

**TECHNOLOGY MANAGEMENT STRATEGIES FOR GLOBAL
COMPETITIVENESS: A POST TRIPS STUDY OF SMALL AND
MEDIUM MANUFACTURING ENTERPRISES OF PUNJAB**

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CERTIFICATE

Certified that the thesis entitled "Technology Management Strategies for Global Competitiveness: A Post TRIPS Study of Small and Medium Manufacturing Enterprises of Punjab" which is being submitted by Mr. Vijay Jain, in fulfilment of the requirement for the award of the Degree of Doctor of Philosophy in Management, Thapar University, Patiala, is a record of the candidate's own independent and original research work carried out by him under my supervision and guidance. The matter embodied in this thesis has not been submitted in part or full to any other University or Institute for the award of any degree.

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CONTENTS

Chapter No.	Topic	Page No.
CHAPTER I :	INTRODUCTION	1-14
	1.1 INDIAN MANUFACTURING	2-5
	1.2 PUNJAB MANUFACTURING	5-10
	1.3 RATIONALE FOR THE STUDY	11
	1.4 OBJECTIVES OF THE STUDY	12
	1.5 ORGANISATION OF THESIS	12-14
CHAPTER II :	REVIEW OF LITERATURE	15-32
	2.1.1 Studies on Technology-Productivity Relation	15-19
	2.1.2 Studies on Innovation and IPRS	19-27
	2.2 STUDIES ON TECHNOLOGY MANAGEMENT STRATEGIES	27-31
	2.3 GAPS IN EARLIER STUDIES	31-32
CHAPTER III :	RESEARCH DESIGN AND METHODOLOGY	33-46
	3.1 PHASES OF RESEARCH	33-34
	3.2 RESEARCH DESIGN	34
	3.3 DATA	35
	3.3.1 Secondary Data	35
	3.3.2 Sample Size and Sampling Technique	35-36
	3.4 DETAILS OF QUESTIONNAIRE	36-40
	3.5 RELIABILITY AND VALIDITY	40-41
	3.6 RESEARCH FRAMEWORK	42
	3.7 OBJECTIVES OF THE STUDY	43
	3.8 HYPOTHESES	43

Chapter No.	Topic	Page No.
	3.9 TOOLS AND TECHNIQUES	43-44
	3.9.1 Chi-square (χ^2)	44-45
	3.9.2 The Analysis of Variance (ANOVA)	45
	3.9.3 Factor Analysis	45
	3.9.4 Canonical Correlation and Multiple Regression Analysis	45-46
CHAPTER-IV :	PRODUCTIVITY AND INTELLECTUAL PROPERTY RIGHTS: POST-TRIPS ANALYSIS	47-63
	4.1 NATURE OF INDUSTRY: POST-TRIPS SCENARIO	47-48
	4.2 TOTAL FACTOR PRODUCTIVITY OF PUNJAB AND INDIAN MANUFACTURING IN POST-TRIPS PERIOD	48-52
	4.2.1 Determinants of Total Factor Productivity of Punjab Manufacturing	52-57
	4.3 INTELLECTUAL PROPERTY RIGHTS: POST-TRIPS SCENARIO	57-59
	4.3.1 State-wise Patenting Scenario	59-60
	4.3.2 Sector-wise Patenting Scenario	60-61
	4.3.3 Country wise Patenting Scenario	61-62
CHAPTER-V :	TECHNOLOGY MANAGEMENT STRATEGIES ADOPTED BY MANUFACTURING SMES: FIRM LEVEL ANALYSIS	64-90
	5.1 PREFERRED CHOICE OF TECHNOLOGY MANAGEMENT STRATEGIES	66-71
	5.2 NATURE OF INDUSTRY AND TECHNOLOGY ADOPTION STATUS	71-73
	5.2.1 Performance Indicators	73-74
	5.2.2 Increase in Range of Goods and Services Introduced	74-75
	5.2.3 Market Share	75-76

Chapter No.	Topic	Page No.
	5.2.4 Persons Employed in R and D	76-77
	5.2.5 Improvement in Quality of Goods and Services Produced	77
	5.3 NATURE OF INDUSTRY AND IMPACT OF TRIPS ON MANUFACTURING SMES	78-79
	5.3.1 SMEs and Intellectual Property Rights	80-82
	5.4 REASONS FOR FILING IPRS	82-84
	5.5 FACTORS INFLUENCING INNOVATION IN MANUFACTURING SMES	84-88
	5.6 FACTORS FOR PROMOTING IPR ENVIRONMENT	88-90
CHAPTER-VI :	CONCLUSION	91-100
	6.1 SUMMARY OF THE RESULTS	91-93
	6.2 REVISITING THE RESEARCH QUESTIONS	93-96
	6.3 IMPLICATIONS OF THE STUDY	98-99
	6.4 LIMITATIONS OF THE STUDY	99
	6.5 RECOMMENDATIONS FOR FURTHER RESEARCH	99-100
REFERENCES:	BIBLIOGRAPHY	101-111
APPENDICES :		
	Appendix – I : Questionnaire	112-116
	Appendix – II : List of Publications	117-118
	Appendix – III : State- wise Patents Filed	119

ABSTRACT

Indian firms have taken decades to catch up with global productivity levels. The time has now come to focus on technology management strategies with a focus on Intellectual Property Rights. Advances in technology have created new opportunities for businesses and new global rules giving value to technology matter a lot in the present times. New rules endorsed by all countries have brought tighter Intellectual Property Protection worldwide. They raise the market value of technology, increasing incentives to invest in R& D. IPRs are mostly filed by large and dominant firms, but it is right time now for SMEs to focus on the IPR strategies and initiate steps to enhance IPR culture in Small and Medium Enterprises of Punjab Manufacturing. The present study has been undertaken to understand the technology management strategies adopted by manufacturing SMEs of Punjab in post-TRIPS period. The study also covers the innovation and Intellectual Property Rights status of manufacturing SMEs of Punjab in India in the Post-TRIPS period. The results highlight the low filing of IPRs as well as low focus on R & D.

Technological innovation is an important challenge faced by Small and Medium enterprises (SMEs). This study investigates the factors which influence the growth, performance, and development of IPR attitude of SMEs in India. The study makes an attempt to highlight the extent of Intellectual Property Rights of Indian manufacturing as a whole and a survey analysis has been undertaken for 100 SMEs of Manufacturing sector of Punjab in India to understand the level of IPR filings by firms in Post TRIPS period. Punjab is a progressive state of India. It has been ranked as one of the growing states of India.

The present study also uses growth rates for analyzing the status of IPRs on all India level. It also presents the sector-wise status of patents filed. Manufacturing SMEs have been categorized on the basis of nature of industry into Durable; Non Durable; and Essential goods. The results of the study highlight the low level of IPRs in India. Durable industries have filed most of the trademarks. Most of the copyrights and patents have been filed by Essential goods. The results of the factors influencing Innovation in SMEs of Punjab Manufacturing depict that: Increased market share; Improved production flexibility; staff employed in R&D; status of IPRs; and Improved Environmental impact or Health Safety aspect explain 87.6 percent of the variation. The final section of the study recommends factors for promoting IPR Culture for SMEs of Punjab manufacturing. Factor analysis results

highlight that two factors viz. i) Policy Initiatives and organizational factors explain 62.85 percent of total variation.

The results of the present study highlight that IPR awareness and developments in Manufacturing SMEs is still at an initial stage and firms are mostly into filing trademarks and copyrights. Patent filing is almost missing. The present study uses a Canonical Correlation and Multiple Regression analysis to determine the factors influencing innovation in manufacturing SMEs. The results of Canonical Correlation have highlighted four factors viz. market share; quality; production flexibility; and status of IPRs are made major contributors to the dependent set measured in terms of Research and Development (R & D) expenditure; and range of new goods and services introduced. The results of multiple regression analysis have highlighted market share; and production flexibility as the important predictors of the model. The weaker IPR status of manufacturing SMEs highlights that there is a need to change the attitude of SMEs regarding Innovation and IPRs. Thus the study also points out the steps that can be initiated for improving the Innovation and IPR Environment for manufacturing SMEs.

LIST OF TABLES

Sr. No.	Table No.	Description	Page No.
1.	Table 1.1	GROWTH RATE OF GDP AND PER CAPITA DOMESTIC PRODUCT OF INDIA AND PUNJAB AT 1999-2000 PRICES	7
2.	Table 1.2	SHARE OF INDIAN MANUFACTURING	8
3.	Table 1.3	NSDP OF PUNJAB AND ITS MANUFACTURING SECTOR	9
4.	Table 1.4	CONTRIBUTION OF SMES AT 1999- 2000 PRICES	10
5.	Table 3.1	DETAILS OF QUESTIONNAIRE	37-40
6.	Table 3.2	RELIABILITY STATISTICS	41
7.	Table 4.1	TOTAL FACTOR PRODUCTIVITY OF PUNJAB AND INDIAN MANUFACTURING (1994-2008)	50
8.	Table 4.2	REGRESSION RESULTS	56
9.	Table 4.3	IPR SCENARIO IN INDIA	58
10.	Table 4.4	STATE- WISE PATENT FILINGS	59
11.	Table 4.5	SECTOR-WISE DISTRIBUTION OF PATENTS	61
12.	Table 4.6	COUNTRY-WISE PATENTING SCENARIO	62
13.	Table 5.1	NATURE OF INDUSTRY	65
14.	Table 5.2	TECHNOLOGY MANAGEMENT STRATEGIES ADOPTED BY SMES	67
15.	Table 5.3	NATURE OF INDUSTRY AND TECHNOLOGY MANAGEMENT STRATEGIES ADOPTED BY SMES	70
16.	Table 5.4	ANOVA RESULTS FOR NATURE OF INDUSTRY AND TECHNOLOGY ADOPTION STATUS	72
17.	Table 5.5	NATURE OF INDUSTRY AND INCREASE IN RANGE OF GOODS AND SERVICES	74
18.	Table 5.6	NATURE OF INDUSTRY AND MARKET SHARE	75
19.	Table 5.7	NATURE OF INDUSTRY AND PERSONS EMPLOYED IN R AND D	76
20.	Table 5.8	NATURE OF INDUSTRY AND IMPROVEMENT IN QUALITY OF GOODS AND SERVICES PRODUCED	77
21.	Table 5.9	NATURE OF INDUSTRY AND IMPACT OF TRIPS ON MANUFACTURING SMES	79
22.	Table 5.10	NATURE OF INDUSTRY AND STATUS OF IPRS IN INDIAN MANUFACTURING	81
23.	Table 5.11	REASONS FOR FILING IPRS	83
24.	Table 5.12	ANALYSIS OF CANONICAL CORRELATION RESULTS	85
25.	Table 5.13	REGRESSION RESULTS	87
26.	Table 5.14	FACTORS FOR PROMOTING IPR ENVIRONMENT	89

LIST OF FIGURES

Sr. No.	Figure No.	Description	Page No.
1.	Figure 4.1	GROWTH RATES OF NATURE OF INDUSTRY	48
2.	Figure 4.2	TFP OF MANUFACTURING SMES OF INDIA AND PUNJAB	51
3.	Figure 4.3	STATE-WISE PATENTS FILED 2009-10	60
4.	Figure 5.1	NATURE OF INDUSTRY	64
5.	Figure 5.2	NATURE OF INDUSTRY	66
6.	Figure 5.3	PRIORITY OF TECHNOLOGY MANAGEMENT STRATEGIES ADOPTED BY SMES	69
7.	Figure 5.4	NATURE OF INDUSTRY AND TECHNOLOGY ADOPTION STATUS	71
8.	Figure 5.5	ARE ROAD MAPS USED?	73
9.	Figure 5.6	ARE ISO STANDARDS (QUALITY AND ENVIRONMENT) USED?	73
10.	Figure 5.7	STATUS OF IPRS IN MANUFACTURING SMES	82
11.	Figure 5.8	COMPLETE VIEW OF RESEARCH	97

ABBREVIATIONS

Abbreviation	Full Form
ANOVA	ANALYZE OF VARIANCE
CSO	CENTRAL STATISTICAL ORGANISATION
DF	DEGREE OF FREEDOM
FDI	FOREIGN DIRECT INVESTMENT
GDP	GROSS DOMESTIC PRODUCT
GATT	GENERAL AGREEMENT ON TARIFFS AND TRADE
GNR	GROSS NET RATIOS
GSDP	GROWTH STATE DOMESTIC PRODUCT
IP	INTELLECTUAL PROPERTY
IPRS	INTELLECTUAL PROPERTY RIGHTS
IPRI	INTERNATIONAL PROPERTY RIGHTS INDEX
NNDP	NET NATIONAL DOMESTIC PRODUCT
NSDP	NET STATE DOMESTIC PRODUCT
R and D	RESEARCH AND DEVELOPMENT
SME	SMALL AND MEDIUM ENTERPRISES
SPSS	STATISTICAL PACKAGE FOR SOCIAL SCIENCES
SEM	STRUCTURAL EQUATION MODELLING
TFP	TOTAL FACTOR PRODUCTIVITY
TFPG	TOTAL FACTOR PRODUCTIVITY GROWTH
TQM/ CI	TOTAL QUALITY MANAGEMENT/CONTINUOUS IMPROVEMENT
TRIPS	TRADE-RELATED ASPECTS OF INTELLECTUAL PROPERTY- RIGHTS
WPI	WHOLESALE PRICES INDEX
WTO	WORLD TRADE ORGANIZATION

CHAPTER-I

INTRODUCTION

India has been a founder member of the General Agreement on Tariffs (GATT) in 1947 and the world trade organization (WTO) in 1995. WTO marks a transition in the way business was conducted and India has been no exception. WTO is the principal international organization governing multilateral trade among members. The WTO administers the implementation of a set of agreements, which include the General Agreement on Tariffs and Trade (GATT), other agreements in the goods sector, and in addition, agreements in two other areas, i.e., Trade in Services and Trade Related Intellectual Property Rights. The WTO agreements were negotiated on the basis of a 'single undertaking' which implies that membership to the organization obligates the acceptance of the results of the Uruguay round of multilateral trade negotiations without exception. The agreement on Trade-Related Aspects of Intellectual Property-Rights (TRIPS) is an international treaty by the World Trade Organization (WTO), which sets down minimum standards for most forms of Intellectual Property (IP) regulations within all member countries of the World Trade Organization. TRIPS mark a beginning of stronger intellectual property regime. Agreement on TRIPS sets minimum standards of protection to be adopted by member countries in respect of Patents; Copyrights and related issues; Industrial Designs; Graphical Indicators; Trade Marks; Layout Designs of Integrated Circuits; and Undisclosed Information (Trade Secrets).

Intellectual Property (IP) embodies products or creations of mind, and Intellectual Property laws aim at safeguarding creators/inventors and other producers of intellectual goods and services by granting them exclusive rights to control the use of these productions. The three most common vehicles for protecting intellectual property are patents; trademarks; and copyrights. The present research is an effort to understand the changes in the technology management strategies adopted by manufacturing small and medium enterprises of Punjab to cope with stronger IP regime for enhancing competitiveness in view of these changes.

In the post-WTO and post-TRIPS era, Indian firms have been under tremendous pressure to improve their competitiveness. The removal of restrictions on imports and the

lowering of customs duties coupled with stronger IPR regime implied that Indian firms have to be as competitive as their international counterparts in order to survive. This has accelerated the process of technological absorption. Several companies also pushed ahead in improving production and improving their products so as to be able to add value to their products and improve profitability. More recently during the last decade, the emphasis has been shifting to innovation and product development. Several industries, particularly the automobile, information technology and the pharmaceutical industries have of late been focusing on a high level of product innovation activity. Section 1.1 of this chapter presents a brief overview of Indian manufacturing sector, followed by a brief introduction of Punjab manufacturing in section 1.2, section 1.3 underlines the rationale for the study and section 1.4 presents the objectives of the study and the last section covers the chapter scheme.

1.1 INDIAN MANUFACTURING

Manufacturing has been recognized as the main engine for economic growth and creation of wealth, thus emphasis was placed on growth of industry in most of the five-year plans in India. Manufacturing is crucial to Indian economy. The effect of improvement in manufacturing goes far beyond its production. Manufacturing spurs demand from raw material to intermediate goods as well as services like transportation, health, financial and other services. Although contribution of Indian manufacturing is not yet very high but its pace of growth remains crucial for overall growth of Indian economy. Further, manufacturing sector will have to carry the responsibility of increasing employment opportunities for the young Indian work force in times to come. Growth of manufacturing sector is equally important for agriculture with focus on the agro-based industries. Growth of food processing sector especially will lead to more employment opportunities for rural youth.

For growth of Indian economy, manufacturing sector is crucial and in future competitiveness of Indian manufacturing sector will prove to be decisive for the direction of growth of Indian economy. In the recent past, manufacturing sector in India has been impacted by global as well as domestic developments. Substantial reduction in trade barriers particularly in respect of manufactured goods both globally and within India, technology revolution impacting productivity and emergence of technology -

driven low cost manufacturing hubs like China, Korea and Taiwan are few major factors challenging the Indian manufacturing to go through major adjustments and changes. India possesses a comparative advantage in terms of experienced work force, large pool of technical and management professionals, endowment of natural resources, and a large domestic market for consumption. Given these factors there is no denying the fact that India has the potential to become a competitive manufacturing hub on the global map. Innovation and prudent use of technology is the key to productivity and productivity ultimately enhances competitiveness. Achieving competitiveness remains central to the robust growth of the Indian manufacturing and any underachievement on this front is not going to help growth of Indian economy in times to come.

The world is changing fast and the world of business is changing faster. In the new millennium, business corporations, both large and small will have to deal with entirely new challenges to meet customer demands, move from competition to collaborative reconfiguration, dovetail supplier and subcontractor processes to the corporate goals and empower employees to be able to meet and surpass customer expectations. Due to global competitiveness now firms have to take more effective steps to improve overall productivity and efficiency. To attain a place in the competitive market, companies have to reduce the price of their products. It can only be possible if production of goods is increased by applying the same input or by reducing time wastage. Thus productivity improvement enhances the scope for survival. Past experience shows that Indian firms took decades to catch up with global productivity levels. (Ahluwalia 1991) Since the present study covers the SMEs, it is important to understand what steps have been initiated by SMEs to improve their productivity and competitiveness.

SMEs are becoming increasingly involved in global competitive markets, basically as part of supply chains and also due to expansion and growth (Cagliano et al, 2001). Worldwide, SMEs account for approximately 95 % of the business population. Given the significant role of SMEs in the national economy in terms of their sizeable contribution to Gross Domestic Product (GDP), employment generation export performance and achieving sustainable economies have placed increasing emphasis on facilitating the creation and development of national SMEs sector (Burrone 2005).

A number of key technology areas, enterprises, big or small have begun to appreciate that IP assets are more valuable than physical assets (Starein, 2002). SMEs have traditionally relied more on local markets. Now they find themselves less-equipped to face market challenges in a highly competitive environment. In addition to banking upon local government help, the SMEs, if they wish to attain higher growth and improve export potential of their products, then they must “re-examine and modify their competitive strategies by fully incorporating innovation within their people processes and products” (Ghobadian and Gallear (1997). Although there is some literature on innovation incorporation within organisational levels and activities (Vossen, 1999), there is a lack of direct studies on this issue, with a reliance on related but indirect studies such as technology management strategies and Intellectual property Rights in SMEs.

Appiah-Adu and Singh (1998) perceive that there is a strong need for new product development in SMEs as it leads to market differentiation and serves as a major opportunity for innovating SMEs in competitive markets. Research involving 500 SMEs concluded that “there is a strong positive link between the extent of adoption of innovation orientation and the degree of customer orientation in SMEs”. According to Vossen (1999) the ability to react rapidly, or to anticipate market changes is a key element of innovation. Thus innovation models for SMEs must be developed for SMEs, rather than accepting scaled down versions of large organisation innovation models (McAdam, 2000). Hagedoorn, and Cloudt (2003), concluded that the number of patents filed by a company is a very good reflection of its technological performance.

Mansfield (1986), in an empirical study of one hundred American manufacturing firms investigated the extent to which patents mattered, especially in case of a firm’s decision to introduce and develop its inventions. Studies by Odagiri (1985) clearly show that improvement in productivity achieved by a firm/industry depends on Research and Development (R & D) efforts of the firm/industry and the flow of new advanced technology embodied in intermediate inputs and capital goods resulting from R & D efforts of input suppliers. Gunasakeran et al. (1996) states that overall productivity and quality improvement strategies are lacking in SMEs. The researchers consider continuous improvement in these to be a fundamental step along the innovation pathway.

The idea that small firms contribute to technological change by producing disproportionate share of innovations relative to their R&D spending has gained mixed support (Symeonidis, 1996; Martinez-Ros and Labeage, 2002) Many researchers have pointed out that large corporations tend to benefit more from the R&D activities of their industrial counterparts, while small firms tend to benefit more from spillovers from research undertaken in university laboratories. (Dorfman, 1983) and Link and Rees, 1990). Thus the new viewpoint is that even SMEs are innovative. Innovating firms whether small or large create new knowledge and Intellectual Property and to reap enhanced benefits from innovation, they are more likely to protect their innovations by various IPRs.

Firms operating in different manufacturing industries create different types of innovation and rely on a different mix of IPRs. These differences are related to (i) industry differences in technological opportunity and (ii) to industry differences in the use of statutory IPRs (Hanel, 2006). Patents are considered a more effective means of appropriating innovation benefits and are used more frequently in the chemical and pharmaceutical industries than in other industries (Levin et al. (1987). Firms often use a combination of IPRs. Trade secret may supplement a patent or it may be used as a substitute for patent protection. Trade-marks are often used along with trade secrets and/or patents and industrial designs. IPRs such as copyright are used frequently in industries concerned with protecting printed material, recordings and software (Hanel, 2006). After an overview of Indian manufacturing the following section provides a glimpse of manufacturing sector of Punjab.

1.2 PUNJAB MANUFACTURING

Punjab is one of the growing states of the Indian union. Punjab economy has experienced an accelerated economic growth and steadily rising per capita income compared to the growth experience of the Indian economy in general and the other states in particular. This remarkable achievement has been essentially attributed to the planned development strategy adopted in Punjab. However, the development strategy had inherent weaknesses and visibly imposed constraints on the economic growth of Punjab economy and prevented it from realizing its full potential.

Development experience of Punjab economy since 1947 has remained quite impressive but Punjab has also witnessed certain swings in growth. Faster rate of economic growth witnessed especially after the mid-sixties added legitimacy to the model of economic growth adopted by the Government of Punjab. The individual property owners both in agriculture and in industry have organized the productive activities. However, the productive sectors that are agriculture and industry remained highly regulated and supported by the state government and also by the Union government (Lakhwinder, 2006). The regulated capitalist economic development experience has shown that the faster rate of economic growth and prosperity in the early stages of development was possible but the state regulation also limits the rate of growth beyond a certain level.

Manufacturing sector in Punjab began to increase in the mid-1950s, as a result of concerted efforts to create a pool of trained workers and provide incentives to entrepreneurs as a part of the rehabilitation program for displaced persons especially after partition. Planning helped channelize resources to priority areas. In all the five-year plans, the state government gave the highest priority to investment in power and other infrastructure. Increasing agricultural output during the 1950s created a demand for more agro processing, agro-input, and machine goods. (Kaur et al. 2008) This was supplemented by an increased demand from the rest of India for such products as machine goods, hosiery, knitwear, textiles, and sporting goods. These factors encouraged industrial development in Punjab, particularly among small-scale industries. By the beginning of the 1960s, Punjab was also producing agricultural implements, bicycles, and foundry products.

A few towns emerged as industrial centers after independence. By the middle of the 1960s, Ludhiana had surpassed Amritsar in manufacturing engineering and consumer products. Gobindgarh's numerous steel rerolling mills produced various iron products. These developments notwithstanding, the state's industrial activity remained rather limited until the green revolution of the mid-1960s, which brought unprecedented growth in agricultural output. Because of close input, output, and consumption linkages, rapid agricultural growth was accompanied by even faster growth in the secondary and tertiary sectors of the Punjab economy. Industry in Punjab, especially SMEs, developed under

competition restricting policies, which included reservation of certain product lines, high import duties and promotional measures. As a result the industry lagged behind in modernization and technological upgrade. But NEP of 1991 based on three planks of liberalisation, privatisation and globalisation, along with signing of the WTO and introduction of TRIPS set in a new era of competition and technology up-gradation, thus manufacturing SMEs of Punjab also had to respond to these changes (Kiran and Kaur, 2007; Sethi et al. 2007). The present research tries to identify how these firms have responded to the stronger IPR regime and competitive environment. A look at growth rates of Punjab and India is given below to highlight the present status.

