

Technology Management Strategies and Small and Medium Enterprises of Punjab Manufacturing: A Use-based Sector Analysis

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The present study tries to explore the factors that influence the growth, performance, and development of IPR attitude of small and medium-sized enterprises (SMEs) in the manufacturing sector of Punjab. The aim of the present research is to examine the technology management strategies of manufacturing SMEs, primarily on the basis of use-based classification. The study is within a single region, namely, Punjab in North India, to minimize the effects of regional variation and to concentrate on this region in need of adoption of emerging technology management strategies in view of increased competition. The liberalization of the Indian economy has opened new opportunities for the manufacturing sector. The success of SMEs is widely dependent on innovations, research and development and intellectual property. It is critical not only to remain competitive but also, to gain significant advantages by developing and commercializing new technologies. In the use-based classification, three categories, namely, durable, non-durable and essential goods have been included. The results indicate that manufacturing SMEs are not active filers of IPRs and mostly file trademarks. Patent filing has been reported by firms in essential goods segment, basically in food and pharmaceutical sector. In order to enhance the IPR environment, the 'policy initiatives' factor is more important than the organizational factor.

Keywords: Technology, manufacturing SMEs, intellectual property rights

In the present age of increasing degree of globalization, it has become equally imperative for SMEs to be technologically innovative and show improved performance. SMEs are becoming increasingly involved in global competitive markets, basically as part of supply chains and also due to expansion and growth.¹ SMEs have traditionally relied more on local markets and are currently less-equipped to face market challenges of a highly competitive environment. In addition to local government help, SMEs in these regions need to 're-examine and modify their competitive strategies by fully incorporating innovation within their people, processes and products'. Although there is some literature on innovation incorporation within organizational levels and activities², 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 (IPRs) in SMEs.³

There is a strong need for new product development in SMEs as it leads to market differentiation and serves as a major opportunity for innovative SMEs in competitive markets. An earlier 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'.⁴ The ability to react rapidly to, or to anticipate market changes is a key element of innovation.³ Thus, innovation models must be developed for SMEs, rather than adopting scaled down versions of large organization innovation models.⁵ The number of patents filed by a company is a very good reflection of its technological performance.⁶

An empirical study of 100 American manufacturing firms, investigated the extent to which patents mattered, especially with regard to the firm's decision to introduce and develop inventions.⁷ 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.⁸ SMEs lack in overall productivity and quality improvement strategies. A continuous improvement in these are considered by researchers to be a fundamental step along the innovation pathway.⁹

It has been argued that small firms contribute to technological change by producing disproportionate

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share of innovations, relative to their R&D spending; an argument that has gained mixed support. 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 arising out of research undertaken in university laboratories.¹⁰⁻¹¹ The new viewpoint is that even SMEs are innovative. Innovating firms whether small or large create new knowledge and to reap enhanced benefits from innovation, they are most likely to protect their innovations by various IPRs.¹² Firms operating in different manufacturing sectors create different set of innovation and rely on a different mix of IPRs. The differences are related to industry differences in (i) technological opportunity and (ii) the use of statutory IPRs.¹³ 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.¹⁴ Firms often use a combination of IPRs. For instance, trade secrets may supplement a patent or may be used as a substitute for patent protection. Trademarks are often used along with trade secrets and/or patents and industrial designs.¹⁵ IPRs such as copyright are used frequently in industries concerned with protecting printed material, recordings and software.¹⁴

Leading Technology Management Strategies

On the basis of literature review, the following technology management strategies were identified:

Introducing New and Increased Range of Goods and Services

Innovation is the successful introduction of a new product 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 in this study are the new products and services introduced by these firms. As many firms chosen in the sample are export firms, they produce competitive products and introduce newer products in view of changing demands.¹⁶ Innovations may be directed towards change in organizational structure (the degree of complexity, formalization, and centralization), technology (introduction of new equipment, tools or methods, automation, or computerization), or human resources (changing the attitudes and behaviour of organizational members through processes of communication, decision making, and problem solving).¹⁷ To achieve success over a period of time, all organizations need to enhance innovations.¹⁸

