ANALYSIS OF BARRIERS AFFECTING TECHNOLOGY TRANSFER IN SMES IN CUTTING TOOL INDUSTRIES

A thesis report submitted in partial fulfillment of
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Submitted By

ASHWANI KUMAR
Roll No: 801082004

Under the guidance of

Sh. SUPREET BHULLAR
Associate Professor
Mechanical Engineering Department
Thapar University, Patiala

DEPARTMENT OF MECHANICAL ENGINEERING
THAPAR UNIVERSITY
(Established under section 3 of UGC Act, 1956)
PATIALA – 147004
INDIA
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DECLARATION

I, **Ashwani Kumar** hereby declare that the work which is being presented in this thesis report entitled, '**Analysis of barriers affecting Technology Transfer in SMEs in Cutting Tool Industries**' by me in partial fulfillment of the requirements for the award of degree of Master of Engineering in Production and Industrial Engineering from MED, Thapar University, Patiala is an authentic record of my own work carried under the supervision of Sh.Supreet Bhullar, Associate Professor, Mechanical Engineering Department, Thapar University, Patiala.

The matter presented in this report has not been submitted in any other University/Institute for the award of Master of Engineering or any other degree.

(Ashwani Kumar) Date _____

This is certified that the above statement made by the candidate is correct to best of my knowledge.

(Sh. SUPREET BHULLAR)
Associate Professor
Department of Mechanical Engineering

(Countersigned by)

(Dr. Ajay Batish)
Professor and Head,
Mechanical Engineering Department
Thapar University, Patiala

(Dr. S.K. Mohapatra)
Dean of Academic Affairs
Thapar University, Patiala

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(Ashwani Kumar)

CONTENTS

ABSTRACT

Small and Medium Scale Enterprises (SMEs) in Punjab play a vital role in contributing to the growth of economic activities and also as an important part of the nation's economy. Technology is often considered as a determinant of the competitiveness of a SMEs and the technology lag can be regarded as one of the major constraints to the development of a competitive and sustainable SMEs sector in any region. In most of the SMEs, productivity and competitiveness cannot be enhanced without technology up-gradation through Technology Transfer and modernization

In this research, an attempt has been made to analyze the barriers which affect Technology Transfer (TT) in the Cutting Tool manufacturing Small and Medium Scale Enterprises (SMEs) in Patiala (Punjab) and to gauge the significance of each barrier so as to establish enablers to ensure smooth transition of technology from source to sink. To realize the objective a set of barriers was identified that led to the failure of the process of Technology Transfer in SMEs in Cutting Tool Industry. Questions were formulated on the basis of these barriers and a structured questionnaire was developed.

Response data related to these barriers was collected through the structured questionnaire. These responses were critically analyzed using statistical tools to establish a relation amongst barriers leading to obstructing a smooth transfer of technology in SMEs. The results of the study reveal that in the cutting tool industry in the region of Patiala, Punjab, out of a total of six barriers considered, Strategic Focus, Financial Aspect, Information and Communication Technology, Government Support, Technology Acquisition and Intra-Organizational Conflicts are the barriers that principally determine the efficient transfer of technology.

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CHAPTER-1

INTRODUCTION

1.1 Knowledge Economy

The Knowledge Economyis a term that refers either to an economy of knowledge focused on the production and management of knowledge in the frame of economic constraints, or to a knowledge-based economy**.** In the second meaning, more frequently used, it refers to the use of knowledge technologies (such as knowledge engineering and knowledge management) to produce economic benefits as well as job creation. The essential difference is that in a knowledge economy, knowledge is a product, while in a knowledge-based economy, knowledge is a tool. This difference is not yet well distinguished in the subject matter literature. They both are strongly interdisciplinary, involving economists, computer scientists, engineers, mathematicians, librarians, geographers, chemists and physicists, as well as cognitivists, psychologists and sociologists.

Various observers describe today's global economy as one in transition to a "knowledge economy," as an extension of an "information society." The transition requires that the rules and practices that determine success in the industrial economy need rewriting in an interconnected, globalized economy where knowledge resources such as know-how and expertise are as critical as other economic resources. According to analysts of the "knowledge economy," these rules need to be rewritten at the levels of firms and industries in terms of knowledge management and at the level of public policy as knowledge policy or knowledge-related policy.

Capitalism is undergoing an epochal transformation from a mass production system where the principal source of value was human labor to a new era of ‘innovation mediated production’ where the principal component of value creation, productivity and economic growth is knowledge.

The Knowledge Economy is emerging from two defining forces:

1) The Rise in Knowledge Intensity of Economic Activities.
2) The Increasing Globalization of Economic Affairs.

1.1.1 Rise in knowledge Intensityof Economic Activities

The rise in Knowledge Intensity is driven by the combined forces of the Information Technology revolution and the increasing pace of technological change. Globalization is driven by national and international deregulation, and by the IT related communication revolution. However, it is important to note that the term 'Knowledge Economy' refers to the overall economic structure that is emerging, not to any one, or combination of these phenomena.

This explosion has been driven by sharp falls in the cost of computing and communications per unit of performance, and by the rapid development of applications relevant to the needs of users. Digitalization, open systems standards, and the development software and supporting technologies for the application of new computing and communications systems including scanning and imaging technologies, memory and storage technologies, display systems and copying technologies are now helping users realize the potential of the IT revolution. It is in the Internet that these technologies come together, and it is the Internet phenomenon that exemplifies the IT revolution. An equally important feature of these technologies is their pervasiveness. While earlier episodes of technical change have centered on particular products or industrial sectors, information technology is generic. It impacts on every element of the economy, on both goods and services; and on every element of the business chain, from research and development to production, marketing and distribution. An equally important feature of these technologies is their pervasiveness. Information and Communication Technology investments are complementary with investment in human resources and skills. The skills required of humans will increasingly be those that are complementary with Information and Communication Technology not those that are substitutes. Whereas machines replaced labor in the industrial era, Information Technology will be the locus of codified knowledge in the Knowledge Economy, and work in the Knowledge Economy will increasingly demand uniquely human (tacit) skills such as conceptual and inter-personal management and communication skills.

1.1.2 Increasing Globalization of Economic Affairs

The other main driver of the emerging Knowledge Economy is the rapid Globalization of economic activities. While there have been other periods of

relative openness in the world economy, the pace and extent of the current phase of Globalization is without precedent.

The global communications revolution has been accompanied by a widespread to economic deregulation, including:

1) The reduction of barriers to Foreign Direct Investment (FDI)and other international capital flows and of barriers to technology transfers.
2) No longer does the industry face a domestic market protected from international competition.
3) Competition is becoming increasingly global and the ability to compete head to head in all major markets is essential for success.
4) Global production is bringing a new global rationalization of production, coordination, combination and accumulation of assets.
5) The comparative advantage of locations increasingly relates to firms' objectives, and is relative to those objectives.

1.2 Characteristics of the Knowledge Economy

The emergence of the Knowledge Economy can be characterized in terms of the increasing role of knowledge as a factor of production and its impact on skills, learning, organization and innovation. The following are some of the important characteristics emerging from Knowledge Economy:

1) Increasing codification of knowledge is leading to a shift in the balance of the stock of knowledge – leading to a relative shortage of tacit knowledge.
2) Information and Communication Technologies (ICT) increasingly favor the diffusion of information over re-invention, reducing the investment required for a given quantum of knowledge.
3) The increased rate of codification and collection of information are leading to a shift in focus towards tacit knowledge.
4) Learning is increasingly central for both people and organizations.
5) Learning involves both education and learning-by-doing, learning-by-using and learning-by-interacting.
6) Initiative, creativity, problem solving and openness to change are increasingly important skills.
7) The transition to a knowledge-based system may make market failure systemic.

1.3 Four Pillars of Knowledge Economy

The following pillars are four critical requisites for a country to be able to fully participate in the Knowledge Economy.

1.3.1. Education & Training

Education system around the globe, while far from perfect, produces a steady flow of skilled workers capable of creating, sharing and using knowledge. An educated and skilled population is needed to create, share and use knowledge.

1.3.2. Information Infrastructure

A dynamic information infrastructure-ranging from radio to the internet is required to facilitate the effective communication, dissemination and processing of information. Communication is the life line of a Knowledge Economy.

1.3.3. Economic Incentive and Institutional Regime

A regulatory and economic environment that enables the free flow of knowledge, supports investment in Information and Communications Technology (ICT), and encourages entrepreneurship is central to the Knowledge Economy. Patents, fair and disinterested courts to enforce them, and other features of commercial law give Entrepreneurs reason to believe they can reap some of the benefits of their innovation. This provides a strong incentive to create new technologies that benefit society.

1.3.4. Innovation

A network of research centers, universities, think tanks, private enterprises and community groups are necessary to tap into the growing stock of global knowledge, assimilate and adapt it to local needs and create new knowledge. Knowledge is a public good because all of society can benefit from it. But economic theory holds that societies tend to under invest in public goods. That is why even market economies need an innovation system to direct society's resources to the creation of knowledge. Innovation system includes its network of universities and research centers, think tanks community groups and private enterprises.

1.4 Technology Transfer

One of the key enablers of Knowledge Economy is Technology Transfer. The importance of Technology Transfer from a development perspective has been well established. One of the fundamental processes that influence the economic

performance of nations and firms is Technology Transfer. Economists have long recognized that the transfer of technology is at the heart of the process of economic growth, and that the progress of both developed and developing countries depends on the extent and efficiency of such transfer. In recent years economists have also come to realize the important effects of international technology transfer on the size and patterns of world trade.

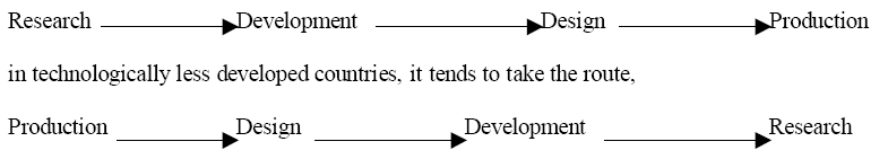
Technology Transfer (TT) is an area of interest not just to business, economists, and technologists but also to other disciplines such as anthropology and sociology. While anthropologists emphasize the impact of TT on changes in patterns of culture and society, sociologists have been more concerned with its role as a vehicle to develop the capacity of individuals and societies to cope with modernization and related changes accompany it. For economists, Mansfield (1975) the focus is on economic growth and achievement of economic goals. However, from the perspective of business and technologists, the main focus of TT is to improve the competitive advantage of firms through the enhancement of customer value. It is envisaged that, through the improvement of competitive advantage, a firm and its partners collaborating in the TT will gain financial and other strategic benefits.

From a business management perspective, the work of Hayami and Ruttan (1971) and Mansfield (1975) provide some of the earliest insights on the modes of TT, which are of relevance even today. Mansfield classified TT into vertical and horizontal TT. Vertical TT is defined as the process from new scientific knowledge through to industrial adoption to consumption, or as information flow from the basic and applied research stages, to development, to production levels. Horizontal TT is defined as the adaptation of a technology from one application to another or as the movement and use of technology used in one place, organization, or context to another place, organization, or context.

Hayami and Ruttan(1975) also refer to "material transfer, design transfer, and capacity transfer." Material transfer refers to the transfer of a new material or product while design transfer corresponds to the transfer of designs and blueprints that can facilitate the manufacturing of the material or product by the transferee. Capacity transfer involves the transfer of know-why and know-how to adapt, and

modify the material or product to suit various requirements. However, these typologies can really be subsumed within vertical and horizontal TT.

The above transfer modes were further elaborated on by (Amsden, 1989) and (Habibie, 1990) argued that while in developed countries the technology/product cycle took the route,



Learners do not innovate and must compete initially on the basis of low wages, state support, high quality and productivity (Amsden, 1989). The route 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. (Habibie, 1990) the architect of the Indonesian aircraft industry, states that, "technology receivers must be prepared to implement manufacturing plans on a step-by-step basis, with the ultimate objective of eventually matching the added-value percentage obtained by the technology transferring firm." Habibie (1990) 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, 1989).