Table 1.1 Growth Rate of GDP and Per Capita Domestic Product of India and Punjab at 1999-2000 Prices

Year	GDP of India (Millions)	Growth Rate	GSDP of Punjab (Millions)	Growth Rate	Per Capita Net National Domestic Product (Millions)	Growth Rate	Per Capita Net State Domestic Product (Millions)	Growth Rate	Percentage Share of Punjab in GDP of India
1999-00	17865250	-	611390	-	158810	-	256310	-	3.42
2000-01	18643000	4.35	631720	3.32	161720	1.83	259860	1.38	3.39
2001-02	19726060	5.81	639950	1.30	167640	3.66	259920	0.02	3.24
2002-03	20482870	3.84	650850	1.70	171010	2.01	259550	0.14	3.18
2003-04	22227580	8.52	691490	6.24	183010	7.01	270250	4.12	3.11
2004-05	23883840	7.45	725870	4.97	193010	5.46	279050	3.25	3.03
2005-06	26156520	9.52	757100	4.30	208060	7.80	285770	2.41	2.89
2006-07	28662650	9.58	840070	10.96	224380	7.84	311330	8.94	2.93
2007-08	31308630	9.23	914700	8.88	242530	8.08	332840	6.91	2.92
2008-09	33424950	6.79	974560	6.54	254090	4.77	348190	4.61	2.91
2009-10	36084760	7.96	1051260	7.87	269510	6.06	368780	5.91	2.91
* Growth Rates (Entire Period)	2.26***		2.54***		2.37***		2.82***		

* Self Calculated (***) p<.001) Source: Central Statistical Organisation

Table 1.1 present a comparative picture of Punjab and Indian Economy. The results indicate that the growth rate of Gross State Domestic Product (GSDP) has improved from 3.32 percent to 7.87 per cent. Gross Domestic Product (GDP) of India has grown at

a faster rate for all the years except in 2006-07. Similar trend is visible in per capita Net National Domestic Product (NNDP) and per capita net state domestic product (NSDP). The share of Punjab in GDP ranged between 2.91 per cent to 3.42 per cent. Although, there have been inter-year variations, but the trend shows that Punjab's share is declining. The decadal growth rates depict that GSDP of Punjab has grown at a faster rate as compared with GDP of India. Per capita NSDP has grown at 2.82 per cent, while Per capita NNDP has grown at a slightly lower rate of 2.37 per cent per annum. Thus it can be inferred that Punjab is a growing state of Indian Economy.

Table 1.2 Share of Indian Manufacturing

Year	GDP at constant prices 1999-2000 in (Millions)	GDP Growth (%age)	Manufacturing in (Millions)	Manufacturing Growth (%age)	Share of Manufacturing in GDP
1999-00	17865250	-	2641140	-	14.78
2000-01	18643000	4.35	2845710	7.74	15.26
2001-02	19726060	5.81	2918030	2.54	14.79
2002-03	20482870	3.84	3116850	6.81	15.22
2003-04	22227580	8.52	3323630	6.63	14.95
2004-05	23883840	7.45	3611150	8.65	15.12
2005-06	26156520	9.52	3975960	10.10	15.20
2006-07	28662650	9.58	4545050	14.31	15.86
2007-08	31308630	9.23	5011660	10.26	16.00
2008-09	33424950	6.79	5224560	4.24	15.63
2009-10	36084760	7.96	5683880	8.79	15.75
*Growth Rates (Entire Period)	2.26***		2.27***		

* Self Calculated (***) p<.001

Source: Handbook of Statistics on the Indian Economy, Reserve Bank of India 2009-10

As the study deals with the manufacturing sector, it is important to understand the share of manufacturing at the all India level and also at state level. Manufacturing contributes an important share in GDP of India and it is 15.75 per cent per annum. The share is almost stable ranging between 14.78 to 16 per cent per annum in 2009-10. The yearly growth shows a declining trend from 2006-07 to 2008-09. This has been a period when

there was a recessionary trend in Indian economy. In the year 2009-10 there has been a revival with enhanced yearly growth rates for both GDP and manufacturing sector.

Table 1.3: NSDP of Punjab and its Manufacturing Sector

Year	NSDP at constant prices 1999-2000 in (Millions)	NSDP Growth (%age)	Manufacturing in (Millions)	Manufacturing Growth (%age)	Share of Manufacturing in NSDP
1999-00	611390	-		-	
2000-01	631720	3.32	84950		13.45
2001-02	639950	1.30	78441	7.66	12.26
2002-03	650850	1.70	83077	5.91	12.76
2003-04	691490	6.24	86135	3.68	12.45
2004-05	725870	4.97	89852	4.32	12.37
2005-06	757100	4.30	94950	5.67	12.54
2006-07	840070	10.95	118400	24.70	14.09
2007-08	914700	8.89	142950	20.73	15.62
2008-09	974560	6.54	148500	3.88	15.23
2009-10	1051260	7.87	167800	12.99	15.96
*Growth Rates (Entire Period)	2.54***		4.08***		

* Self Calculated *** (p<.001)

Source: Indiatat database

During the same period manufacturing sector in Punjab moved from Rs. 84950, million to Rs.167800 million. The yearly growth varied from 5.91 per cent to 24.70 per cent. The share of manufacturing ranged from 12.26 to 15.96 per cent. Growth for the entire period has been higher for Punjab manufacturing, i.e., 4.08 per cent as compared to Punjab's State Domestic Product at a rate of 2.54 per cent. This highlights that manufacturing sector of Punjab is a growing sector contributing around 16 per cent to NSDP. Thus manufacturing sector is extremely important sector. Thus the present research is focused on manufacturing sector to study the steps that can be taken to further improve the performance and growth of this emerging sector.

Small and Medium Enterprises (SMEs) in India constitute an important segment of Indian economy. The contribution of SMEs alone has been greater than 7% to GDP and 45% to manufacturing output and 40 per cent of total exports of the country. The sector is estimated to employ about 59 million persons in over 26 million units throughout the country. (Annual Report MSME, 2010-11) It is also the second largest provider of employment after agriculture. Small enterprises are those enterprises where investment in plant and machinery is from Rs 2.5 - 50 million rupees and medium enterprises are those enterprises where investment in plant and machinery is more than Rs 50 million but less than 100 million.

Table 1.4: Contribution of SMEs at 1999-2000 prices

Year	Total Industrial Production	GDP
1999-00	39.74	5.86
2000-01	39.71	6.04
2001-02	39.12	5.77
2002-03	38.89	5.91
2003-04	38.74	5.79
2004-05	38.62	5.84
2005-06	38.56	5.83
2006-07	45.62	7.20
2007-08	45.24	8.00
2008-09	44.86	8.72

Annual Report MSME 2010-11

SMEs of Punjab manufacturing provide employment to 0.956 million people, have fixed investment of Rs 67523.3 million and total production is Rs 442529.2 million (Annual Survey of Industries, 2009-10). Thus small scale sector is a major contributor to manufacturing.

1.3 RATIONALE FOR THE STUDY

Modern industry is driven by technology, and lack of proper technology management strategies can stunt economic growth. Thus, there is a strong need to evaluate available technology management strategies for enhancing competitiveness, to overcome new challenges and become top performer. At the strategic level, the main challenge is to become globally competitive by adopting collaborative manufacturing strategies. The process of acquiring a production capability is initiated by importing plant from another country or having a new plant built with the help of a technology provider. Through training and ‘learning by doing’, the firms learn how to operate the plant, and gradually improve the yield from it. In the next stage, firms develop an investment capability, the ability to create a new plant of a chosen capacity and specifications. Finally, firms develop an innovation capability the ability to create new products and manufacturing infrastructure to produce these products.

In order to be competitive the manufacturer needs to be able to produce efficiently, at least on par with others operating on similar plants. Producing new products is not the only thing, producing products having uniqueness or some form of IPRs helps to enhance competitiveness in this changing globalised and integrated world we are living in today. Against this backdrop, there is an urgent need for manufacturing firms to devise new technology management strategies to give impetus to technology-led innovation and IPR status for improving global competitiveness. This is true not only for large scale firms but is equally important for SMEs. TRIPS have been associated with compliance to stricter Intellectual Property Regime. Thus the present study has been under-taken with the perspective of understanding the changes or priorities of technology management strategies adopted by manufacturing SMEs of Punjab for global competitiveness in the post-TRIPS era. Earlier studies on technology, productivity and IPRs have mostly covered size-wise analysis. For understanding inter-industrial differences in IPR status of the firms, technology management strategies adopted by SMEs have been analysed on the basis of nature of the firm, whether the firm belongs to Durable goods sector, Non-Durable goods sector or Essential goods sector.

1.4 OBJECTIVES OF THE STUDY

The **broad objectives** of the study are as follows:

1. To study the Technology Management Strategies used by the Small and Medium Manufacturing Enterprises of Punjab.
2. To study the extent of Intellectual Property Rights of Small and Medium Manufacturing Enterprises of Punjab.
3. To study the reasons for protecting Intellectual Property in the present globalised scenario.
4. To recommend the factors for developing IPR Culture for Small and Medium Manufacturing Enterprises of Punjab.

1.5 ORGANISATION OF THESIS

Chapter I: Introduction

This Chapter is introductory in nature, providing a brief overview of the background of the research work. It sets the scene for the research questions and problem statement. This chapter introduces the structure of thesis. It covers the global as well Indian scenarios of Indian Manufacturing and Punjab Manufacturing. It also covers the development of parameters and defines the objectives of the study.

Chapter II: Review of Literature

Chapter two presents the review of literature related to innovation; Intellectual Property Rights (IPR) and productivity. This chapter also covers the literature on technology management strategies. The review helps to know the emphasis and the methodologies used to achieve the objectives of research being done, the time periods of the study, thus it helps to identify the gaps in earlier studies and avoids duplication of results and focus on the right direction.

Chapter III: Research Design and Methodology

This chapter discusses the methodology of the study. In this chapter methodology used for both secondary data and primary data analysis has been described. It discusses the detailed methodologies adopted in the study, the population of the study, the variables, measuring instrument, methods of data collection and methods of data analysis.

Chapter IV: Productivity and Patenting of Indian Manufacturing: A Post TRIPS Analysis

This Chapter deals with the analysis of secondary data covering current scenario on the basis of Nature of Industry. The three sectors considered are: Durable goods, Non-Durable goods and Essential goods. This chapter maps out the growth profile of the Indian and Punjab manufacturing industries in terms of Total Factor Productivity (TFP) for the post-TRIPS period, from 1994-2008. Ordinary least square regression and stepwise regression are run between TFP and factors affecting productivity. Inter sectoral analysis of TFP has been used to identify the growing sectors of the economy. The chapter ends by discussing IPR scenario in the post-TRIPS phase at national and sectoral level.

Chapter V: Technology Management Strategies and Punjab Manufacturing in Post TRIPS Period: Firm level Analysis

This chapter covers the analysis of responses gathered from 100 respondent firms on the basis of the questionnaire administered to them and presents the outcome of such analysis. The chapter starts with the preferred technology management strategies adopted by manufacturing SMEs of Punjab, covers the status of innovation and technology adoption of these firms on the basis of nature of industries. Using Analysis of Variance (ANOVA) it tries to find relationship between technology management strategies and nature of industry. The chapter also summarises the Canonical correlation variates and important predictors of innovation using multiple regression. The study also discusses the IPR scenario of respondent firms, the reasons for protecting intellectual wealth, finally indicates the steps to enhance IPR culture amongst these organisations.

Chapter VI: Conclusions, Limitations and Further Study

This chapter covers the learnings, recommendations and conclusions of the study and also highlights the recommendations regarding technology management strategies of manufacturing SMEs. This chapter also involves a critical assessment of the work, revisiting the hypotheses, and demonstrating decision, thoroughness, contribution, and comparison with similar work. The chapter also lists further research areas/ gaps.

Chapter Summary:

In order to present discussion in lucid style, the present study is divided into six chapters. Chapter one is introductory in nature providing a brief overview of the manufacturing sector of India and Punjab manufacturing. It also covers the need and importance of SMEs in manufacturing sector. In the post-liberalisation and post-TRIPS era, the removal of restrictions on imports and the lowering of customs duties, along with increasing emphasis on IPR imply that manufacturing SMEs have to be as competitive as their international corporations in order to survive. The chapter thus highlights the need for research in this direction

CHAPTER-II

REVIEW OF LITERATURE

A review of literature pertaining to the study is a pre-requisite for the formulation of research plan. It enables the investigator to be in a position to dig new ground in the area being investigated. In order to have a proper perspective of the subject, it is essential to have a bird's eye view of the findings of other academic researchers. Thus, the planning and execution of any research study should be preceded by a thorough review of literature in related fields since it helps to familiarize with the work that has been done in that area. This chapter presents the review of literature on technology management strategies adopted by manufacturing industries in different countries of the world, specifically in India. The review also focuses upon the changing perceptions regarding technology and innovation and IPRs in this changed globalised scenario, especially after adoption of the TRIPS regime. Section 2.1 covers the studies on Productivity, Innovation and IPR; section 2.2 covers the studies on technology management strategies. A thorough review of literature helps in identifying the uncovered areas, the research gaps which are presented in section 2.3.

Review of literature has been classified under the following headings:

2.1 Studies on Productivity, Innovation and Intellectual Property Rights

2.2 Studies on Technology Management Strategies

2.1 STUDIES ON PRODUCTIVITY, INNOVATION AND INTELLECTUAL PROPERTY RIGHTS

2.1.1 Studies on Technology-Productivity Relation

Productivity is the sine-qua-non of modern state and occupies an important place in the development and growth of a nation. Kuznets (1966) pointed out that rapid growth in industrial productivity is an essential element in the development and structural transformation of the newly developed economies. Lindbeck (1984, 1986) drew attention

to the poor record of developing countries in 'speeding up the rate of productivity growth.' While output in manufacturing in developing market economies increased by 5 per cent per annum during 1960 to 1981, the accompanying increase in labour input was as high as 3.7 per cent, this implies that the increase in labour productivity was about 1.3 per cent.

Empirical studies on technology-productivity nexus undertaken for industrialized countries have shown that technological advancement is a major source of productivity improvement. The studies of Sherer (1984) and Grilliches and Mairesse (1984) on the nexus between productivity and technology reveal that advances in the latter result in improvement in the former. Similar results were obtained for Japanese industry by Odagiri (1985) and French industry by Cuneo and Mairesse (1984). These studies clearly show that improvement in productivity achieved by a firm/industry depends on Research and Development (R & D) efforts of the firm/industry and the flow of new advanced technology embodied in intermediate inputs and capital goods resulting from R & D efforts of input suppliers. Further studies on return from R & D expenditure carried for industrialized countries indicate that the private rates of return on R & D are fairly high (ranging between 20 to 50 %) which reflects R & D investment and efforts are a major factor influencing efficiency growth and productivity. Shifts in the production function are defined as Hicks Neutral if they leave marginal rates of substitution untouched but simply increase or decrease the output attainable from any given output (Solow 1957).

According to Beets (1994) technological change stands for the change in historically acquired capital structure and the problem of economic growth is then the problem of accumulating a given amount and type of capital. But technological change also brings about an increase in per capita income, either by reducing the amount of inputs per unit of output or by yielding more output for given amount of inputs (Martino, 1983). Adoption, the first stage of the technology transfer process is simply a firm's awareness of a certain technology's existence. While the adoption decision clearly affects implementation, it is composed of different processes and is analytically distinct from implementation (Steensma, 1996). The firms, which are able to adopt a particular type of manufacturing technology, become quite comfortable in adopting the next level of innovation (Mansfield, 1993).

Adaptation of technology is a phase that starts after a technology has been adopted and put to use in production activities or facilities. According to Mansfield (1993), the success or failure of technology transfer solely depends on the accumulated level of technology of a nation. The higher the technological level of a nation, the better judge the nation will be for the assessment and selection of proper technologies. For gaining competitive advantage and developing a firm's internal capabilities, technology adoption and adaptation are considered to be among the most critical elements for a firm (Khamba and Singh, 2001, Kaur, et al. 2008). Sheel (2002) states that for technological advances new infrastructures, mainly telecommunication, information technology, new strategic thinking practices are needed for hyper competitive environment.

The study by Sethi et al. (2007) on manufacturing flexibility highlights that the human factor in terms of skills, technical expertise, training involvement, and attitude has emerged as the most significant factor for achieving flexibilities in manufacturing industries. Kanwar et al. (2001) empirically examine the relation between the protection of intellectual property rights and technological change. The researchers found an evidence to support the claim that the former encourages the latter. The results of the study imply that the lack of an incentive structure can be a significant mitigating factor for technological change even when other constraints such as internal funds, availability of skills and trade orientation may not be binding.

According to Venkataramanaiah and Parashar (2007) Indian economy is expected to become the second largest in the world, ahead of the United States, by 2050, and the third largest after China and the United States by 2032. The turnaround in manufacturing and other sectors, which has occurred in the face of increased global competition, is due to improved efficiency following several policy reforms in recent years. Small and medium enterprises (SMEs) constitute 6 per cent of GDP, 34 per cent of national exports and account for the employment of more than 30 million people. SMEs have improved their performance and presence through industrial cluster approaches. The researchers present the experiences of three auto clusters in three major locations in India and conclude that by suggesting suitable cluster interventions competitiveness and sustainability of the SME sector can be improved.

Increased globalisation and changes in technology have resulted in increased need by many SMEs to use innovation as a means of seeking competitive advantage. But, there is scant empirical research relating to the implementation of innovation management in SMEs. Gunasakeran et al. (1996) state that overall productivity and quality improvement strategies are lacking in SMEs. Thus, rapid decision making by inspired leaders can fail to incorporate innovative practice due to a basic lack of fundamental resources. The researchers consider continuous improvement to be a fundamental step along the innovation pathway. Bessant and Caffyn (1997) state that continuous improvement can generate a multiplier effect leading to radical innovation.

Davenport and Bibby (1999) highlight 'entrepreneurial dynamism' as an important driver of increased innovation. The findings of the survey by Mc Adam et al. (2008) suggest that a leadership style that is too intensive could lead to less innovation. Thus, leadership that is overly directive and controlling may filter out empowered innovative action among employees. Further, Mc Adam et al. (2010) use an empirical study to develop and test a structural equation modelling (SEM) of innovation implementation, collecting data from 395 SMEs in the UK. The findings show that the effects of leadership, people and culture on innovation implementation are mediated by business improvement activities relating to Total Quality Management/Continuous Improvement (TQM/ CI) and product and process developments. The results of the study suggest that SMEs have an opportunity to leverage existing quality and process improvement activities to move beyond continuous improvement outcomes towards effective innovation implementation.

Based on empirical data collected from 220 Italian firms, Majocchi and Zucchella (2003) investigate the relationship between internationalization and performance. They suggest that performance is not determined by export intensity and the number of international agreements, but by the ability of firms to gain access to specific markets, such as North America. Moreover, the results indicate that performance tends to suffer when SMEs internationalize through FDI, a finding that suggests a 'liability of foreignness' effect at the outset of international expansion. However, this negative effect can be offset by the international competencies that SMEs develop through intense export activity.

Regarding Punjab manufacturing a study by Kiran and Kaur. (2007) covering the period 1980-81 to 2002-03 depicts a deceleration in growth of value added and total factor productivity in Post-reform period. According to this study in this changing environment of greater openness and competitiveness there is an urgent need for the industries to become more productive and then help the economy to achieve a higher growth. Hence higher investment in R&D and encouraging firms for IPRs can play a vital role in enhancing productivity and competitiveness of manufacturing sector.

Patents statistics are also used to map certain aspects of the dynamics of the innovation process (e.g. co-operation in research, diffusion of technology across industries or countries, etc.), or of the competitive process (the market strategy of businesses). There are a lot of studies on the impact of size of the firm on innovations (Schumpeter, 1934, Sherer, 1984), as well as on productivity technology nexus (Sherer 1982, 1983; Grilliches 1984; Odagiri, 1985; Kiran and Kaur, 2007). Thus there are a number of studies in technology productivity nexus. These studies are not only relevant for large manufacturing but equally pertinent for manufacturing SMEs.

2.1.2 Studies on Innovation and IPRS

Innovation in the manufacturing sector is a very complex process which is propelled by numerous factors (Becheikh et al. 2006). Although there is substantial evidence to show that a number of SMEs in a wide variety of sectors do engage in technological innovations (Hoffman et al. 1998), yet the ability and innovative capacity of SMEs varies significantly, depending on their sector, size, focus, resources, and the business environment in which they operate (Burrone and Jaiya 2005). The focus on human factor is not new in literature on manufacturing. Many studies have focussed on the human resource as an important factor in enhancing competitiveness (Sethi et al. 2007; Kaur et al. 2007).

Hassan Arif et al. (2006) are of the opinion that successful organizations in today's business environment are those which manage quite well their human resources along with their technological resources. This includes effective manpower planning, recruitment and selection process, realistic performance plans and development oriented performance appraisal, effective learning system providing ample learning opportunities

with the help of training, performance guidance and other mechanisms such as mentoring. It has been suggested that a firm may leverage its knowledge assets to achieve a competitive advantage (Day, 1994; Garvin, 1993; Sinkula, 1994).

The results of the study by Yang et al. (2008) strongly support the notion that managers and firms need to prepare themselves for knowledge innovation to create a facilitating culture in an effort to foster and sustain the firm's innovation capability. Managers also should encourage organisational learning by emphasising an organisation's ability to learn considering learning as an investment, rather than an expense. Ghobadian and Gallear (1997) opine that SMEs are more likely to be people orientated than system orientated. Organizations perform better when they are making investment in training their employees and broaden their skills (Hollbeche, 1998). This underlines the increasing importance of human capital in SMEs.

Innovation has been one of the key drivers of sustainable competitive advantage for small and medium-sized enterprises (SMEs). On the basis of a survey sample of 188 Chinese manufacturing SMEs, Xie et al. (2010) explore barriers, cooperation networks and policy requirements in innovation for SMEs. The study reveals that the 'lack of technical experts' is the most important barrier; the 'customer', the most important cooperation partner; and the 'preferential tax policy', the most favourable policy in innovation for SMEs. These findings reveal that many Chinese SMEs have difficulties in achieving successful innovation. Therefore, policies should be made based on internal and external constraints to facilitate innovation of SMEs, and the policies should be varied depending on the size as well as the mode of ownership of firms.

Luecke and Katz (2003) define, 'Innovation . . . as the successful introduction of a new thing or method . . . Innovation is the embodiment, combination, or synthesis of knowledge in original, relevant, valued new products, processes, or services.' Innovation typically involves creativity, but is not identical to it: innovation involves acting on the creative ideas to make some specific and tangible difference in the domain in which innovation occurs. Amiable et al. (1996) propose: 'innovation as the successful implementation of creative ideas within an organization. In this view, creativity by individuals and teams is a starting point for innovation; the first is necessary but not sufficient condition for the second.'

For innovation to occur, something more than the generation of a creative idea or insight is required: the insight must be put into action to make a genuine difference, resulting for example in new or altered business processes within the organization, or changes in the products and services provided. Davila et al. (2006) characterize innovation as an organizational or management process. According to them, 'Innovation is a management process that requires specific tools, rules and discipline'. Firms sustain competitive advantage by continuously differentiating their products and services from those of their competitors (Chen et al, 2009; Koellinger, 2008). The firms can constrain and direct an R&D department's ability to take action and differentiate themselves from rivals. Gopalakrishnan (2000) categorises innovation on the basis of speed and magnitude and this provides an effective method of investigating the link between innovation and firm's performance. Garcia and Calantone (2002) propose that if an idea has not been developed and transformed into a product, process, or service, or if it has not been commercialized, then it would not be classified as an innovation.

Researchers like (Kahn et al., 2003; Danneels and Kleinschmidt, 2001; Roseno, 2005) call for a better understanding of exactly what innovation means, going beyond the incremental and radical categorization. They argue that little has been said about what criteria are used for innovation classification and who applies those criteria. Thus, introducing and stressing the different perspectives of individuals involved in the innovation process is becoming an essential point. As noted by Blackman and Davison (2004), although the focus of innovation is, historically, economic (Nystrom, 1980; Scherer, 1984) yet the source of innovation perception is social (Zaltman et al., 1973; Burns and Stalker, 1961). Zaltman et al. (1973) are of the opinion that the distinguishing characteristic of an innovation is that, instead of being an external object, it is the perception of a social unit that decides its radicalness. It depends on the amount of experience people in the organization have with the innovation they are developing (Green et al., 1995; Hage, 1980; Roberts and Berry, 1985).