Investment in R&D

Improvement in productivity achieved by a firm/industry often depends on R&D efforts of the firm/industry.¹⁹⁻²¹ Innovative output is the product of knowledge generating inputs, most notably R&D.²² About 90 per cent of all private R&D expenditures in the United States are undertaken by 400 of the largest corporations.²³

Marketing Strategies

Initially it was assumed that 'more R&D in' resulted in 'more successful new products out.' With one or two notable exceptions, little attention was paid to the transformation process itself or to the role of the marketplace in the process.²⁴ But in this era of e-business, marketing strategies can play an important role. Small organizations need to focus on providing their customers with a set of web applications that best serve the customer, rather than using a hit-and-miss approach.²⁵ The information environment can be an impediment to the development of emerging economies. Thus the SMEs need to think beyond conventional marketing practices of large companies. They need to search for alternative marketing approaches such as personal contact networks, social networks, e-commerce tools, B2B portals, business networks and industry and marketing networks.²⁶ In the context of new product development it consists of bringing together two main components, i.e., markets and technology.²⁷

Improved Quality of Goods and Services

Not only the firms have to be innovative to introduce new products, they also need to think of introducing quality products. In the current age of global competition, quality of goods and services can make much difference since consumers demand products with quality certifications.²⁸

Improved Production and Flexibility

Enhancing productivity has always been of prime concern to SMEs in the manufacturing industry that primarily run on minimum costs and minimum resources.^{2,19, 29} The nexus between productivity and technology reveal that advances in the latter result in improvements in the former.^{30,31}

Reduced Labour Costs

Cost cutting strategies have dominated the business world and hold all the more significance for SMEs. These include reduced labour costs per unit and reduced material and energy per produced unit/transaction. Efficiency of factors of production can enhance the firms competitiveness.²⁹

Technology Upgradation

SMEs face serious constraints in acquiring new and appropriate technology.²⁸ SMEs need innovative products if they have to gain and maintain technological advantages.³²

Change in Managing Practices

Small firms have an innovative advantage generally emanating due to the difference in management structures between large and small firms.³³ The bureaucratic organization of large firms is not conducive to undertaking risky R&D.²³ For instance, the emergence of new ideas for product innovations among the top management in SMEs in Finland.³⁴

Indigenous Technological Development

Since new technology is expensive and SMEs face cost constraints, 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.²⁸ If a firm has to technologically innovate, it should have in-house technological competence in the form of technically qualified and motivated entrepreneurs or managers with innovative ideas and technically skilled employees.³⁵

Re-training of Workers

A successful organization in today's business environment is one which manages its human resources well along with the technological resources.³⁶ It 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. Organizations perform better when they invest in training their employees and broaden their skills.³⁷ Although manufacturing firms of Punjab use new technologies, they report lack of adequate training and re-training programs to equip workers with latest technology.²⁹

Price Strategy

An SME's capacity to meet growing customer expectations is based largely on their ability to innovate and deliver new products at competitive prices.²

Design and Methodology

A self structured questionnaire was piloted in 15 SMEs and with 20 academics working in related disciplines, each with extensive SME experience. These

pilot tests led to improvements in the wording of the questionnaire and removal and addition of some questions. The sample for the survey included 100 SMEs from the state of Punjab. The units which have been considered for analysis have at least 50 employees and a gross business income over Rs 25,00,000. The reason for selecting these enterprises is that they have at least some knowledge of IPRs, follow technology management strategies and will be able to use some part of their income on innovations.

Data was collected from 9 districts consisting of Patiala, Ludhiana, Gobindgarh, Jalandhar, Bhikhi, Mansa, Mohali, Barnala and Hoshiarpur. 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 more than 600 steel re-rolling mills despite being situated far from the source of raw materials. The questionnaire designated was sent to 140 enterprises and 100 duly filled questionnaires were taken for analysis. The rate of response was 72 per cent. Of the sample firms, 52 firms belonged to the durable goods category, 30 to the non-durable goods category and 18 to the essential goods category. The reliability statistics of the sample is given in Table 1.