Today, firms that own technology have many ways of exploiting their technological assets for profitability and growth. While internal exploitation of technological assets, through designing, developing, manufacturing, and selling products and processes continues to be important, interest in external exploitation, by selling the technology that a firm owns through Technology Transfer, has intensified in recent years. This may be attributed mainly to the globalization of business, liberalization of the economies of many developing economies, and greater emphasis on the protection of intellectual property after the formation of the World Trade Organization (WTO). Indeed, today, the transfer of manufacturing technology has become an important part of the international business strategy of firms. Similar flexibility exists in the case of buyers of

technology. In today's international business setting, depending on the attributes of the technology, its intended use, and the motivations of the transferee and transferor, a wide range of TT modalities are available (Ramanathan, 2001). The focus need not merely be on the purchase of plant and equipment or licensing. However, planning and managing a Technology Transfer project, especially an International Technology Transfer (ITT) project, is not easy. The experience gained over three decades, provides a comprehensive list of problem areas associated with Technology Transfer. Many of these problems still persist and with rapidly changing technological and business trends new problems have emerged. The productive entities that have been most affected by these problems are Small and Medium Scale Enterprises (SMEs). Large organizations can relatively easily gain access to the resources needed to overcome these problems unlike SMEs. Evidence exists to show that governments, international agencies, and Non-Governmental Organizations (NGOs) have all attempted to alleviate these problems by introducing various supportive measures. Yet, many of these measures make the tacit assumption that TT is a relatively predictable process whereby buyers of technology (transferees) acquire, assimilate, and then improve the purchased technology, often with the assistance from government policies. This approach tends to oversimplify the magnitude of the problem faced by SMEs in planning and implementing TT projects.

There are a wide range of problems faced by SMEs and this requires that Technology Transfer agencies adopt a holistic approach to assist SMEs to be successful in bringing the technologies they need, through TT projects, so that they can compete effectively and grow in today's global business setting by deciding as to how the Technology Transfer capability of a firm contributes towards customer value creation and enhanced competitiveness. Also, how the operations at a firm level can be influenced by the National Innovation System (NIS).

1.5 The Influence of the National Innovation System on the Firm

The productive entities of a nation, namely customer-value creating firms, are embedded within a National Innovation System (NIS) of a country. If the NIS supports and fosters "technology based" development, then the firms are better able to compete by enhancing customer-value through technology-based

interventions. Based on the work of (Sharif and Ramanathan, 2001) the NIS of a country may be, for the sake of convenience, be considered as consisting of the following interacting elements:

- Firms
- Physical infrastructure
- Facilitating infrastructure
- Collaborating infrastructure
- Market rivalry
- Clusters
- National policy setting

The "physical infrastructure" refers to the supply of electricity, water and related utilities, transportation facilities, and communication facilities. Clearly, if this is poorly developed or ineffective then firm level activities will suffer. In fact this is a critical issue in many developing nations.

The "facilitating infrastructure" refers to national/sectoral institutions, which play a catalytic role in guiding technology-based economic activities. These include institutions such as investment promotion boards, venture capital institutions, science and technology information centers, technology forecasting and technology foresight services, and Technology Transfer advisory services. These institutions can promote the commercialization of indigenous innovations and promote the transfer of the right technologies.

The "collaborating infrastructure" comprises the academic institutions engaged in science and technology education and research; the range of Research and Development (R&D) related organizations and design engineering and production units. Strong linkages between these this "triad" institutions can enhance technological activities.

Another element of the NIS, namely, "market rivalry" that exists in a country also fashions the technological trajectory of a firm. Extremely intense market rivalry may lead to a shakeout and only a few firms may eventually survive(Porter, 1990). The right level of rivalry in an industry improves industry attractiveness. It could also facilitate innovative behavior at the firm level

whereby each firm tries to retain and possibly enlarge its market share by trying to meet customer demands better.

The last element of the NIS, namely, "clusters" of related firms and industries comprising subcontractors, component dealers and manufacturers, and upstream and downstream industries can facilitate co-operation and enhance local content and economic value added in manufactured output.

The various elements of the NIS described this far, are embedded within a national development policy climate. A national policy that supports "technology-based development" is liable to remain a mere piece of rhetoric if it is not substantiated by a means of implementing it. These means are referred to as policy instruments. Policy instruments are the links between the expressed purpose and the results that are sought in practice. There are both direct and indirect policy instruments. The three major types of instruments for fostering "technology-based development" are legal instruments, financial instruments, and fiscal instruments. Examples of legal instruments which are technology specific are laws, acts, decrees, and regulations for the promotion of science, technology, and research and development activities, legal cover for various types of enterprises involving technology transfer, technology contract law, environment protection laws, and intellectual property law.

1.6 Small and Medium Scale Enterprises (SMEs)

Small and Medium Scale Enterprises are defined as those entrepreneurial units in business operations which operate and serve at a limited scale in limited vicinity, with limited means for operations, usually owned and controlled by single individual as owner-manager and sometimes owned as a family business. It is difficult to put definition of Small and Medium Scale Enterprises(SMEs) right away due to the nature and structure of SMEs. Several definitions are available for use.First, a look at how developed and industrialized nations in the West define SMEs and then operational definition from India's point of view will be derived.

1.6.1 Operational Definition of Small and Medium Scale Enterprises (SMEs) in Western Countries

1.6.1.1 United States of America (U.S.A)

The definition of small business is set by a government department called the Small Business Administration (SBA) in U.S. According to the Small Business Act, a small business concern is "one that is independently owned and operated and which is notdominant in its field of operation." The most widely used one in the entrepreneurship literature is the definition provided by the SBA. The SBA defines SMEs as stand-alone enterprises with fewer than 500 employees (Beamish, 1999).

1.6.1.2 European Union (EU)

European Union define SMEs in three distinct categories; medium-size, small and micro. The category of Micro, Small and Medium-Sized Enterprises (SMEs) is made up of enterprises which employ fewer than 250 persons and which have an annual turnover not exceeding 50 million euro, and/or an annual balance sheet total not exceeding 43 million euro. Small enterprises are defined as enterprises which employ fewer than 50 persons and whose annual turnover or annual balance sheet total does not exceed 10 million euro. Micro enterprises are defined as enterprises which employ fewer than 10 persons and whose annual turnover or annual balance sheet total does not exceed 2 million euro.

1.6.2 Operational Definition of Small and Medium Scale Enterprises (SMEs) in India

Discussion on various SME definitions leads to the main SME definition which is considered of Small and Medium Scale Enterprises Development Authority (SMEDA). SMEDA defines SME as:

“Small enterprise is defined as an enterprise which employs 10 - 35 employees and has productive assets of Rs. 2 - 20 million.”

“Medium enterprise is defined as an enterprise which employs 36 - 99 employees and has productive assets of Rs. 20 - 40 million.”

Table-1.1 SME definition proposed by SME policy

Size	Sector	Employment (a)	Total Assets (Excluding Land & Building) (Rs. Millions) (b)	Annual Sales (Rs. Million) (c)
Small	Manufacturing	≤ 50	Up to 30.0	≤ 100.0
	Service	≤ 50	Up to 20.0	≤ 100.0
	Trade	≤ 20	Up to 20.0	≤ 100.0
Medium	Manufacturing	51-250	30.0 to 100.0	100.0 to 300.0
	Service	51-250	20.0 to 50.0	100.0 to 300.0
	Trade	21-50	20.0 to 50.0	100.0 to 300.0

Source: SME Policy (2007)

SME sector of India is considered as the backbone of economy contributing to 45% of the industrial output, 40% of India's exports, employing 60 million people, create 1.3 million jobs every year and produce more than 8000 quality products for the Indian and international markets. With approximately 30 million SMEs in India, 12 million people expected to join the workforce in next 3 years and the sector growing at a rate of 8% per year, Government of India is taking different measures so as to increase their competitiveness in the international market.

There are several factors that have contributed towards the growth of Indian SMEs. Few of these include; funding of SMEs by local and foreign investors, the new technology that is used in the market is assisting SMEs add considerable value to their business, various trade directories and trade portals help facilitate trade between buyer and supplier and thus reducing the barrier to trade

With this huge potential, backed up by strong government support, Indian SMEs continue to post their growth stories. Despite of this strong growth, there is huge potential amongst Indian SMEs that still remains untapped. Once this untapped potential becomes the source for growth of these units, there would be no stopping to India posting a Gross Domestic Product (GDP) higher than that of US and China and becoming the world's economic powerhouse. Implementation of single definition recommended in SME policy (2007) can benefit SMEs in various ways like formal and legal procedures.

1.6.3 Importance of Small and Medium Enterprises (SMEs)

Small and Medium Scale Industry has gained popularity in the last 60 years by accomplishingto a great extent, the socioeconomic objectives like decentralization of industries and economic intrusiveness. Small Scale Industry generates employment opportunities for economically weaker section of society (Zenger, 1994).

The development of small business is viewed as highly important for the Indian economy. This is due to the fact that growth potential of small businesses in general and, on technology-based export-oriented small businesses in particular, can act as catalyst to further drive the industrialization process in India. It is within this framework that government support programmes for small businesses are potentially viewed as being highly important towards enhancing small businesses. Small and Medium Scale Enterprises (SMEs) are known to have contributed significantly to economic development job creation and sustainable livelihood (OECD, 2004).

Small and Medium Scale Enterprises (SMEs) have been regarded as the engine of economic growth and employments. As the growth of industry giants have been slowing, the role of SMEs becomes more important. The contribution of this sector to manufacturing output, employment and exports is significant. Actually, developing countries have increased their share both of export and import over last decade, and are expected to be doing continuously in future (Romero et al., 2012).

1.7 Enhancing Competitiveness of SMEs through Technological Capability

All enterprises whether they are large firms or SMEs can compete effectively only on the basis of "customer value creation." Customer value may be defined as a function of quality, delivery, flexibility, convenience, and cost. Quality represents how well the good or service meets customer expectations. Speed describes the time needed to design, produce, and deliver the good or service as characterized by determinants such as cycle time and speed to market. Flexibility reflects how easily and quickly the firm can modify goods or services to meet customer needs in terms of aspects such as options and extent of customization possible. Creating convenience for the customer implies not only speed of service, but also self-service, process visibility, and easy to use, streamlined, consistent, and reliable

customer service. Lastly, cost refers to all objective and subjective costs that the customer incurs to acquire, use, and dispose of the good or service and includes dimensions such as discounts, rebates, and incentives. Customer value is enhanced as quality, speed, flexibility, and convenience increases while cost decreases.

The framework, as depicted in Figure 1, implies that a firm acquires and deploys technology, to create customer value, through the fulfillment of productive activities. The effectiveness of these activities would be determined by the firm's core technological and supportive capabilities. The generic core technological capabilities include design engineering, research and development (R&D), production, and selling and CRM capabilities. The elements of these capabilities are listed below (Panda and Ramanathan, 1998).

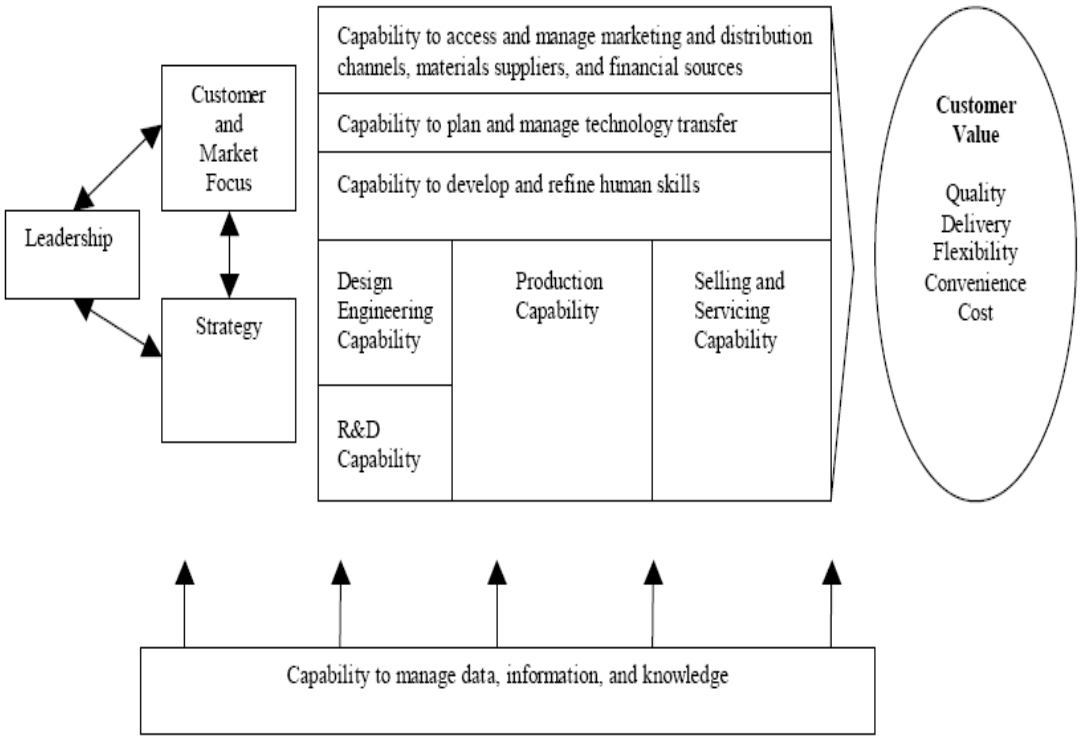


Figure 1: Customer Value Creation through Technological Capability

1.7.1 Design engineering capability

1) Capability to carry out routine design and detail engineering of a product/process.