According to Howard et al. (2008) innovation facilitates how SMEs respond to market changes and maintain their competitive advantage. The study analyses the relationship between the degree of innovation (measured as innovation in products, processes and administration systems) and performance among 1,091 Spanish manufacturing SMEs. The results show that innovation positively impacts the performance of SMEs in low and high technology industries. Innovation was more important to achieving a competitive

advantage to high technology firms than low technology firms. The study by Krishnaswamy et al. (2010) describes the origin and process of technological innovations leading to the development and introduction of new products in the electronics industry in Bangalore, India. The results highlight that all the three categories of SMEs have achieved successful product innovations, leading to their gradual growth over time, not only in terms of employment and investment, but also in terms of sales turnover.

In Scherer's (1984, 2005) view, for large firms, different advantages related to the head start made by a firm, the price premia, and the market share inertia can be more effective than the legal monopoly granted by patent in determining the firm's performance and success. Patent protection plays an important role in fostering innovative investments for small new technology-based ventures and it has been considered less important as stimulus for well-established corporations. In such a case IPRs will be less important for large scale firms. By paying specific attention to two US monopolization cases, Scherer opines that competition plays a much more effective role in nurturing innovation than intellectual property, while a substantial scepticism has been raised 'toward monopoly positions that have been sustained through the accumulation of internally-developed patents for longer than the 20 years contemplated in the current patent law'. Hence, in Scherer's view, this suggests a substantial reorientation in innovation policy. The empirical analysis conducted by Pfister and Deffains (2005) on French foreign direct investments pushes forward the reasoning, though in a very limited setting and under very specific conditions. The researchers contradict the view that the exclusion of imitators should make foreign firms more confident towards the profitability of their investments. Rather, the empirical findings seem to suggest that stronger patent protection intensity seems to decrease foreign direct investments, at least in countries with a high GDP or with a low R and D.

Some researchers express that IPRs are anti-competitive. The emergence of IPRs as exclusive rights of distribution in downstream markets may heavily affect the productive processes and industry organization as a whole, bringing even at times negative consequences on consumers' welfare (Ghosh, 2005; Heimiler and Nicita, 2004; Ramello, 2003, 2005). The contributions contained in this issue challenge some of the traditional views on efficiency of IPRs and on their impact on innovation and economic growth. While IPRs are a powerful tool in solving free-riding and hold-up problems, they can

also lead to a number of inefficiencies that are mainly addressed by regulators and by anti-trust enforcers.

According to Robson et al. (1988) the use of intellectual protection differs significantly across industries. The inter-industry differences in the use of IPRs are determined by the technology sector, the nature of the products, their stage in the life cycle and competitive conditions. According to Hanel (2006) a patent-friendly environment is now prevalent in India, patents are increasingly used for protecting innovations from imitation. Mansfield (1986), in an empirical study of one hundred American manufacturing firms, investigated the extent to which patents mattered, especially in case of a firm's decision to introduce and develop its inventions. For pharmaceuticals in particular, patents were seen as critical, but in four sectors (office equipment, motor vehicles, rubber, textiles) patents were deemed of no importance whatsoever. Interestingly, however, at least half of the patentable inventions were in these four sectors. Mansfield opined that there seemed to be some extra benefit conferred by patents that were justified the costs. Half of his respondents, moreover, patented an increasing percentage of their inventions.

Intellectual Property is the term that describes the ideas, inventions, technologies, artworks, music and literature that are intangible when first created, but become valuable in tangible form as products. In other words, intellectual property is the commercial application of imaginative thought to solve a technical or artistic challenge. Intellectual Property is not the product itself, but the special idea behind it, the way the idea is expressed and the distinctive way it is named and described. Intellectual Property, in its literal sense means the things that originate from human brain. This creation of human mind or Intellectual Property is considered to be the most invaluable asset, especially in today's globally competitive environment (Kavitha and Shivakoumar, 2008). India is emerging as the hub of 'knowledge economy' in South Asia. India has proved her strength in information technology (Kavida and Shivakoumar, 2009). Innovation and IPRs can play a vital role in the knowledge economy. The emphasis is not on physical or tangible assets but on intangible knowledge assets. Intellectual Property is vital because it is a stimulus to innovation, a vehicle for technology transfers, and a magnet for financing (Khong, 2003).

As new opportunities open up, the critical role of technology as a driver of economic progress has been widely acknowledged. The degree of patenting activity provides an index of countries or companies which are active in various fields and also the fields in which technology is progressing and the fields in which technology is stable. (WIPO, ISIP, 1997) The registered trademarks bear witness to commercial interests in the market of the country and an analysis of IPR and their presence in different countries provides a means of testing the soundness of many policies and investment decisions.

Employee's creativity and innovation skills can increase only by giving them appropriate recognition and reward for their creative work (Koning, 1998). There is, however no consensus on the relationship between Stronger IPRs and increase in technological activity. A study by Kumar (2002) opines that there has been a lot of controversy on the role of Intellectual Property Protection (IPP) regime especially the patent system in fostering innovation, technology and industrial development of a country. IPP is expected to encourage innovation by rewarding the inventor, but strong IPP regime may also inhibit diffusion of knowledge and even technology development in the countries that are technology followers. Countries have fine-tuned their IPP regimes as per their developmental requirements. Against this backdrop, the on-going attempt to strengthen the IPP regimes worldwide, as a part of the TRIPS Agreement, appears to adversely affect the technological activity in developing countries by choking the knowledge spill over besides implications for the access and affordability to life saving drugs by the poor. The researcher assesses the impact of IPR on Indian Economy with reference to agriculture and industry. Small and medium size enterprises have tried to adjust to the new paradigms to acquire competitiveness. Their survival itself will depend heavily on how effectively they imbibe innovative technology. It is generally accepted that invention and innovation are instruments of success in the global economy. The researcher highlights that the survival of industries and their ability to acquire competitive edge will depend heavily on how effectively they imbibe innovative technology.

According to Pradhan (2007), small firms had played an important role in enhancing domestic technological capabilities in drugs production and have been instrumental in keeping drug prices affordable for the Indian populace in remote rural areas. This rise of small firms in this sector has been facilitated by a set of strategic government policies implemented in the past decades like adoption of a process of patent regime, relaxation

granted from price control and industrial licensing requirement, reservation of items for exclusive production and preference in government procurement, etc. Since 1990s the regulatory regime for small firms underwent dramatic changes with withdrawal of most of the favourable policies and implementation of regulations like a long-term product patent regime, withdrawal of exemption from price controls, implementation of good manufacturing practices, etc. all of which have had a number of implications for the survival and growth of small pharmaceutical firms today

Maheswary et al. (2008) opine that small-scale industries have failed to cope up with the emerging challenges to keep abreast with the latest developments especially, in the field of IPRs. In India most of these industries are lagging far behind and facing technical obscurity, being unaware about management of their knowledge based assets like IPRs. Each player in a given field would try to outpace its competitors by introducing new products through innovations. The researchers highlight the reason for protecting intellectual wealth, role of government in making the small enterprises viable and also what measures should be and are being taken. The study also deals with the steps taken for creating IPR culture and suggests the initiatives for small-scale industries. In order to be competitive in today's globalised and liberalized world, Indian organizations have to use advanced technology, technical manpower, and innovative research and development (Narain et al., 2004).

The study by Leitner (2011) examines the relationship between intellectual capital and different product innovation strategies based on a longitudinal analysis of Austrian firms assuming that intellectual capital is an important complementary asset for innovation activities. The data was collected in 1995 and 2003 using the same questionnaire among a firm sample of 91 small and medium-sized firms in manufacturing industries. The study delivers evidence for a positive association between human capital and product innovativeness. Moreover, firms which have strength in both human and structural capital have a higher likelihood to be highly innovative.

As a result of globalization and liberalization, coupled with WTO regime, Indian SMEs have been passing through a transitional period. With slowing down of economy in India and abroad, particularly the USA and European Union and enhanced competition from China and a few low cost centers of production from abroad, many units have been facing a tough time. SMEs having strong technological base, international business

outlook, competitive spirit and willingness to restructure shall withstand the present challenges and come out with shining colors to make their own contribution to the Indian economy.

Recent empirical studies have supported the finding that the propensity to patent has increased (Hall and Ham, 2001). Most companies now leverage patents as an integral part of business strategy (Kingston, 2001). The use of patents and other statutory instruments of IPP by manufacturing firms is closely but not exclusively related to their innovation status. Innovating firms create new knowledge and intellectual property and in order to appropriate the benefits from innovation, they are more likely to protect it by various intellectual property rights and other strategies than firms that do not innovate. According to Cohen et al. (2000) the reasons for patenting differ between industries that usually introduce a 'discrete' product defined as a new substance introduced for example by a chemical or pharmaceutical firm and those introducing a 'complex' product innovations characteristic of electronic or telecommunication products that typically comprise a large number of patentable elements. Their study also shows that the reasons to patent in general and to protect discrete or complex innovations in particular, are also driven by other motivations than to prevent imitation such as: to preserve exclusivity; blocking cumulative innovation; defensive patenting; patents serving as bargaining chips in negotiations and cross-licensing; licensing revenue; to prevent suits and to enhance firm's reputation.

Firms often use a combination of several IPRs. Trade secret may supplement a patent or it may be used as a substitute for patent protection. Inventors choose to use trade secret when they believe that patent protection is too costly relative to the value of their invention, or that it will give them a reward substantially less than the benefit of their invention (as reflected, in part, in the length of time before anybody else will invent it), either because the invention is not patentable or because the length (or other conditions) of patent protection is too cumbersome. The purpose of IPRs is to create incentives to maximize the difference between the social benefits of the creation of information and the social costs, including the costs of administering these rights (Besen and Raskind, 1991; Maskus, 2000).

IPRs can play an important role in technological development of the SMEs (Idris, 2002). A study by Haakon (2004) on 'Innovation and IPR' stated the need of IPR, benefits to

the different concerns as well as planning for implementing such strategy demands an engagement across the whole organization affecting projects, processes and culture of the company. It focuses R&D on uniqueness, which in turn triggers creativity, invention and innovation. A Study by Kiran, (2004) highlighted that the protection of IPR plays a dominant role in inventions and innovation. The result of this study depicts the acceleration in growth of patents during the post TRIPS period. A study by Kanwar et al. (2001), found evidence to support the claim that the Intellectual Property Rights encourage the technological change, as Intellectual Property Protection was found to have a strong positive association with R&D investment.

Among the few available indicators of technology output, IPR indicators are probably frequently used. IPR based statistics have several uses. They allow for measuring the inventiveness of countries, regions, firms or individual inventors, under the assumption that patents reflect inventive output and that more patents mean more inventions. Keller and Holland (1982) concluded that the number of an inventor's patents is significantly correlated with superior performance ratings and self-rating. Hagedoorn and Clood (2003) concluded that the number of patents filed by a company is a very good reflection of its technological performance. The study covered 1200 high-technology companies. At the country level, Rassenfosse and Pottelsberghe (2008) have found a high correlation between patent numbers and R&D performance.

Thus this section covered literature related with technology-productivity nexus, focused on studies related with technology adoption, adaptation, manufacturing performance, and IPRs and innovation in manufacturing. The next section focuses on literature related to important technology management strategies prevalent to enhance global competitiveness.

2.2 STUDIES ON TECHNOLOGY MANAGEMENT STRATEGIES

In the modern knowledge and networked age, technology is perhaps every nation's most important resource. Technology and its management are today matters of global primacy. Technology is being developed, improved, combined, refined, bought, sold, and traded around the world at an unprecedented pace. Technology management strategies have thus become imperative in the face of changing trade environment characterized by

global competition due to high innovation risks, short product cycle, high investments in R&D, production and marketing and need for highly skilled human resources. This section covers the literature review related to all the aspects of technology management strategies adopted by manufacturing SMEs of Punjab for enhancing productivity and efficiency.

SMEs have traditionally relied more on local markets and now find themselves less-equipped to face market challenges for growth and exports in a highly competitive environment. In addition to local government help, SMEs in developing countries like India must “re-examine and modify their competitive strategies by fully incorporating innovation within their people, processes and products” (Mc Adam, 2008). Although there is some literature on innovation incorporation within organisational levels and activities (Ghobadian et al.,1997), there is a lack of direct studies on this issue and increasing relevance has been placed on indirect studies, i.e., through as technology management strategies and intellectual property rights in SMEs (Vossen, 1999).

According to Gunasekran et al., 1996) overall productivity and quality improvement strategies are lacking in SMEs. Continuous improvement in these may be a fundamental step along the innovation pathway. The ability to react rapidly, or to anticipate, market changes is a key element of innovation (Vossen, 1999). Thus innovation models for SMEs must be developed for SMEs, rather than accepting scaled down versions of large organization innovation models.

A number of researchers place high importance on IPRs. The number of patents filed by a company is a very good reflection of its technological performance (Hagedoorn et al., 2003). In an empirical study of one hundred American manufacturing firms, Mansfield (1993) investigated the extent to which patents mattered, especially in case of a firm’s decision to introduce and develop its inventions.

Small firms contribute to technological change by producing disproportionate share of innovations, relative to their R&D spending. Many researchers have pointed out that large corporations tend to benefit more from the R&D activities of their industrial counterparts, while small firms tend to benefit more from spillovers from research undertaken in university laboratories (Symeonidis, 1996). Regarding different forms of IPRs, the perception of researchers vary. Hanel (2006) considered Patents a more effective means of appropriating innovation benefits and are used more frequently in the

chemical and pharmaceutical industries than in other industries. Moreover, firms often use a combination of IPRs. Trade secret may supplement a patent or it may be used as a substitute for patent protection. Trade-marks are often used along with trade secrets and/or patents and industrial designs (Levin et al., 1987). IPRs such as copyright are used frequently in industries concerned with protecting printed material, recordings and software (Hanel, 2006). Thus different technology management strategies are adopted by manufacturing industries, including manufacturing SMEs.

On the basis of literature review the following technology management strategies have been identified:

- i. Introducing new and increased range of goods and services: Innovation . . . is successful introduction of a new thing or method . . . Innovation is the embodiment, combination, or synthesis of knowledge in original, relevant, valued new products, processes, or services Increased range of goods and services are the new products and services introduced by these firms. New increased range of goods and services is now accepted as a measure innovation (Luecke and Katz, 2003).
- ii. Investment in R and D: Literature reveals that improvement in productivity achieved by a firm/industry depends on Research and Development (R&D) efforts of the firm/industry and the flow of new advanced technology embodied in intermediate inputs and capital goods resulting from R & D efforts of input suppliers (Odagiri, 1985). Innovation results through project teams or R&D departments (Martino, 1983; Morton, 1971; Zaltman, 1973). Innovative output is the product of knowledge generating inputs, most notably R&D (Griliches and Mairesse, 1984). About ninety percent of all private R&D expenditures in the United States are undertaken by 400 of the largest corporations (Scherer, 1991).
- iii. Marketing strategies: In the context of new product development consists of bringing together two main components: markets and technology (Danneels et al., 2001).
- iv. Improved quality of goods and services: Not only the firms have to be innovative to introduce new products, but they have to think of introducing quality products. In the current age of global competition quality of goods and services can make much difference. Consumers demand products with quality certifications (Sethi et al., 2007).

- v. Improved production, flexibility: Enhancing productivity has always been the prime concern for SMEs in the manufacturing industry that primarily run on minimum costs and minimum resources (Ghobadian and Gallear, 1997; Martino, 1983; Kiran and Kaur, 2008). The nexus between productivity and technology reveals that advances in the latter result in improvement in the former (Scherer, 1984).
- vi. Reduced labor costs per unit and reduced material and energy per produced unit/transaction: Cost cutting strategies have dominated the business world and hold all the more reference for SMEs. Efficiency of factors of production can enhance the firms competitiveness (Kiran and Kaur, 2008).
- vii. Technology up-gradation: Although SMEs face serious constraints in acquiring new and appropriate technology (Martino, 1983), but technology upgradation has always demanded attention.
- viii. Change in managing practices: The bureaucratic organization of large firms is not conducive to undertaking risky R&D (Scherer, 1991). Top management is responsible for articulating the company's competitive strategy and how innovation will serve this strategy. Companies can focus innovation on products, processes and markets (e.g., new ways to serve customers). They also can focus on incremental or radical innovation (McAdam et al., 2000; Weerawardena and McColl-Kennedy, 2002).
- ix. Indigenous technological development: Since new technology is expensive and SMEs face cost constraints so they resort to developing indigenous technology. For gaining competitive advantage and developing firm's internal capabilities, technology adoption and adaptation are considered to be among the most critical elements for a firm (Martino, 1983).
- x. Retraining of Workers: Successful organizations in today's business environment are those which manage well along with their technological resources along with their human resources also (Hassan et al., 2006). Retraining includes effective manpower planning, recruitment and selection process, realistic performance plans and development oriented performance appraisal, effective learning system providing ample learning opportunities with the help of training, performance guidance and other mechanisms such as mentoring. Although manufacturing firms of Punjab used

new technologies, they reported lack of adequate training and retraining programs to equip workers with the latest technology (Kiran and Kaur, 2008).

- xi. Competitive price strategy: Firms can compete on price or differentiation (Porter, 1985). SMEs capacity to meet growing customer expectations is based largely on their ability to innovate and deliver new products at competitive prices (Ghobadian and Gallear, 1997).

2.3 GAPS IN EARLIER STUDIES

From the above review it is clear that although there are a number of studies done on covering different aspects viz. technology adoption, technology adaptation, technology management, innovation, or productivity. Relatively sparse literature is available on technology management strategies and IPRs in Manufacturing SMEs. Most of the studies on IPRs focus on pharmaceutical sector. Moreover, these studies have been conducted at the all India level. The results about the impact of reforms on the productivity growth of manufacturing sector are mixed. No conclusive evidence can be drawn from these studies. The reason may be the differences in the methodologies used in different studies and the issues related with the measurement of inputs especially the capital. There hasn't been a comparative study on TFP in Punjab and all India manufacturing covering post-TRIPS period.

The present study tries to fill in the gap by taking a comprehensive view of technology management strategies adopted by manufacturing SMEs by covering productivity, innovation and IPR status of Punjab manufacturing. Thus from the above literature it can be inferred that there is a need for studying all these aspects to understand how manufacturing SMEs are managing their technologies, and which strategies are preferred by them. Earlier studies have focussed on productivity and performance indicators and there is not enough research on manufacturing SMEs and innovation, technology and IPR relation. Earlier studies have focused on size-wise relationship between productivity and IPRs. The present research attempts to study the relationship from nature of the firm perspective, viz. Durable, Non-Durable and Essential goods. The present study has been undertaken against this backdrop to understand the innovation, technology, and IPR

status of manufacturing SMEs and it also suggests steps to build an innovative and IPR conducive environment in Punjab for enhancing competitiveness.

Chapter Summary:

This Chapter presents the views of earlier researchers on various aspects of technology management, the origin of the concept, the developments in methodologies related with productivity, technology, innovation and Intellectual Property Rights. The review covers the changes in the technology management strategies adopted by Indian and Punjab manufacturing in view of globalisation and liberalisation after the adoption of World Trade Organisation and Trade Related Aspects of Intellectual Property Rights. The chapter also identifies the research gaps and outlines the broad area of research.

CHAPTER-III

RESEARCH DESIGN AND METHODOLOGY

This chapter covers the phases of research to explain the complete research process employed to achieve the objectives. The chapter covers the research design, sampling design, methods of data collection, selection of sample and survey areas, development of the hypotheses and methods of data analysis. The purpose of this study is to analyze the technology management strategies adopted by Manufacturing SME's of Punjab in post-TRIPS period.

3.1 PHASES OF RESEARCH

The complete research process was carried out in following four phases:

Phase I: Understanding the existing perspectives

Phase I of the study explored the current status of manufacturing sector of India and Punjab. This has been done by analysing growth rates of Indian and Punjab Manufacturing in Chapter I. In depth study has been undertaken of literature on technology-productivity nexus, innovation and Intellectual Property Rights. Literature review on technology management strategies has also been expounded.

Phase II: Assessment of factors for technology management strategies of manufacturing SMES

Phase II of this research fosters designing of a well-structured questionnaire to assess technology management strategies used by manufacturing SMEs. The complete emphasis of this questionnaire was to uncover the perception and status of manufacturing SMEs regarding technology adoption, innovation and intellectual property rights. The questionnaire has been designed after extensive literature review and validated through discussions with academicians and financial intermediaries/practitioners.

Phase III: Assessment of productivity and intellectual property rights status of manufacturing in post-TRIPS period

Any study on technology management has to be initiated by covering the productivity aspects. The first phase of research presents analysis of overall manufacturing scenario in terms of Durable, Non-Durable and Essential goods sector. This phase also covers the productivity scenario of India and Punjab in post-TRIPS period. This phase of research focussed on using TFPG index for finding out sector-wise productivity growth of twenty two manufacturing sectors. This would help in understanding the growing sectors of manufacturing. This analysis has been based on secondary data available through Annual Survey of Industries and Annual Patent Reports. This phase presents the current scenario of Indian and Punjab manufacturing. The emphasis of research has been to find out the state-wise and sector-wise status of IPRs.

Phase IV: Technology management strategies adopted by manufacturing SMEs: firm level analysis

The core objective of the study has been to examine and prioritise technology management strategies used by manufacturing SMEs of Punjab for enhancing competitiveness. The last phase of research has been undertaken with the help of sample survey of manufacturing firms from the state of Punjab on the basis of nature of industries from all three categories, i.e., Durable, Non-Durable and Essential goods. For understanding inter-industrial differences in IPR status of the firms, technology management strategies adopted by SMEs have been analysed on the basis of nature of the industry, viz. Durable goods sector, Non-Durable goods sector or Essential goods sector. The study also covers the reasons for filing IPRS, and the factors influencing innovation in manufacturing SMEs. This comprehensive analysis will help in presenting the holistic picture of manufacturing SMEs of Punjab and thus help in improving the productivity, efficiency and competitiveness of manufacturing SMEs.

3.2 RESEARCH DESIGN

The present research has been taken with the objective to study the Technology Management Strategies used by the Manufacturing SMEs of Punjab using a descriptive research design.

3.3 DATA

The study is based on both primary data and secondary data for analysis. Secondary data has been used for industry level analysis and primary data for firm level analysis.

3.3.1 Secondary Data

The data for analysis has been collected from Annual Survey of Industries. Data on suitable deflators has been obtained from “Index numbers of Wholesale Prices.” Ministry of Industry. The gross measure of value added is obtained by adding depreciation to net value added. The data on gross value added was deflated using industry specific wholesale prices (at 1993-94 prices). For labour input total number of persons employed was used and for capital, gross fixed capital at replacement cost was used. Perpetual inventory method (Balakrishnan, et.al., 1994) is used.

The capital stock at any year is calculated as:

$$K_t = K_0 + \sum_{t=1}^T I_t$$

Where I, is investment in year t and K₀ is capital stock for benchmark year, i.e. 1993-94. Investment figures were obtained using the formula:

$$I_t = (B_t - B_{t-1} + D_t) / R_t$$

Where B is book value of fixed capital, D is depreciation. For R wholesale prices index of machinery (base 1993-94=100) is used.

The study uses entire manufacturing covering all twenty two industries at two digit level for analysing productivity trends for Indian and Punjab Manufacturing.

3.3.2 Sample Size and Sampling Technique

For primary data questionnaire method was used. Around 240 firms were approached out of which 100 questionnaires complete in all respects were taken up for analysis. The response rate was 42 percent which is pretty reasonable for primary data collection. Data has been collected from the following districts: Patiala, Ludhiana, Gobindgarh,

Jalandhar, Bhikhi, Mansa, Mohali, Barnala and Hoshiarpur. The reason for selecting these districts is that some of the prominent range of products of Punjab viz. Engineering goods, hosiery items, pharmaceuticals, food and agro products, textiles, electronics, hand and machine tools are clustered in these areas. Ludhiana is known for the production of bicycles and components, hosiery, sewing machines and parts, machine tools, auto-parts, industrial fasteners, electrical and electronic goods. About 21 per cent of the total industrial units in Punjab are located in Ludhiana district. Famous for hand tools, pipe fittings, valves and leather products, Jalandhar is well-known for its sports-goods too. Hoshiarpur, Mohali and Barnala are famous in the country for pressure cookers, castings and machine tools. Bhikhi, Mansa are known for cotton ginning. Mandi Gobindgarh, popularly known as the 'Steel-Town' of Punjab, hosts a number of steel re-rolling mills. Thus, Punjab is a state which has almost all types of manufacturing industries. Further sample has been drawn to cover industries from all sectors, viz. Durable goods, Non-Durable goods and Essential goods.