Table 1 — Reliability statistics

Items	No of items	Cronbach alpha
Technology management strategies	22	0.901
Extent of intellectual property rights	12	0.901
Reasons for protecting IPR	11	0.804
Factors for developing IPR culture	07	0.795
Overall impact of TRIPS on performance	10	0.820
Total	62	0.837

The study was taken up with a view to study (i) the technology management strategies adopted by the manufacturing SMEs of Punjab, (ii) the extent of intellectual property rights of manufacturing units of Punjab, (iii) the reasons for protecting intellectual wealth in the present globalized scenario, and (iv) the factors for creating IPR environment for manufacturing SMEs of Punjab.

Technological Management Strategies Adopted by Manufacturing SMEs

Preferred Choice of Technology Management Strategies

An overview of the technology management strategies adopted by SMEs have been compiled and ranked on the basis of percentage of scores (Table 2).

Generally, in order that a firm sustains its competitive advantage, it must continuously differentiate its products and services from competitors.³⁸⁻³⁹ The firms can constrain and direct an R&D department's ability to take action and differentiate themselves from competitors. The results of the same are discussed below:

- 1 Training of workers got the highest ranking among all the management strategies. Most of the respondents expressed that the companies were currently focussing on training of their employees to enhance the overall productivity. Training was also adopted in SMEs to acquaint the workers with new machines acquired by the firms.
- 2 With the overall score of 74 per cent, price strategy was ranked second. The oldest and the most favoured strategy is still predominant among manufacturing SMEs.
- 3 Technology upgradation got the third rank with a score of 69.8 per cent. The respondents were of the view that survival in a modern world is impossible

without new technology. In fact, SMEs in Punjab willingly adopt and buy new technologies.

- 4 Indigenous technological development was ranked fourth. Since indigenous technology results in cost saving, development of indigenous technology wherever feasible is the next preferred strategy.
- 5 Change in managing practices got the fifth rank. Due to globalization, manufacturing companies have to continually put forth new managing strategies. Managing in the changing globalized scenario is becoming more complex and demands significant attention.
- 6 Improved quality of goods and services was ranked somewhat 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 had come to focus on quality standards to gain competitive advantage.
- 7 Increased range of goods and services introduced by the firms was ranked next on priority. With increasing global competition, customers want more choices for the products. There were many SMEs which introduced new range of goods and services in the post-TRIPS period.
- 8 Marketing focus is an area in which SMEs still lag behind and much effort is required to switchover to well accepted marketing strategies. This was placed at the eighth position, since the firms were probably more focussed on quality improvement strategies.
- 9 Improved production and flexibility got a lower rank. This is probably due to globalization and increased competition resulting in big manufacturers overshadowing smaller manufacturers. As SMEs are suppliers to the big manufacturers, increased focus needs to be placed on improving productivity for improving performance.

Table 2 — Technology management strategies adopted by SMEs

Technology management strategies adopted by SMEs	No of responses (N _i) with each score choice (S _i)					Total score $\sum (N_i * S_i)$	% age score	Rank
	1	2	3	4	5			
Increased range of goods and services	6	15	44	22	13	321	64.2	7
Investment in R&D	79	12	8	1	-	131	26.2	11
Marketing strategies	6	15	47	19	13	318	63.6	8
Improved quality of goods and services	4	12	47	22	15	332	66.4	6
Improved production, flexibility	6	19	42	22	11	313	62.6	9
Reduced labour costs per unit	25	42	25		4	216	43.2	10
Reduced material and energy per produced unit/ transaction	27	39	29	1	4	216	43.2	10
Technology upgradation	-	11	44	30	15	349	69.8	3
Change in managing practices	-	16	43	28	13	338	67.6	5
Indigenous technological development	-	13	48	28	13	347	69.4	4
Training of workers	-	5	36	41	18	372	74.4	1
Price strategy	-	4	39	40	17	370	74.0	2

- 10 Reduced labour cost and reduced material and energy produced were not preferred strategies. Respondents felt that higher prices of raw material, high labour prices, electricity problems and high taxation on raw materials left very little to strategize in the hands of manufacturers.
- 11 What was most surprising is that investment in R&D got the lowest priority, whereas, it should have had much more emphasis. Indian SMEs are still not able to invest heavily in R&D. Their low score to investment in R&D is a cause of concern.

