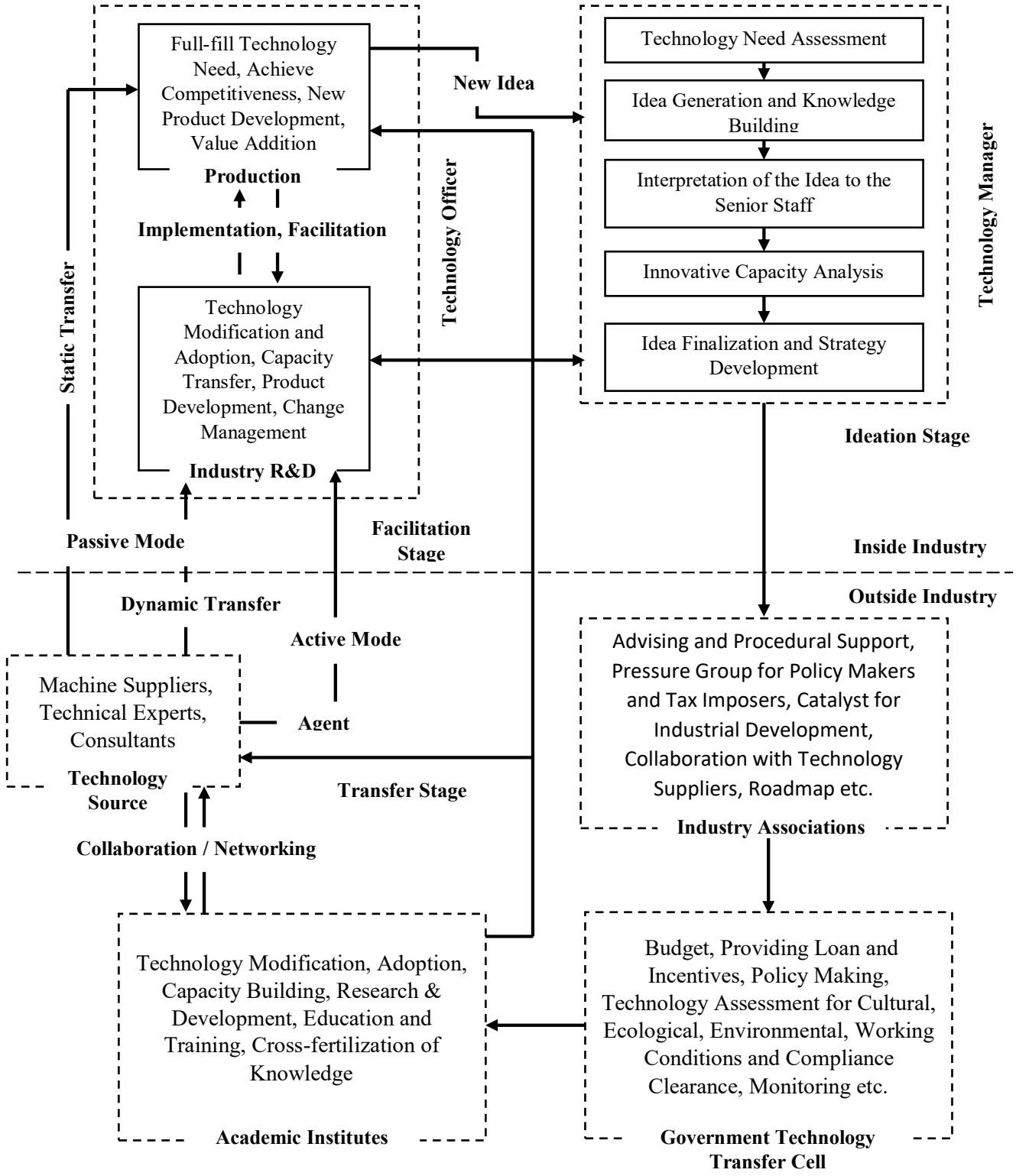

Figure 5.5: Conceptual Model of the Proposed Technology Transfer Mechanism

Chapter 6: Rationale of the Conceptual Model

6.1 Introduction

The technology transfer mechanism developed in this research is a novel approach as such kind of study has not been done before for the textile and apparel sector of Bangladesh. However, question arises, whereas such mechanism (the conceptual model) is rationale and applicable in the industries and the target of sustainable technological development in the industries can be achieved. Validation of such model is an overwhelming task as it requires industries to adopt the model which requires a considerable period of time. As the research is aimed at the sectoral development, the implementation of such mechanism is a long term process and the success of such model can only be realized after large intervention projects run for a long period of time in the industries; which is beyond the scope of this particular research. However, in such circumstances, Delphi method is used to extract views from the experts in the subject area so that the rationale of the proposed conceptual model can be justified. The justification of using the Delphi method can be confirmed from various examples like in the study of 'Measuring Organizational Cultural Intelligence' by Lima et.al. [96] and in the study of 'Development and Validation of an Instrument to Operationalize a Conceptual Model' by Jamie et. al. [97]. In all occasions Delphi method was used to validate conceptual models for which it was otherwise impossible.