Although there are around two lakh SMEs in Punjab, but in the present study only those units have been considered for analysis which have at least 100 employees and a gross business income over Rs 5 Million. Such firms are approximately 1000 in number. Thus, the survey covers 1 percent of the firms. Small sized family units are not included in this study. The reason for taking these enterprises is that that they may be possessing knowledge about IPRs. Another reason for selection of these units is that they may be using advances technology compared to small family units predominant in Punjab. The random sample was drawn from the population of enterprises in the Punjab state, stratified by provinces as explained above.

3.4 DETAILS OF QUESTIONNAIRE

The review of selected literature provided an initial development of the draft questionnaire. The final questionnaire consists of a total of 60 questions which include mostly Likert scale type questions. Random stratified sampling technique has been used for collecting the data. Information has been collected from manufacturing firms located in Patiala, Ludhiana, Gobindgarh, Jalandhar, Bhikhi, Mansa, Mohali, Barnala, Nabha and Hoshiarpur. Table 3.4 gives details about the purpose of each question. First seven questions cover profile of the respondent firm, while the other questions 8-18 were for studying a variety of responses of SMEs regarding Technology Management Strategies.

Question 19-26 cover the technology adoption status of manufacturing SMEs and quality standards implemented.

The next four questions (27-30) seek responses of the respondents on IPR status covering patents, trademarks, copyrights filed by the firms. The next 11 questions seek responses from the respondents regarding reasons for protecting IPRs.

The next 7 Questions (42-48) seek responses on various aspects like factors for developing IPR culture. And finally last part of the questionnaire focussed upon analyzing the overall impact of TRIPS. This section Questions (49-60) covered the opportunities and threats due to adoption of TRIPS. The questions were framed on the aspects given in table 3.1:

Table 3.1			
Details of Questionnaire			
Sr. No.	Gist of Questions	Response method	Basic Objective/ Purpose
1.	Type of firm	Please tick (✓) one option: 1. Public Ltd 2. Private Ltd	Organisational Profile
2.	Type of Organization	1. Small 2. Medium	√
3.	Nature of Firm	1. Durable Goods 2. Non- Durable Goods 3. Essential goods	√
4.	Increase in range of goods and services introduced	Likert scale	√
5.	Market share	√	
6.	Persons Employed in R&D	√	
7.	Improvement in Quality of Goods and Services Produced	√	
Technology Management Strategies			
8.	Introducing new and increased range of goods and services	Likert scale	Priority of Tecnology Management Strategies
9.	Investment in R and D	√	

	Marketing Strategies	√	
10.	Improved quality of goods and services	√	
11.	Improved production, flexibility	√	
12.	Reduced Labor Costs per unit	√	
13.	Reduced material and energy per produced unit/transaction	√	
14.	Technology Up gradation	√	
15.	Change in managing practices	√	
16.	Indigenous Technological development	√	
17.	Retraining of Workers	√	
18.	Price Strategy	√	
Technology adoption and Implementation of Quality Standards			
19.	Are R & D roadmaps used?	Dichotomous scale	Quality certification status
20.	Are ISO Standards (Quality and Environmental) followed?	√	√
21.	Technology plays a vital role in company's business strategy	Likert scale	Technology Adoption: level and Status
22.	At present, which technology are you using	√	
23.	Have you been adopting new technology in the past to match market requirements?	√	
24.	Better options of Tech availability due to globalisation	√	
25.	Top management support is one of the key factors for new technology adoption	√	
26.	Active involvement of in-house Engineers in tech adoption	√	
IPR Status			
27.	Number of Patents of your firm	Number Status	To assess the IPR status of Punjab Manufacturing
28.	Total No. of Trademarks	√	
29.	Total No. of Copyrights	√	
30.	Status of IPRs in last Ten years	Likert scale	
Reasons for protecting IPR			
31.	Company's Survival is dependent on IPRS	Likert scale	Perception regarding need for IPRS
32.	IPRs enhance Global	√	

	Competitiveness		
33.	IPRs enhance Global Trade	√	
34.	IPRs enhance inventions and encourage Innovations	√	
35.	IPRs lead to enhanced Profits	√	
36.	IPRs lead to enhanced Sales	√	
37.	IPRs attract More FDI	√	
38.	IPRs lead to increase in Licensing of Technologies	√	
39.	IPRs enhance expenses on R& D	√	
40.	IPRs Protect Imitation of Technology	√	
41.	IPRs contribute to higher Economic growth	√	
	Factors for Developing IPR Culture		
42.	Organising more programs for IPR awareness	Likert Scale	Relative importance of Policy and organisational factors
43.	Pool patenting is a good solution		
44.	Reduction of Taxes and Fees	√	
45.	Faster Registration Process	√	
46.	Govt. Assistance for facilitating Patent filing	√	
47.	Support for Entrepreneurial and Managerial Development for SMEs	√	
48.	Punishment for IPRs violation	√	
	Overall Impact of TRIPS		
49.	Manufacturing SMEs have become efficient	Likert Scale	SWOT analysis
50.	Manufacturing SMEs have been associated with increase in profits	√	√
51.	A severe downturn in the economy can have a crippling effect on Manufacturing SMES	√	
52.	There is heavy competition for manufacturing SMEs and there is no room for success	√	
53.	Growing middle class are providing opportunities for manufacturers to increase their profitability	√	√

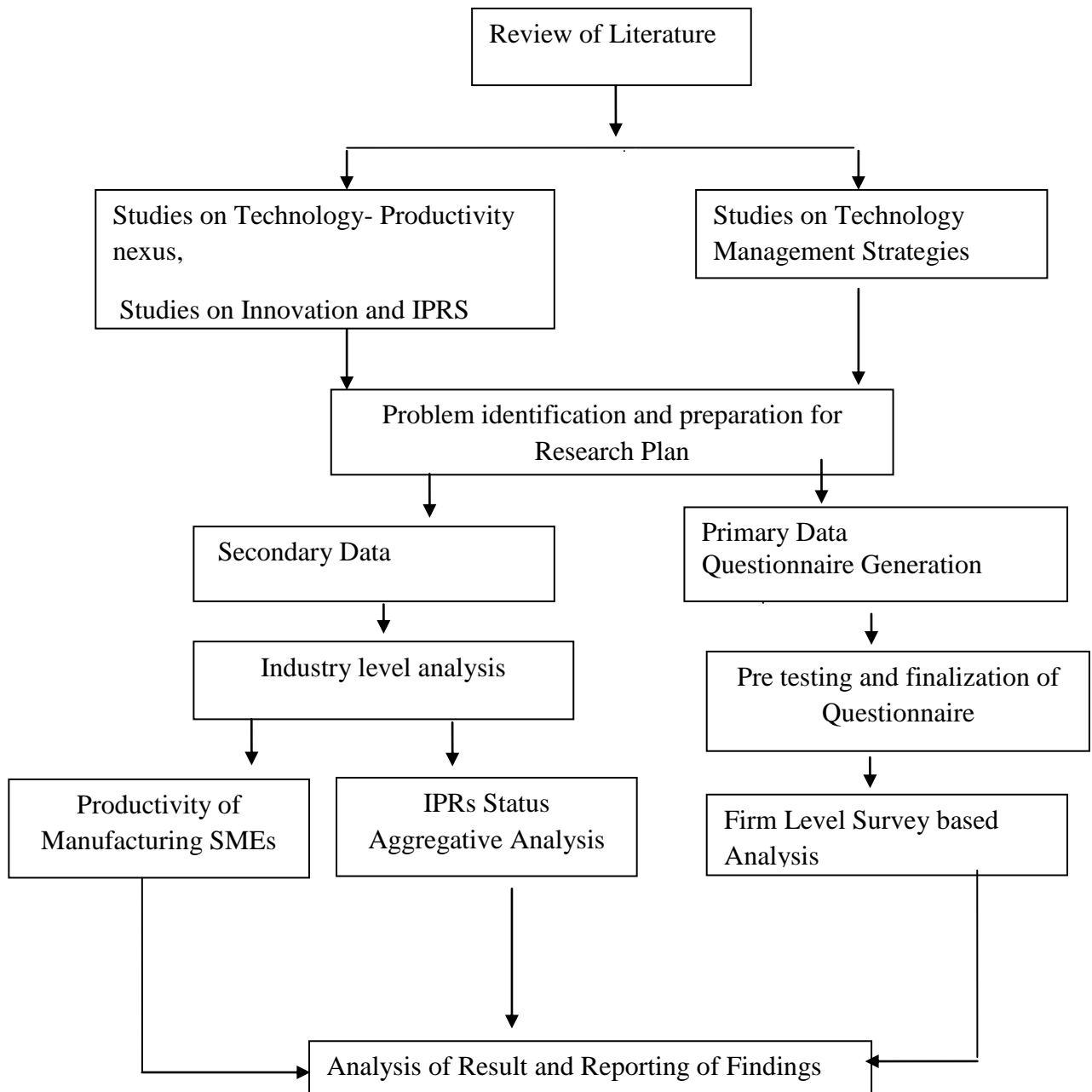
54.	Manufacturing SMEs face threat from competitive products of other countries	√	
55.	Manufacturing SMEs have shift to better technology	√	
56.	Threats due to TRIPS in form of big competitions from foreign companies	√	
57.	IPR system enabled innovators to appropriate a larger portion of the social benefits from their innovations	√	
58.	Stronger patent protection has improved the composition of firm's R&D expenditures	√	
59.	Personnel turnover is low	√	
60.	The firm is able to introduce product variant in short time	√	

3.5 RELIABILITY AND VALIDITY

The questionnaire was tested for its validity and reliability. Validity is the property by which a questionnaire measures what it is supposed to measure. The questionnaires was got validated by the peers and possesses a good validation score (3.75 on a scale of 5). Pilot study was also done on 20 manufacturing SMEs. The changes suggested by experts were incorporated in the questionnaire and responses recorded. Some questions were deleted and some reworded. Reliability applies to a measure when similar results are obtained over time and across situations. When the outcome of the measuring process is reproducible, the measuring instrument is reliable. The two dimensions underlying the concept of reliability are: repeatability and consistency. In the present study, the questionnaire has an overall reliability score of 0.876. Hence the questionnaire was found to be valid and reliable to be used for the present research study. Table 3.2 describes the Reliability status.

Table 3.2 Reliability Statistics		
Items	No of Items	Cronbach Alpha
Technology Management Strategies	12	.901
Performance Indicators and Technology adoption and implementation	10	.751
Extent of Intellectual Property Rights	04	.901
Reasons for protecting IPR	11	.804
Factors for Developing IPR Culture	07	.795
Overall impact of TRIPS on performance	12	.820
Overall	56	.876

3.6 RESEARCH FRAMEWORK



3.7 OBJECTIVES OF THE STUDY

- To study the Technology Management Strategies used by the Small and Medium Manufacturing Enterprises of Punjab.
- To study the extent of Intellectual Property Rights of Small and Medium Manufacturing Enterprises of Punjab.
- To study the reasons for protecting Intellectual Property in the present globalised scenario.
- To recommend the factors for developing IPR Culture for Small and Medium Manufacturing Enterprises of Punjab.

3.8 HYPOTHESES

H₁: There is a significant difference among firm's technology management strategies on the basis of nature of the industry.

H₂: Post-TRIPS period depicts inter-industry differentials and IPR filings are higher by Durable goods industry.

H₃: IPRs are important determinants of innovation activity of SMEs.

H₄: Policy Initiatives factor is more important than organizational factor for promoting IPR conducive environment for manufacturing SMEs.

3.9 TOOLS AND TECHNIQUES

Data has been analyzed with the help of SPSS (Statistical Package for Social Sciences) package version 19. Statistical tools like Chi-square (χ^2) test, ANOVA, Factor analysis Canonical Correlation and Regression analysis have been applied to test the hypotheses.

Growth rates have been calculated as:

$$Y = ab^t$$

$$\text{Log } Y = \text{Log } a + t \text{ Log } b$$

A lot of studies on performance of manufacturing focus on productivity analysis, so an effort has been made to analyse the productivity performance of Manufacturing SMEs of Punjab and compare it with all India Manufacturing at two digit level for Post TRIPS period. In this study the measure of Total Factor Productivity Growth (TFPG) used is derived from a Translog production function under the assumptions of competitive equilibrium.

$$\Delta \log TFP(t) = \Delta \log V(t) [(S_L(t) + S_L(t-1)) / 2] \Delta \log L(t) - [((1 - S_L(t)) + (1 - S_L(t-1))) / 2] \Delta \log K(t) \quad \dots (i)$$

V, L, K, TFP and S_L denote value added, labor, capital, total factor productivity and share of labor income in value added respectively.

The principal source of data used in this study is ASI. The gross measure of value added is obtained from net value added and depreciation data. For labor input total number of persons employed has been used.

Capital input is measured by the estimates of gross fixed capital stock at replacement cost at constant prices using perpetual inventory accumulation method. For estimating gross fixed capital stock at purchase prices, Hashim and Dadi's Gross Net Ratios (GNR) have been used. GNR for land was assumed to be unity. To convert the gross value of fixed capital stock at purchase prices to current prices, Gross Net Ratio of Hashim and Dadi available for two-digit industry groups were used. Wholesale Prices Index (WPI) of machinery and machine tools with base 1993-94 has been used to obtain capital stock at constant prices.

The returns to labor are measured by the total emoluments while returns to capital are measured as value added minus the returns to labor. This is done on the basis of the assumption that returns to the two factors exhaust the value added in the process of production.

3.9.1 Chi-square (χ^2) test

Chi-square (χ^2) test is strongly recommended when the researcher is interested in understanding the association between two variables or to check whether they are independent of each other. For example, the present research, at firm level analysis, intends to know whether the performance of different research parameters was

independent of nature of industries. Hence Chi-square (χ^2) test was used to get the precision.

3.9.2 The Analysis of Variance (ANOVA)

Analysis of variance (ANOVA) is a set of techniques for studying cause and effect of one or more factors (independent variables) on a single dependent variable. In the present study One-way ANOVA has been used. F-test under ANOVA has been conducted to understand whether there is a significant difference across the different levels of firms on the basis of nature of Industry. In Nature three categories included are: Durable, Non-Durable Goods and Essential goods, as explained earlier.

3.9.3 Factor Analysis

The technique of factor analysis provides a fascinating way of reducing the number of variables in a research problem to a smaller and more meaningful number by combining related ones into factors. It relieves the researcher from the confusion arising through overlapping measures of the same underlying variables. Moreover the cost of further research may be reduced by focusing efforts on fewer variables for study.

In the present study, Factor analysis has been used for identifying reasons for understanding the filing IPRs and factors influencing IPRs conducive environment in manufacturing SMEs of Punjab.

3.9.4 Canonical Correlation and Multiple Regression Analysis

The study also uses Canonical correlation and multiple regression analysis for finding out the important predictors of innovation. Canonical correlation measures the bivariate correlation between linear composites of independent variables and dependent variable (Innovation). Innovation in the firm in this study is measured by investment in R&D and Increased Range of goods and services. The independent variables of the model are: nature of firm; market share; quality; production flexibility; reduced labour costs; reduced environmental costs and status of IPRs. The results of Canonical correlation

have been used for Multiple Regression. The dependent variable used in Regression has been investment in R and D. The independent variables of the model are: market share, quality, production flexibility and status of IPRs selected using Canonical correlation.

Chapter Summary:

Choice of an appropriate research design and methodology is one of the most important aspects that pave the way for targeted outcomes in the research process. This chapter elaborates the step by step approach employed for the research. Methodology that has been applied at different phases of this study has been explained thoroughly, followed by a research framework. Finally, a brief overview of rationale for statistical methods like Chi-square, ANOVA, Factor analysis, Canonical correlation and multiple Regression used for testing hypotheses is also outlined.

CHAPTER-IV

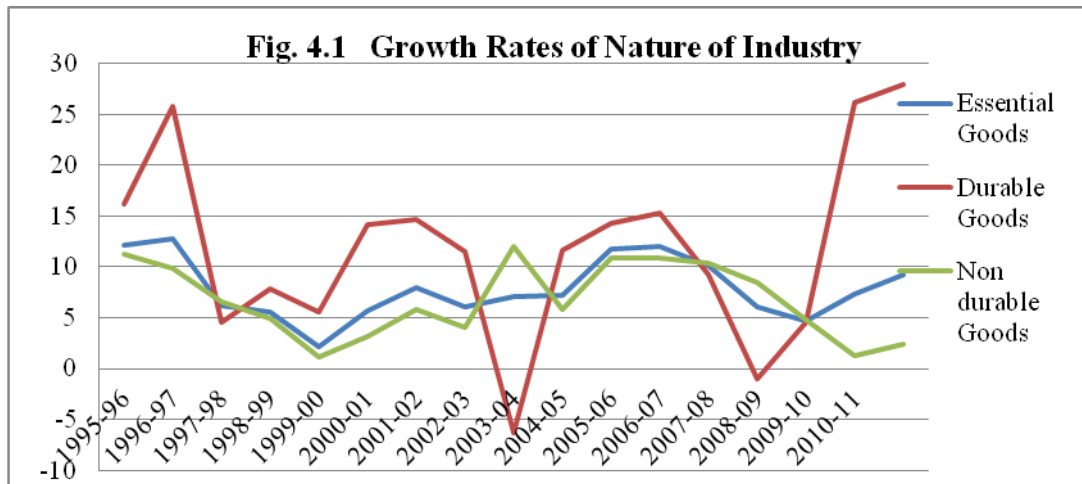
PRODUCTIVITY AND INTELLECTUAL PROPERTY RIGHTS:

POST-TRIPS ANALYSIS

This chapter deals with aggregative analysis at all Indian manufacturing level and Punjab manufacturing. The first section covers the growth rates of manufacturing industry on the basis of nature of industry, viz. Durable Goods, Non-Durable Goods and Essential goods. Section 4.2 covers the total factor productivity of Punjab manufacturing and Indian manufacturing for comparative analysis. The analysis has been done for twenty two digit manufacturing covering the post-TRIPS period from 1994-2008. This section also covers the factors influencing total factor productivity. This section has been related with the first objective of the study covering the technology management strategies adopted by manufacturing SMEs covering the aggregate industry level analysis. Section 4.3 covers the IPR status at India level in post-TRIPS, followed by state-wise and sector-wise analysis of patenting scenario. This section is related with achieving the second objective to understand industry level differences in IPR Scenario and also covers the Inter-State level IPR scenario.

4.1 NATURE OF INDUSTRY: POST-TRIPS SCENARIO

Growth rates have been calculated at India level for the three sectors, viz. Durable goods, Non-Durable goods and Essential goods for post-TRIPS period to find out which sector has been growing at faster rate. As shown in figure 4.1, the Durable goods industry is growing at a faster rate than the other two categories. Non-Durable goods industry has a slower growth rate. The Essential goods industry is also now growing at a higher rate after the recessionary slowdown in 2007-08 and 2008-09. In fact impact of recession is felt on all three categories, but the recovery of Durable goods has been at a faster pace. Thus, the industry-wise analysis of manufacturing highlights that the Durable goods sector has recorded an accelerated growth compared to Non-Durable goods and Essential goods sector in post-TRIPS period.



4.2 TOTAL FACTOR PRODUCTIVITY OF PUNJAB AND INDIAN MANUFACTURING IN POST-TRIPS PERIOD

Productivity is an important aspect of technology management. The significance of productivity for economic growth was highlighted by Kuznets (1966) when he showed that rapid gain in industrial productivity was the crucial underpinning of western industrialization. Productivity can be measured conventionally using labour and capital productivity but comprehensive estimate of efficient resource utilization can be gauged from total factor productivity growth (TFPG), because the latter includes along with labour and capital efficiency, the impact of technological progress and human resource development e.g. the learning curve, increased skill acquisition, etc.

Modern economists emphasize the catalytic role the technological changes play in the growth of an economy. Empirical studies show significant contribution of technological change to aggregate growth. For developed countries traditional inputs play but a minor part in economic growth. The empirical work of Abramovitz, 1956 shows that economic growth of developed countries like the United States of America cannot be explained in terms of capital formation alone when the technical attributes of labour and capital are assumed to have remained constant. This has brought about an appreciation of the role of technological changes as the prime mover of economic growth. In the developed countries research and development has been institutionalized and the technological advances have taken place in quick succession. Consequently, the techniques of production have changed very quickly in advanced countries. Imitation and adaptation of the techniques of production evolved and the adoption of these technologies provided a

short cut to the developing economies for initiating and furthering economic growth (Kindleberger 1958). The new capital goods are emphasized as the carriers of more advanced and efficient techniques of production than those embodied in old capital goods (Solow 1957).

In the narrow sense in which most of the economists use the term, technology, stands for capital goods and equipment and their structure. Technological change, therefore, stands for the change in historically acquired capital structure and the problem of economic growth is then the problem of accumulating a given amount and type of capital. But technological change brings about an increase in per capita income, either by reducing the amount of inputs per unit of output or by yielding more output for given amount of inputs. Technological changes of an economy therefore, refer to changes in the input-output relations of production activities (Mathur 1962).

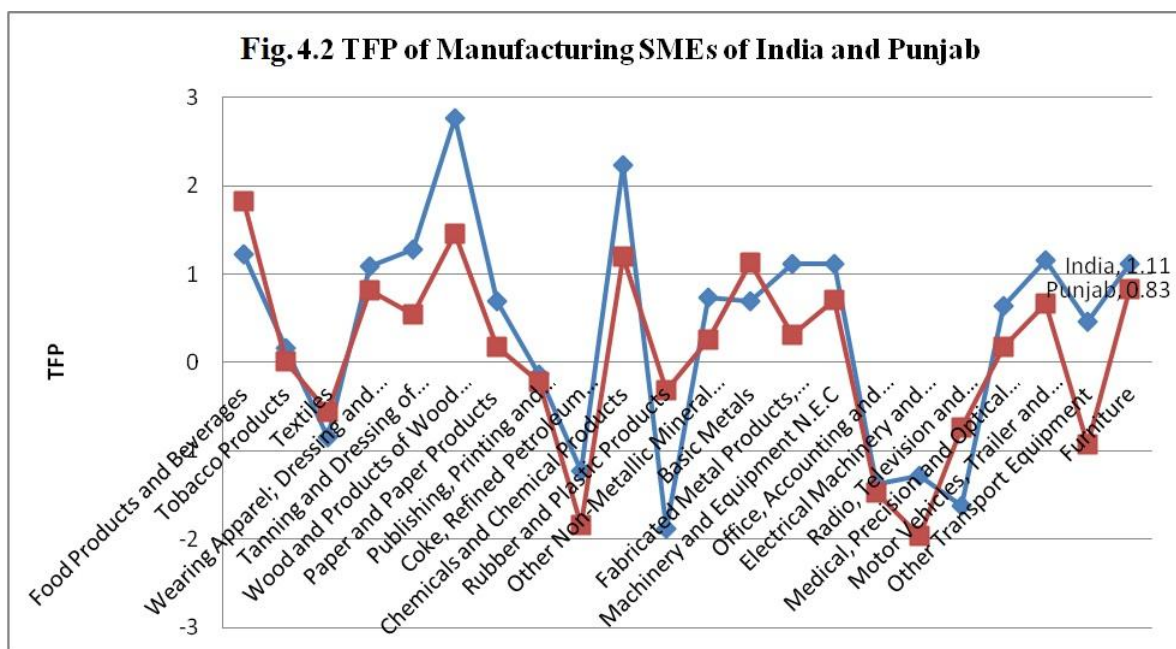
Consequently, as economy moves from lower to higher stages of development there occurs a shift from simpler to more modern and complicated techniques of production. Whichever aspect of economic development we look at, be it industrial growth or performance or export performance, the underlying factors seem to be linked with productivity performance.

In the face of intensified global competition and liberalized trade, productivity has emerged as a key indicator of successful restructuring and upgrading by firms and industries. Productivity growth has traditionally been regarded as one of the main sources of income growth, along with factors such as capital accumulation and the deepening of human capital development. Innovation holds the key to increasing productivity, and productivity gains are the key to both economic growth and raising the standard of living.

Increasing productivity is the key to maintaining competitiveness in manufacturing. Since the adoption of WTO, and TRIPS productivity enhancement has become an integral part of many countries' technology management strategies. So before switching over to firm level analysis, the present study analyzes the productivity trends of Punjab and Indian manufacturing. This will help in understanding the growing sectors of Punjab manufacturing. The analysis has been done for twenty-two industrial groups for the period 1994-2008, covering the post-TRIPS period.