Nature of Industry and Technology Management Strategies Adopted by SMEs

For in-depth analysis, ANOVA (analysis of variance) was also 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 3.

Accordingly, H_1 (hypothesis 1) is that there is a significant difference among technology management strategies of firms on the basis of use-based classification.

ANOVA results highlight that investment in R&D and price strategy have not emerged significant, while for all other strategies the results are significant since $p < 0.01$. There is therefore, a significant difference among firms' technology management strategies of different use-based sectors. Inter-industrial differences do in fact, affect technology management strategies adopted by firms. Thus the above hypothesis was accepted.

Table 3 — Nature of industry *vis-à-vis* technology management strategies adopted by SMEs

		Sum of squares	df	Mean square	F	Sig (p)
Increased range of goods and services	Between groups	19.496	2	9.748	7.525	0.001**
	Within groups	125.664	97	1.296		
	Total	145.160	99			
Investment in R&D	Between groups	.083	2	0.042	1.425	0.245
	Within groups	2.827	97	0.029		
	Total	2.910	99			
Marketing strategies	Between groups	25.343	2	12.671	10.777	0.003***
	Within groups	114.047	97	1.176		
	Total	139.390	99			
Improved quality of goods and services	Between groups	15.263	2	7.631	6.776	0.002**
	Within groups	109.247	97	1.126		
	Total	124.510	99			
Improved production, flexibility	Between groups	15.555	2	7.777	6.794	0.002**
	Within groups	111.035	97	1.145		
	Total	126.590	99			
Reduced labour cost	Between groups	25.353	2	12.677	14.563	0.001***
	Within groups	84.437	97	0.870		
	Total	109.790	99			
Reduced material and energy per produced unit/transaction	Between groups	33.435	2	16.717	19.094	0.001***
	Within groups	84.925	97	0.876		
	Total	118.360	99			
Technology upgradation	Between groups	21.526	2	10.763	19.411	0.001***
	Within groups	53.784	97	0.554		
	Total	75.310	99			
Change in management practices	Between groups	23.621	2	11.811	18.122	0.001***
	Within groups	63.219	97	0.652		
	Total	86.840	99			
Indigenous technology development	Between groups	21.201	2	10.601	21.263	0.001***
	Within groups	48.359	97	0.499		
	Total	69.560	99			
Re-training of workers	Between groups	6.293	2	3.146	4.689	0.011**
	Within groups	65.097	97	0.671		
	Total	71.390	99			
Price strategy	Between groups	2.668	2	1.334	2.250	0.111
	Within groups	57.492	97	0.593		
	Total	60.160	99			

F= F- statistic; df = degrees of freedom, $p < 0.001$ ***; $p < 0.01$ **; $p < 0.05$ *

SMEs and Intellectual Property Rights

Any study on technology management would be incomplete without analysing the IPR scenario. 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 products, their stage in the life cycle and competitive conditions.⁴⁰

IPR Status of Manufacturing SMEs

Sector-wise analysis underscores that firms in the essential goods category file more IPRs. As depicted in Fig. 1, manufacturing SMEs in Punjab are mostly into filing trademarks. The number of patent applications filed is still low indicating that the manufacturing sector is still in an embryonic stage. The industries in the durable goods category have filed most of the trademarks (18 of 21), but lag in filing of patents and copyrights. In the case of non-durable goods sector, only one, namely, a cookware firm filed for a copyright and three trademarks were filed by cotton ginning mills