6.2 Rationale of the Conceptual Model (Results of Delphi Study)

The conceptual model is developed to provide the industries with a proper guideline to adopt a mechanism for technology transfer according to their innovative capacity and also to define functions of the other stake-holders to participate in the transfer process for the overall technological development of the textile and apparel sector of Bangladesh and for capacity development of all the parties involved at large.

In the Delphi study ten questions were served to the panelists from which twenty statements were originated. These statements were again transmitted to the panel members to obtain their consensus and formulate expert recommendations (figure 6.1).

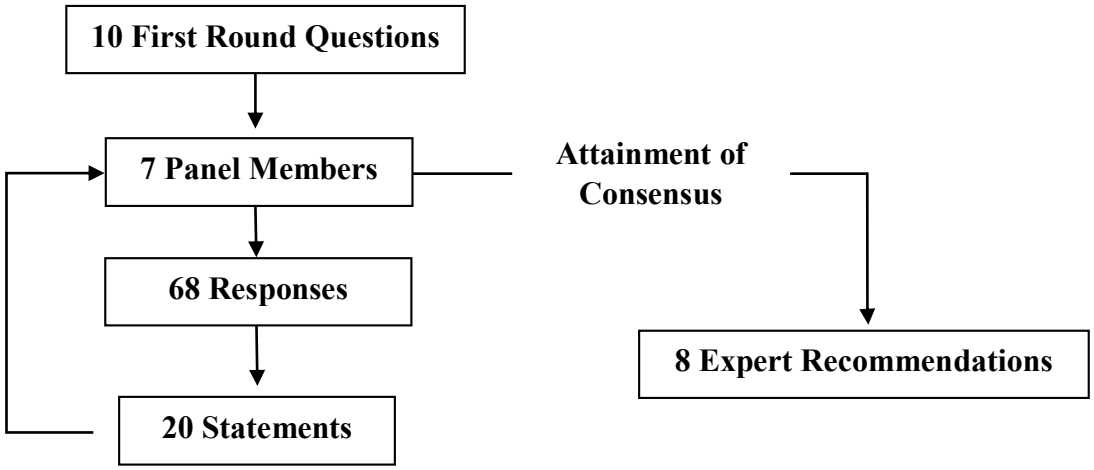

Figure 6.1: Flow of the Expert Opinion Generation in the Delphi Method

Statements in consensus from the Delphi method indicates that 100% of the panel members strongly agree with the needfulness of such a mechanism for the industries. According to the statement, every industry looking for technological development must have a long term strategy and that must be parallel with their business goal. Without appropriate strategy competitiveness in the long run cannot be achieved. It further states that, for technological development industries must be nimble, agile and responsive; for this they must adopt a mechanism or a strategy. A proper strategy helps proper integration of the elements of technological fundamentals and the new technological inclusion in the system gets easier. So, it can be confirmed that the attempt to develop such a mechanism is valid. However, continuous feedback loop can be adopted to ensure essential changes in the technology strategy as per the organizational requirement.

In terms of the innovative capacity and the development of the transfer mechanism on the basis of innovative capacity, 81% of the experts opine in the Delphi study that the innovativeness is a crucial factor for transferring the skill-ware and info-ware components of the technology. The transfer mechanism proposed here is to ensure the transfer of all the four components of technology for which the measure of innovativeness is vital. One element of the transfer mechanism here is the Transfer Mode where different modes of transfer is suggested according to the level of innovativeness of the industry. So, the consideration of the industrial innovative capacity in developing the transfer mechanism can also be termed justified. However, apart from the

innovativeness other aspects like the decision making process is also termed vital by the experts in the Delphi statements.