Industry Code	Industry Name	Post- TRIPS Productivity	
		India	Punjab
15	Food Products and Beverages	1.23	1.83
16	Tobacco Products	0.16	0.01
17	Textiles	-0.85	-0.56
18	Wearing Apparel; Dressing and Dyeing of Fur	1.09	0.82
19	Tanning and Dressing of Leather, Manufacture of Luggage, Handbags Saddlery, Harness and Footwear	1.28	0.54
20	Wood and Products of Wood and Cork, Except Furniture; Articles of Straw and Plating Materials	2.76	1.45
21	Paper and Paper Products	0.69	0.17
22	Publishing, Printing and Reproduction of Recorded Media	-0.14	-0.22
23	Coke, Refined Petroleum Products and Nuclear Fuel	-1.23	-1.84
24	Chemicals and Chemical Products	2.23	1.19
25	Rubber and Plastic Products	-1.88	-0.31
26	Other Non-Metallic Mineral Products	0.73	0.25
27	Basic Metals	0.69	1.13
28	Fabricated Metal Products, Except Machinery and Equipments	1.12	0.31
29	Machinery and Equipment N.E.C	1.11	0.71
30	Office, Accounting and Computing Machinery	-1.38	-1.47
31	Electrical Machinery and Apparatus N.E.C.	-1.28	-1.97
32	Radio, Television and Communication Equipment and Apparatus	-1.63	-0.74
33	Medical, Precision and Optical Instruments, Watches and Clocks	0.64	0.18
34	Motor Vehicles, Trailer and Semi-Trailers	1.15	0.66
35	Other Transport Equipment	0.46	-0.93
36	Furniture	1.11	0.83

The present study has used Translog index of TFPG as highlighted in Chapter III. Translog index is considered to be a better measure of TFPG as highlighted by Ahluwalia (1991). The results as depicted in Table 4.1 highlight that for all India Manufacturing highest growth has been recorded for: i) Wood and products of wood and cork, except furniture; articles of straw and plating materials followed by ii) Chemicals and chemical products, and iii) Food products and beverages. In case of Punjab manufacturing the highest growth has been recorded by i) Food products and beverages, followed by ii) Wood and products of wood and cork, except furniture; articles of straw and plating materials and Chemicals and chemical products. Electrical machinery and apparatus n.e.c. has performed badly for both Indian and Punjab manufacturing. Similarly publishing, printing and reproduction of recorded media and coke, refined petroleum products and nuclear fuel are the sectors showing poor performance at all India level as well as at Punjab level. But for all sectors Indian manufacturing has performed better than Punjab manufacturing in post-TRIPS period.



Overall results depict that rate of growth of total factor productivity for Indian and Punjab manufacturing is low and hence, a cause of concern. Seven sectors for all India manufacturing and eight sectors for Punjab manufacturing show negative TFP. Hence in terms of productivity the picture isn't rosy both for Punjab manufacturing as well as for Indian manufacturing. TFP is represented though fig. 4.2

Earlier studies on productivity have reported mixed findings. Studies by Ahluwalia (1991) for the period 1959 to 1985 examine total factor productivity by Translog index. This study indicates that during the two decades of the sixties and the seventies total factor productivity in the manufacturing sector declined. However, there is also a finding that in the first half of eighties productivity growth improved. As per researcher the dominant source of the acceleration in total factor productivity has been the growth of value added. Goldar and Kumari (2003) report a deceleration of TFP growth in Indian manufacturing in the 1990s; their analysis indicates that the lowering of effective protection of industries promoted productivity growth during the period 1991-98. Unel (2003) has concluded that total factor productivity (TFP) growth in aggregate manufacturing and many sub-sectors accelerated after the 1991 reforms.

A study by Milner et al. (2007) explores the impact of trade policy reforms on TFP growth in the Indian manufacturing sectors using the industry data at two-digit obtained from the Annual Survey of Industries covering the period from 1984–1985 to 1997–1998. The picture at the disaggregated level shows that 12 of the 17 industry categories report higher TFP growth in the post-reform period while for five two-digit industries productivity growth is lower in the post-reform period.

There has not been exhaustive study on Productivity for Punjab manufacturing. A study by Kiran and Kaur (2007) report a deceleration in productivity in post-reform era in Punjab manufacturing. Overall analysis of total factor productivity depicts a deceleration in productivity in eleven sectors in the nineties onwards era, (1992-2003) the period associated with liberalisation. Most of the earlier studies have also reported low rate of growth of productivity. Thus there is a need to identify the factors influencing productivity. The following section covers the same.

4.2.1 Determinants of Total Factor Productivity of Punjab Manufacturing

After analyzing trends in productivity it is significant to enquire what factors govern the temporal, spatial and cross-sectional changes in productivity in the manufacturing industries. For this, the important determinants of productivity have been analysed. A study of such factors helps in analysing the conditions which retard and stimulate productivity, and also in discovering the nature and character of the relationship that exists between different determinants of productivity. A study of determinants of productivity helps in analysing which variables influence productivity the most and

should be varied in order to have an immediate effect on productivity. Ordinary least square regression model has been used for analyzing the factors affecting productivity. The time period for the analysis is 1994-95 to 2007-08.

It is hypothesized that productivity is dependent on these variables. The independent variables used in the model are discussed below:

- i. *Rate of growth of output*: Rate of growth of output is an important determinant of productivity as productivity is measured as a ratio of output to input. The higher rate of growth of output should lead to higher labour productivity of the industry. The movements in labour productivity have normally a specific relationship with movements in output. Verdoorn (1949) examined the empirical relationship by estimating the equation of the form:

$$P = \alpha + \beta Q \quad \dots \text{(ii)}$$

Where P is the Productivity growth and Q is the output growth and α and β are parameters. The equation (4.1) was later popularized as Verdoorn's law. He observed a constant long run relationship between output growth and productivity growth. Kennedy (1971) observed a strong correlation coefficient between output growth and productivity growth for Irish manufacturing industry for the period 1946-66. Goldar (1986) has also examined the determinants of productivity in Indian manufacturing sector for the period 1960-70 and found that the one per cent higher growth in output is associated with 0.4 per cent higher growth in TFP. Ahluwalia (1991) estimates the relationship between growth in value added and TFPG. The growth in value added has a positive and statistically significant impact on productivity growth. The elasticity of total factor productivity with respect to value added is 0.37.

In the present study, output is measured by the growth rate of output at constant prices. There are a number of reasons for expecting a positive association between growth in output and growth in productivity. The faster an industry grows, the more the opportunity it has to explore the benefits of an expanding level of operations. The expansion of the industry explores the economies of scale. So an increase in inputs leads to a higher increase in output. In situations where there is excess capacity in an industry, the expansion in scale of operations allows the utilization of this capacity and thus increases efficiency of the factors. Besides the effect of better utilization of

capacity and economies of scale, there is also the effect of learning by doing on productivity performance. Adoption and adaptation of new technologies takes time. In the course of absorption of technology, learning by doing has a positive impact on productivity growth.

- ii. *Capital Intensity*: Capital intensity is the capital-labour ratio of the industry. Capital is the fixed capital employed and labour is measured by the total persons engaged. The most immediate factor affecting output per worker is the amount of machinery available. It is quite evident that the worker helped by machine will produce more than the workers operating with little or no machinery. The need to employ more or less machinery is determined by a number of factors such as size of the plant, the state of technological advancement, the nature and character of products, the size of the market, the availability of capital and human resources and the possibility of substituting one by the other. The quality, size of the machinery, as well as the application of modern techniques in general are of equal importance.

In U.S. several empirical studies undertaken by the National Bureau of Economic Research, the U.S. Bureau of Labour Statistics and the National Industrial Conference Board show that rapid increases in the output per man hour in American industry are associated with the technical improvements and their application to productive processes. Although, it is difficult to measure quantitatively the degree of relationship between technical change and productivity, yet a number of empirical studies bear ample testimony to the fact that the technological advances have made significant contribution towards the rapid rise in industrial productivity. Higher capital intensity involves more embodied technical progress and scope for learning by doing. Empirical studies on the technology-productivity nexus analysed on American industries by Terlecky (1974), Scherer (1982, 1983) and Griliches (1984) have shown that technological advancement is a major source of productivity improvement. Similar conclusions have been presented in the studies of Odagiri (1985) for Japanese industries and Cuneo and Mainsesse (1984) for French industries.

- iii. *Investment*: Composition of capital affects productivity. Investment is taken as the change in the capital stock. Investment figures have been obtained using the formula:

$$I_t = (B_t - B_{t-1} + D_t) / R_t \quad \dots \text{(iii)}$$

Where B is the book value of fixed capital, D is the depreciation and R is an appropriate deflator for fixed capital. For R wholesale price index of machinery (base 1993-94 = 100) has been used. Productivity can be increased by increasing the use of capital goods, machinery and equipment.

- iv. *Growth in Number of Factories*: The next variable taken in the present study is growth in number of factories over the period. The source of data for this variable is the Annual Survey of Industries. This variable captures the effect of increase in the number of factories on productivity during the period of study. The study by Ahluwalia (1991) reveals that the growth of factories in an industry is negatively related to total factor productivity growth. This probably reflects an adverse impact on productivity growth of the phenomenon of fragmentation stemming from the policies of protection of the small scale sector.
- v. *Scale Variable*: Scale variable is measured as the capital stock per factory (an average of two points of time during the period). Ahluwalia's (1991) scale variable, 'capital stock per factory' is an average of the value for two points (1959-60 and 1975-76) during the period (1959-60 to 1979-80). The estimated regression coefficient for scale variable is positive but not statistically significant in Ahluwalia's study. In the present study, scale variable is measured as the average of capital stock per factory taken for two points 1996-97 and 2003-04 during the period. The source of data is the Annual Survey of Industries.
- vi. *Total Emoluments*: Total factor productivity also depends on the efficiency of labour. The ability of the worker, the willingness, and the system of wage payment influence the efficiency of labour. The attitude and behavior of the workers are influenced partly by the system and partly by their morale, feeling of responsibility and trade union practices and attitudes. The system of wage payments exerts an important influence on the worker's urge to produce more. The source of data for this variable is the Annual Survey of Industries.

The relationship of productivity growth with all the aforementioned variables can be represented by an equation of the form:

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6) \quad \dots (iv)$$

Where X_1 is output growth; X_2 is capital intensity; X_3 is investment; X_4 is growth in number of factories; X_5 is scale variable and X_6 is total emoluments.

The purpose of the study is to find out the relationship between growth in total factor productivity and growth in variables like rate of growth of output, capital-labour ratio, rate of growth of investment, scale variable, rate of growth of factories and total emoluments. The dependent variable is total factor productivity growth. Regression results of the entire manufacturing sector in Punjab are depicted in table 4.2:

Table 4.2					
Regression Results For Determinants of TFPG of Punjab Manufacturing					
Variable	B	SE B	β	T	P
(Constant)	1.177	.342		3.443	.001
X_1 :Output Growth	.943	.069	.866	12.877	.001***
X_2 :Capital Intensity	.568	.061	.353	6.168	.001***
X_3 :Investment	.541	.070	-.276	-4.145	.002***
X_4 :Growth in no Of factories	-.836	.274	-.118	-3.047	.143
X_5 :Scale variable	-.648	.213	-.320	-3.043	.083
X_6 :Total Emoluments	.497	.208	.431	5.443	.045*
Notes: $R^2 = 0.843$, Adjusted $R^2 = 0.806$; S.E of Regression = .486; DW = 2.031; F-statistics = 117.06; Significance (F- statistics) $p < .001$					

The results indicate that total factor productivity is positively related to output, capital intensity, investment and total emoluments. It is negatively related to growth in the number of factories and scale variable. Output, capital intensity and Investment are statistically significant at .01 percent level and total emoluments are significant at 5 percent level. The model explains 80.6 percent of variations in total factor productivity. A significant positive relationship between output growth and total factor productivity growth has been observed in a number of earlier studies (Kendrick 1961, 1973; Ahluwalia, 1991) and others have pointed out that productivity growth and output growth are interrelated. Just as productivity growth can be seen as an effect of output growth because of differential scale economies and technological progress that it creates, output growth may also be seen as a consequence of productivity growth because of

lowering of costs and prices that the latter leads to and the increase in demand that fall in prices themselves lead to.

A significant and positive relationship has also been observed between capital intensity and total factor productivity in this study. Similar results have been reported earlier researchers (Sherer,1984; Grilliches and Maires, 1984; Odagiri, 1985; Cuneo and Maires, 1984). The regression coefficient of total emoluments is also positive. Motivation is basic to all human behavior and it leads to improvement in productivity. Productivity depends on financial incentives provided to workers and other employees. This includes the methods of paying wages, salaries, rewards and other incentive plans.

These results highlight the use of technology in improving TFP as highlighted by positive association between TFP and Capital Intensity. Motivation is also considered important for improving productivity. Thus steps can be taken for enhancing productivity by focussing on these key areas.

4.3 INTELLECTUAL PROPERTY RIGHTS: POST-TRIPS SCENARIO

This is an age where information and knowledge translate into economic prosperity and well being, hence creating and protecting intellectual property is central to development. Unfortunately, in India there is a lack of awareness about what our intellectual wealth is and how it can be used to our advantage in order to promote social, cultural and economic growth. Globalization and the rapid proliferation of technology have elevated the importance of intellectual property protection. The intangible nature of intellectual property and the worldwide inconsistency of standard practices create challenges for those businesses wishing to protect their inventions, brands, and business methods in foreign markets. Patents are equally useful for Small Manufacturing Enterprises (SMEs). IPRS, it is generally felt benefit the owner of the IP and add value to all industrial as well as business concerns and laboratory discoveries. Patents provide incentives for private sector investors to enhance their investments and help in their growth and development. Hence the need of the hour is that all business corporations, whether SMEs or large corporations, should have their independent Research and Development (R&D) units. Proper documentation and maintenance of secrecy are considered as issues of prime importance.

A look at International Property Rights Index is essential before proceeding to analyse IPR Scenario of Indian manufacturing. International Property Rights Index (IPRI) has values ranging from 0 to 10, with 10 representing the strongest level of property rights protection and 0 reflecting the non-existence of secure property rights in a country. In case of IPRI India is at 32nd rank with 5.2 score. Norway occupies top rank with 8.3 score. The developed countries like United Kingdom, Germany and Australia share the score of 8.1 and are ranked 6-8 and USA is at fourteenth rank with 7.4 score. Thus in terms of IPRI (International Property Rights Index, 2007), India still has a long way to go to catch up with globally competitive environment.

Year	Patents			Trade marks		
	Filed	Examined	Granted	Filed	Examined	Granted
1995-96	7036	18540	1533	42723	4357	5310
1996-97	8562	24036	907	43234	5560	4686
1997-98	10155	2706	1844	46712	7116	4120
1998-99	8954	3424	1800	51704	42104	5300
1999-00	4824	2216	1881	66378	42500	8010
2000-01	8503	549	1318	84275	-	14202
2001-02	10592	1356	1591	90236	159735	6204
2002-03	11466	9538	1379	94120	249003	11190
2003-04	12613	10709	2469	92251	89958	39762
2004-05	17466	14813	1911	78996	72091	45015
2005-06	24505	11569	4320	85699	77500	184325
2006-07	28940	14149	7539	103419	85185	109361
2007-08	35218	11751	15261	123514	63605	100857
*G. Rates	3.73**	4.57**	4.73**	2.25**	3.95**	4.18**
Notes: *** p < .001						

* Self calculated

The present study is focusing upon the three basic forms of IPRs viz. patents, trademarks and copyrights. The researchers tried to assess the IPR scenario by calculating the growth rate for patents and trademarks filed, examined and granted. The data for the

same has been taken from Patent reports. As depicted in table 4.3 regarding the overall patenting scenario the absolute number of trade-marks filed in India is much higher as compared to the patents filed. In terms of growth rates of patents granted, the rate is higher than that of trademarks. Thus post TRIPS period is depicting improvements in IPR scenario in India.

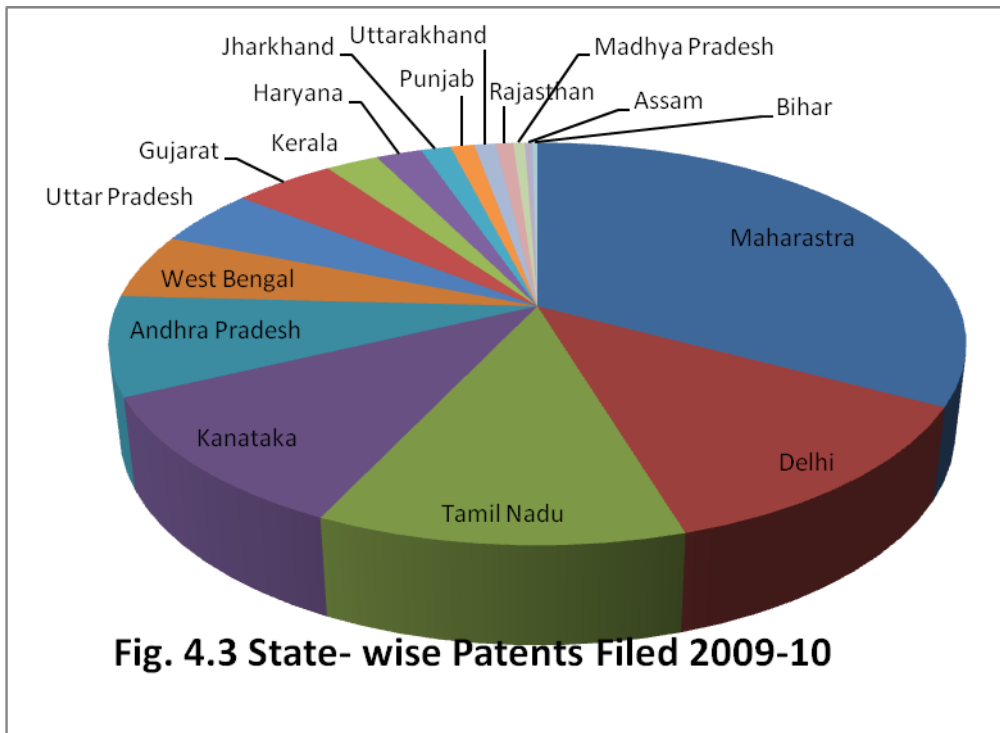
4.3.1 State-Wise Patenting Scenario

Patents constitute an important form of IPRs. A look at the Punjab's patent filing (Table 4.4) in comparison to other states indicates that Punjab still has to tread a long path before reaching the place where Maharashtra, Tamil Nadu and Karnataka are. Maharashtra has filed 2286 patents in 2008-09, while Punjab just 75. The situation has somewhat improved after 2006-07 for Punjab, but this data reveals that awareness in Punjab about patent filing is still low compared to other developed states.

Year/ states	Mahara shtra	Delhi	Tamil Nadu	West Bengal	Gujar at	Karna taka	Kerala	Uttar Pradesh	Har yana	Andhra Pradesh	Madhya Pradesh	Bihar	Punjab	Rajas- than	Assam	Jhar- khand
2000- 01	545	663	174	143	147	112	77	27	20	100	30	31	15	7	4	
2001- 02	650	678	220	161	120	147	70	80	27	120	19	8	14	13	3	21
2002- 03	681	726	290	116	161	118	85	103	75	196	30	2	46	13	8	3
2003- 04	921	795	330	154	189	180	66	126	45	222	29	9	27	28	9	21
2004- 05	1093	935	397	131	179	216	79	72	48	254	45	41	27	28	6	35
2005- 06	1233	1018	433	214	203	428	96	193	93	408	55	29	29	17	15	15
2006- 07	1607	1310	2	244	337	596	128	205	93	385	33	14	74	44	14	131
2007- 08	1936	812	708	303	286	814	123	161	123	414	50	21	44	36	16	85
2008- 09	2286	868	755	364	319	553	166	321	144	364	37	17	75	55	23	94

State- wise patent filing for the year 2009-10 (Fig. 4.3) is again a pointer to low patent filing by Punjab in comparison to Maharashtra, Tamil Nadu, Karnataka, Andhra Pradesh

and Kerala. Even neighbouring state Haryana is ahead of Punjab. Thus Punjab is lagging behind in patent filing.



4.3.2 Sector-wise Patenting Scenario

There is a lot of discussion whether patenting is dependent on nature of industry. As depicted in the beginning of the chapter, the Durable goods sector has recorded higher growth as compared to Non-Durable goods and Essential goods sector. Thus, an attempt has been made to analyse whether patent filing in Durable goods industry is also higher. So the sector-wise growth rates of patents have been undertaken to reflect a clearer position of inter-industrial differential in patent filing. As shown in table 4.5, Chemical, Drug and Food sectors depict higher growth rates than electrical and mechanical sector.

The results do depict inter-industry differentials. The highest growth has been accorded by Chemical industry, followed by Drugs and Food Sector. Electrical industry (Durable Goods) growth rate has been the lowest, although in absolute terms, the number has increased from 787 in 2006-07 to 1078 in 2007-08.

Table 4.5							
Sector-wise distribution of Patents							
Year	Chemical	Drug	Food	Electrical	Mechanical	General	Total
1995-96	470	132	34	56	159	682	1533
1996-97	282	71	18	54	142	340	907
1997-98	503	291	58	177	381	434	1844
1998-99	609	150	35	138	462	406	1800
1999-00	516	307	250	147	569	92	1881
2000-01	353	276	72	142	254	221	1318
2001-02	483	320	36	139	311	302	1591
2002-03	399	312	67	118	228	255	1379
2003-04	609	419	110	396	539	396	2469
2004-05	573	263	67	245	414	349	2053
2005-06	1140	508	140	451	1448	633	4320
2006-07	1989	887	244	787	2526	1106	7539
2007-08	4071	1783	554	1078	3230	5011	15727
G. Rates	4.81**	4.17**	4.11**	3.81**	4.01**	4.09**	4.73**
Notes	P<.001						

Source: Indiatat database.

These results are indicative of the fact that nature of industry does influence the patent status of firms, as the growth rates of chemical, drug and food sectors are higher compared to the mechanical and electrical sector. Thus Durable goods sector has recorded lower growth in patent filing as compared to Non-Durable goods and Essential goods industry.

4.3.3 Country-wise Patenting Scenario

Regarding Impact of Patents vs. Trademarks vs. Copyrights the situation in India reflects that filing of trademarks is higher as compared to Patent.

Table 4.6				
Country-wise Patenting Scenario				
Country	Patent filing by origin and office (2007)	Patent Granted (2007)	Trademarks filing by origin and office (2007)	Trademark Granted (2007)
Norway	6654	1774	15976	8085
UK	24999	5930	40484	31966
Australia	26840	11236	61040	43786
India	28940	7539	103419	109361
Germany	60992	17739	83352	60638
China	245161	67948	681358	248197
USA	456154	157283	304129	172427

Source: WIPO Publication No. 941 (E) 2009

The table provides a breakdown of Total Patents and Trademark filed and granted in the year 2007. From the results it can be inferred that both in terms of Patent filed and granted, India is lagging behind developed countries like U.S.A, Germany. Even China is fastly improving its situation in Patent filing. Similar trends are visible for patents granted as well. The situation is slightly better for India in term of trademarks filing reflecting the results emerging from present study.

Chapter Summary:

This chapter presents the overall scenario of the nature of Industry. Productivity growth of India as well as of Punjab is low in post-TRIPS period. Output, capital intensity, investment and total emoluments are important predictors of TFPG of Punjab manufacturing measured by Translog index. In terms of IPRs, post-TRIPS period reflects an improvement in patent and trademark filing as well as granting status. The state-wise patent filing reflects that Punjab has to take initiatives to improve patent filing as it is lagging behind many states of India, including Haryana, its neighboring and competitor

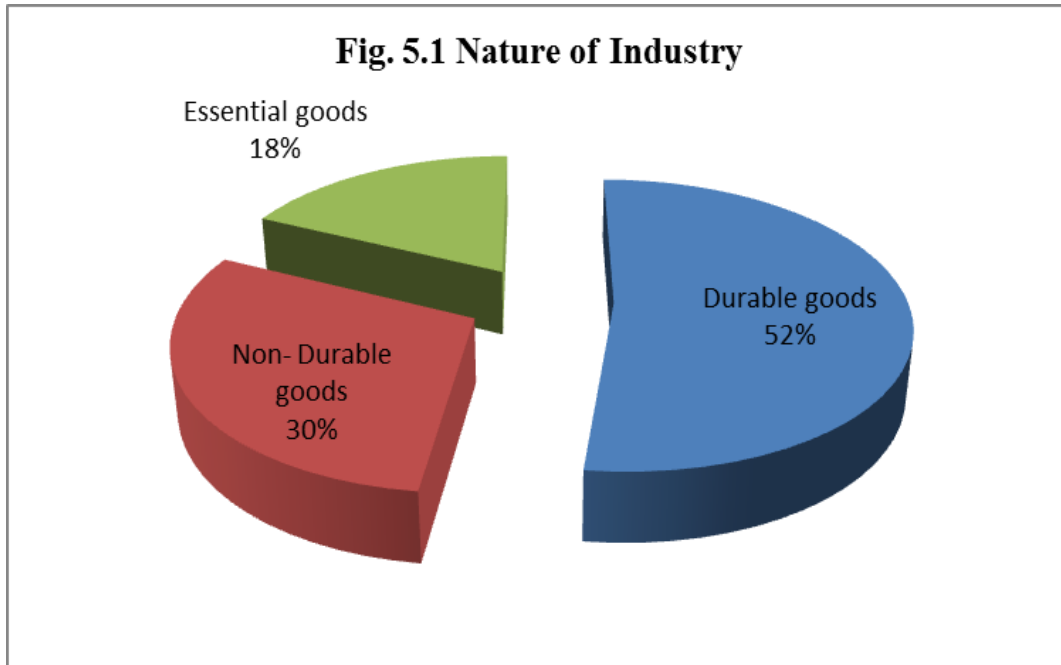
state. Inter- industrial differentials are prevalent in patent filing, with chemical, drug and food sectors being higher as compared to mechanical and electrical sector.