2) Capability for adapting purchased technology.
3) Capability for duplicating purchased technology.

1.7.2 R&D capability

1) Capability to improve existing products and processes.
2) Capability to generate radical technologies.
3) Capability to develop expeditionary and future-oriented market intelligence for the development of new products and processes.

1.7.3 Production capability

1) Capability to effectively plan and control production operations and deliver quality.
2) Capability to carry out troubleshooting and total productive maintenance.
3) Capability to customize production.

1.7.4 Selling and servicing capability

1) Capability to reach customers and identify customer needs.
2) Capability to provide product information to customers.
3) Capability for managing customer relationships

These core technological capabilities have to be supported by generic supportive capabilities. These supportive capabilities include the following:

1) Capability to plan and manage Technology Transfer (specifies, identify, assess, negotiate, and finalize the purchase or sale of product, process, and peripheral technologies from global technology suppliers).
2) Capability to continuously develop and refine human skills (Human Resources Development – HRD).
3) Capability to access and work effectively with marketing and distribution channels.
4) Capability to effectively access necessary material inputs for production through effective partnering with global supply networks.
5) Capability to identify funding sources and obtain funds at competitive rates from global sources for expansion and growth.

CHAPTER-2

LITERATURE REVIEW

2.1 Theoretical Models

Some of the important theoretical models in context of creativity and innovation in SMEs are presented as follows

Benett and Hudson, (1999)studied the fast-changing global industrial environment is forcing companies to improve their competitiveness byacquiring new technical skills and investing inmore advanced technologies. However, therewere many factors inhibiting the adoption ofnew technologies, particularly by Small andMedium-Sized Enterprises (SMEs), including

1) Lack of capital investment funds.
2) Lack of staff to investigate new technology.
3) Lack of access to expert help.
4) Lack of time to investigate new systems.
5) Lack of knowledge of available systems

Benner and Sandstrom, (2000)analyzed the institutional regulation of academic research, with a special emphasis on how norms in the academic system wereconstituted via research funding.It wasargued that funding was a key mechanism of change in the norm system since its reward structure influences the performance and evaluation of research. The empirical analysis was based on the public financing of technical research in Sweden, with comparisons made with other countries. The two dominant models of research funding, an intra-academic model and a top–down interventionist model, seem to be replaced partly with a catalytic one. According to the studysome agencies still reproduce a model of reputational control and a collegial orientation among researchers. It was concluded that the forces of change and continuity are engaged in a process of negotiation about the normative regulation of academic research.

JudithSutz(2000) analyzed the University–Industry–Government relations in Latin America from two points of view: a ‘‘bottom-up’’ and a ‘‘top-down’’ one that considers the outcomes of the institutionalization efforts recently developed in the region. The results of the top-down mechanisms were reported to the well

below expectations of policy makers, in the sense that the historical low involvement of industry in knowledge and innovation activities — the reversal of which is one of the main goals of such mechanisms — has not substantially improved. The bottom-up experiences, on the other hand, usually exhibit successful results at micro level, but face great difficulties for broadening the impact of the technical solutions found.

Marri et al. (2002) studiedall SMEs, the long term goal was to stay in business, grow and make profit. Especially in manufacturing SMEs must understand the dynamic changes. According to the study, with the triangular cooperation Government-Industry-University, CIM can successfully be implemented in SMEs. A model had been developed with the help of an empirical study. Some of the findings and recommendation are:

1) SMEs face lack of government support in terms of necessary findingsto implement CIM.
2) Lack of collaboration with local universities. It is important for SMEs to collaborate with the universities in the areas such as short-term employee training, seminars/ workshops to explain CIM to factory managers.
3) Using University faculty as advisors and consultants, commissioning research to solve particular problems, providing placement opportunities for students will help facilitate transfer of knowledge.

Johnston and Loader (2003) studied was designed to provide insight barriers to Small to Medium Sized Enterprises (SME's) participation that could be addressed by training provider by examining evidence from training programme offered. Previous research findings identifying influences on SME's participation on training had been used an analytical framework to examine an experience of training design and delivery in practice. The analysis of a projected data within the framework identified supports some of the relationship between SME'S participation and these influences. SME's had been taken up the training; participation grewover a period of time. Finally it seems that the approach taken has been successfully in overcoming the barriers to SME's participation.

Debackere and Veugelers (2005) studiedthe transfer of scientific and technological know-how into valuable economic activity has become a high

priority on many policy agendas. Industry Science Links (ISLs) were considered an important dimension of this policy orientation. The study documented and analyzes the evolution of "effective" university-based Technology Transfer mechanisms. The research described how decentralized organizational approaches and incentives that stimulate the active involvement of the research groups in the exploitation of their research findings might be combined with specialized central services offering Intellectual Property management and spin-off support. More particularly, study analyzed how the creation of:

1) An appropriate balance between centralization and decentralization within academia.
2) The design of appropriate incentive structures for academic research groups.
3) The implementation of appropriate decision and monitoring processes within the TTO.

Gulbrandsen and Smeby(2005) the study reflected optimistic and pessimistic views on the implication of this development. The study reported that there wassignificant relationships between industry funding and research performance, professors with industrial funding describe their research as applied to a greater extent, they collaborate more with other researchers both in University and in Industry, and they report more scientific publications as well as more frequent entrepreneurial results. The study suggested that there was neither a positive nor negative relationship between University publishing and entrepreneurial outputs.

Elmuti et al. (2005) explored the essence of strategic alliances generally represent inter firm cooperative agreement aimed at achieving competitive advantage for the partners. Study discussed strategic alliances between corporations and institutions of higher education. The major underlying motives for creating these alliances and the critical success factors were also discussed. The paper also analyzed the success stories. Highlights the major advantages for the academic community research funding and practical learning opportunities for students and for industry lower research and development costs and technology transfer opportunities that affect competitiveness. The drawbacks included the partners' different working

cultures and values. The study reported that alliances must be supported by continuous learning and restructuring processes to overcome the differences.

Allen and Taylor (2005)studied the significant barriers impede the effective commercialization of new technologies created at universities. They reviewed the nature of these barriers and considered one solution in the form of a collaborative network environment i.e.National Network for Technology Entrepreneurship and Commercialization. Thestudy contributed on two levels to the knowledge of engineering managers who were attempting to rapidly implement technology:

1) It explained an important new tool for facilitating collaboration and commercialization.
2) It described the challenges met and overcome in the organization and implementation of a virtual network.

Pecas and Henrique (2006) contributed to the implementation of best practices of collaboration between university and industrial Small and Medium Sized Enterprises (SMEs). This paper presented the experience carried on collaboration between universities and SME companies should be based on a small projects base. These projects must be focused in localized problematic areas in the industrial companies, where the potential of improvement and innovation was large, must diagnose the problematic situation and propose new and efficient solutions supported by technical/scientific methodologies. The involvement of managers and collaborators of SME companies and the clearly definition of their roles in the project were fundamental issues for the collaboration success. Theresults achieved so far demonstrated a set of benefits:

1) Training of young engineering students for an active problem-solving attitude.
2) Promotion of a collaboration culture between SME and academia world for real problems-solving and for continuous improvement and innovation processes.

Pamela Muller (2006) studied the transfer and commercialization of knowledge through entrepreneurship as well as University– Industry relationships and the impact of this on regional economic growth. The study proposed following results are:

1) A well developed regional knowledge stock is a crucial determinant of economic performance.
2) Regions with a higher level of entrepreneurship experience greater economic performance.
3) Universities are a source of innovations. The more firms draw from knowledge generated at Universities, the more those regions experience economic growth.

Finally the studyconcluded that the proposed knowledge transmission channels entrepreneurship and University–Industry relations increase the permeability of the knowledge filter, thus improving regional economic performance.

Omar and Landry (2007) addressed four questions: What was the extent of the collaboration between the natural sciences and engineering researchers in Canadian universities and government agencies and industry? What were the determinants of this collaboration? Which factors explained the barriers to collaboration between the university, industry and government? Were there similarities and differences between the factors that explain collaboration and the barriers to collaboration?Finally, paper presented the results, and what they imply for future research and theory building. The study proposed a list of factors that affected the researcher's choice to collaborate with industry.

1) To look for business opportunities.
2) To gain knowledge about practical applications useful for teaching.
3) To generate additional research funds.
4) To create student internships and job placement opportunities.
5) To supplement funds for research assistants and laboratory equipment.
6) To supplement funds for the researcher's own research projects.

Yi Wang (2007) presented a strategic framework of successful knowledge transfer through the development of University-Industry interactions in China. The research was designed based on qualitative analysis. Data were collected through documentary analysis. Modes of University-Industry interactions during the process of knowledge transfer were identified, which contributed to the success of knowledge transfer at different stages of University-Industry relations. They are:

1) University-dependent low sticky interaction;
2) University-dependent high sticky interaction;
3) Mutual-dependent high sticky interaction; mutual-dependent low sticky interaction.

In addition, the development of entrepreneurial spirit within the university and the implementation of Professors of Practice have also been recognized as vital for building and maintaining effective University-Industry interactions.

Dooley and Kirk (2007)identified the requisite attributes and organization to be displayed by a research university in order to engage successfully in collaborative research with industry partners. The conceptual framework contrasted the traditional public funding model against the requirements of the "triple helix" model of Government-University-Industry research funding.According to the study, the design and leadership of the consortium achieved vital performance outcomes, namely:

1) Accelerating the production of new knowledge about cell signaling processes relating to serious diseases.
2) Faster transfer of new knowledge into drug development processes of pharmaceutical companies.

Elisa Ughetto (2007) interpreted Foresight in the light of the Triple Helix concept. The paper explores, in the light of the Triple Helix framework, the architecture of a Technology. Foresight could be seen as a way of catalyzing the multidisciplinary relationships among the three different spheres of the Triple Helix model, thus bringing them to dialogue and to share a common space for building visions on long-term challenges. Participation of stakeholders with different backgrounds, dynamics of overlapping opinions, emergence of hybrid organizations and exchange of formal roles are some of the elements characterizing a Foresight exercise that reflect a Triple Helix configuration.

Rangaet al. (2008) presented the results of a recent exploratory study aiming to enhance the innovative capacity of small firms in terms of economic growth. The triple helix perspective was adopted to examine the causes of the poor knowledge transfer among small firms, University, Government and others Public agencies. Main causes included insufficient communication between parties, specific

problems, poor visibility of Government programmes for small firms, high bureaucracy and overlapping of responsibilities between Government agencies with an entrepreneurship-support mission, cultural and language differences.A number of policy recommendations weresuggested, particularly at the University–Industry interface, as the 'university' institutional sphere appears to be the least active in the collaboration with smallfirms.

Bechina Arntzen (2008) presented a general framework for fostering research collaboration and knowledge flow between university and industry in Thailand. With the aim of comprehending complex interactions of the University-Industry linkage, the adopted research methodology for collecting data was based on a combination of various approaches, such as qualitative methods encompassing in-depth interviews, researcher participations and various documents analysis. A framework Government, University, Industry and Networks was developedencompassing the main factors that could make University-Industry relationships more successful in Thailand.