86% of the panelists strongly agree with the statement from the Delphi that the Industry association like BGMEA, BKMEA, BTMA should open a state of the art technology transfer cell to assist industry in modern technology adaptation, manage resources and provide guideline & information. They have to play a big role as a catalyst in technology assessment, quality assurance, policy dialogue and capacity development of the industries and create a mutual assistance platform where industry owners can share common interests, build co-operations, foster information sharing and also offer training. 97% experts also opined about the role of government and the institutes in the Delphi method. According to the statements in consensus, the government must recruit people having education and experience in textile and apparel industry and technology so that they can understand the need requirements in terms policy and other support. One expert also opined about the inclusion of Textile cadre in the Bangladesh Cadre Services (BCS). In terms of technology transfer government must play big role in policy formulation and providing adequate financial facilities for capital machinery imports. Government can promote innovative industries by awarding incentives for value addition and energy efficient technology adoption. Another statement reports that the government should take initiatives to build a science and technology park dedicated for the textile and apparel sector to foster state of the art technological development. In terms of the institutes, 100% agreement was reached in the Delphi study suggesting that, University should develop a special technology transfer cell or business incubation center or a research and innovation center to foster integrated and intensive research to formulate new technology so that the over dependence on the foreign source for technology can be checked. University-Industry collaborations should be strengthened and technology management specialists should be appointed to maintain a smooth flow of information. In the conceptual model similar functions of the industry association, government and institutes has been incorporated specifying their functions and scoped of contribution in terms of ensuring a comprehensive technology transfer system.

100% agreement was also reached in the Delphi statement which reports that, positions like Technology Manager or Chief Technology Officer must be created in the industries with incumbents experienced in technology transfer and development processes. This is because the

functional managers are not competent in technology transfer related activities and they are completely occupied in production and quality related operations in the industry. The proposed technology transfer mechanism also suggests the Technology Personnel element which specifies two dedicated positions (Technology Manager and Technology Officer) in the industry to identify need, transfer and assimilate technology. As such positions are not available right now in the industries, experts suggested that there must be a well-trained committee/team in the industry assigned to do the technology need assessment regularly and design technology transfer and development activities. For this the functional managers in the committee must develop their managerial skills through appropriate training and education. 100% experts also suggested about the development of a specialized Technology Transfer Office (TTO) to assist the industry in technology need capacity assessment, infrastructure and behavioral assessment. According to the assessment and the internal and external environment of the industry, the TTO will suggest appropriate model of technology transfer for the respective industries. This justifies the secondary objective of this research which is to provide a comprehensive framework on the existing technology transfer practices of the textile and apparel industries for the development of a specialized TTO not only to facilitate technology transfer but also work as a catalyst for capacity development of all the stake-holders.

So after analyzing all the opinions from the experts originated as statements in consensus through the Delphi method it can be confidently stated that the technology transfer mechanism described in this research is logical, time-worthy and rationale. The summary of the recommendations of the panelists and their consensus percentage is illustrated in a radar chart in figure 6.2.

The mechanism is a crying need for the industries if they want to develop their technological fundamentals and most of the philosophies around which the conceptual model of the mechanism has been developed is valid and justified. The Delphi study also reports that the mechanism is applicable in the industries given that the concerned personnel in the industry are provided with appropriate training on technology management. Hence, the obligation of developing a special TTO for capacity building in the industries and assist the industries in effective technology transfer is also justified.