Patents constitute an important form of IPRs. A look at the Punjab's patent filing in comparison to other states indicates that Punjab still has to tread a long path. In 2008-09 Maharashtra has filed 2286 Patents, Delhi has filed 868 Patents, Tamil Nadu has filed 755 and Karnataka filed 553 patents, while Punjab just filed 75 patents. The situation has somewhat improved after 2006-07 for Punjab, but this data reveals that awareness in Punjab about patent filing is still low in comparison to other industrialised states.

A comparison of India with other countries of the world has been depicted through International Property Rights Index (IPRI) India is at 32nd rank with 5.2 score. Norway occupies top rank with 8.3 score. The developed countries like United Kingdom, Germany and Australia share the score of 8.1 and are ranked 6-8 and USA is at fourteenth rank with 7.4 score. Thus in terms of IPRI (International Property Rights Index, 2007), India still has a long way to go to catch up with globally competitive environment. This infact validates the results of the present study that IPR filing in India has been low and has to improve.

CHAPTER-V
TECHNOLOGY MANAGEMENT STRATEGIES ADOPTED BY
MANUFACTURING SMES: FIRM LEVEL ANALYSIS

This chapter covers the firm level analysis focusing on the technological management strategies adopted by manufacturing SMEs of Punjab in section 5.1, followed by Nature of Industry and Technology adoption status including firm level performance based on nature of industry in section 5.2. After analyzing performance of sample firms with respect to market share, R&D and quality of goods and services, the next section 5.3 covers the nature of Industry and Impact of TRIPs on Manufacturing SMEs. This section also includes the IPR status of Manufacturing SMEs. Section 5.4 deals with the reasons for filing IPRs, section 5.5 covers the factors influencing innovation in manufacturing SMEs, and the final section 5.6 covers the factors for promoting IPR conducive environment.

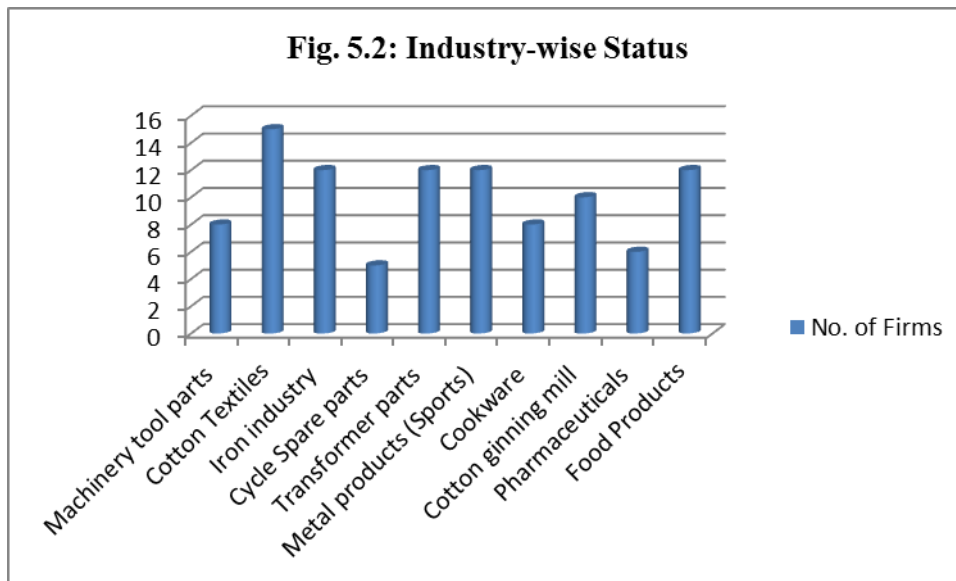


As depicted in fig 5.1 the sample consists of 52% firms from Durable goods category, 30 from Non-Durable goods category and 18 in Essential goods category. Regarding the

nature of industries, effort has been made to cover all areas. Categories of firms within these sectors have been depicted in Table 5.1.

Table 5.1		
Nature of Industry		
Industry Category	Industry Name	No. of Firms
Durable	Machinery tool parts	8
	Cotton Textiles	15
	Iron industry	12
	Cycle Spare parts	5
	Transformer parts	12
Non-Durable	Metal products (Sports)	12
	Cookware	08
	Cotton ginning mill	10
Essential	Pharmaceuticals	06
	Food Products	12
Total		100

Figure 5.2 diagrammatically depicts the categorisation of the sectors covered. The sample tried to cover all sectors.



5.1 PREFERRED CHOICE OF TECHNOLOGY MANAGEMENT STRATEGIES

The first **objective** of the present study has been:

To study the Technology Management Strategies used by the Small and Medium Manufacturing Enterprises of Punjab.

This has been achieved through section 5.1 and 5.2 related with technology management strategies, technology adoption and performance indicators. The study has used weighted mean and standard deviation to present this analysis. Along with the descriptive statistics, Chi-Square and ANOVA have been used to achieve this objective.

The related hypothesis is:

H₁: There is a significant difference between technology management strategies of firms on the basis of nature of firm.

Associated with the main hypothesis are related hypothesis H_{1a}- H_{1d} explained in subsequent analysis.

Generally, firms' sustainable competitive advantage requires that the firms continuously differentiate their products and services from competitors (Chen et al., 2009; Koellinger, 2008). Firms can constrain and direct an R&D department's ability to take action and differentiate it from competitors. On the basis of literature review as explained in chapter II, twelve technology management strategies have been identified. Through a self-structured questionnaire the responses were sought from 100 manufacturing SMEs.

Initial part of research in this phase focused on identifying the preferred technology management strategies. The study tried to rate these strategies on the basis if percentage of scores as highlighted in table 5.2.

S. No.	Technology Management Strategies adopted by SMEs	No. of Responses (Ni) with each score choice (Si)					Total Score $\sum (Ni*Si)$	% age Score	Rank
		1	2	3	4	5			
1.	Increased range of goods and services	6	15	44	22	13	321	64.2	7
2.	Investment in Rand D	79	12	8	1	-	131	26.2	11
3.	Marketing Strategies	6	15	47	19	13	318	63.6	8
4.	Improved quality of goods and services	4	12	47	22	15	332	66.4	6
5.	Improved production, flexibility	6	19	42	22	11	313	62.6	9
6.	Reduced Labor Costs per unit	25	42	25		4	216	43.2	10
7.	Reduced material and energy per produced unit/transaction	27	39	29	1	4	216	43.2	10
8.	Technology Up gradation	-	11	44	30	15	349	69.8	3
9.	Change in managing practices	-	16	43	28	13	338	67.6	5
10.	Indigenous Technological development	-	13	48	28	13	347	69.4	4
11.	Training of Workers	-	5	36	41	18	372	74.4	1
12.	Competitive Price Strategy	-	4	39	40	17	370	74	2

The results of the preferred technology management strategies are discussed below:

1. Training of workers has got the highest priority among all the management strategies. Most of the respondents expressed that the firms are currently focussing on training of their employees, as training will enhance the overall productivity. Training has also

been adopted in SMEs to acquaint the workers with new machines acquired by the firms.

2. With the overall score of 74 % having a second rank, price strategy is still considered very important management strategy. The oldest and still the most favoured strategy still predominates among Manufacturing SMEs.
3. Technology up gradation got the third rank with a score of 69.8 %. The respondents are of the view that in modern world they have to focus on new technology. In fact Punjab SMEs are adopters of new technologies and willingly buy new technologies.
4. Regarding Indigenous technological development the manufacturers gave it fourth rank. Indigenous technology results in cost saving. So the next preferred strategy adopted has been development of indigenous technology wherever feasible.
5. Change in managing practices got the fifth rank. Due to globalization, manufacturing companies have to think about various new managing strategies. Managing in the changing globalised scenario is becoming more complex and demands higher attention.
6. Improved quality of goods and services ranked some-what lower in priority, as compared to other strategies adopted by firms. However, the respondents opined that increasing quality consciousness cannot be ignored and the time has come to focus on quality standards to gain competitive advantage by improving quality of their products.
7. Increased range of goods and services introduced by the firms has been ranked next on priority. With increasing global competition customers want more choices of the products. There have been many SMEs which have introduced new range of goods and services in the post-TRIPS period.
8. Regarding marketing focus SMEs are still lagging behind and there is much effort required to switchover to well accepted marketing strategies. This was placed at eighth rank, may be the firms are now focussing more on other strategies viz technological up gradation and quality improvement strategies.
9. Improved production and flexibility got ninth rank. Due to globalization, competition has increased and big manufacturers eat small manufacturers. As SMEs are suppliers

to the big manufacturers, an increased focus has to be placed on improving productivity for improving performance and to stay ahead of the rivals.

10. Reduced labour cost and material and energy produced per unit got a lower rank because they thought that due to higher prices of raw material along with high labour prices as well as electricity problem along with high taxes on raw material may be not much is in the hands of manufacturers.
11. What has been most surprising is that investment in R and D got the least priority. Indian SMEs are still are not able to invest more on R&D. They have given a lower score to investment in R and D which is a cause of concern. So there has to be more focus in R and D.

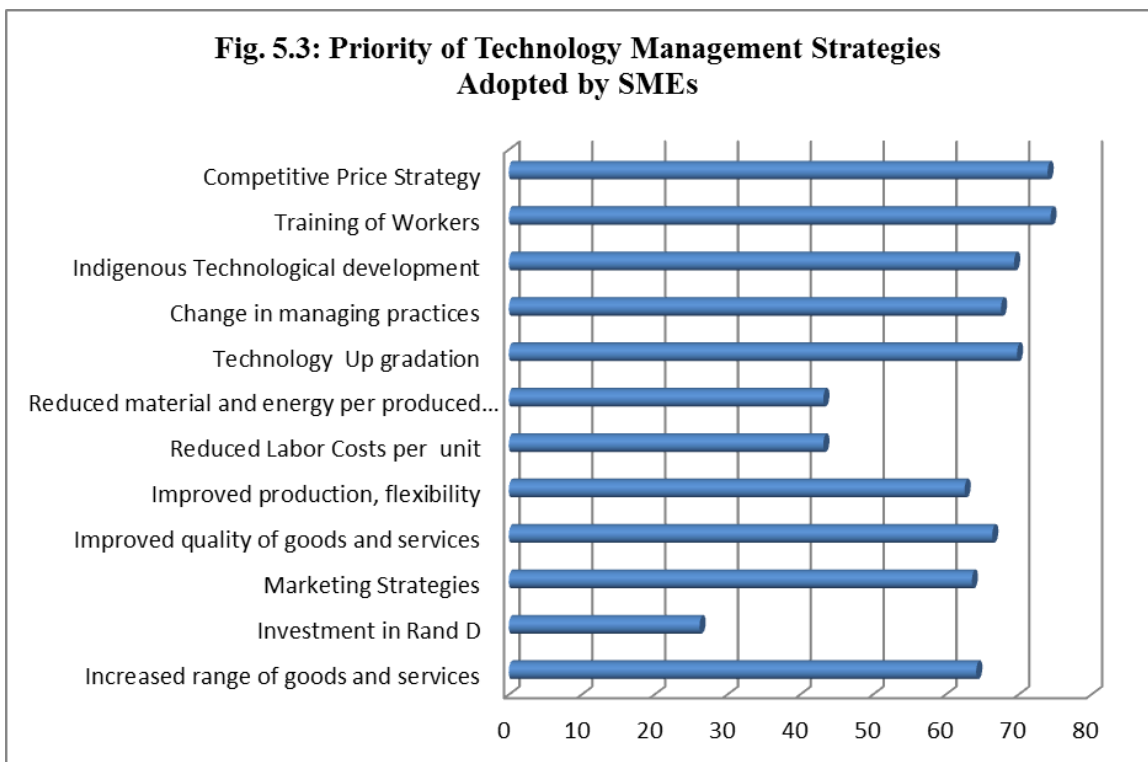


Fig. 5.3 Priority of Technology Management Strategies Adopted by SMEs

Since the present research has been undertaken from nature of industry perspective, an effort was made to understand the relation between nature of industry and technology management strategies adopted by SMEs. As explained earlier the firms have been grouped into the following three categories viz. Durable goods; Non- Durable goods; and Essential goods.

The main reason for this has been to understand whether there has been a difference in adoption of technology management strategies on the basis of nature of industry. Thus for in-depth analysis, ANOVA has been applied to find the relation between nature of industry and technology management strategies adopted by SMEs. The results of the same are given in table 5.3

		Sum of Squares	Df	Mean Square	F	Sig.
1. Increased range of goods and services	Between Groups	19.496	2	9.748	7.52	.001**
	Within Groups	125.664	97	1.296		
	Total	145.160	99			
2. Investment in Rand D	Between Groups	.083	2	.042	1.42	.245
	Within Groups	2.827	97	.029		
	Total	2.910	99			
3. Marketing Strategies	Between Groups	25.343	2	12.671	10.77	.003***
	Within Groups	114.047	97	1.176		
	Total	139.390	99			
4. Improved quality of goods and services	Between Groups	15.263	2	7.631	6.77	.002**
	Within Groups	109.247	97	1.126		
	Total	124.510	99			
5. Improved production, flexibility	Between Groups	15.555	2	7.777	6.79	.002**
	Within Groups	111.035	97	1.145		
	Total	126.590	99			
6. Reduced labor Cost	Between Groups	25.353	2	12.677	14.56	.001***
	Within Groups	84.437	97	.870		
	Total	109.790	99			
7. Reduced material and energy per produced unit/transaction	Between Groups	33.435	2	16.717	19.09	.001***
	Within Groups	84.925	97	.876		
	Total	118.360	99			
8. Technology Up-gradation	Between Groups	21.526	2	10.763	19.41	.001***
	Within Groups	53.784	97	.554		
	Total	75.310	99			
9. Change in Management Practices	Between Groups	23.621	2	11.811	18.12	.001***
	Within Groups	63.219	97	.652		
	Total	86.840	99			
10. Indigenous technology Development	Between Groups	21.201	2	10.601	21.26	.001***
	Within Groups	48.359	97	.499		
	Total	69.560	99			
11. Retraining of Workers	Between Groups	6.293	2	3.146	4.68	.011**
	Within Groups	65.097	97	.671		
	Total	71.390	99			
12. Competitive Price Strategy	Between Groups	2.668	2	1.334	2.25	.111
	Within Groups	57.492	97	.593		
	Total	60.160	99			

ANOVA results highlights that investment in R and D and price strategy have not emerged significant, while for all other strategies the results are significant. Hence they are pointers to the fact that there is a significant difference among firms' technology management strategies on the basis of nature of industry. Inter-industrial differences do affect technology management strategies adopted by firms. Detailed analysis related with technology management strategies of Durable, Non-Durable and Essential goods has been achieved through related hypothesis H_{1a}- H_{1d}.

5.2 NATURE OF INDUSTRY AND TECHNOLOGY ADOPTION STATUS

The study tries to find out the technology adoption status of respondent firms. Accordingly section 3 of questionnaire covered this aspect. As depicted through fig 5.4 Essential goods have reported that technology plays a vital role in firms' business, have reported advanced use of technology and have reported active support of top management and in house engineers for technology adoption. This sector is followed by Non-Durable goods sector, while Durable goods sector is lagging behind in technology adoption and facilitation.

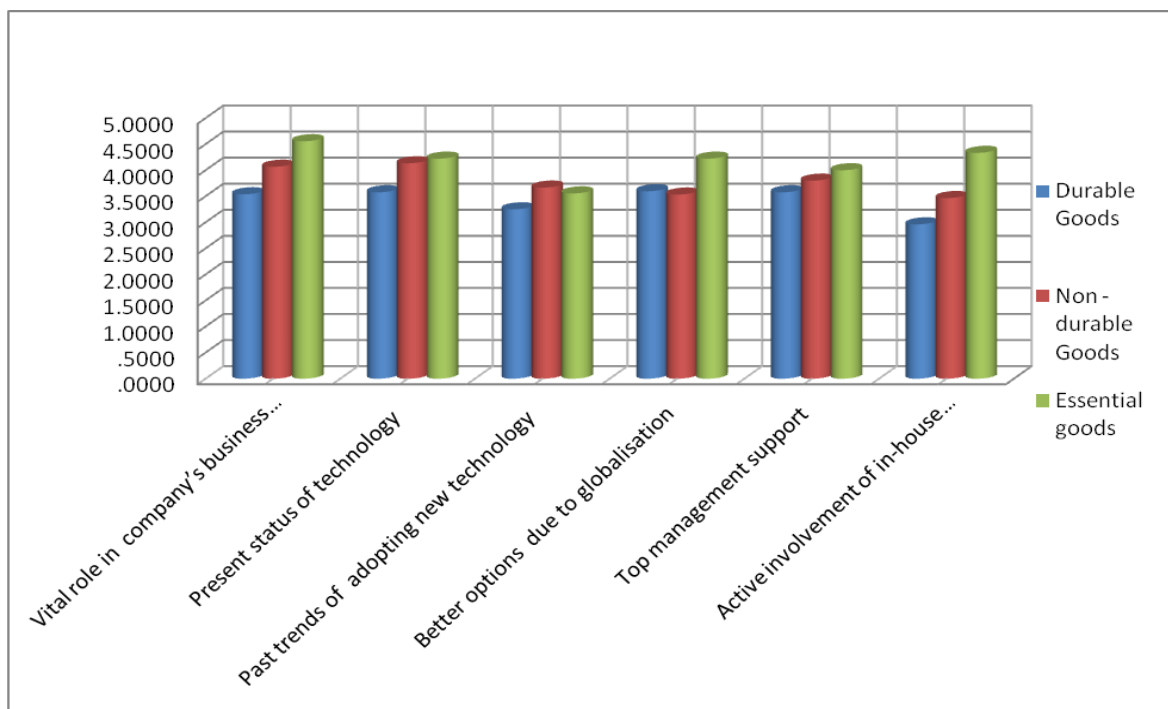


Fig.5.4 Nature of Industry and Technology Adoption Status

ANOVA results (table 5.4) highlight a significant difference in technology adoption status on the basis of nature of industry in case of these four technology parameters: i)

Technology plays a vital role in company's business strategy; ii) present status of technology used; iii) Better options of technology availability due to globalisation; and iv) Active involvement of in-house engineers in tech adoption. These results are indicative of the fact that there is a significant difference in technology adoption and initiatives towards technology. Moreover adoption across different sectors as highlighted earlier the steps towards adoption are more in Essential goods industry.

		Sum of Squares	Df	Mean Square	F	Sig.
Technology plays a vital role in company's business strategy	Between Groups	15.326	2	7.663	11.394	.001***
	Within Groups	65.234	97	.673		
	Total	80.560	99			
Present status of technology used	Between Groups	8.770	2	4.385	6.517	.002***
	Within Groups	65.270	97	.673		
	Total	74.040	99			
Have you been adopting new technology in the past to match market requirements?	Between Groups	3.649	2	1.824	1.866	.160
	Within Groups	94.861	97	.978		
	Total	98.510	99			
Better options of Technology availability due to globalization	Between Groups	6.293	2	3.146	4.689	.011*
	Within Groups	65.097	97	.671		
	Total	71.390	99			
Top management support is one of the key factors for new technology adoption	Between Groups	2.668	2	1.334	2.250	.111
	Within Groups	57.492	97	.593		
	Total	60.160	99			
Active involvement of in-house Engineers in tech adoption	Between Groups	25.650	2	12.825	25.188	.001***
	Within Groups	49.390	97	.509		
	Total	75.040	99			

Fig. 5.5 Are Road Maps Used ?

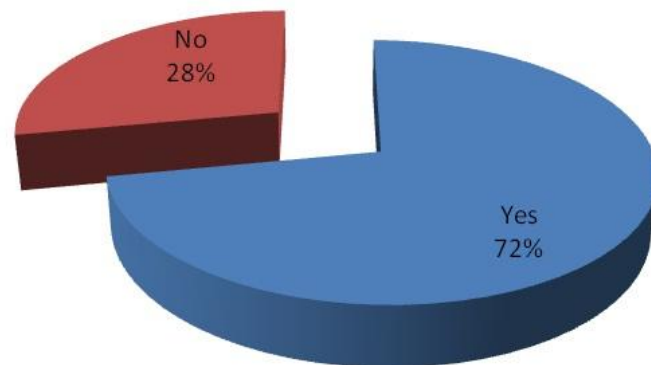
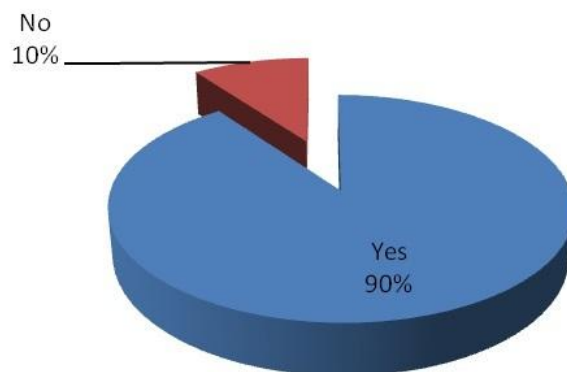


Fig. 5.6 Are ISO Standards(Quality and Environment) used ?



A shift towards Quality enhancement is evident as results indicate that 72 percent of respondents reported that they are using roadmaps and further 90 percent replied in affirmative to ISO standards being used. Thus there is an increasing realisation to adhere to quality standards.

5.2.1 Performance Indicators

In order to get a comprehensive view of why firms in Durable, Non-Durable and Essential goods have responded to the new challenges that have emerged by signing TRIPS. It is essential to have a look at performance indicators:

- i. Increase in range of goods and services introduced
- ii. Market share
- iii. Persons employed in R & D
- iv. Improvement in quality of products

5.2.2 Increase in Range of Goods and Services Introduced

Lumiste et al. (2004) found that innovation helped Estonian SMEs to improve their performance in terms of market share and diversified range of goods and services. Is there a relation between nature of industry and increase in range of goods and services introduced? Which sectors are more prone to introducing increased range of goods and services? These are some questions which the present research tends to answer. The industry level analysis depicts that Durable goods industry reports higher rate of growth as compared to Non- Durable and Essential goods Industry. Accordingly the hypothesis proposed is:

H_{1a}: Firms in Durable goods category are introducing increased range of goods in the market as compared to those in Non-Durable and Essential goods Category.

Nature of Industry/ Increase in Range of Goods and Services		1.00	2.00	3.00	4.00	5.00	Total
Durable	Count	8	8	21	11	4	52
	% within Nature of Industry	15.4%	15.4%	40.4%	21.2%	7.7%	100.0%
Non-Durable	Count	2	4	11	11	2	30
	% within Nature of Industry	6.7%	13.3%	36.7%	36.7%	6.7%	100.0%
Essential	Count	2	0	2	4	10	18
	% within Nature of Industry	11.1%	.0%	11.1%	22.2%	55.6%	100.0%
Total	Count	12	12	34	26	16	100
Chi-Square: 30.740***; Df:8; p <0.001							

The results of the survey highlight (Table 5.5) that firms in Essential goods category are responding positively to increase in range of goods and services introduced, as from a total of 18 firms in this category, 14 reported as a increase. Durable and Non-Durable industries reported moderate impact of TRIPS on a range of Goods and Services introduced. The results of Chi-square suggest a relationship between the nature of industry and increased range of goods and services introduced. The results don't support the above hypothesis as firms in Essential goods are more into introducing increased range of goods in the market as compared to firms in Durable goods Industry.

5.2.3 Market Share

H_{1b}: Firms in Durable goods category report a higher increase in market share as compared to those in Non-Durable goods and Essential goods Category.