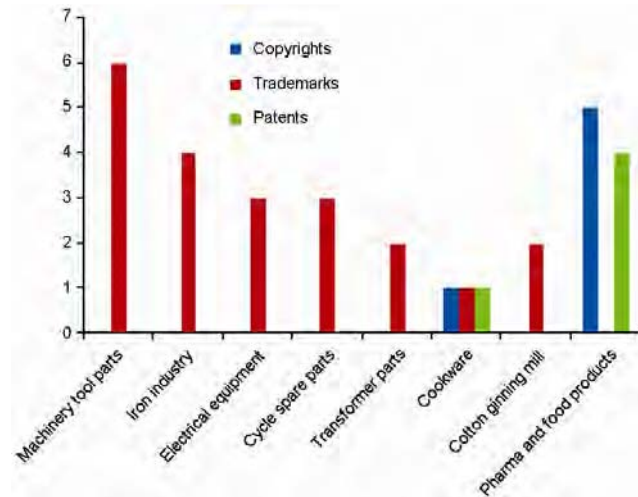


Fig. 1 — IPR status of SMEs in manufacturing sector

and cookware. An obvious answer as to why the essential goods manufacturers top in IPR filing is that the sector covers pharmaceutical, food products and beverage industries, which are far more active in patent filing. Consequently, hypothesis 2 is that IPR filing of manufacturing SMEs of Punjab is low.

The manufacturing industries of Punjab own fewer IPRs as depicted by results. These are pointers to the fact that IPR protection is at a nascent stage in the case of manufacturing SMEs. There have been assertions that a patent-friendly environment is now prevalent in India, as patents are being increasingly used for protecting innovations from imitation.¹⁴ But the same is not true for manufacturers in Punjab as results of the present study show. Small-scale industries have failed to cope up with the emerging challenges to keep pace with the latest developments especially, in terms of IPRs.⁴¹

Reasons for Filing IPRs

As the above analysis shows that the manufacturing SMEs of Punjab do not file a large number of IPRs, and that technology focus requires an enhancement of IP protection along with stronger commitment and productivity improvement. Therefore, the study attempted to explore the firms’ perceptions as to why IP protection is sought in the first place.

Factor analysis resulted in four factors, namely, (i) Enhancing global competitiveness, (ii) Improving performance, (iii) Technological development and (iv) New investment opportunities. 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 0.801 to 0.822 (Table 4). The second factor, namely, technological development had four variables accounting for 21.853 per cent of variation. Here the variable, ‘IPRs lead to increased licensing of

Table 4 — Reasons for filing IPRs

Factor	Items	Factor loading	Eigen value	% variance	Cumulative
Enhancing global competitiveness	- IPRs enhance global competitiveness	0.822	3.128	26.066	26.066
	- IPRs enhance global trade	0.801			
	- Company’s survival is dependent on IPRs	0.801			
Technological development	- IPRs enhance expenses on R&D	0.780	2.622	21.853	47.919
	- IPRs protect imitation of technology	0.746			
	- IPRs contribute to higher economic growth	0.709			
	- IPRs lead to increased licensing of technologies	0.659			
Improving performance	- IPRs lead to enhanced profit	0.918	2.151	17.927	65.847
	- IPRs lead to enhanced sales	0.865			
New investment opportunities	- IPRs attract more FDI	0.522	1.138	9.486	75.332
	- IPRs for CSR	0.512			

technologies' had a lower item loading of 0.659 while the variable, 'IPRs enhance expenses on R&D' had a higher item loading of 0.780.

The next perceived factor having very high item loadings is filing IPRs for enhancing the firms' performance. This factor accounts for 17.927 per cent of variation. Literature supports the argument that increase in market share leads to enhanced sales, enhanced profits and hence more money can be spent for building innovation culture. A robust and positive effect of market share on observable headcounts of innovations and patents has been observed, although increased product market competition in the industry tends to stimulate innovative activity.⁴² 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; IPRs attract more FDI and IPRs for corporate social responsibility (CSR) accounting for a lower variation as well as having lower item loadings. In the context of Finnish SMEs, on an average, the contribution of innovated new products was more to total sales than to profits.⁴³ Sales turnover of innovative firms grew faster than that of non-innovative firms.⁴⁴

These results highlight the increasing importance firms place on filing IPRs for enhancing global competitiveness and for technological development. Although firms, especially SMEs cannot be assumed to be at the threshold of technological breakthrough, still there is now a realization that technology management strategies need added attention.