Ashekele and Matengu (2008) examined and presented empirical evidence on factors that contribute to the successes and/or failures in Technology Transfer using a case of wood work. The case study presented the empirical evidence of the impact of Technology Transfer framework on an SME manufacturing enterprise at the northern town of Rundu, Namibia. The paper further definedthe concept of Technology Transfer and reviews the Namibian government's policy and strategic framework for SME Technology Transfer in the private sector. Overall, the resultssupport the view that internal factors, such as personalcommitments, willingness to learn and competency, as well asexternal factors, such as access to a variety of services, stronglyinfluence the success of Technology Transfer.

Dewan and Nazmin (2008) studied the potential contribution of Information and Communication Technology (ICT) to improve the competitiveness of Small and Medium-Sized Enterprises(SMEs) in developing countries was long been recognized. The realization of this potential had been problematic and over recent years there had been a number of initiatives supported by government, non government and foreign agencies which have endeavored to aid and encourage the uptake of ICT to enable access to such promised benefits. Despite strong

theoretical arguments suggesting that ICT hadmuch to offer to SMEs, the study would seem to suggest that use of ICT by SMEs in Bangladesh Small and Cottage Industries Corporation's (BSCIC) industrial estates was still in its infancy. The study also identifies some significant barriers which were impacting upon the level of ICT adoption amongst SMEs, and confidence on ICT of the SMEs in Bangladesh.

Salvatore et al.(2008) explored some activities can be summed up as follows:

1) Determine the opportunities for Technology Transfer in terms of specific requirements.
2) Identify appropriate sources of technical breakthroughs, scientific information and other technological developments (or findings) that should meet the identified needs.
3) Build bridges between donor and recipient.
4) Follow through initial contacts with other complementary services (e.g. on IPR and innovation finance), skills and inputs to accommodate the transfer of the technology.

Bond et al. (2008) studied Knowledge Transfer networks and suggested that these were composed of interconnected firms, government entities, and research organizations that played a critical role in the funding, development industries.Using social network, social identity, and relevant attribution and motivation theories, a conceptual model that explained key outcomes of start-up Knowledge transfer network was developed. A preliminary empirical investigation found evidence that social identification with the networkwas a key moderating mechanism. Identification played a practical role in creating positive Knowledge-Transfer benefits for firms. Identification also played a symbolic role byaffecting participants' perceptions performance in light of Knowledge-Transfer benefits thatthey received.

Sandra Meredith (2008) examined the level of benefit to learning through developing strong links between universities and industry, suggested a methodology for building bridges between universities. A case study approach which included the development of interactive projects that join students with industry, and follow-up questionnaire surveys of the outcomes, carried out among

students and businesses. This paper asserted that student learning was considerably improved by completing the Learning Cycle with real-life experience. For the future, it was important to further develop this style of learning, not only for the benefit of students, but also to strengthen links between university and industry.

Simon Philbin (2008) purposed to improve the understanding of University-Industry research collaboration through the development of a new process model. A literature review was carried out on collaborative partnering and supporting factors namely social capital and the role of knowledge. Empirical research involved a series of 32 structured interviews with relevant stakeholders, and a new process model to be proposed. The study found that there was a lack of integrative frameworks for the management of research collaborations. The research focused on University-Industry research collaborations and although it may be applicable to other forms of collaborations. A model was proposed, which was a logical methodology that could be utilized by practitioners from both University and Industry in order to improve the process of research collaboration and facilitate more effective transfer of knowledge.

Giuliania and Arza(2009) explored the factors driving the formation of valuable University-Industry linkages conceived as those linkages between universities and firms that had a higher potential to diffuse knowledge to other firms in their regional economy. The empirical strategy combined case-study methodology with econometric techniques using data from two wine clusters in Chile and in Italy. The firm's knowledge base was found to be a key driver of valuable university-Industry linkages. It was conclude that selectivity should be encouraged among policy makers endeavoring to promote University-Industry linkages.

Burhanuddin and Arif (2009) explored the factors inhibiting the adoption of new technologies especially related to Information and Communication Technology (ICT) in the challenging world today. According to the study it was important to identify the primary obstacles they faced with regard in adopting new technology. In order for them to survive in a long run, thisstudy identified problems and constraints faced by SMI inMalaysia. Then, focus on the challenges and barriers for them in adopting new technology. The researchers visited few

foods processing SMI in the Southern Region of Malaysia and make comparison with few important publications on SMI development.

Mora et al. (2009) analyzed how obstacles to Industry–University relations affect the success of their cooperation models, using a sample of collaborations coordinated by the Technological and Industrial Development Center (CDTI) in research and development activities in service industries. The results showed that for the industry partner the key considerations affecting the dynamics of cooperation with research organizations weremissed deadlines and problems associated with the appropriation of results. The importance of these obstacles also had a negative effect on success, especially in aspects related to the results of the project and its overall performance.

YueFeifei (2009) discussed the issues associated with Technology Transfer in the pharmaceutical industry. Although Technology Transfer had received substantial attention amonggovernment, enterprise and universities in recent days, comprehensive strategy and holistic approach to deal with this issue was not considered. The study will first define the importance of Technology Transfer and discussed the factors that might impact the process. The study also focused on how companies can make Technology Transfer process a competitive weapon.

Toke Bjerregaard (2009) studied of the total population of university departments and SMEs involved in collaborative research projects sponsored by a new governmental programme in Denmark, the aim of which was to build new Research and Development alliances between Industry and Universities. Some collaborationwas thus informed by a short-term strategy aimed at achieving immediate Research and Development results. The findings pointed to the importance of taking the diverse reasons and micro strategies informing collaborative efforts into account when studying University-Industry collaborations. According to the study different strategies could prove successful in optimizing the outcome of University-Industry collaborations depending upon, e.g. partners' previous collaborative experiences.

Schmiemann M (2009) determined that American universities transfer technologies more rapidly and more effectively than their European counterparts.

The study reported that this was mainly because there were substantial cultural, legal, and regulatory differences between the two regions, and even within Europe. Alsothat European university could enhance their effectiveness in Technology Transfer if this function was given more visibility and prestige, enhanced public support, and formal procedures are implemented to facilitate benchmarking. The paper, examined some of the differences in university technology transfer in Europe and the U.S., and discussed these new approaches, which had recently been fully supported by the European Commission

Jasinski (2009) identified key barriers for Technology Transfer (TT) in a transitional economy. Poland was presented as a case study, with an emphasis on domestic TT.According to empirical research, the most disturbing barriers facing the enterprise sector are: R&D institutions not fully open or prepared to cooperate with firms; inefficient systems supportingcorporate innovation and R&D activities; obstacles hindering firms in acquiring outside financial resources, a lack of own financial resources; and a lack of innovative culture and mentality among employees.

Eom and Lee (2010) studied the determinants of Industry–University and Industry–Government research institute (IUG) cooperation, and its impact on firm performance. First, they find that among the determinants of IUG cooperation, traditional firm characteristic variables of size and Research and Development(R&D) intensity were not significant. Second, the study found no significant impact on the innovation probability of firms. The study suggested that the IUG cooperation could not guarantee the success of a firm in technological innovation. The study reported a positive impact of the IUG cooperation on patents generated from new product innovation but find none in terms of volume of sales or labor productivity. These results seemed to reflect the still transitional nature of the National Innovation System (NIS) and knowledge industrialization in Korea.

Bubelaand Caulfield (2010) analyzed that Technology Transfer Offices (TTOs) played a central role in the knowledge translation and commercialization agenda of Canadian universities. Despite, a disconnection between the expectations of government and research institutions and the reality of what Technology transfer

offices did. Interviews with professionals at Canadian Technology Transfer offices have revealed that, at their best, Technology Transfer Offices support the social and academic missions of their institutions by facilitating knowledge mobilization and research relationships with other sectors, including industry; however, the study reported that this did not always produce obvious or traditional commercial outputs. Thus, the existing metrics used to measure the success of Technology Transfer offices did not capture this reality and, as such, realignment was needed.

Furukawa et al. (2011) proposed a quantitative analysis of researcher mobility (i.e. transfer from one institution to another) and collaborative networks on the basis of author background data extracted from biographical notes in scientific articles to identify connections that are not revealed via simple co-authorship analysis. The research classified networks according to various dimensions including authors, institutions and countries. The results of the quantitative analysis indicate that mobility networks extend beyond the typical collaborative networks describing institutional and international relationships. The study also discussed sectoral collaboration considering the mobility networks. According to the study findings indicated a limitation of collaborative analysis based on bibliometric data. The method was subject to several limitations:

1) Only certain journals include biographical notes in their scientific articles, and many that did include biographical notes provide incomplete information.
2) Only the field of computer vision was examined, and as research into this field could easily be conducted at a large number of institutions.

The study developed complementary techniques for incorporating a broader range of scientific journals into our research to gain even greater insight.

Jawad Iqbal et al. (2011) studied the role of university, in the knowledge economy had been altered from knowledge producers to knowledge capitalizes for improved economic performance. Important attributes were identified from the studies conducted in the field of knowledge economy.Influence of identified attributes on university had been measured using structure equation modeling technique. Data in the study was collected using survey questionnaire. Apart from

above the “Time Factor” was also one of the limitations for this study. This research identified new dimension of university role in knowledge. The idea hadnot been explored completely. Future research can be performed in other developing countries as well. Due to the important role university in knowledge economy, a comprehensive research could also be conducted in future using other dimensions of research collaborations.

Siti Aishah et al. (2011) analyzed the Technology Transfer could not be successfully achieved if technology absorption capabilities were not taken seriously. This study was conducted to investigate the relationship between absorption capability attributes; employee capability, knowledge sharing, working culture, R&D capability and communication capability with Technology Transfer performance. The pilot study was conducted by using questionnaire surveys which were distributed to national automotive companies. The pilot results were analyzed using Statistical Process for Social Science (SPSS) software. In conclusion, by presenting this new development of absorption capability variables, the real data could be proceeded to be collected. However, the study suggested that an in-depth analysis was needed to be carried out to confirm the validation of the instruments used.

From the review of literature, it is evident that the indigenous technological capabilities of developing countries are generally weak and that, in the import of technology, a number of obstacles render the technology acquisition process less effective or a failure economically and/or technically (Awny, 2005). The general problems of the SME sector, apart from capacity-building in technology as reflected in various studies, highlight the inadequacy of SMEs in legislation, business networks particularly international, and various support services – financial, legal, and marketing. Even more pertinent is the lack of access to crucially needed venture capital for the creation of new SMEs and the continuance of existing operations. With interest rates on loans being quite high, and repayment periods relatively very short, SMEs cannot be expected to flourish. Currently, the progress of SMEs is hampered by weak infrastructure, insufficiency of electric power, and high costs of energy, water, and industrial space. The other drawbacks, such as the inability of SMEs to keep pace with the rapid development

in global finance and economy, and the inadequacy of their management and organizational practice, add to their burgeoning problems. The continuance of the enterprise reform process and the strengthening of SMEs are largely dependent on aid from international agencies and foreign countries.

The barriers to Technology Transfer that SMEs encounter vary across different sectors in different countries. However, many of the general problems can be classified under specific categories. Those problems that are typical to SMEs as recipients of technology (sink) i.e. the problems they face within the firm and also those that occur at the source level from the SMEs' perspective of the technology providers (source) as problem centers may be grouped under the first category. The sources of technology for SMEs are large firms; public research institutes or R&D laboratories; and academic research institutes. The second category, based on the review of literature, is formed on the basis of the type of problems SMEs encounter. These problems are associated primarily with the pre-acquisition stage, the post-acquisition stage, and other factors.

The following factors were identified from the review of literature that are inherent to technology transfer in SMEs.