Nature of Industry/ Market Share		1	2	3	4	5	Total
Durable	Count	6	12	22	8	4	52
	% within Nature of Industry	11.5%	23.1%	42.3%	15.4%	7.7%	100.0%
Non-Durable	Count	2	4	13	9	2	30
	% within Nature of Industry	6.7%	13.3%	43.3%	30.0%	6.7%	100.0%
Essential	Count	2	0	0	6	10	18
	% within Nature of Industry	11.1%	.0%	.0%	33.3%	55.6%	100.0%
Total	Count	10	16	35	23	16	100
Chi- Square: 37.073***; Df: 8 ;p<0.001							

Results highlight that in case of Durable goods category, only 12 firms (23 %) reported a higher increase in market share. In case of Non-Durable goods the percentage was higher as 37 percent firms reported high/very high increase in market share. The situation was totally different for firms in Essential goods category as 89 percent firms here reported high/very high increase in market share. Results of Chi-square suggest a relationship

between the nature of industry and market share of firms. Thus, the hypothesis that firms in Durable goods category report a higher increase in market share as compared to other categories is not accepted.

5.2.4 Persons Employed in R and D

Nature of Industry	1	2	3	4	5	Total
Durable Goods	29	13	5	3	2	52
% within Nature of Industry	55.8%	25.0%	9.6%	5.8%	3.8%	100.0%
Non-Durable Goods	4	4	8	8	6	30
% within Nature of Industry	13.3%	13.3%	26.7%	26.7%	20.0%	100.0%
Essential goods	2	0	2	2	12	18
% within Nature of Industry	11.1%	.0%	11.1%	11.1%	66.7%	100.0%
Total	35	17	15	13	20	35
% of Total	35.0%	17.0%	15.0%	13.0%	20.0%	35.0%
Notes: Chi- Square=55.367***, Df:8, p<.001						

H_{1c}: Firms in Durable goods category report more persons employed in R and D as compared to those in Non-Durable and Essential goods.

As depicted in the table above, regarding the relation between nature of industry and persons employed in R and D, there are mixed results. Only 5 out of 52 Durable firms rate their persons employed in R and D as high/ very high. In case of Non-Durable goods industry the situation is totally different where only 14 out of 30 firms report high/ very high. In case of Essential goods the situation is a little better as 77.8 % firms report high/ very high number of staff employed in R and D. Chi-square is significant in depicting an association between the two. Hence, the above hypothesis that Firms in Durable goods Industry report more persons employed in R and D is not accepted. The above results

highlight that persons employed in R and D in Durable and Non-Durable categories are still less and the situation demands attention.

5.2.5 Improvement in Quality of Goods and Services Produced

H_{1d}: Firms in Durable goods category report an improvement in quality of goods and services produced as compared to those in Non- Durable and Essential goods category.

Nature of Industry		1.00	2.00	3.00	4.00	5.00	Total
Durable	Count	4	4	30	8	6	52
	% within Nature of Industry	7.7%	7.7%	57.7%	15.4%	11.5%	100.0%
Non-Durable	Count	2	2	11	11	4	30
	% within Nature of Industry	6.7%	6.7%	36.7%	36.7%	13.3%	100.0%
Essential	Count	2	0	0	6	10	18
	% within Nature of Industry	11.1%	.0%	.0%	33.3%	55.6%	100.0%
Total	Count	8	6	41	25	20	100
Chi- Square: 30.655***; Df: 8 ; p<0.001							

The above table depicts that 14 out of 52 firms in Durable goods category report an improvement in the quality of the products. In case of Non-Durable goods 50 percent of firms reported an improvement in quality of their products. In this case also the response is better for Essential goods as 16 out of 18 firms report an improvement in quality of products. Chi-square is significant. Thus there is a relation between nature of industry and improvement in quality of products. Here again firms in Essential goods industry reports a higher increase in quality of goods and services as compared to goods in Durable and Non-Durable goods category. Hence the above hypothesis is not accepted.

5.3 NATURE OF INDUSTRY AND IMPACT OF TRIPS ON MANUFACTURING SMES

The present study also tried to find out the impact of TRIPS on Manufacturing SMEs. A set of questions were framed to analyze this by means of addressing to new opportunities offered by TRIPS. Equally important has been to assess the impending threats imposed by TRIPS.

Results as depicted in table 5.8 indicate that there is almost a consensus amongst all three categories of firms that manufacturing SMEs have become efficient and manufacturing SMEs have been associated with increase in profits. There is also a growing realization that manufacturing SMEs face threat from competitive products of other countries. All categories of firms have accepted that stronger patent protection hasn't improved the composition of firm's R and D expenditures. Again it throws light on low investment in R & D. All three categories of firms have given lower rating to the viewpoint that IPR system has enabled innovators to appropriate a larger portion of the social benefits from their innovations. Thus these indicators are pointers to the fact that manufacturing SMEs are yet not fully prepared for the competitiveness due to stronger IPR regime.

Table 5.9 Nature of Industry and Impact of TRIPS on Manufacturing SMEs

S. No.	Factors	Nature of Industry							
		Durable Goods		Non- Durable Goods		Essential goods		Total	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	Manufacturing SMEs have become efficient	4.81	.40	4.47	1.04	4.89	.32	4.72	.67
2	Manufacturing SMEs have been associated with increase in profits	4.81	.63	4.80	.55	5.00	.00	4.84	.55
3	A severe downturn in the economy can have a crippling effect on Manufacturing SMES	2.75	.71	2.83	.46	2.50	.51	2.73	.62
4	There is heavy competition for manufacturing SMEs and there is no room for success	3.52	.80	3.27	.69	4.11	.90	3.55	.83
5	Growing middle class are providing opportunities for manufacturers to increase their profitability	3.79	.85	3.17	.79	4.22	.81	3.68	.90
6	Manufacturing SMEs face threat from competitive products of other countries	4.04	.56	4.30	.70	4.33	.59	4.17	.62
7	Manufacturing SMEs have shift to better technology	3.85	1.07	3.80	.85	3.83	.86	3.83	.96
8	Threats due to TRIPS in form of big competitions from foreign companies	3.38	.93	3.37	.93	3.00	1.03	3.31	.95
9	IPR system enabled innovators to appropriate a larger portion of the social benefits from their innovations	2.79	.94	3.00	1.11	3.06	.94	2.90	.99
10	Stronger patent protection has improved the composition of firm's R&D expenditures	2.83	.83	2.67	.99	2.17	1.04	2.66	.95
11	Personnel turnover is low	2.54	.58	2.73	.52	2.67	.69	2.62	.58
12	The firm is able to introduce product variant in short time	3.42	1.11	3.73	.87	3.17	.38	3.47	.96

5.3.1 SMEs and Intellectual Property Rights

Any study on technology management would be incomplete without analyzing the IPR scenario. Thus after an analysis of technology management strategies of manufacturing SMEs of Punjab, the focus of the study has shifted to analyze the IPR scenario of manufacturing SMEs of Punjab. According to Robson et al. (1988) the use of intellectual protection differs significantly across industries. The inter-industry differences in the use of IPRs are determined by the technology sector, by the nature of the products, their stage in the life cycle and competitive conditions.

The second **objective** of research has been:

To study the extent of Intellectual Property Rights of Small and Medium Manufacturing Enterprises of Punjab.

This has been achieved through the data related with total number of IPRs filed by manufacturing SMES in all three categories, viz. Durable, Non- Durable and Essential goods. Section 5.3 covers status of various forms of IPRS filed by SMEs.

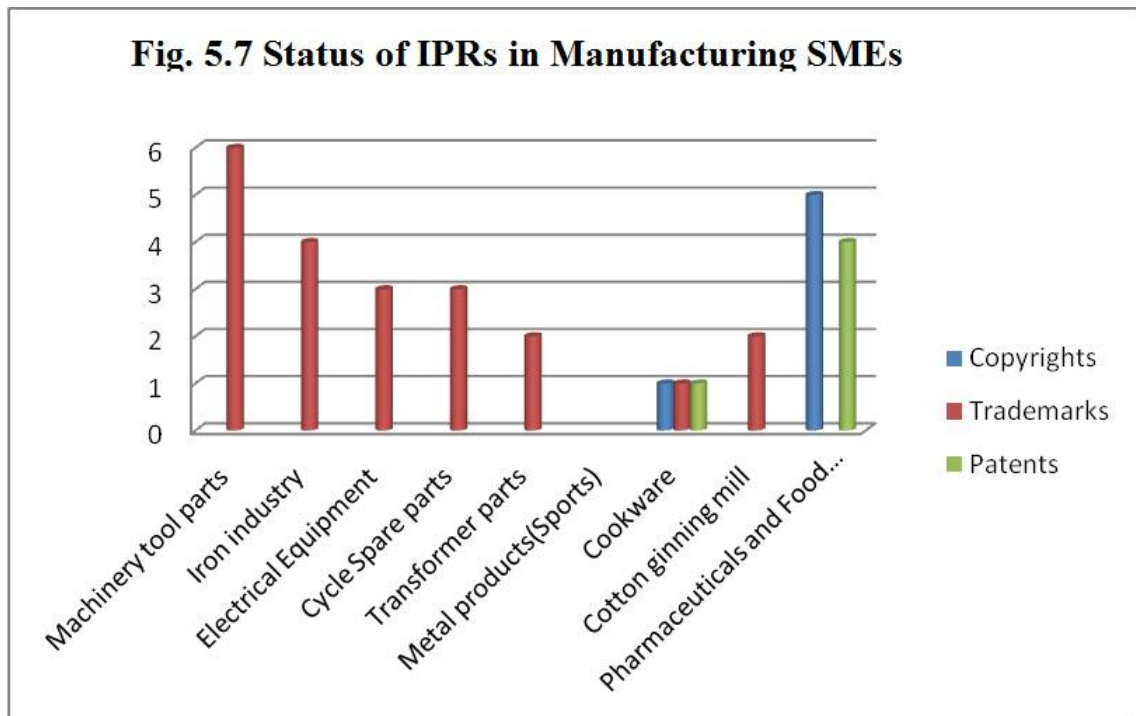
The related hypothesis is:

H₂: Post-TRIPS period depicts inter-industry differentials and IPR filings are higher by Durable goods industry.

The results of the present study (table 5.10) highlight that firms in Essential goods category are filing more of IPRs. As depicted in Fig.5.7 Manufacturing SMEs of Punjab are mostly into filing Trademarks. The number of patents filed is still low and hence the status needs to be improved. This data suggests that IPR awareness and IPR status of Indian manufacturing is still in the nascent stage. Firms in Durable sector have filed most of the trademarks (18 of 21). But it is lagging in filing patents and copyrights. And if we see the Non-Durable industry only one cookware firm filed copyright. Three trademarks have been filed by cotton ginning mill and cookware firm. Most of the copyrights and patents have been filed by firms in Essential goods category. An obvious reason for this is that this sector covers the pharmaceutical industries and the food products and beverages, which are more active in patent filing. This has been highlighted through earlier researchers as well (Robson *et al* (1988); Mansfield (1986).

Thus the status of IPR filing in manufacturing SMEs is low. These results are pointers to the fact that patent and copyright filing is at an initial stage in case of manufacturing SMEs. According to Hanel (2006) as patent-friendly environment is now prevalent in India, patents are increasingly being used for protecting innovations from imitation. But the same is not true for manufacturing SMEs of Punjab as the results of the present study don't support this. This is corroborated further by Maheswary and Bhatnagar (2008), who opine that small-scale industries have failed to cope up with the emerging challenges to keep abreast with the latest developments especially, in the field of IPRs.

Nature of Industry	Category of Industry	Copyrights	Trademarks	Patents
Durable	Machinery tool parts		6	
	Iron industry		4	
	Electrical Equipment		3	
	Cycle Spare parts		3	
	Transformer parts		2	
Non-Durable	Metal products(Sports)			
	Cookware	1	1	1
	Cotton ginning mill		2	
Essential	Pharmaceuticals and Food Products	5		4
	Total	6	21	5



5.4 REASONS FOR FILING IPRs

The third **objective** of present research has been:

To study the reasons for protecting Intellectual Property in the present globalised scenario.

This has been achieved through Factor Analysis presented in Section 5.4 and Canonical correlation and Regression analysis presented in section 5.5.

The related Hypothesis is

H₃: IPRs are important determinants of innovation activity of SMEs.

As the above analysis depicts Manufacturing SMEs of Punjab are filing less IPRs and are mostly filing trademarks, while technology focus requires filing more of patents. Hence, the study tried to find out the firms' perceptions regarding the reasons for protecting IPRs.

Table 5.11 Reasons for Filing IPRs					
Factor Name	Items	Factor Loading	Eigen Value	% of Variance	Cumulative
Enhancing Global competitiveness	i. IPRs enhance Global Competitiveness	.822	3.128	26.066	26.066
	ii. IPRs enhance Global Trade	.801			
	iii. Company's survival is dependent on IPRs	.801			
Technological Development	i. IPRs enhance expenses on R& D	.780	2.622	21.853	47.919
	ii. IPRs protect imitation of technology	.746			
	iii. IPRs contribute to higher economic growth	.709			
	iv. IPRs lead to increased licensing of technologies	.659			
Improving performance	i. IPRs lead to enhanced Profit	.918	2.151	17.927	65.847
	ii. IPRs lead to enhanced Sales	.865			
New Investment Opportunities	i. IPRs attract more FDI	.522	1.138	9.486	75.332
	ii IPRs for CSR	.512			

On the basis of factor analysis results four factors that emerged are: i) Enhancing global competitiveness, ii) Improving Performance, iii) Technological development and iv) New investment opportunities. These four factors account for 75.332 percent of total variation. Enhancing global competitiveness emerged as an important factor explaining 26.066 percent of total variation. All the variables in this factor account for high loadings in the range of .801 to .822. The second factor viz. technological development had four variables accounting for 21.853% of variation. Here the item, 'IPRs lead to increased

licensing of technologies' had a lower item loading of .659 while the variable , 'IPRs enhance expenses on R and D' had a higher item loading of .780.

The next perceived factor having very high item loadings is filing IPRs for enhancing the firms' performance. This factor accounts for 17.927 percent of variation. Literature supports that Increase in market share leads to enhanced sales and enhanced profits and hence, more money can be spent for building innovation culture. Blundell et al. (1999) find a robust and positive effect of market share on observable headcounts of innovations and patents although increased product market competition in the industry tends to stimulate innovative activity. Furthermore, the impact of innovation on market value is larger for firms with higher market shares.

The last factor is IPRs for new investment opportunities. It has two items viz. i) IPRs attract more FDI and ii) IPRs for CSR accounting for a lower variation as well as having lower item loadings. Lehtimaki (1991) observed in context of Finnish SMEs that on an average, the contribution of innovated new products was more to total sales than to profits. Engel et al. (2004), found, as did Roper (1997), that sales turnover of innovative firms grew faster than that of non-innovative firms.

Once again the factors highlight that there is an increasing perception of greater need to place on IPRs for enhancing global competitiveness and for technological development. Although firms especially SMEs cannot be accepted as knocking at the frontiers of technological breakthroughs, yet there is now a realization that technology management strategies need added attention.

5.5 FACTORS INFLUENCING INNOVATION IN MANUFACTURING SMES

The present study uses Canonical correlation and regression analysis for understanding the factors influencing innovation in manufacturing SMEs (Table 5.12)

	Results with all variables		Results after deletion						
			Nature of Firm	Market share	Quality	Prod. Flexibility	Reduced labour costs	Reduced Energy costs	Status of IPRs
Canonical correlation	0.785		0.618	0.745	0.712	0.723	0.664	0.677	0.654
Canonical Root	0.542		0.414	0.392	0.694	0.432	0.426	0.429	0.421
F statistic	p< 0.001		p< 0.001	p< 0.001	p< .001	p< 0.001	p< 0.001	p<0.001	p<.001
Dependent variable	Canonical cross loading	Canonical loadings	Canonical loadings						
Investment in R&D	-0.548	-0.949	-0.460	0.879	0.733	-0.463	-0.954	-0.767	-0.707
Increased Range of Goods and Services	-0.510	-0.941	-0.553	0.853	0.936	-0.449	-0.567	-0.756	0.712
Shared Variance	0.892		0.777	0.623	0.891	0.812	0.801	0.823	0.805
Redundancy index	0.322		0.342	0.342	0.287	0.342	0.307	0.321	0.338
Independent variables	Canonical cross loading	Canonical loadings	Canonical loadings						
Nature of Firm	-0.542	-0.479	N.A.	-0.853	-0.832	-0.830	-0.776	-0.777	-0.801
Market share	-0.632	-0.833	-0.587	N.A.	-0.406	-0.417	-0.429	-0.422	-0.456
Quality	-0.659	-0.712	-0.304	-0.380	N.A.	-0.485	-0.307	-0.395	-0.357
Prod. Flexibility	-0.825	-0.854	-0.442	-0.630	-0.618	N.A.	-0.622	-0.682	-0.698
Reduced labour costs	-0.517	-0.547	-0.457	-0.651	-0.640	-0.652	N.A.	-0.648	-0.685
Reduced Env. Costs	-0.508	-0.454	-0.326	-0.503	-0.522	-0.519	-0.523	N.A.	-0.511
Status of IPRs	-0.663	-0.643	-0.566	-0.543	-0.576	-0.559	-0.583	-0.566	N.A.
Shared variance	0.840		0.367	0.346	0.304	0.308	0.327	0.353	0.432
Redundancy index	0.292		0.144	0.168	0.152	0.147	0.144	0.162	0.154

Canonical correlation measures the bivariate correlation between linear composites of independent variables and dependent variable (innovation). Innovation in the firm is measured by: Investment in R and D and Increased Range of Goods and Services. The independent variables of the model are: Nature of Firm, Market share, Quality, Production Flexibility, Reduced labour costs, Reduced Environmental costs and status of IPRs. Results of Canonical correlation as shown in table 5.12 depict that a strong and statistically significant ($r = 0.785$, $p < 0.001$) has been found between innovation and independent variables.

To assess the validity of the Canonical loadings, statistical runs were made by dropping one variable at a time and re-executing the canonical correlation analysis. Results are indicative of stability of canonical loadings and the statistical significance of the univariate and step down F tests for the Canonical correlation function. Canonical loadings measure the correlation between the individual dependent and independent variables and their respective canonical variates, and are similar in interpretation as factor loadings. The table also depicts the results of these stability runs after the deletion of Nature of Firm, Market share, Quality, Production Flexibility, Reduced labour costs, Reduced Energy costs and Status of IPRs. The Canonical loadings ranged from 0.454 to 0.854 for independent variables. Dependent variable viz. Investment in R&D and Increased Range of Goods and Services also loaded strongly (0.949 and 0.941). Stability runs dropping independent variables in turn were conducted. The results in columns 3-9 depict stability of Canonical loadings.

The computation of Canonical cross loadings has been suggested as improved method to interpret the results of Canonical correlation analysis as compared to Canonical loadings (Hair et al., 1985). This procedure involves correlating each of the originally observed dependent variable directly with the independent Canonical variate, and vice versa. Cross loadings provide a more direct measure of the dependent-independent variable relationships by eliminating an intermediate step involved in conventional loadings. The cross loadings of independent variables from the analysis indicate that Market share, Quality, Production flexibility and status of IPRs have the largest contribution to the dependent set, viz. Investment in R&D and Increased Range of Goods and Services, with cross loadings of 0.632 and above.

The Redundancy index indicates the amount of variance in a Canonical variate explained by the other Canonical Variate in the Canonical function. The Redundancy index for the dependent variable has been 0.322 and for the independent variables it is 0.292. The shared variance of the dependent variables and independent variables has been 0.892 and 0.840. Hence the above independent variables are fit to be chosen to explain variation in the dependent variable.

Table 5.13						
Regression Results						
Variable	B	SE B	β	t	P	Tolerance/ VIF
(Constant)	.567	.226		2.505	.014	
Market Share	.521	.058	.551	9.062	.000	.560/2.22
Production Flexibility	.456	.058	.460	7.878	.000	.588/2.05
Quality	-.058	.056	-.045	-1.033	.304	.869/1.15
Status of IPRs	-.047	.076	-.026	-.617	.539	.950/1.05
Dependent Variable: R& D Expenditure						
Notes: $R^2 = 0.842$, Adjusted $R^2 = 0.835$; S.E of Regression = .45; DW = 1.61; F-statistics = 126.69 Significance (F- statistics) < .001						

Further for closer examination of relationship between the four factors viz. Market share, Quality, Production flexibility and status of IPRs as chosen by Canonical correlation a multiple regression analysis was performed with expenditure on R & D as the dependent variable (Table 5.13). The value of R^2 measures variability in the outcome by predictor variable which leads to the connotation that 84.2% of the variance in dependent variable, i.e., R& D expenditure is predicted by market share and production flexibility, quality of goods and services and status of IPRs.

The results indicate that the predictor variable Market Share ($p = 0.001$) and production flexibility ($p = 0.001$) are significant. The value of $\beta = 0.52$ reveals that market share contributes the maximum to the model which indicates that a unit change in this predictor variable has a large effect on criterion variable. Similarly, high $t = 9.062$ indicate that predictor variable has large impact on criterion variable. The tolerance values highlight the correlation between the predictor variables whereas VIF is an

alternative measure of collinearity in which high values reveal strong relationship between predictor variables. The tolerance for each variable is > 0.560 (1.05) which indicate that there is no problem of multi-collinearity (overlap between dependent variables). It is important to mention here all the variables are considered together when these values are computed and deleting any one variable from the independent variable can affect the level of significance for other dependent variable.

Multiple regression analysis has been performed using Investment in R&D as dependent variable and the independent variables, viz. Market share; Quality; Production flexibility; and status of IPRs. Market Share and Production Flexibility have emerged as important predictors. The model doesn't choose IPRs as important predictors. One reason for this could be that manufacturing SMEs of Punjab are not yet actively filing IPRs. This underlines the need for creating awareness amongst small entrepreneurs regarding IPRs.

5.6 FACTORS FOR PROMOTING IPR ENVIRONMENT

Thus after analyzing the reasons for filing IPRs it is equally important to throw light on the factors for promoting IPR Conducive Environment. The above analysis has highlighted low level of IPR filings by Manufacturing SMEs of Punjab. Hence it is very important to initiate steps to enhance IPR culture.

The last **objective** of research has been:

To recommend the factors for developing IPR Culture for Small and Medium Manufacturing Enterprises of Punjab.

Factor Analysis has been used for identifying the Factors for promoting IPR-Conducive environment in Manufacturing SMEs of Punjab. The results have been presented in section 5.6.

Accordingly the related hypothesis has been:

H₄: Policy Initiatives factor is considered more important than Organizational Factors in developing IPR Environment.

The present study used seven questions related with IPR environment. These seven variables were reduced to two factors through factor analysis viz. (i) Organizational

Factors and (ii) Policy Factors. In developing countries like India, a lot of steps are initiated by States for facilitating IPR filings.

Table 5.14 Factors for Promoting IPR Environment								
Factor	Eigen value	% of Var.	Cum. %	Items	Factor Load	Mean	S.D	Rank
Policy Initiatives	2.31	32.99	32.99	i. Government Assistance for facilitating Patent filing	0.732	4.73	.45	2
				ii. Support for entrepreneurial managerial develop. for SMEs	0.718	4.72	.67	3
				iii. Reduction of Taxes/Fees	0.709	4.32	.68	5
				ii. Severe Penalty for IPR violation	0.695	4.84	.55	1
				iv. Faster Registration Process	0.595	4.56	.70	4
Mean of Policy Initiatives						4.63		
Organizational Factors	2.09	29.85	62.85	i. Organizing More programs for IPR awareness	.912	4.14	.71	6
				ii. Pool patenting is a possible solution	.844	3.91	.68	7
Mean of Organizational Factors						4.02		
Overall Mean						4.46		

As explained above on the basis of Factor analysis, two factors namely Policy initiatives and Organizational Factors have been identified. Policy initiatives factor covers the following items, viz. i) Government assistance for facilitating patent filing with item loading of 0.732 ii) Support for entrepreneurial and managerial development for SMEs 0.718 iii) Reduction of taxes and fees 0.709 iv) Severe penalty for IPR violation 0.695 and v) Faster registration process 0.595. Organizational factors include: i) Organizing more programs for IPR awareness (.912) and ii) Pool patenting is a possible solution (.844).

Overall mean of both the factors is 4.46. Mean of policy initiatives factor is 4.63 and is much higher than overall mean. The relative importance of this factor may also be highlighted through the factor loadings. Three items viz.