Factors for Promoting IPR Environment

After analysing the reasons for filing IPRs, it is equally important to throw light on factors for promoting IPR environment.

On the basis of factor analysis, two factors namely policy initiatives and organizational factors have been identified. The various items covered under the two factors and their item loadings are detailed in Table 5. Overall mean of both the factors is 4.46. The mean of policy initiatives factor is 4.63 and much higher than overall mean. The relative importance of this factor may also be highlighted through the factor loadings. Three of its items including government assistance in facilitating patent filing, support for entrepreneurial and managerial development for SMEs and reduction of taxes and fees account for a factor loading of more than seven and the percentage of variance explained by this factor was also high at 32.99.

Accordingly, the hypothesis 3 is that policy initiatives are considered more important than organizational factors in developing an IPR environment.

Thus, for stimulating IPR culture in SMEs, assistance by the government is preferred in terms of patent facilitation centres. This has to be supported by other policy initiatives like faster registration and lower fees. Pool patenting as a possible solution is least on priority with lowest mean score. Hence, 'policy initiatives' is high on priority compared to organizational factors. This hypothesis was also accepted. In a developing country like India, policy factors can play an important role in facilitating patent search, creating IPR awareness and supporting IPR filing through facilitation centres.

Table 5 — Factors that promote an environment conducive to IPR

Factor	Eigen value	% of var. exp.	Cum. %	Items	Factor loading	Mean	S D	Rank
Policy initiatives	2.31	32.99	32.99	(i) Govt assistance in facilitating patent filing	0.732	4.73	0.45	2
				(ii) Support for entrepreneurial and managerial development of SMEs	0.718	4.72	0.67	3
				(iii) Reduction of taxes and fees	0.709	4.32	0.68	5
				(iv) Severe penalty for IPR violation	0.695	4.84	0.55	1
				(v) Faster registration process	0.595	4.56	0.70	4
Mean of policy initiatives					4.63			
Organizational factors	2.09	29.85	62.85	(i) Organizing more programmes for IPR awareness	0.912	4.14	.71	6
				(ii) Pool patenting as a possible solution	0.844	3.91	.68	7
Mean of organizational factors						4.02		
Overall mean						4.46		

Conclusion

In order to be competitive in today's world of globalization and liberalization, Indian organizations have to make use of advanced technology, technical manpower, and innovative research and development. As far as technology management strategies adopted by SMEs of Punjab are concerned, training of workers was the preferred strategy. Majority of the respondents felt that the companies currently focus on training of their employees, as training is accepted as the first step to improve the overall productivity. Training has also been adopted in SMEs to acquaint the workers with new machines acquired by the firms. Price strategy came next on priority and though old is still considered an important strategy. Technology upgradation got the next rank. As Punjab SMEs adopt and willingly buy new technologies, it is obvious why this strategy is preferred over others.

On the basis of use of three of the categories, namely, durable, non-durable and essential goods for analysis, it is evident that manufacturing SMEs of Punjab are still hesitant to file IPRs. Patent filing is almost negligent in durable and non-durable goods category. In case of essential goods segment, patent filing is prevalent in the food and pharmaceutical sector. The results highlight the changes being introduced in this sector, which can be said to be a growing sector in manufacturing SMEs.

In a number of key technology areas, enterprises, big or small have begun to appreciate that IP assets are more valuable than physical assets.⁴⁵ Thus there is a dire need for creating a IPR conducive environment. The low number of IPRs filed by SMEs in the manufacturing sector prompted the authors to analyse the factors that stimulated filing of IPRs. Of the two factors, i.e., policy initiatives and organizational factors, the former got a higher priority. Government agencies like Punjab Council of Science and Technology, patent facilitation centres and Central agencies like TIFAC can play a vital role in this scenario. These agencies have a lot of schemes to help the SMEs, but many more steps need to be initiated to create awareness among SMEs to actively file IPR.

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