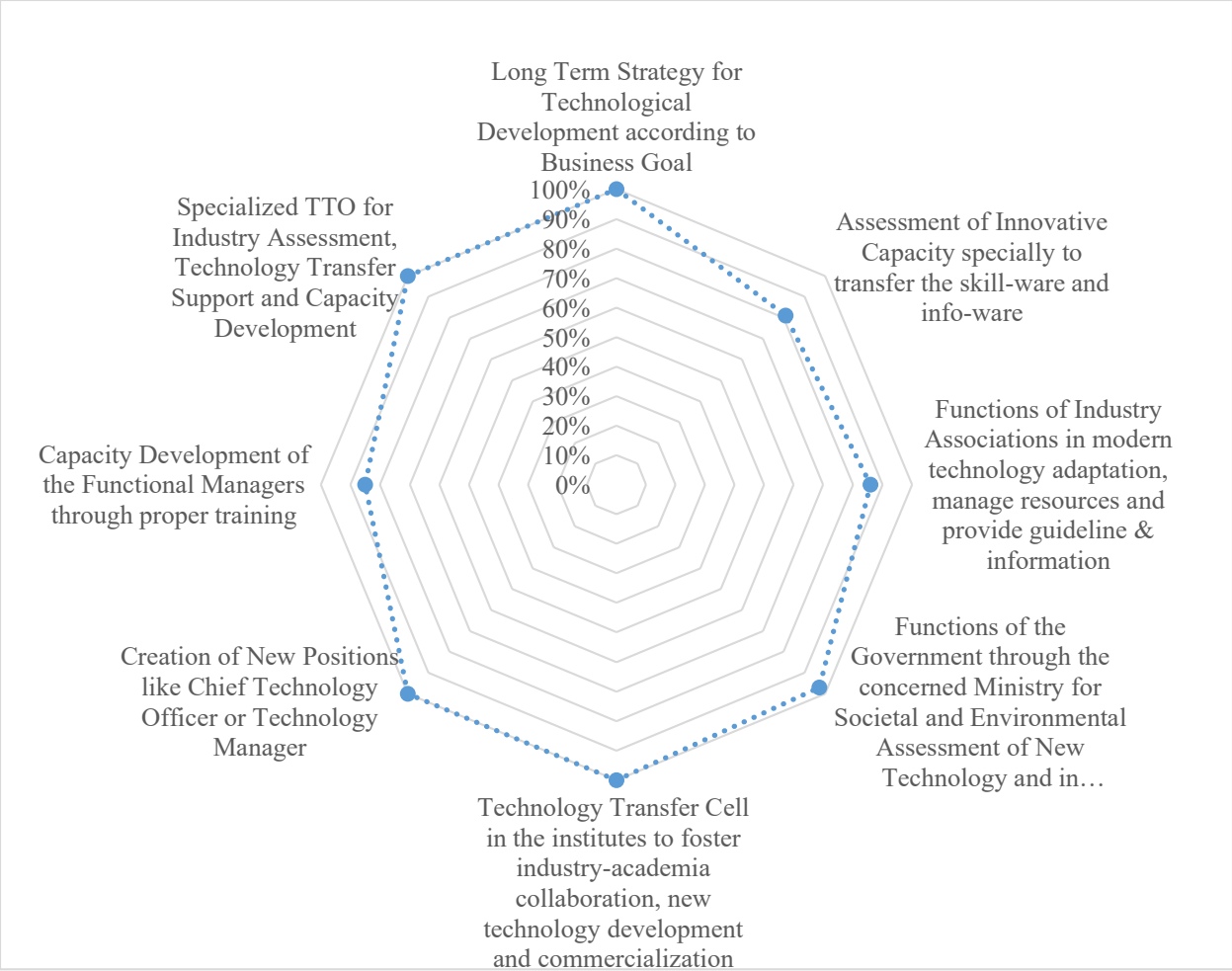

Figure 6.2: Radar Chart of the Consensus Percentage of the Expert Recommendation from the Delphi Study

A summary of the final 8 recommendations from the experts can be grouped as follows:

1. Industries must have a Long Term Strategy for Technological Development according to their Business Goal
2. Assessment of Innovative Capacity is essential; without innovativeness it is not possible to transfer the skill-ware and info-ware
3. Functions of Industry Associations in modern technology adaptation, to manage resources and to provide guideline & information is inevitable
4. Functions of the Government through the concerned Ministry for Societal and Environmental Assessment of New Technology and in Policy Formulation is required.

5. Technology Transfer Cell in the institutes is a must to foster industry-academia collaboration, new technology development and commercialization
6. Creation of New Positions like Chief Technology Officer or Technology Manager in the industries
7. Capacity Development of the Functional Managers through proper training
8. Development of Specialized TTO for Industry Assessment, Technology Transfer Support and Capacity Development

Chapter 7: Recommendation and Conclusion

7.1 Recommendations for Effective Technological Development

The development of the textile and apparel sector of Bangladesh highly depends on the technological development of the industries. But industries are yet to concentrate extensively on developing the technological fundamentals due to lack of knowledge of technology management and low innovative capacity. In this circumstances the textile and apparel sector of Bangladesh needs to adopt an effective technology development strategy immediately to ensure sustainable development. This research identifies the weaknesses in the current practice in terms of technology development process and also the innovative capacity of the industries. A technology transfer mechanism is proposed which is believed to be beneficial for the industries to develop their technological fundamentals in an effective way. Statements are also originated from the Delphi method which are the expert recommendations for the industry in terms of how to develop their technological fundamentals in an effective way. The following are my personal suggestions formulated for the textile and apparel sector of Bangladesh so that they can follow the proposed technology transfer mechanism and ensure a sustainable way of development.