1) Pre-Technology Acquisition Strategy Focus

The success of Technology Transfer depends largely on the decisions made prior to the acquisition of the technology in question. Here, planning has to take place at different levels, be it the organizational and management aspects of technology choice, or organization preparedness for the acquisition. From the organizational and management perspective, SMEs as recipients feel hindered by the lack of a formalized and institutionalized mechanism within the firm, where technology choice could be discussed comprehensively. Alternative or similar technologies are not evaluated, particularly in terms of their pricing. SMEs admit that often they fail to be realistic, and their selection of technology is inappropriate. Probing a little more into the absence of institutional mechanisms, we observe a lack of coordination among different planning entities, and their inability to reach a consensus on the criteria to be used for technology choice as also on prioritization, if more than one related technology needs to be acquired. Observations have been recorded on inadequate planning in choosing appropriate technology for adoption/adaptation at the pre-acquisition stage, laboratory scale, pilot plant, or

commercially proven level as the case may be (Desai, 1985; Kahen, 1995; Rosenberg and Frischtak, 1985; Saad et al, 2002; Ramanathan, 1994). These cover the following:

- No assessment of the number of research units that need to be engaged in the transfer process.
- No assessment of the number and the nature of employees to be involved.
- No serious consideration of the project's viability.
- No regard for the division of work into small, manageable units.
- No/limited attention to technology obsolescence.
- No study of the utilization of excess capacity and the volume of resources such as suitability/availability of local raw material.
- No training of personnel and no assessment of skill levels.

Problems also arise from the non-assessment of forward and backward linkages with the present set-up, and inappropriate mechanisms for implementing the transfer (Kotelnikov, 2008). According to (Intarakumnerd et al. 2002), only a small minority of large subsidiaries large domestic firms and SMEs has the requisite capability in R&D, whereas the majority still struggle with improving their design and engineering capability.

SMEs are also impeded by the differences in the competence level of source and sink in technical knowledge, the lack of skill in the collection and the analysis of relevant data, and inadequate information on service/product mix.

A crucial issue often ignored by SME management is the lack of provision of incentive systems for learning and assimilating new technologies or the process thereof. (Chen and Sun, 2000) have recorded their observations on the lack of motivational policies for professionals to engage in the technology transfer process.

SMEs, on the other hand, have witnessed at the source level to a lack of formalized and institutionalized criteria, resulting in the adoption of the monocular dimension (Moon et al., 2004). The delivery of technology and systems is too complex at the source which has already to contend with a general inability of planners or key decision-makers to extend their 'field of vision' as also inadequate research of the mechanisms chosen for implementing the technology transfer. SMEs too encounter problems since they observe inadequate

planning in choosing appropriate technology for commercialization, even at the source level when the provider has alternative options available. (Yang, 2001) note that such unsound technology expertise or tacit knowledge makes it difficult for SMEs to comprehend the technology on offer.

Underestimation by the source of problems in transferring technology to a developing country setting, or overestimation of SMEs' technological capabilities, results in unrealistic expectations in meeting deadlines and targets (Awny, 2005). The source's limited understanding of the sink's needs and the over-emphasis on hardware with meager focus on soft skills (Saad et al., 2002) adds to the problems. Further, the complexities in the collection and the analysis of relevant data hold true for the technology provider's domain too. SMEs often complain of the technology provider's overdependence on a key individual or on predicted contingencies (e.g. an oil price hike) which aggravates complexities once the key person leaves or the expected emergency does not occur.

i. **Lack of Planning and Strategy Making**

   Successful organizations in today's business environment are those who play who plan in advance and use different planning tools. It includes effective manpower planning recruitment and selection process, realistic performance plans development oriented performance appraisal, effective learning system providing ample learning opportunities with the help of training, performance guidance and other mechanism such as mentoring.

ii. **Partner Selection**

   Inadequate information about the transferor; the lack of easy access and linkages to Technology Transfer agencies, and to other intermediary organizations, as also to the transferor's bank references, balance sheets, and/or annual reports slow down, or at times even stall, the technology transfer process (Saji et al., 2005). (Tidd and Izumimoto, 2002), (Feldman et al., 2002) suggest that the indecisiveness on the nature of partnerships (joint venture, strategic alliance) as also the lack of surety about the mechanisms of technology acquisition (licensing, sub-contracting, acquisition of company, imitation, foreign purchase, or informal means) often thwart the transfer of technology.

   Obstacles to successful foreign affiliations are another major concern for SMEs. (McNamara, 2005) found that the global SMEs were adept in

adjusting to international market standards, but less skilled in forging ties with local sector networks. This study highlighted the disparate leanings in Korean and Japanese manufacturing SMEs in China and Thailand, respectively, which revealed strong home country links but relatively weak ties with local host country networks.

A similar scenario prevails at the source, where SMEs encounter inadequate information and, due to the technology provider's over-dependence on their foreign partner, unnecessary delay in decision making.

iii. Technology Choice

The most crucial barrier for SMEs in choosing appropriate technology is the high reached within the firm on the specific technology to meet their objectives, the market price of the chosen technology is often found to be exorbitantly high, necessitating a redraft of the SME's objectives as also a search for other sources of finance. The studies by (Avnimelech and Teubal, 2006), (Mohan, 2004), and (Zucker et al., 2002) reveal problems in seeking venture capital/early stage funds in the case of start-ups. In a similar context, problems arise due to the lack of incubation units (Menon, 2002; Macdonald and Joseph, 2001). SMEs face considerable difficulty due to the management's poor clarity on the capital requirements; it's mistiming of expenditures, and inability to carry out a financial analysis, for example, in the form of input-output ratio calculation, and related subjects. The consequences of such lapses are that the management takes expedient rather than rational decisions.SMEs consider that the technology offered by the transferor has a very high valuation.

iv. Negotiation Skills in Technology Transfer

The inability to negotiate with the technology provider, particularly in respect of the cost of technology, as also in implementing parameters, hinders the transfer process. The lack of negotiation skills among members in the SMEs results in incompatibility in the stated objectives of source and sink. Another restraining factor is the lack of mutual trust (Manimala and Thomas, 2005). Also, the differences in negotiation approaches and strategies lead to complexities.

2) Post –Technology Acquisition

Another crucial problem during the post-acquisition stage is the inability of SMEs to adapt the chosen technology to local needs. This is often due to the high cost and the poor quality of locally available materials. Other barriers hindering the smooth transfer of technology are the highly centralized transfer and implementation process; and, often due to reasons of secrecy, the interminable delays, and sometimes even the project's termination. The case study in (Manimala and Thomas, 2005) of an Indian firm acquiring technology from a German source is a classic illustration of the problems cited above.

SMEs consider that the shortage of experienced Technology Transfer professionals and inadequate technological maturity are serious hindrances in the delivery system. And delays in the supply of supplementary materials and equipment required for speedier implementation further stymie operation targets. The SME perspective also reflects the improper handling and the inadequate availability of technical knowhow at different stages of development at the source. This may be the case at the initial documentation stage, pre-production, small-scale production, or mass production level.

i. Lack of Talents in Labour Market

Although some owner-managers of small businesses consider their human resource practices and problems as a high priority and they also acknowledge that Human Resource Management(HRM) can play a significant role in developing competitive advantage, but one of the biggest difficulties faced by them is gaining competitive edge form the improved capability of the people. The number of staff and managers are not sufficient in SMEs and the management level is relatively low. As a result, this sector cannot meet the need of in-house innovation and other R&D activities.

ii. Lack of Appropriate Entrepreneurial and Managerial Skills

The activity and characteristics of small business, especially in the stage of their creation and the early phases of their development, are directly linked to the characteristics of the entrepreneur. Entrepreneurship is the process of creating something new with the values by developing the necessary time and effort. It requires the devotion of time and effort. The most important is that the entrepreneurship required risks taking abilities and creativity which lead to development of the organization (Hewitt, 2005).

iii. Market Forces and Competitiveness

The failure of SMEs to conduct a professional market research deprives them of an accurate evaluation of the acquired technology's market potential (Avnimelech and Teubal, 2003). This is especially so in the case of start-ups, which are at a disadvantage because of their limited or complete absence of focus on marketing channels comprised of distributors, wholesalers, retailers, and such other entities. (Motohashi, 2003) observes that SMEs concentrate too much on immediate sales, and show scant attention to the importance of collating and analyzing broad-based information and formulating a long-term strategy for dealing with major fluctuations in the business environment. In the case of combating competitiveness, the major shortcoming of SMEs is the total disregard of an assessment of suppliers and competition in their limited research efforts (Grieve, 2004). The study by (Grieve, 2004) highlights the SMEs' stance on the lack of assessment of market size, segmentation, customers, suppliers, competitors, price, etc. on the part of technology providers. SMEs feel that some effort towards such estimation needs to be carried out at the source. SMEs allege that the technology provider is unable to outsmart competition in similar business and that its grasp of the tactics of competition warfare is deficient.

3) Intra-Organizational Conflicts

The small firms find it extremely difficult to accept and to implement available technology, as their employees lack the requisite education and the appropriate skills (Lundvall, 2002). The lack of proper documentation and inept handling of information and people at different stages of development be it during transfer, at the production stage, or at the post-acquisition level lead to problems at the time of implementation. The inability of the staff involved at the pre-acquisition level to explain the procedural know-how to members at the implementation level is a major setback. The lack of face-to-face talks with key implementers, both at source and sink, and the non-involvement of competent people in the implementation and the operation of new technology cause serious bottlenecks in the delivery of technology and its operationalization (Saad et al.,2002). SMEs also experience difficulty in team integration.

Another barrier to Technology Transfer at this stage is the problems encountered in the integration of new technology. This arises from the neglect to monitor the

performance of the new technology and its synchronization with other technology interfaces. In other words, the key people involved in implementation fail to grasp the essentials of plant and machine layout, equipment positioning, repairs and troubleshooting, testing, quality control, and other operational procedures. Other closely related problems arise from constraints in production and conformity assessment (Saad et al., 2002) where the technology's novelty has been wrongly assessed, particularly in the absence of a comparative evaluation with other domestic or international counterparts. Further, the failure to estimate the technology's cost and pricing and to arrange working capital for smooth operations adds to the existing risks.

1. Unequal division of power can give rise to conflict.
2. Both identical and diverse goals may be a source of conflict.
3. Forced cooperation can be a source of conflict.

4) Financial Factors

A common yet crucial problem for SMEs is the high transaction cost involved and the restricted cash flow (Kotelnikov, 2008). Augmenting this financial bind is the ongoing deprivation of sufficient capital at the development stage, which is essential in the case of start-up firms. At the management level, the fault lies in poor timing of expenditures, and the neglect of a professional financial analysis and assessment of the risks entailed and the expected returns. For instance, many SMEs tend to ignore the calculation of the debt/equity ratio or the equity/capital structure; the break-even point or profitability; and the estimation of the growth potential due to the technology transaction. Some of the obstacles in financial factors are:

1. Problem in getting loan
2. Poor investment abilities
3. Lack of systematic budget system
4. Low capital base

5) Government Support

The limited incentives provided by the government to acquire technology place SMEs at a disadvantage. Further, governmental support in the Technology Transfer process is inadequate (Avnimelech and Teubal, 2003), government approvals and certifications are impeded by long delays, and excessive interference by the government often adds to the existing problems (Jin and Zou,

2002). Some SMEs are also unaware of the regulatory norms. NGOs are working on socio-economic sector in the development of SMEs. They are privately owned organization registered under the social welfare act. They normally work through grants, aids or donation based finances. They are having a very constructive role in the SME development. The special property of this sector is gender development. They at some places tried to replicate Grameen banks model. Non-governmental Organization(NGO), a non-for-profit agency not affiliated with any government or private sector entity, devoted to managing resources and implementing projects with the goal of addressing social problems. NGO is a community based organization with its own management structure. The organization may receive some or all of its operating funds through a government department known as the funder; however it is accountable or answerable to its stakeholders -the people who stand to benefit or lose by its actions. The funder is one of those stakeholders. NGOs play a vital role in development of SME. NGOs helps to reduce poverty, NGOs create awareness in women of rural areas to develop small business in their own premises. The viewpoint here is that the lack of adequate fiscal and monetary incentives in the Technology Transfer process (Jin and Zou, 2002) pushes up the price of the technology that the SMEs negotiate for purchase from the transferor. Similar to the problems faced by SMEs, the source is also subject to delays in getting approvals and certifications from the government, slowing down the entire Technology Transfer process.