- i.) Govt. assistance for facilitating patent filing,
- ii.) Support for entrepreneurial and managerial development for SMEs
- iii.) Reduction of taxes and fees

These three variables are having factor loading of more than seven and the percentage of variance explained by this factor has also been high (32.99).

Thus, for improving the IPR culture in SMEs, the assistance by Govt. is preferred in terms of patent facilitation centers as well as other policy initiatives like faster registration and lower fees are also having higher means than organizational factors. Pool patenting as a possible solution is least on priority; it has the lowest mean score. Hence the above results highlight that policy initiatives factor is considered more important than organizational factors in developing IPR culture. Thus this hypothesis has been accepted. In a developing country like India, policy factors can play an important role in facilitating patent search, creating IPR awareness and supporting IPR filings through facilitation centers.

Chapter Summary:

This Chapter is related with the responses from manufacturing SMEs regarding their technology adoption status and their preference regarding technology management strategies used. It also gives an insight into the performance of sample firms in terms of: increase in range of goods and services introduced; market share; persons employed in R and D and improvement in quality of products. The analysis is indicative of better performance of Essential goods industry compared to Durable and Non-Durable goods industry. The study covers the IPR status and factors influencing innovation in manufacturing SMEs. The analysis throws light on the poor patenting scenario of manufacturing SMEs. The study also indicates the factors for improving IPR environment.

CHAPTER VI

CONCLUSION

The present chapter aims to recollect the various phases of the study. Summary of the research with the main findings has also been presented. Answers to the research questions have been included in this chapter along with the implications of the study. Research contributions from this work have been listed and limitations of the study have also been pointed out. Recommendations based on the study have also been included along with the future work directions in this chapter.

6.1 SUMMARY OF THE RESULTS

The literature review as well as the study has yielded understanding about a number of important issues and conclusions regarding technology-productivity nexus, and innovation and IPR status of manufacturing SMEs. The study tries to assess the productivity status of manufacturing sector of India and Punjab for all 22 sectors based on ASI data. IPR status in post TRIPS period was also examined to proceed further towards analysis. Both state-wise and sector-wise analysis has been done. Based on the literature review a questionnaire had been designed to get responses through a survey of 100 manufacturing firms of Punjab representing all the sectors viz. Durable, Non-Durable and Essential goods.

The study assumes importance in the light of the fact that no such study has earlier been conducted in India on Punjab Manufacturing to cover all these aspects. The aggregative analysis helps in presenting a comprehensive view of Punjab manufacturing, their status in terms, of technology, productivity and IPRs in post-TRIPS period, a period associated with stronger IPR regime. Effort has been made to examine the technology management strategies adopted by manufacturing SMEs of Punjab to identify the preferred strategies. Last section is devoted to enhancing IPR environment.

Major **Findings** of the study are:

- For all sectors the performance of Indian Manufacturing is better than that of Punjab Manufacturing in post-TRIPS period.

- Overall results are indicative of the fact that the rate of growth of total factor productivity for Indian and Punjab Manufacturing is low and hence a cause of concern.
- Seven sectors for all India Manufacturing and eight sectors for Punjab Manufacturing show negative TFP.
- The important predictors of total factor productivity are output, capital intensity, investment and total emoluments.
- Total factor productivity is positively related with output, capital intensity, investment and total emoluments and negatively related to growth in a number of factories and scale variable.
- Output growth is an important predictor of total factor productivity.
- Overall IPR status also is indicative of the fact that the absolute number of trade-marks filed in India is much higher as compared to the patents filed.
- Patents granted and trademarks granted are increasing at a faster pace than patent filing and trademark filing.
- Training of workers has got the highest priority among all the technology management strategies.
- Price strategy the oldest strategy was the next preferred among Manufacturing SMEs.
- Investment in R and D got the least priority as it was rated lower than other strategies.
- ANOVA results highlight that there is a significant difference among firms' technology management strategies on the basis of nature of Industry.
- Essential goods have reported that technology plays a vital role in firms' business, have reported advanced use of technology and have reported active support of top management and in house engineers for technology adoption.
- Essential goods sector is followed by Non-Durable goods sector, while Durable goods sector is lagging behind in technology adoption and facilitation.
- ANOVA results highlight a significant difference in technology adoption status on the basis of nature of industry.
- Ninety out of 100 sample firms possessed ISO and Environmental standard certification.
- 14/ 18 of Essential goods firms reported an increase in a range of goods and services. Durable and Non-Durable industries reported moderate impact of TRIPS on the range of goods and services introduced.
- Essential goods category reports a higher increase in market share as compared to Durable and Non-Durable goods.

- The number of persons employed in R and D in Durable and Non-Durable categories is still less as compared to Essential goods category.
- Essential goods report a higher increase in quality of goods and services as compared to goods in Durable and Non-Durable category.
- The results highlight that firms in Essential goods category are filing more of IPRs than firms in Durable and Non-Durable category.
- Enhancing global competitiveness and technological development are two important reasons for filing IPRs.
- Market share; production flexibility; quality; and status of IPRs are important predictors of R and D.
- Policy Initiatives factor is considered more important than organizational factors in developing IPR culture.

6.2 REVISITING THE RESEARCH QUESTIONS

H₁: *There is a significant difference among firm's technology management strategies on the basis of nature of firm.*

Technology management in the present study has been examined at Industry level by TFP and at firm level by technology adoption level of manufacturing SMEs and by preference regarding technology management strategies. The results at industry level analysis indicates that in terms of growth rates (Fig. 4.1) the Durable goods industry is growing at a faster rate than the Non-Durable goods and Essential goods industry.

Overall TFP results highlight inter-industrial differences in TFP. In case of Punjab Manufacturing highest growth in TFP (Table 4.1) has been recorded by Food products and beverages. Even for Indian manufacturing the TFP is positive and is 1.23 for this sector. Electrical machinery and apparatus not elsewhere classified (n.e.c) has performed badly for both Indian and Punjab manufacturing. Similarly Office, Accounting and Computing Machinery sector has also reported deceleration in post-TRIPS era. Thus in terms of TFP performance, Essential goods industry is performing better than Durable goods industry.

ANOVA results (table 5.4) are indicative of the fact that investment in R and D and price strategy has not emerged significant, while for all other strategies the results are significant. Moreover in terms of technology adoption also ANOVA results (table 5.4) highlight a significant difference in the level of technology adoption status on the basis of nature of the Industry. Essential goods industry considered technology playing a vital role in firms' business, and reported advanced use of technology. These firms also highlight active support of top management and in house engineers for technology adoption. Thus, it can be inferred that inter-industrial differences do affect technology management strategies adopted by firms. Thus the above hypothesis that '*there is a significant difference among firm's technology management strategies on the basis of nature of firm*' has been accepted.

The studies by Sherer (1984); Grilliches and Maires (1984); Odagiri (1985); and Cuneo and Maires (1984) on the nexus between productivity and technology reveal that advances in the latter result in improvement in the former. Kiran and Kaur (2007) report a deceleration in productivity in post-reform era in Punjab manufacturing. As depicted by results from the present study the performance of Manufacturing SMEs in terms of TFP is slow and thus there is an urgent need to address low TFP. Thus there is a need to identify the factors influencing productivity.

H₂: *Post-TRIPS period depicts inter industry differentials in IPR filings.*

The results regarding IPR status (Table 4.3) show that the absolute number of trademarks filed in India is much higher as compared to the patents filed, but in terms of growth rates, patents granted are growing at a faster pace than trademarks. Patents play a vital role in terms of technology development. Patents for the industry have grown at a rate of 4.73 percent per annum in the post-TRIPS period. Sector-wise patenting scenario depicts inter-industrial differential in patent filing (Table 4.4). The highest growth has been accorded by chemical goods category at the rate of 4.81 percent per annum, followed by drugs at a rate of 4.17 percent per annum. Electrical industry growth rate has been the lowest, although in absolute terms, the number has increased from 787 in 2006-07 to 1078 in 2007-08, but the rate of growth has been at 3.17 percent per annum.

Firm level analysis is indicative of difference in patent filing on the basis of nature of industry. Essential goods industry is more into filing IPRs as depicted in Table 5.9 as it is

into filing patents as well as copyrights. Although in terms of absolute numbers, Durable goods sector is leading with 18 IPRs, but they are all trademarks. This hypothesis is accepted as above analysis supports that there are inter-industrial differentials. Overall industry statistics point out that Chemical and Drugs industry is growing at a higher rate, but the statistics of SMEs are indicative of the slow growth of IPRs, especially of patents. Hence there is a need for building IPR culture amongst SMEs.

H₃: *IPRs are important determinants of Innovation activity of SMEs.*

This hypothesis has been tested through Canonical Correlation and Regression analysis. Innovation in the firm is measured by: Investment in R & D and Increased Range of Goods and Services. The independent variables of the model are: nature of firm; market share; quality; production flexibility; reduced labour costs and environmental costs; and status of IPRs. Results of Canonical correlation as shown in table 4.16 depict that a strong and statistically significant correlation ($r = 0.785$, $p < 0.001$) has been found between innovation and independent variables. The cross loadings of independent variables from the analysis indicate that market share, quality, production flexibility and status of IPRs have the largest contribution to the dependent set, viz. investment in R and D and increased range of goods and services, with cross loadings of 0.632 and above.

Multiple regression analysis has been performed using investment in R and D as dependent variable and the above chosen independent variables, viz. market share; quality; Production flexibility; and status of IPRs. Market share and production flexibility have emerged as important predictors. The model does not choose IPRs as important predictors. One reason for this could be that manufacturing SMEs of Punjab are not yet actively filing IPRs. This underlines the need for creating awareness amongst small enterprise entrepreneurs regarding IPRs. So the present hypothesis has not been accepted.

Blundell, *et al.* (1999) has also indicated a positive relation between market share and innovations and patents. According to Hanel (2006) as patent-friendly environment is now prevalent in India, patents are increasingly used for protecting innovations from imitation. Rassenfosse and Pottelsberghe (2008) have found a high correlation between patent numbers and R and D performance. But the results of the present study highlight

the low filing of IPRs by manufacturing SMEs and hence an absence of patent-friendly environment in the state of Punjab. This has been supported by Maheswary et al. (2008) who expressed that small-scale industries have failed to cope up with the emerging challenges to keep abreast with the latest developments especially in the field of IPRs.

As the above analysis depicts the poor performance of manufacturing SMEs regarding IPRs, so the next research question has been focused on understanding as to which factor, viz. Policy initiatives or Organisational factor is more important in promoting IPR culture in manufacturing SMEs.

H₄: *Policy Initiatives factor is more important for promoting IPR culture for manufacturing SMEs than the Organisational Factor.*

Factor analysis has been used to answer this question. The results of Factor analysis highlight that two factors for enhancing IPR awareness are: i) Policy initiatives and ii) Organisational factor explain 62.85 percent of total Variation. Policy initiatives factor is having higher Eigen value and higher mean score and the items in this factor have higher loadings, thus this factor is more important than the organisational factors. Hence this hypothesis has been accepted.

The complete view of Research has been depicted through fig.5.8

NATURE OF INDUSTRY

- Durable Goods
- Non -Durable Goods
- Essential goods

OBJECTIVES OF THE STUDY

- To study the Technology Management Strategies used by the Small and Medium Manufacturing Enterprises of Punjab.
- To study the extent of Intellectual Property Rights of Small and Medium Manufacturing Enterprises of Punjab.
- To study the reasons for protecting Intellectual Property in the present globalised scenario.
- To recommend the factors for developing IPR Culture for Small and Medium Manufacturing Enterprises of Punjab.

METHODOLOGY

- Growth Rates
- Total factor Productivity
- Survey (Self Structured Questionnaire)

RELIABILITY & VALIDITY

- Pilot Survey for pre-testing the Questionnaire
- Validation by Experts
- Calculation of Cronbach Alpha

ANALYSIS

- Mean, Standard Deviation, Factor Analysis, Canonical Correlation and Regression analysis

TECHNOLOGY ADOPTION AND FACILITATION

Essential goods have reported:

- Technology plays a vital role in Firms.
- Advanced use of Technology.
- Active support of Top management and in house engineers.
- Essential goods sector is followed by Non-Durable goods sector.
- Durable goods sector is lagging behind in technology adoption and facilitation.

PREFERRED TECHNOLOGY MANAGEMENT STRATEGIES

- Training of workers.
- Price strategy
- Technology Up-gradation
- Indigenous Technological Development

RESULTS- SECONDARY DATA

- Durable goods industry is growing at a faster rate than the Non-Durable goods and Essential goods industry.
- High growth of TFP has been recorded by Food products and Beverages (Essential goods).
- Low Growth rates of TFP recorded for Electrical machinery and apparatus (Durable Goods).
- Growth rates, patents granted are growing at a faster pace than trademarks.
- In case of Patents the highest growth has been accorded by Chemical goods category followed by Drugs and Food Sector.
- The important predictors of total factor productivity are output, capital intensity, investment and total emoluments.

RESULTS- SURVEY BASED ANALYSIS

- Overall results highlight low patent filing by manufacturing SMEs of Punjab
- Essential goods industry is filing more patents as well as copyrights.
- Durable goods industry is filing more trademarks.
- Market share, quality, production flexibility and status of IPRs have the largest contribution to the dependent set, viz. investment in R and D and increased range of goods and services
- Market share and production flexibility have emerged as important predictors of Innovation measured through investment in R and D.
- Policy Initiatives factor is more important for promoting IPR culture for manufacturing SMEs than the Organisational Factor.

Fig.5.8: COMPLETE VIEW OF RESEARCH

6.3 IMPLICATIONS OF THE STUDY

The findings of this study have significant policy implications for the Punjab manufacturing firms and other related firms. Based on the findings of study, the following policy implications can be offered.

Both Indian and Punjab manufacturing sector is using higher inputs, especially, capital, but still the performance in terms of productivity is low and needs to be improved. Focus has to be concentrated on efficient use of capital. Judicial use of capital along with labour could make important productive contribution to the manufacturing SMEs of Punjab. This is reflected by higher Capital Labour ratio of Indian Punjab Manufacturing and higher technology adoption at the firm level.

Manufacturing SMEs of Punjab need to adopt a global mind set to strengthen design and innovation skills; enhance training skills to manage a world-class organization and to build a competitive edge by improving IPR environment. A right focus on these strategies will lay the foundations for ambitious long term growth. Manufacturing SMEs of Punjab can decide which technology management strategies to opt for achieving global competitiveness.

The United States of America has been the largest filer of PCT with 31.9% of the total PCT filings in January 2009. A significant proportion of PCT filings also originated from Japan (20.8%) and Germany (10.3%). India is way behind. During the period 2004 to 2009 the largest increase in PCT filings was in medical technology (17.5%), followed by Electronics, micro-structural and nanotechnology (17.2%), semiconductors (15.7%), thermal processes and apparatus (13.7%) and electrical machinery, apparatus, energy (13.4%). (PCT, 2009) The sector-wise growth rates calculated also highlighted that in India also Chemical and Drugs and Pharmaceuticals are having higher growth as compared to Electrical Engineering Industry. Thus the results of the present study are supported by worldwide trends in patent filing. (WIPO, 2009) This implies increased focus to be devoted to sectors lagging behind.

In the rigorous product patenting regime following TRIPS, the new source of growth in the future for the Punjab firms to tap is productive R and D, which can help improve patentable innovations. In this knowledge driven economy, firms require accelerated transition from the early stages of accumulation of minimum knowledge levels of

innovative capability, especially in Punjab from adoption and adaptation of new technology to the creation and management of knowledge as a strategic asset. This will help enhance global competitiveness and improve the productivity environment of Manufacturing SMEs.

6.4 LIMITATIONS OF THE STUDY

The limitations of the present study originate mainly from the database and the methodology used. Estimates of output and input in the present study are not free from certain biases. There are conceptual problems in the measurement of capital and these are very difficult to overcome. The standard methodology used in this study also has certain limitations. The measure of total factor productivity growth used in this study is derived from a Translog production function under the assumption of competitive equilibrium (where the factors are paid the value of their respective marginal products) and constant returns to scale. These assumptions have been frequently questioned in literature. Another limitation is that the sample size is relatively small.

6.5 RECOMMENDATIONS FOR FURTHER RESEARCH

- Investigations of technology management strategies as reflected by the findings in this study will deepen the understanding of motivators and facilitators of technology and also provide more detailed directions for future research.
- By including extensive factors, a comprehensive framework of technology management and its rigour can be built. It would be useful to concentrate future research on determining the contribution of foreign capital and technology to the productive performance of the Punjab manufacturing industries.
- The results of the present study indicate that retraining of workers got the highest priority, followed by price strategy and technology up gradation. Thus the present study recommends that there is a need for SMEs to focus on these three key areas.
- It is indicative from the results that there is a stronger need to improve investment in R & D.
- As reflected by results of the present study there is a need to focus on IPR policies especially in terms of patent filings. The firm level analysis can be taken up to see the impact of reforms especially by taking into account R and D intensity and investment climate.

- Further studies can include only active IPR filing manufacturing SMEs from north-west India. Based on these a framework can be designed for improving IPR environment.
- In depth analysis through case studies can add more vigour and life to such research.

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Appendix –I:

QUESTIONNAIRE

On

Technology Management Strategies for Global Competitiveness:

A Post TRIPS Study of Small and Medium Manufacturing Enterprises of Punjab

Dear Sir/Madam,

We are conducting research to study the technology management strategies for global competitiveness. Your valued response/opinion would help us to understand the Post TRIPS scenario of Small and Medium Manufacturing Enterprises of Punjab.

Section A: Organizational Structure (Please tick the appropriate option)

1	Type of firm	Small Scale		Medium Scale		
2	Type of Organization	Private Limited		Public Limited		
3	Nature of Firm	Durable Goods	Non- Durable Goods	Essential goods		
		<i>Please rate the following from 1-5, 1 for lowest and 5 for highest</i>				
		1	2	3	4	5
4	Increase in range of goods and services introduced					
5	Market Share					
6	Persons Employed in R&D					
7	Improvement in Quality of goods and Services produced					

Section B: Technology Management Strategies (Please tick the appropriate option)

A. Technology Management Strategies	<i>Please rate the following from 1-5, 1 for lowest and 5 for highest</i>				
	1	2	3	4	5

i.	Increased range of goods and services				
ii.	Investment in R and D				
iii.	Marketing Strategies				
iv.	Improved quality of goods and services				
v.	Improved production flexibility				
vi.	Reduced Labour Costs per unit				
vii.	Reduced material and energy per produced unit/transaction				
viii.	Technology Up gradation				
ix.	Change in managing and marketing practices				
x.	Indigenous Technological development				
xi.	Retraining of Workers				
xii.	Price Strategy				
B. Technology Adoption and Implementation of Quality Standards					
1	Are R & D roadmaps used	Yes	No	Sometimes	
2	Are ISO Standards (Quality and Environmental) used	ISO 9000:2008		ISO 14000:2004	
		Please rate the following with 1 for the lowest and 5 for the highest			
		1	2	3	4
(i)	Technology plays a vital role in company's business strategy				

(ii)	At present, which technology are you using					
(iii)	Have you been adopting new technology in the past to match market requirements?					
(iv)	Better options of Tech availability due to globalisation					
(v)	Top management support is one of the key factors for new technology adoption					
(vi)	Active involvement of in-house Engineers in tech adoption					

Section C: Intellectual Property Rights Status

1.	Total No. of patents					
2.	Total no of trademarks					
3.	Total no of copyrights					
4.	Status of IPRS	Please rate the following with 1 for the lowest and 5 for the highest				
		1	2	3	4	5

Section D: Reasons for protecting IPR

	Reasons for protecting IPR	Please rate the following with 1 for the lowest and 5 for the highest				
		1	2	3	4	5
1	Company's Survival is dependent on IPRS					
2	IPRs enhance Global Competitiveness					

3	IPRs enhance Global Trade					
4	IPRs enhance inventions and encourage Innovations					
5	IPRs lead to enhanced Profits					
6	IPRs lead to enhanced Sales					
7	IPRs attract More FDI					
8	IPRs lead to increased Licensing of Technologies					
9	IPRs enhance expenses on R& D					
10	IPRs Protect Imitation of Technology					
11	IPRs contribute to higher Economic growth					

Section E: Factors for Developing IPR Conducive Environment

	Factors for Developing IPR Conducive Environment	Please rate the following with 1 for the lowest and 5 for the highest				
		1	2	3	4	5
1.	Organizing More programmes for IPR awareness					
2.	Pool patenting is a possible solution					
3.	Reduction of Taxes and Fees					
4.	Faster Registration Process					
5.	Govt. Assistance for facilitating Patent filing					
6.	Support for Entrepreneurial and Managerial Development for SMEs					

7.	Severe Penalty for IPR violation					
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Section F: Overall Impact of TRIPS

	Overall Impact of TRIPS	Please rate the following with 1 for the lowest and 5 for the highest				
		1	2	3	4	5
1.	Manufacturing SMEs have become efficient					
2.	Manufacturing SMEs have been associated with increase in profits					
3.	A severe downturn in the economy can have a crippling effect on Manufacturing SMES					
4.	There is heavy competition for manufacturing SMEs and there is no room for success					
5.	Growing middle class are providing opportunities for manufacturers to increase their profitability					
6.	Manufacturing SMEs face threat from competitive products of other countries					
7.	Manufacturing SMEs have shift to better technology					
8.	Threats due to TRIPS in form of big competitions from foreign companies					
9.	IPR system enabled innovators to appropriate a larger portion of the social benefits from their innovations					
10.	Stronger patent protection has improved the composition of firm's R&D expenditures					
11.	Personnel turnover is low					
12.	The firm is able to introduce product variant in short time					

Seal of the company

Signature of the Respondent

Thanks for your Valuable Time

Appendix -II: List of Publications

Papers Published – SCI indexed						
S. No	Author(s)	Year of Publication	Title of Paper	Name of the Journal, Volume/ page numbers	Name of the Publisher	Impact Factor
1	Vijay Jain & Dr.(Ms) Ravi Kiran	2011	Enhancing innovation and intellectual property culture in manufacturing small and medium enterprises	African Journal of Business Management	Academic Journals	1.105
2	Vijay Jain & Dr.(Ms) Ravi Kiran	2011	Technology Management Strategies and Small and Medium Enterprises of Punjab Manufacturing: A Use-Based Sector Analysis	Journal of Intellectual Property Rights	National Institute of Intellectual Property Rights	0.170
Papers Published						
3	Dr. (Ms) Ravi Kiran and Vijay Jain	2009	Technology Management Strategies: A Post TRIPS Study of Punjab Manufacturing	International Review of Business Research Papers Vol.6, No.1 February 2010, pp. 382-391	World Business Institute, Australia	
4	Vijay Jain and Dr (Ms) Ravi Kiran	2011	A Post TRIPS Analysis of studies on Technology Management Strategies by Indian Manufacturing for Global Competitiveness	Business and Social Sciences Review (BSSR) Vol. 1, No. 3, (September - 2011), pp. 32-47	Business and Social Sciences Review	ISSN: 2047-6485

Papers in International Conferences (those held outside India)						
S. No	Author(s)	Year of Publication	Title of Paper	Name of the Journal, Volume/ page numbers	Name of the Publisher	Status
5	Dr. (Ms) Ravi Kiran and Vijay Jain	2011	Innovation and Intellectual Property Rights: A Post TRIPS Analysis of Manufacturing SMEs	RBAC International Management Conference, Bangkok, 3-4 March 2011, pp 18-28.	RBAC International Management Conference, Bangkok,	IC Bangkok
Papers Published in International / National conference in India						
6	Dr. (Ms) Ravi Kiran and Vijay Jain	2009	Intellectual Property Rights and Management In India: Post TRIPS Perspectives and Policy Imperatives	National Conference on Innovation, Management and Entrepreneurship, Thapar University, Patiala, Nov 6-7, pp 45.	Thapar University, Patiala	NC, India
7	Dr. (Ms) Ravi Kiran and Vijay Jain	2010	Perception and Attitude towards IPRs of Small and Medium Manufacturing Enterprises of Punjab	Seventh International Conference on New Paradigm in Management Theory and practice , 4-5 September, 2010, Punjabi University, Patiala, pp 44	Punjabi University, Patiala	IC , India

Appendix- III:

State- wise Patents Filed		
S. No.	State	Patents Filed
1	Maharashtra	2286
2	Delhi	868
3	Tamil Nadu	813
4	Karnataka	755
5	Andhra Pradesh	553
6	West Bengal	364
7	Uttar Pradesh	321
8	Gujarat	319
9	Kerala	166
10	Haryana	144
11	Jharkhand	94
12	Punjab	75
13	Uttarakhand	67
14	Rajasthan	55
15	Madhya Pradesh	37
16	Assam	23
17	Bihar	16