a. Every industry must have idea about their innovative capacity. For that it is recommended to adopt awareness building and training programs among the employees. Innovative capacity of the industries can be determined by answering the questionnaire and analysis used in this research. A measure of their individual innovative capacity will lead to effectiveness of technology transfer.
b. Industries should determine their position in terms of technological completeness. That is to determine what is their position in terms of their technological fundamentals and their business need. A study of the existing technological capability and their ability to up-gradation will lead to develop a clear picture of technological development.
c. Industries must adopt an appropriate technology transfer mechanism for effective transfer of technology. Without the proper mechanism it is not possible to yield the most benefit out of the transferred technology. Industries can adopt different strategies and transfer

modes according to their innovative capacity and business need as described in this research.

d. Industries must consider technology as a major factor of production and business development and continue comprehensive research, training and awareness building programs so that continual development of technology is assured and the complex process of technology transfer is made conceivable through cross-fertilization of knowledge among industries.
e. The government should take proper steps to establish a specialized Technology Transfer Office so that the administrative and bureaucratic issues associated with the transfer process can be simplified. A separate Technology Transfer Cell for the textile and apparel sector will promote innovative ideas and strengthen the technological capacities both in the industries and academic institutes.

7.2 Conclusion

The findings from this thesis can be a reliable guideline for the technological development of the textile and apparel sector of Bangladesh. As a qualitative research this thesis was successful in some valuable fact finding about the innovativeness of the industries and also built a wide-ranging concept of technology transfer mechanism so that the industries can benefit from it. Expert opinions were drawn through the Delphi method which formulates expert recommendations for the industry as well. Consensus on all the Delphi statements proves the validation of the proposed technology transfer mechanism as well. The general aim was to create a guideline for the industries so that they can continuously develop their technological fundamentals to ensure sustainable growth in the contemporary competitive market. As textile and apparel sector is the lifeline of Bangladesh economy, the development of this sector bears great significance. So, the scope of this research is very wide in terms of developing the technological capacity of the industries along with the other stake holders in a sustainable way.

82% of the targeted industries contributed in this research. As it is a qualitative research which is aimed for fact finding and concept building, statistical or quantitative data is only for secondary use. Again, as the sampling has been done in snowball technique, it was ensured that common

names of the industries were coming forth as the snowball process progressed. It was also ensured that only knowledgeable people from the mid-level managers are approached for the survey so that information are closest to the real scenario.

As long as extension of research is concerned more suggestions and recommendations from scholars working in this area can be incorporated in the proposed transfer mechanism to make it more effective. Intervention project can be undertaken in some factories by implementing the transfer mechanisms and their success can be compared before and after the intervention project. Research also can be carried out further finding how to improve the innovativeness of the industries. Designing specific programs for the industries targeting specific innovative factors for improvement can be a useful research for the industry.

A final verdict can be made about the research is that, the analysis of the innovative capacity of the industries and the development of the conceptual model of the technology transfer mechanism creates a new domain of research that opens a wide scope of cross-fertilization of knowledge to work further so that the complex and dynamic system of technology transfer for the industries are made more achievable in the near future.

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Annexure- 1 : Questionnaire

There are general questions on the culture, resource, competencies, networks and the innovative performance of your organization to determine the capacity of your organization to innovate. Please click any options from 1 to 3 according to your agreement about the questionnaire. There are some questions that require your short answers.

This survey is a part of a M.Sc. thesis aimed at developing an effective technology transfer mechanism for the textile and apparel sector of Bangladesh. It is assured that the information shared in the survey will be kept confidential and will only be used for research purpose.

Thanking you,

Maeen Md. Khairul Akter,
Institute of Appropriate Technology (IAT)
Bangladesh University of Engineering and Technology (BUET)

* Required

Respondent's Information

1. **What is the name of your industry?** *

2. **What is the location of the industry?** *

3. **What is the type of your industry?** *
   Mark only one oval.
   - ◯ Composite Textile
   - ◯ Garments/Apparel
   - ◯ Spinning
   - ◯ Weaving
   - ◯ Knitting
   - ◯ Washing
   - ◯ Denim
   - ◯ Other: _____

4. **Total number of years in operation?** *

5. **Total number of employee?** *

6. **Total yearly turnover?**

7. **Name and designation of the respondent (your name and designation).** *

8. **Your age?** *

9. **Your Qualification?** *
Mark only one oval.