6) Lack of Information, and Communications Technology (ICT)

The lack of communication infrastructure and of a similar business network has been recognized as a drawback by (Kotelnikov, 2008) as also by SMEs. The other problems relating to Information and Communications Technology (ICT) are the lack of reliance of SMEs on e-commerce and e-trading, insufficient resources to obtain information and to explore opportunities for technology transfer and up-to-date information about technology target markets and the lack of SMEs' knowledge in the application of ICT in the production process. Difficulties also arise from the fact that most SMEs do not have a web presence which denies access to their profiles. Yet another barrier is that the transfer of know-how and know-why (if applicable) is not language-specific. In a case involving transfer from Japanese source to Indian sink, the Technology Transfer agreement specified

that all communication and know-how transfer should be in English (Kumar and Bhat, 2001).

SMEs experience inadequate communication and a deficient business network at the source (Rao, 2001). The lack of appropriate resources to obtain information and to explore the opportunities for technology transfer and up-to-date information on technology target markets, particularly about SMEs, is a serious impediment in the transfer process. The language barriers also inhibit effective communication between sources and sink personnel. An interesting case of Technology Transfer from a German firm to an Indian company records that the language barrier caused significant complications (Manimala and Thomas, 2005). The incompatibility of stated objectives with the SMEs is yet another problem at the source.

Other barriers from the review of literature included the following:

1) Industry Associations

SMEs often do not explore avenues for information and knowledge, be it prospective buyers/sellers, technology exhibitions/fairs, related on-line services, publications, conferences/seminars, and the patent literature and databases. At other times, problems may arise due to erroneous information from such sources. Another frustrating issue is the high service fees that some agencies charge for providing expertise to SMEs. The problem of information seepage is also not ignored when the same supporting agencies may be sharing vital technical or organization details with competitors of the SME. Often, no attention is paid to the supporting agencies in Technology Transfer. SMEs also perceive that the technology provider's association with big supporting agencies and industry associations often hampers and/or delays the transfer process, as key decisions are taken in consultation with the latter.

2) Academia-Industry Relationship

The limited or complete lack of shared R&D infrastructure, which may be very cost-effective, is a constraint. The interactive nature of the innovation process makes it necessary for firms to cooperate with other organizations to conduct their Research and Development (R&D) initiatives, including competing firms, research organizations, government laboratories, industry research associations, and universities. Academia-Industry (A-I) alliances represent an evolving trend for the advancement of knowledge and new technologies. Collaboration between

industries and universities has emerged as one of the priorities in the Organization for Economic Co-operation and Development (OECD) countries and has become a trend in European innovation policy. Relationships of this type have long been considered crucial to the development of the innovation system in any country. The collaboration of academia and industry leads to mainly two types of transfers from university to industry; these are R&D results transfer and Technology Transfer. The R&D results transferred leads to innovative ideas in industry which leads to new product development with the help of Technology Transfer from university to industries. For firms, A–I collaborations provide access to new knowledge and technologies, can solve technological problems in products and manufacturing processes, and maintain access to highly trained students, facilities and faculty members in university. Academia-Industry research strategic alliance is a new pattern to convert economic growth methods as well as to implement the scientific outlook on development. Among partners external to the firm, collaboration with universities has been championed as a vital component of innovation in knowledge intensive sectors within regions. Academia-Industry collaboration can stimulate learning and help drive the advancement of new technologies.

3) Intellectual Property Rights

The most commonly stated problem of SMEs in respect of Intellectual Property Rights (IPR) is the substantial expenditure required to file and maintain Intellectual Property (IP). The SMEs' apparent lack of interest in IP protection, the high cost of obtaining a patent, and the prospect of larger litigation costs these factors combine to discourage SMEs from investing in patents, particularly in foreign countries (Xueyi, 2007). It has been observed that many developing countries with the help of a change in their IP systems and laws are able to attract Foreign Direct Investment (FDI) in the Research and Development (R&D) especially in the industrial and the scientific field. Therefore, promotion and protection of the intellectual property spurs economic growth, creates new jobs and industries, enhancing the quality and enjoyment of life. Licenses to use patents, trademarks and copyrights are often combined with transfer of know how in the form of training and are increasingly an important term in such transactions. This lack of a stated clause pertaining to ownership of IPR, particularly in the case of start-up firms offering technology to SMEs, leads to grave problems later on

(Vohora et al., 2004). Due to resource constraints, SMEs are often unable to file IP in other countries for licensing the technologies which would result in the realization of revenue returns; often, the alliances/tie ups among big firms for innovation and patent strategy exclude SMEs and thereby erect an entry barrier.

The perception of SMEs is that the high cost of IP filing leads to escalation in the price of technology. SMEs also observe that the transferors do not assess the need for IP for commercialization (Aggarwal, 2000). The other drawback is the lack of clarity over ownership of the IPR title, which leads to disputes.

4) Other Important Factors

Often, SMEs ignore the established safety norms. They are not equipped to deal with environmental concerns (Carrol and Turpin, 2002) and pay scant attention to sustainable development. Environmental issues are most frequently a result of the interaction between human activities of production and the environment. Under fierce competitive pressure in the market economy and as part of the coping strategy when faced with difficulties to cover basic needs, enterprises and individuals are creating environmental issues. These drawbacks result in delays in getting government clearances and may lead the SMEs into difficult predicaments with environmentally conscious people and concerned NGOs, particularly on issues of health, education, and the environment.

SMEs perceive that the technology providers do not follow adequate safety considerations nor do they convey the same at the time of negotiations at the pre-acquisition stage. Environmental concerns, such as the utilization of less energy, are also not addressed by the transferor.

Large geographical distance between source and sink not only escalates the cost of Technology Transfer but also obscures communication. Often, the need for successful technology choice or its implementation is facilitated by physical presence at the site for face-to-face talks. SMEs are often at a disadvantage when they are not located in industrial clusters, and science/ technology/ entrepreneurs parks. Cultural differences lead to the lack of adaptability to and understanding of the source's work culture. This problem is even more acute when the source is a foreign country whose different language is often misinterpreted. Yet another barrier is the lack of investment insurance which ensures risk coverage for the SMEs.

2.2 Conceptual Model

Based on the examination of the literature review and scope of the present research, a conceptual model has been derived and presented in figure 2.1. The issues which have come into picture from the literature review are broadly classified into four areas which include Strategic Focus, Intra-Organizational Conflicts, Technology Acquisition, Financial Aspect, Government Support and Information and Communication Technology. It is proposed to focus on these six dimensions of barriers in an industry.

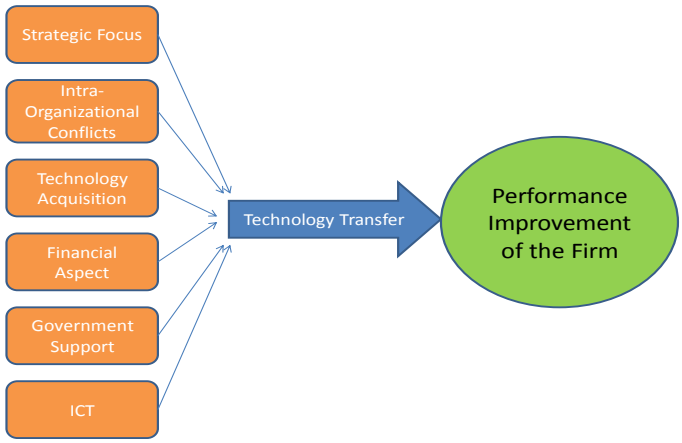


Figure-2 Conceptual Model of Research Work

2.3 Research Hypotheses

Prior studies of small business in developing countries have identified Financial Aspect, Government Support, Lack of Information and Communication Technology, Lack of Strategic focus (lack of market research, Technology Choice, Partner Selection etc), Technology Acquisition as the main barriers to Technology Transfer. (Manimala and Thomas, 2005; Kotelnikov, 2008; Lundvall, 2002; Saad et al., 2002). While some of the studies have produced inconsistent findings, others have shown inconsistencies that render additional research necessary. So, these barriers were taken input parameters and the various indicators of development of improved performance of the firm.

As a result, the following hypotheses are proposed so as to increase our understanding of the problems experienced by business owners in the region.

1. H_1 Strategic focus significantly affects the Technology Transfer in SMEs.

2. H_2Intra-Organizational Conflicts significantly affects the Technology Transfer in SMEs.
3. H_3 Technology Acquisition significantly affects the Technology Transfer in SMEs.
4. H_4 Financial Aspect significantly affects the Technology Transfer in SMEs.
5. H_5 Government Support significantly affects the Technology Transfer in SMEs.
6. H_6 Information and Communication Technology (ICT) significantly affects the Technology Transfer in SMEs.

CHAPTER-3

PROBLEM FORMULATION

3.1 Gaps in Literature

From the literature review, evidence shows that a substantial amount of work in the area of Technology Transfer has been carried out successfully. Most of this work has been reported in the Western Countries and the East Asian Countries. All the successful collaborationsbetween the source (organization providing the technology) and the sink (organization embedding/adopting the technology) involving Technology Transfer were based on high level of interactions and on the identification of key enablers before initiating the transfer process. Literature also indicates that most of the research in the area of Technology Transfer considered region specific factors of the source and the sinkwhile assuming other factors as constant or too insignificant as to affect the Technology Transfer process.Literature also shows significant use of the channel of Government – University – Industrycollaboration, while addressing issues Technology Transfer related to Large Scale Industry and some SMEs. In India, limited research has been done in this regard which mainly considers the influence of a few factors affecting Technology Transfer. Also very limited work has been done in the Cutting Tool Industry especially in Punjab inIndia.Theproposed work will critically analyze the internal and external barriers affecting successful Technology Transfer in the Cutting Tool Industry in Punjab and will determine factors contributing significantly towards successful Technology Transfer.

3.2 Objective of the Study

To analyze the internal and external barriers affecting successful Technology Transfer in the Cutting Tool Industry in Punjab and will determine factors contributing significantly towards successful Technology Transfer.

3.3 Research Methodology

1. Technology Transfer

- Evaluation of current technology
- Type of methodology used to check alignment between existing and new technology

- Government policy changes
- Competitor's adoption of new technology

2. **LinkageandSupport Structures of SMEs**
   - Government laboratories/Institutes
   - Expertise from within local milieu (clusters)
   - Technology Transfer institutions
   - Agencies supporting organizational R&D
3. **Barriers to Technology Transfer in SMEs**

   i. **Strategic Focus**
      - Technology choice
      - Negotiations in deciding royalty
      - Technical assistance from source
      - Partner selection

   ii. **Technology Acquisition**
      - Lack of Talents in Labour Market
      - Market Forces and Competitiveness
      - Lack of Appropriate Entrepreneurial and Managerial Skills

   iii. **Intra-Organizational Activities of SMEs**
      - Opposition by employees
      - Management problems
      - Lack of information

   iv. **Financial Aspects**
      - High cost incurred during transfer of technology
      - Lack of technology transfer fund
      - High interest rate

   v. **Government Support**
      - Concession to SMEs
      - Lack of Tax Rebates
      - Licensing to Technology Transfer

   vi. **Communication and ICT-Enabling Environment**
      - Lack of appropriate resources to obtain information
      - Lack of resources for up-to-date information on technology target markets about SMEs

The study was carried out in Small to Medium Scale Cutting Tool Organizationsin Patiala region of Punjab that had successfully implemented or were in the process of implementing Knowledge and Technology Transferinitiatives. The selection of the region was primarily done on the basis of the dominance of the SMEs in the cutting tool sector in Punjab and their market presence. The research methodology after an exhaustive literature survey included the following:

1. Identifying Independent and Dependent variables.
2. Formulating a Questionnaire based on the variables identified.
3. The format of questionnaire included a balanced combination of Dichotomous as well as scaled questions to elicit responses that would lead to reliable analysis.
4. Questionnaire reliability using Cronbach's Alpha.
5. Data collection and Analysis.
6. Results and suggestions.

3.3.1 Questionnaire Design:

For effectively conducting the survey, the first task was to design a questionnaire. A relevant and detailed questionnaire containing objective type questions with multiple choice answers pertaining to the desired conceptual framework was designed. Responses were taken from the personnel at the managerial position or from the owners/ entrepreneurs. Scaled items were used in the analysis, since the research interest was to examine the effects of independent variables on dependent variables.