- ◯ PhD
- ◯ MSc
- ◯ BSc
- ◯ Diploma
- ◯ Other: _____

10. **Your no. of years' experience?**

Survey form for determining Industrial Innovative Capacity

11. **The company has a well-defined vision and mission for innovation** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

12. **The company has a strong determination and commitment for its innovation goal** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

13. **The company influences the creation of strong culture to achieve innovation goal** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

14. **The top management has a strong intention for innovation** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

15. **The company endows necessary resources for innovation** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

16. **The company integrates the innovative pursuits of the employees** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

17. **The company train, recruit and nurture innovative people** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

18. **The company is flexible in decision making** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

19. **There is freedom of work** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

20. **The company is not resistant to change** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

21. **The company's risk propensity is high** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

22. **The company provides reward and recognition of innovation** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

23. **The company appreciates innovative behavior** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

24. **Adequate financial investment in R&D** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

25. **Adequate financial investment in training** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

26. **Adequate financial investment in technological development** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

27. **The company's individual knowledge stock is very rich** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

28. **The company has a very rich database, customer list, manuals and trademarks or patents** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

29. **The company's employee profile is very rich (education, experience)** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

30. **The company has a low staff turnover** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

31. **The company's employees are committed and motivated** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

32. **The company conducts various employee training programs** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

33. **The company has a developed infrastructure** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

34. **The company's administrative process is very efficient** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

35. **The company has very rich accreditation and certifications** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

36. **Employees are involved in role-playing for better coordination and idea generation** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

37. **Extensive collaborations among departments** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

38. **The company always pursues expert opinion** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

39. **The company has experienced organizational support structure for projects: Technical, procurement, subcontractors, quality assurance, manufacturing, project accounting, contract administration etc.** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

40. **The company uses project management tools** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

41. **The company provides project management training to employees** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

42. **The employees are very high in product knowledge** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

43. **The employees are very high in process knowledge** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

44. **Employee's linguistic skill is high** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

45. **Employee's computer and IT skill is high** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

46. **Employee's social and interpersonal skill is high** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

47. **Employee's willingness and ability to experiment, test and learn new things is very high** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

48. **The company has a very good relation with customers** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

49. **The company has a very good relation with competitors** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

50. **The company has a very good relation with strategic alliance partners** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

51. **Communication among the staffs is open and a very strong team spirit (based on trust and confidence)** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

52. **Emotional state of the staff of the company is very safe** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

53. **Collaborations within the organization is very strong** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

54. **Collaborations outside the organization is very strong** *
Mark only one oval.

	1	2	3	
Disagree	◯	◯	◯	Strongly agree

Survey form for determining Industry's Current Technology Transfer Practices

Answer the following questions to portray an idea of the firm's current innovative performance regarding technology transfer/development

55. **During the period 2012 and 2017 did you introduce any technology in your firm that, from the firm's standpoint, were new or significantly improved?** *

Mark only one oval.

- ◯ Yes
- ◯ No

56. **If yes, how many technology or technology components were transferred?**

_____

57. **Which was the technology transfer channel?** *

Check all that apply.

- ☐ FDI
- ☐ Licensing
- ☐ Import of capital goods
- ☐ Foreign education and training
- ☐ Technical consultation
- ☐ Joint Venture
- ☐ Reverse engineering
- ☐ Participating in international trade fairs
- ☐ Other: _____

58. **Which of the following statement best describes the technology innovation process of your firm?** *

Check all that apply.

- ☐ Adept with the technology through practice
- ☐ Adapt with the change in technology through training
- ☐ Adoption of a complete new technology through consultation and foreign expert service

59. **Which of the following statement best describes the implication after introducing the new technology/ technology component in your firm?** *

Check all that apply.

- ☐ The firm launched new products in the market
- ☐ The firm incorporated new features in their product mix
- ☐ The firm gained in its productivity
- ☐ The firm was able to gain cost cutting
- ☐ The firm was able to reduce negative impact on the environment

60. **Which of the following statement best matches with your organization's scenario after technology innovation** *

Mark only one oval.

- ◯ The results of technology innovation is satisfactory compared to the investment
- ◯ The results of technology innovation is not satisfactory compared to the investment