3.3.2 Questionnaire Validation and Reliability: The 'Technology Transfer Questionnaire' was prepared through an extensive literature review and validated through peer review from academicians, and practitioners from the industry. To ensure the relevance and effectiveness of the questions to the manufacturing industry, the questionnaire was pre-tested on a representative sample of industry chosen on statistical basis and type of industry under the scope of present research work. The suggestions received from peers, academic experts, and senior executives from industries were incorporated to make the questionnaire more relevant to the purpose so that it may bring out key outcomes. The objective was to confirm that responses were based on correct interpretation of the questions. A reasonable consistency was found in the responses of manufacturing companies to the questionnaire items. The

qualitative feedback provided was very helpful in the preliminary efforts to assess the reliability of the scales. Further, Cronbach's Alpha coefficient was determined for each aspect as well as the item-to-total correlation for empirical analysis.

3.3.3 Sampling and Data Collection: The survey included personal visits (along with a postpaid reply envelope) and the questionnaire was mailed to the 50cutting tool organizations in the sample frame (organizations to be surveyed were chosen at random from among the member industries of various 'District Industrial Centers' of different districts in the state of Punjab). Each questionnaire was sent personally to the respondent after a short enquiry in which the person was asked to participate. This technique additionally offered the opportunity to verify the respondent's data. A reminder with an additional copy of the questionnaire was sent to all the non-respondents to the initial study. A total of 35 responses were received and elimination of incomplete or unusable responses resulted in 25 cases.

3.3.4 Analysis of response

The analysis of responses of the survey was carried out from the following view points:

Technology Transfer Process was considered to comprise of seven main components (or aspects):

- Strategic Focus
- Intra-Organizational Conflicts
- Technology Acquisition
- Financial Aspect
- Government Support
- Information and Communication Technology (ICT)
- Research Output as a result of successful Technology Transfer process to SMEs

The status of each component of 'Technology Transfer Implementation Program' was been evaluated and discussed for the Cutting Tool Sector.

3.3.5 Empirical Analysis: The empirical analysis was carried out to evaluate the factors contributing to Technology Transfer initiatives towards achieving manufacturing performance improvements. Relationships between input success factors and output

performance parameters were explored in the study. For this, independent and dependent constructs (variables) were formulated based on literature review and the objectives of this research. Constructs related to Technology Transfer activities were categorized as dependent variables whereas, the enablers, factors enabling Technology Transfer were categorized as independent variables.

The six distinct inputsconstruct (Enablers) that influenced the Technological Transferobjectives included:

- Strategic Focus
- Intra-Organizational Conflicts
- Technology Acquisition
- Financial Aspect
- Government Support
- Information and Communication Technology (ICT)

The output performance parameter was based on construct that comprised of the following parameter:

- Degree of importance of factors in Technology Transfer.

Statistical Tools: The convergent and discriminant validities of the constructs and their measures were carried out. Various statistical tools and techniques were employed using SPSS software (SPSS 20.0) to predict the results.

i. **Cronbach's Alpha Coefficient:** This parameter was used for convergent validity. It is assessed by the correlation among items which make up the scale or instrument measuring the construct (internal consistency validity). The internal reliability of items (inter-item analysis) under each output parameter was assessed by using Cronbach's Alpha coefficient, as recommended for empirical research in operations management. Cronbach's alpha is an index of reliability associated with the variation accounted for by the true score of the 'underlying construct'. Construct is the hypothetical variable that is being measured. Alpha coefficient ranges in value from 0 to 1 and may be used to describe the reliability of factors extracted from dichotomous (that is, questions with two possible answers) and/or multi-point formatted questions or scales. The higher the score, the more reliable the generated scale is (Best

and Kahn, 1986; Flynn et al. 1990; Radhakrishna, 2007). Cronbach'sAlpha coefficient (α) is defined as per the following equations.

$$\alpha = \frac{N}{N-1}\left(1 - \frac{\sum_{i=1}^{N}\sigma_{Y_i}^2}{\sigma_X^2}\right) \quad \text{---------- Equation 3.1}$$

Here, N is the number of components (items or testlets), $\boldsymbol{\sigma^2_X}$is the variance of the observed total test scores, and $\boldsymbol{\sigma^2_Y}$ is the variance of component i.
Alternatively, the standardized Cronbach's alpha can be defined as

$$\alpha = \frac{N \cdot \bar{c}}{(\bar{v} + (N-1)\cdot \bar{c})} \quad \text{---------- Equation 3.2}$$

Here, **N** is the number of components (items or test-lets), $\bar{v}$ equals the average variance and $\bar{c}$ is the average of all co-variances between the components.

ii. t-Test Analysis: To find the relationship between key inputs and key outputs, Pearson's correlation coefficient values (r values) between various issues of inputs and the Transfer Indicators (output parameters) have been calculated. The correlation values obtained was further validated using t-test. Pearson's correlation values and t-values (obtained from t-test) were worked out to ascertain significant issues and factors contributing to the success of TT implementation program in industry. The t-values obtained (from t-test) can also be worked out through empirical expression indicated in Equation 3.3.

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}} \geq t_{n-2} \text{ (from't' Tables)} \quad \text{---------- Equation 3.3}$$

Here, '**n-2**'represents degrees of freedom (df) for a particular test, '**r**' represents Pearson's correlation coefficient between a particular input issue and an output parameter, '$\mathbf{t_{n-2}}$'is the $t_{critical}$ value from statistical tables for (**n–2**) degrees of freedom.

iii. Multiple Regression Analysis: Further, multiple linear regression analysis was performed taking into account a set of all independent variables and each dependent variable individually. This technique was used to identify a set of

variables which conjointly contribute significantly towards the criterion variable. The notations employed in this test include: β= Regression Coefficient (Beta Coefficient), R= Multiple Correlation Coefficient.

3.4 Conclusion

Based on the data collected from the questionnaire, barriers in Technology Transfer were identified and suggested to Industries for enabling successful Technology Transfer.

The analysis constituted the use of the following tools:

1. Correlation between key inputs and output parameter.
2. Regression Analysis of independent variables with dependent variable.

CHAPTER-4

ANALYSIS OF FINDINGS

Data which was surveyed needs further statistical analysis to explain of hypothesized relationships and to achieve research objectives.

This chapter presents the results of statistical analysis and highlighting significant findings.

Since the relationships observed were linear according to correlation analysis were employed. The detailed Questionnaire were subjected to Cronbach's Alpha and data collected was analyzed using correlation analysis using statistical package software system (SPSS 20) through the spread sheet application of Microsoft Excel 2007.

4.1 Reliability Analysis of Questionnaire

Table-4.1 Cronbach's Alpha value

Factors	Cronbach's Alpha
Factor 1 Strategic Focus	0.715
Factor 2 Intra-organizationalconflicts	0.701
Factor 3 Technology Acquisition	0.795
Factor 4 Financial Aspect	0.740
Factor 5 Government Support	0.739
Factor 6 Information and Communication Technology	0.720
Factor 7 Technology Transfer	0.750

The suggestions received from peers, academic experts, and senior executives from industries were incorporated to make the questionnaire more relevant to the purpose so that it may bring out key outcomes. The objective was to confirm that responses were based on correct interpretation of the questions. A high degree of consistency was found in the responses of manufacturing and engineering executives to the questionnaire items. The qualitative feedback provided was very helpful in the preliminary efforts to assess the reliability of the scales. From the Cronbach'sAlpha analysis all the factors satisfies reliability test. Further,

Cronbach's Alpha coefficient was assessed for each scale item as well as the item-to-total correlation for empirical analysis.

4.2 Correlation Analysis

To find the relationship between key inputs and key outputs, correlation coefficient values between various issues of inputs and the Transfer Indicators (output parameters) have been calculated. The correlation values obtained have been worked out to ascertain significant issues and factors contributing to the success of TT implementation program in SMEs.

Results and Discussions:

From the Correlation Analysis, we analyze:

1. Input factor 1 Strategic Focus significantly correlates ($r=0.499^{*}$; $p=0.013$; $t=2.76^{*}$) with output factor Technology Transfer. Thus Hypothesis H_1 was accepted and hence it was concluded that Strategic Focus moderately affects the Technology Transfer to SMEs. Therefore, correlation between Strategic Focus and Technology Transfer was significant at the 0.05 level of confidence.
2. Input factor 2 Intra-Organizational Conflicts significantly correlates ($r=0.585^{**}$; $p=0.003$; $t=3.45^{**}$) with output factor Technology Transfer. Thus Hypothesis H_2 was accepted and hence it was concluded that Intra-organizational Obstacle strongly affects the Technology Transfer to SMEs. Therefore, correlation between Intra-Organizational Conflicts and Technology Transfer was significant at the 0.01 level of confidence.
3. Input factor 3 Technology Acquisition significantly correlates ($r=0.555^{**}$; $p=0.005$; $t=3.19^{**}$) with output factor Technology Transfer. Thus Hypothesis H_3 was accepted and hence it was concluded that Technology Acquisition strongly affects the Technology Transfer to SMEs. Therefore, correlation between Technology Acquisition and Technology Transfer was significant at the 0.01 level of confidence.
4. Input factor 4 Financial Aspect significantly correlates ($r=0.418^{*}$; $p=0.038$; $t=1.97^{*}$) with output factor Technology Transfer. It means Hypothesis H_4 was accepted and hence it was concluded that Financial Aspect significantly affects the Technology Transfer to SMEs. Therefore, correlation between Financial Aspect and Technology Transfer was significant at 0.05 level of confidence.

Table-4.2 Correlation analysis of Input factors with Output Factor

Correlations Analysis								
		Strategic Focus	**Intra-organization conflicts**	**Technology Acquisition**	**Financial Aspect**	**Govt. Support**	**ICT**	**Technology Transfer**
Strategic Focus	Pearson Correlation (r)	1	0.472*	0.294	0.163	0.087	0.193	0.499*
	Sig. (2-tailed) (p)	-	0.020	0.164	0.447	0.685	0.366	0.013
	T value (t)	-	2.56*	1.47	0.79	0.41	0.94	2.76*
Intra-organizational Conflicts	Pearson Correlation (r)	0.472*	1	0.378	0.276	.124	0.376	0.585**
	Sig. (2-tailed) (p)	0.020	-	0.069	0.192	0.564	0.070	0.003
	T value (t)	2.56*	-	1.95	1.37	0.599	1.94	3.45**
Technology Acquisition	Pearson Correlation (r)	0.294	0.378	1	0.303	-0.252	-0.085	0.555**
	Sig. (2-tailed) (p)	0.164	0.069	-	0.150	0.234	0.695	0.005
	T value (t)	1.47	1.95	-	1.52	-1.24	-0.409	3.19**
Financial Aspect	Pearson Correlation (r)	0.163	0.276	0.303	1	0.156	0.512*	0.418*
	Sig. (2-tailed) (p)	0.447	0.192	0.150	-	0.466	0.011	0.038
	T value (t)	0.792	1.37	1.52	-	0.757	2.85*	1.97*
Govt. Support	Pearson Correlation (r)	0.087	0.124	-0.252	0.156	1	0.571**	0.100
	Sig. (2-tailed) (p)	0.685	0.564	0.234	0.466	-	0.004	0.643
	T value (t)	0.418	0.599	-1.24	0.757	-	3.33**	0.481
ICT	Pearson Correlation (r)	0.193	0.376	-0.085	0.512*	0.571**	1	0.436*
	Sig. (2-tailed) (p)	0.366	0.070	0.695	0.011	0.004	-	0.033
	T value (t)	0.943	1.94	-0.409	2.85*	3.33**	-	2.32*
Technology Transfer	Pearson Correlation (r)	0.499*	0.585**	0.555**	0.418*	0.100	0.436*	1
	Sig. (2-tailed) (p)	0.013	0.003	0.005	0.038	0.643	0.033	-
	T value (t)	2.76	3.45**	3.19**	1.97*	0.481	2.32*	-
*. Correlation is significant at the 0.05 level (2-tailed).				**. Correlation is significant at the 0.01 level (2-tailed).				