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Annexure-2

List of Industries Participating in the Survey

Sl	Industry Name	Address	Type
1	Envoy Textiles Ltd	Jamirdia, Valuka, Mymensing	Denim
2	Esquire Knit Composite Limited	Katchpur, Narayangong	Composite Textile
3	Adury Fashion & Print Ltd	Korardi, Shibpur, Narsingdi	Composite Textile
4	Momtex Expo Ltd.	Panchdona, Narsingdi, Bangladesh	Composite Textile
5	Aman Tex Ltd	Boiraghirchala,Sreepur,Gazipur	Composite Textile
6	Masco Printing & Embroidery Ltd.	Sataish, Tongi, Gazipur	Screen Printing
7	Square denims Ltd.	Olipur, Shayestaganj, Habigabj	Denim
8	Masco Group	Gazipur	Composite Textile
9	Liberty knitwear ltd.	Gazipur	Composite Textile
10	Libas Textiles	Shirir Chala, Bager Bazar, Gazipur, Bangladesh	Garments/Apparel
11	Iris Fabrics Ltd.	Ziranibazar, Kashimpur, Gazipur.	Composite Textile
12	Square Fashions Limited	Jamirdia Maserbari, Valuka, Mymensingh.	Composite Textile
13	NAZ Bangladesh Ltd.	5, Bishuya Kuribari,Mirzapur,Gazipur-1700,Bangladesh	Composite Textile
14	Nur Group	Chandra, Kaliakoir, Gazipur, Dhaka	Composite Textile
15	Saad Saan Textile Mills Ltd	Mulaid, Sreepur, Maona, Gazipur	Weaving
16	Noman Composite Textile Mills	Jamirdia, Valuka, Mymensing	Composite Textile
17	Zaber Spinning Mills Ltd	Sreepur, Gazipur	Spinning
18	Dird Composite Textiles Ltd	Rajendrapur, Kashimpur, Gazipur	Composite Textile
19	Square Fashion Ltd	Square Masterbari, Jamirdia, Bhaluka, Mymensing	Composite Textile
20	Zaber & Zubair Fabrics Ltd	Pagar, Tongi, Gazipur	Composite Textile
21	Fakir Apparels Ltd	BSCIC Industrial Area, Enayethnagar, Shashangaon, Fatullah, Narayanganj	Composite Textile
22	FCI BD	DEPZ, Ganakbari, Savar, Dhaka – 1349	Garments/Apparel
23	Zubair Spinning Mills Ltd	Mulaid, Sreepur, Gazipur, Dhaka	Spinning
24	Amber Denim	Banglabazar, Rajedrapur, Gazipur, Dhaka	Denim
25	Pioneer Denim Ltd	Hobigonj, Sylhet	Denim

26	Outpace Spinning Mills Ltd	Sreepur, Gazipur, Dhaka	Spinning
27	Cotton Group	Valuka, Mymensing	Composite Textile
28	SIM Fabrics ltd	Narayanganj, Dhaka	Weaving
29	Padma Poly Cotton ltd	Tejjgaon I/A, Dhaka	Composite Textile
30	Nassa Group	Tejgaon I/A, Dhaka	Composite Textile
31	JK Spinning Ltd	Naojor, Gazipur, Dhaka	Spinning
32	Fakir Fashion Ltd	Narayanganj, Dhaka	Composite Textile
33	Fakir Knitwear	Narayanganj	Composite Textile
34	Urmi Group	Head Office, Gulshan-1, Dhaka	Composite Textile
35	GMS Knit Composite	Sreepur, Gazipur, Dhaka	Composite Textile
36	Badsha Textiles Ltd	Jamirdia, Valuka, Mymensing	Spinning
37	Maksons Spinning Ltd	Birulia, Ashulia, Savar, Dhaka	Spinning
38	Metro Spinning Mills Ltd	Narayanganj, Dhaka	Spinning
39	Epyllion Knitex Ltd	Banglabazaar, Rajendrapur, Gazipur, Dhaka	Composite Textile
40	Nassa Denim Mills Ltd	Comilla	Denim
41	SQ Celcius Ltd	Bhaluka, Mymensing	Garments/Apparel

Annexure-3

Delphi Method for the Rationale of the Conceptual Model

First Round Questionnaires

Question 1	According to your opinion, should an industry have a certain mechanism or strategy to develop the technological fundamentals of the industry? Please express your reason.
Question 2	Do you think the industry must have a clear idea about their innovative capacity? Please express your reason.
Question 3	In your opinion, how the innovative capacity of an industry is related with the technological innovation?
Question 4	In your opinion, what should be the main roles of industry associations like BGMEA/ BKMEA/ BTMA, in the technology transfer mechanism of the textile and apparel industry?
Question 5	In your opinion, what should be the main role of government (Ministry of Textiles and Jute/ Department of Textiles/ Department of Environment) in the technology transfer mechanism of the textile and apparel industry?
Question 6	In your opinion, how the academic institutions and research centers can contribute in the technology transfer mechanism of the textile and apparel industry?
Question 7	Do you think technology management specialists can extensively contribute to manage their technological fundamentals? Please express your reason.
Question 8	According to your opinion, what are the steps to be taken by industry managers to effectively transfer a technology or technology component?
Question 9	Do you think, a model of technology transfer developed according to the innovative capacity of the industries can help the industries is ensuring sustainable technological development
Question 10	According to your opinion what will be the role of a Technology Transfer Office (TTO) in developing a smooth mechanism of technology transfer in the industries?