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5. Input factor 5 Government Support indicated weak correlation (r=0.100; p=0.643; t=.481) with Technology Transfer. Thus Hypothesis H_5 was rejected and hence it was concluded that Government Support showed weak correlation with Technology Transfer to SMEs due to lack of collaboration process in the Patiala region of Punjab.
6. Input factor 6 Information and Communication Technology (ICT) significantly correlates ($r=0.436^{*}$; p=0.033; $t=2.32^{*)}$ with output factor Technology Transfer. Thus Hypothesis H_6 was accepted and hence it was concluded that ICT moderately affects the Technology Transfer to SMEs. Therefore, correlation between ICT and Technology Transfer was significant at the 0.05 level of confidence.

   From the correlation matrix, it was inferred that all variables except Government Support showed weak correlation with dependent variable and Intra-Organizational Conflicts indicated highest correlation value of 0.585.

4.3 Multiple Regression Analysis

Further, multiple linear regression analysis was performed taking into account a set of all independent variables and each dependent variable individually. This technique was used to identify a set of variables which conjointly contribute significantly towards the criterion variable. The notations employed in this test include: β= Regression Coefficient (Beta Coefficient), R= Multiple Correlation Coefficient.

Results and Discussion

From the multiple regression analysis, we analyze:

From the model summary, the Adjusted R Square value tells us that our model accounts for 49.4% of variation in the dependent variable**.**

From the coefficient table, the standardized beta coefficients give a measure of the contribution of each variable to the model. Using the enter method, a significant model emerged, Adjusted R square = 0.494 Significant variables were shown below:

i. Beta value (β=0.213), which indicated positive value, means dependent variable was increases in response to a greater use of the independent variable.

ii. Beta value (β=0.168) which indicated positive value, means dependent variable was increases in response to a greater use of the independent variable.

iii. Beta value (β=0.467) which indicated positive value, means dependent variable was increases in response to a greater use of the independent variable.

iv. Beta value (β=-0.056) which indicated negative value, means dependent variable was decreases in response to an increase in independent variable.

v. Beta value (β=-0.062) which indicates negative value, means dependent variable was decreases in response to an increase in independent variable.

vi. Beta value (β=0.435) which indicates positive value, means dependent variable was increase in response to a greater use of the independent variable.

I. From the multiple regression analysis, I analyze Financial Aspect and Government Support were negative related with the dependent variable.

II. Technology Acquisition indicated higher value of beta (β=0.467) and 'p' was less than 0.05. Hence, this was emerged as the most important predictor of the model. The results that emerged from correlation matrix were replicated by regression results

Table-4.3 Multiple regression analysis of combined input variables with output variable

Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.791[a]	0.626	0.494	0.4995

a. Predictors: (Constant), ICT, Technology Acquisition, Strategic Focus, Government Support, Financial Aspect, Intra-Organizational Conflicts

Coefficients[a]					
Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.(p)
	B	Std. Error	Beta (β)		
(Constant)	-0.840	0.690		-1.217	0.240
Strategic Focus	0.219	0.175	0.213	1.249	0.229
Intra-organizational Conflicts	0.208	0.238	0.168	0.875	0.394
Technology Acquisition	0.559	0.223	0.467	2.506	0.023
Financial Aspect	-0.080	0.274	-0.056	-0.292	0.774
Government Support	-0.076	0.232	-0.062	-0.328	0.747
ICT	0.587	0.311	0.435	1.888	0.076
a. Dependent Variable: Technology Transfer					

4.4 Conclusion

This chapter presented the data analysis using different techniques to fulfill the research objectives, showing the relationship between studied factors and their probable behavior in relation to each other. The hypothesis and relationships of all study factors were well supported by the research findings.

CHAPTER -5

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The survey was administered on the SME's in the Cutting Tool Industry at Focal Point, an Industrial hub for Cutting Tool Industry in the Patiala region of Punjab. This was a pilot study done for a limited sample size in order to ascertain the barriers in Technology Transfer. The Questionnaire was designed to learn more about Technology Transfer taking place in the SMEs, investigating the factors such as, their knowledge base, their interaction with supporting agencies, and the typical barriers to Technology Transfers. The study was also formulated to map broadly Technology Transfer issues in SMEs in the Cutting Tool Industry, which would review the existing practices in Technology Transfer, both vertically with governmental organization, and horizontally among networks of SMEs and provide preliminary indications of barriers in Technology Transfer.

The outcome of the study helps to clarify, at the abstract level, the complexities in the Technology Transfer process as well as highlights the barriers and their impact on Technology Transfer in SMEs in the Cutting Tools Industry. By listing select barriers in a Technology Transfer process, this study provides a preliminary research reference and document support to policy-makers interested in the development of knowledge infrastructure in SMEs, and thereby facilitating a broad understanding of the creation of suitable conditions for the progress of SMEs in the transfer of technology. The study gives reasonable indications of the relationships that exist between the dependent variable and independent variables

5.2 Results

5.2.1 Correlation Analysis

- Strategic focus was showedmoderate correlation(r=0.499*; p=0.13; t=2.76*)with Technology Transfer in SMEs at a 0.05 level of significance.
- Intra-organizational obstacle was showedstrong correlation (r=0.585**; p=0.003; t=3.45**) withTechnology Transfer in SMEs at a 0.01 level of significance.

- Technology Acquisitionwas showed strong correlation (r=0.555**; p=0.005; t=3.19**) with Technology Transfer in SMEs at a 0.01 level of significance.
- Financial Aspect was showed moderate correlation(r=0.418*; p=0.038; t=1.97*) with Technology Transfer in SMEs at a 0.01 level of significance.
- Government support was showed weak correlation(r=0.100; p=0.643; t=0.481) with Technology Transfer in SMEs at a 0.01 level of significance.
- ICT was showed moderate correlation(r=0.436*; p=0.033; t=2.32*) with Technology Transfer in SMEs at a 0.01 level of significance.

From the correlation matrix, it was inferred that all variables except Government Support were significant and Intra-Organizational Conflicts indicated the highest correlation value of 0.585.

5.2.2 Multiple Regression Analysis

- Adjusted R square value tells us the all the independent variables account 49.4% variance in the dependent variable.
- From the multiple regression analysis, I was analyzedFinancial Aspect and Government Supportwere negative related with the dependent variable.
- Technology Acquisition indicated higher value of beta (β=0.467) and 'p' was less than 0.05. Hence, this was emerged as the most important predictor of the model.

5.3 Discussions and Recommendations

- To improve Technology Acquisition strategy so as to improve the utilization of excess capacity and the volume of resources such as suitability/availability of local raw material and the problems encountered due to the non-assessment of forward and backward linkages with the present set-up and inappropriate mechanisms for implementing the transfer. SMEs encounter inadequate information and due to the technology provider's over-dependence on their foreign partner, unnecessary delay in decision making is introduced thereby overshooting transition dates and affecting performance and efficiency of the SMEs.
- The government needs to act as an enabler or a facilitator for SMEs to provide matching grants for technology absorption as well as addressing constraints to other

financial factors such as improving credit information on SMEs, strengthening collateral registries, and facilitating leasing.

- SMEs needs to expand their network to seek support from the financial sector: bankers, financiers, including domestic and foreign investors, venture capitalists, and angel investors. At the intra-organizational level, cost-cutting measures need to be adopted a requirement that is superfluous if financial planning is undertaken in advance, and reassessment is carried out at periodic intervals of the Technology Transfer process.
- SMEs needs to prepare systems of Information and Communication Technology support to encourage the development and the transfer of competence. A crucial area that needs their attention is the strengthening of technology-upgrading initiatives, including technology hardware support and softer organizational capabilities.
- Provision of an incentive system, proper documentation, exposure through trade fairs/exhibitions, and careful observation of safety, environment, and energy norms, and such other factors further reinforce the SMEs' capability in the Technology Transfer process.
- The development of Human Resource Development in specific industries must be identified. Linkage should be established between training and credit programs so that the SMEs are in a position to invest in the up-gradation skills.
- Participation of SMEs in international exhibitions, business delegations and buyer-seller meets must be facilitated to assist them in accessing foreign technology transfer for their production requirements.
- Academia-Industry collaboration can stimulate learning and help drive the advancement of new technologies.

5.4 Future Scope

While carrying out the present study, a number of areas have come to focus, where detailed research can be taken up. These areas demand more exploration and analysis through further research. The scope for future work has been presented as follows.

- The present study has been carried out with a sample of 25 industries only. The results of the study can be further validated by taking a larger sample of industries in the Cutting Tool Sector.

- The present study has been carried out by taking 6 input variables as determinants of Technology Transfer; this study can be further done by taking into consideration some more input variable impacting Technology Transfer in Small Scale Industries.
- The present work has concentrated on manufacturing industry only. The work can be extended to other categories like process industry, and other sectors in the manufacturing industry etc.
- Comparisons can be drawn with Medium Scale Industries in the same sector so as to find common ground for improvement and use expertise to streamline the Technology Transfer process.
- Work can also be explored in the dimension of the degree of support extended by the government at the local, state and the national level with respect to the industry sector.
- Impact of forming industrial clusters in Technology Transfer can also be an explored.

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APPENDIX-I

Detail of Respondent to the Questionnaire

S.No.	Name of the Organization	Adress	Year of Inception	Main Product
1	Aro Tech Industries	D-9, Focal Point, Patiala	2003	*Master Gears, Straight and Bevel Cutters Blades*
2	Bhasker Cutting Tool	D-76, Focal Point, Patiala	2009	*Milling Cutters, Piper Cutters*
3	Canon Tool Company	D-149, Focal Point, Patiala	1996	*Gear Hobs, Milling Cutters*
4	Eskay Tool Industries	D-228, Focal Point, Patiala	2001	*Hobs and Gear Cutters*
5	Ferro Tech Tools	C-134, Focal Point, Patiala	2005	*Reamers, End Mill Cutters, Slitting Saw*
6	Ganesh Corporation	D-91, Focal Point, Patiala	1997	*Cutting Tools*
7	Global Enterprises	C-6, Focal Point, Patiala	1995	*Gear Hobs, Milling Cutters*
8	Jeevandeep Tools	D-110, Focal Point, Patiala	1997	*Shank Type Tools, End Mill cutters*
9	Jyoti Tools	A-18, Focal Point, Patiala	1985	*Gear Hobs, Milling Cutters, Form Tools*
10	Kapson India	D-99, Focal Point, Patiala	1999	*Shaving Gear Cutters, Gears Worm*
11	K.V Tools	Sirhind Road, Patiala	2001	*H.S.S. Milling Cutters*
12	Lalson Tool Corporation	D-277, Focal Point, Patiala	2002	*H.S.S. Cutting Tools*
13	Modules Tools	D-268, focal Point, Patiala	2006	*Hobs, Masters Gears, Gear Shapers Cutters*
14	Perfect Engg. Tools	D-16, Focal Point, Patiala	1994	*Reamers, Dovetail Cutters*
15	Precision Tools	D-136, Focal Point, Patiala	2007	*Shank Type Tools, End Mill cutters*
16	P.S. Tools	D-207, focal Point, Patiala	2011	*Cutting Tools*
17	R.J. Tools	D-8, Focal Point, Patiala	2003	*Reamers, EndMill Cutters*
18	Shakti tool Industries	D-291, Focal Point, Patiala	2005	*Reamers, End Mill Cutters, Slitting Saw*
19	Shaktiman Tech Tool	D-205, Focal Point, Patiala		*Broaches*
20	Star Auto Industries	D-57, Focal Point, Patiala	2004	*End Mill Cutters, Slot Drills, Counter Bore*
21	Super Hobs and Broaches Ltd	B-22, Focal Point, Patiala	1999	*Side and Face Cutters, Slotting Saw*

22	Surya Tools Industries	D-97, Focal Point, patiala	1998	*End Mill Cutters, Slot Drills, Counter Bore*
23	United Broaches Company	D-220, Focal Point, Patiala	2006	*Involute Gears, Shank Type Tools*
24	Versa Agro Industries	D-33, Focal Point, Patiala	1999	*Cutting Tools*
25	V.V. Industries	D-86, Focal Point, Patiala	2012	*Cutting Tools*