Statements in Consensus Originated from the Delphi Study

Sl No.	Statement	Mode of Consensus	Intensity of Consensus	General Positive/ Negative Consensus	Remarks
1	For technological development industries must be nimble, agile and responsive; for this they must adopt a mechanism or a strategy. A proper strategy helps proper integration of the elements of technological fundamentals and the new technological inclusion in the system gets easier.	Strongly Agree	100%	100%	Consensus Achieved
2	Every industry looking for technological development must have a long term strategy and that must be parallel with their business goal. Without appropriate strategy competitiveness in the long run cannot be achieved.	Strongly Agree	71.42%	100%	Consensus Achieved
3	Along with the innovative capacity the decision making process of the industries is also a vital factor for effective technology transfer.	Strongly Agree	57%	85.71%	Consensus Achieved
4	Without being innovative only the techno-ware component is transferred; industries cannot transfer skill-ware and info-ware of the technology.	Strongly Agree/ Agree	42.85%	85.71%	Consensus Achieved
5	Top management knowledge	Agree	42.85%	71.42%	Consensus

	level and flexibility are the key factors for industrial innovative capacity.				Achieved
6	Industry association like BGMEA, BKMEA, BTMA should open a state of the art technology transfer cell to assist industry in modern technology adaptation, manage resources and provide guideline & information.	Agree	42.85%	71.42%	Consensus Achieved
7	Industry association have to play a big role as a catalyst in technology assessment, quality assurance, policy dialogue and capacity development.	Strongly Agree	57.14%	85.71%	Consensus Achieved
8	Industry association should create a mutual assistance platform where industry owners can share common interests, build co-operations, foster information sharing and also offer training.	Strongly Agree	57.14%	100%	Consensus Achieved
9	Government should take initiatives to build a science and technology park dedicated for the textile and apparel sector to foster state of the art technological development.	Strongly Agree/ Agree	42.85%	85.71%	Consensus Achieved
10	Government must recruit people having education and experience in textile and apparel industry	Agree	57.15%	100%	Consensus Achieved

	and technology so that they can understand the need requirements in terms policy and other support. Textile Cadre in the BCS is mandatory now.				
11	Government must formulate proper policy regarding gas price and priority energy connections to the industries.	Strongly Agree	57.15%	100%	Consensus Achieved
12	Government can promote innovative industries by awarding incentives for value addition and energy efficient technology adoption.	Agree	57.15%	100%	Consensus Achieved
13	University should develop technology transfer cell or business incubation center or a research and innovation center to foster integrated and intensive research to formulate new technology so that the over dependence on the foreign source for technology can be checked.	Strongly Agree	57.15%	100%	Consensus Achieved
14	University-Industry collaborations should be strengthened and technology management specialists should be appointed to maintain a smooth flow of information.	Strongly Agree	57.15%	100%	Consensus Achieved
15	Positions like Technology Manager or Chief Technology	Agree	57.15%	85.71%	Consensus Achieved

	Officer must be created in the industries with incumbents experienced in technology transfer and development processes; Technology Managers must have autonomy within the organization in a controlled manner.				
16	Functional managers in the industry must develop their managerial skills through appropriate training and education.	Agree	57.15%	100%	Consensus Achieved
17	There must be a well-trained committee/team in the industry assigned to do the technology need assessment regularly and design technology transfer and development activities.	Strongly Agree	57.15%	85.71%	Consensus Achieved
18	Continuous Feedback Loop decision making system must be adopted in the industries to make sure there is continuous change in the technology development strategy according to organization need.	Agree	57.15%	100%	Consensus Achieved
19	The proposed conceptual model of technology transfer mechanism will help industry managers to adopt and assimilate transferred technologies.	Strongly Agree	57.15%	100%	Consensus Achieved
20	A specialized Technology Transfer Office (TTO) can be	Strongly Agree	57.15%	100%	Consensus Achieved

	developed to assist the industry in technology need capacity assessment, infrastructure and behavioral assessment. According to the assessment and the internal and external environment of the industry, the TTO will suggest appropriate model of technology transfer for the respective industries.				