

Transfer of innovations: a case of working of patents in India

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Patents are the protected form of innovations and the currency of a knowledge-based economy. This article is an outcome of the analysis of working of patents data, which were published on the Indian Patent Office (IPO) website during 2012 and 2013, and continuously updated thereafter. For an overview of working of patents in India, an aggregate of 64 companies and/or organizations were selected for this study. The results of the analysis revealed that Qualcomm topped the list with 1113 granted patents at IPO, followed by Council of Scientific and Industrial Research (1085), Hindustan Unilever (773), Samsung Electronics (705), and Philips (352). The objective of this study was to determine the workability of patents in India, and the results indicated that all the seven patents granted to Indofil (an Indian company, which manufactures agricultural, specialty and performance chemicals) were in working conditions, which apparently signified that the firm had effectively transferred the innovations for production and for the end-user. IPO was preferred as an important patent filling offices (PFO) by different national and international companies for filling their innovations. The results of this study provide an opportunity for the inventors, market players, researchers and consumers to know about the innovations which are lying in the PFOs of the different countries and lapsed after completing their life, i.e. 20 years.

Keywords: Companies and organizations, development and commercialization, innovations, technology transfer, working of patents.

‘INNOVATION’ is an important word, which is frequently used in today’s academia and policy matters¹. The Association of University Technology Managers (AUTM), USA, has defined it as ‘the process of transferring scientific findings from one organization to another for the purpose of further development and commercialization’². To define this word, Baregheh *et al.*³ analysed 60 different definitions of innovation and concluded that ‘Innovation is the multi-stage process whereby organizations transform ideas into new or improved products, services or processes, in order to advance, compete and differentiate themselves successfully in their marketplace’. It is

an accepted fact that innovations emerge from the university system and are adopted by industry⁴. In USA, the research and development (R&D) organizations were reported to effectively transfer their intellectual property (IP)-protected technologies after 1980s, when the initial Bayh–Dole legislation was passed⁵. After this Act, the process of technology transfer became the responsibility of these institutions which got central funding⁶. Asia has been a prominent player not only in science, technology and innovation, but also in linking different cultures of the world⁷. An active academic technology transfer programme provides support and benefits to the public⁸.

Patents are the protected form of innovations and the currency of a knowledge-based economy. They are considered as an emerging asset that can be proactively managed, developed and nurtured to enhance business value^{9,10}. The patent system places innovations in a market process, acting simultaneously as a legal framework that facilitates disputes over ownership and infringement, thus lowering the cost of patent enforcement for individual firms¹¹. Without a functioning or working patent system, knowledge and labour cannot be alienated, and its value would be limited to the ability or inclination of the innovator to put it to use¹¹. Such a closed knowledge system would be disadvantageous for the innovators by inhibiting their ability to monetize their ideas, which they can do under a patent system even if they lack the time, skills or resources to commercialize it themselves¹¹.

India is gifted with all the elements, which are necessarily required to become a global driver of innovation. It has a strong market potential, an innovative talent pool and an underlying culture of frugal innovation. Innovative countries have demonstrated the leverage of their cultural advantage to capture the potential markets in the world. For example, Japan leveraged its cultural emphasis on ‘efficiency and team work’¹², to revolutionize the manufacturing and engineering industries. The Republic of Korea (South Korea) utilized its cultural emphasis on ‘speed’ and it harbours the major world-class companies such as Samsung and LG. China has sustained a GDP growth in excess of 10% for more than two decades by virtue of its ‘ability to scale’. USA and Israel have leveraged the diversity of their populations to lead global innovation.

An often-cited example of a US company leveraging global talent is that of General Electric (GE). GE has

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been an early pioneer of globalizing research with its centres in India, China, Germany and Brazil, in addition to the parent research centre in USA. The John F. Welch Technology Centre (JFWTC), in Bengaluru, India, was set up in September 2000 at its present 50-acre campus. Today, JFWTC is home to over 4000 researchers and engineers contributing to product development and IP filed and owned by the parent GE. Close to 2000 of the 30,000 patents awarded between 2011 and 2016 to GE have Indian inventors from JFWTC and Indian talent in other global centres¹³.

The performance of firms should not be measured based on the intensity of R&D expenditure, but on technology commercialization capabilities, which play the role of a mediator in the relationship between R&D and innovation performance¹⁴.

Statement of the problem

Intellectual Property Right (IPR) is a creation of the human mind¹⁵. From a social perspective, the absence of a functioning patent system as observed in many developing countries annihilates immeasurable values of knowledge and ideas by providing no system through which they could realize their tradable worth¹¹. The actual growth of Science & Technology (S&T) in a country depends upon the working of the patents rather than the number of patents granted in that country. In view of the above, it has emerged that the status of local working of patents is of utmost importance to decipher the reach of innovation to its destination, i.e. user market. The Indian Patent Office (IPO) was selected for this purpose, where information received from patentees regarding working of patented inventions on a commercial scale (in India u/s 146 of the patents act 1970 for year 2012/2013) is published. Thus, the objective of this study was to know the status of local working of patents granted by IPO to different national and international organizations.

Materials and methods

Background

This article is an outcome of the analysis of working of patents data, which were published on the IPO website during 2012 and 2013, and continuously updated thereafter. The objective of this study was to determine the patent filing trends and their workability in India. A review of last 10 years' IPO annual reports indicates that the patent filing organizations at IPO belonged to different national as well as international public and private organizations¹⁶. For an overview of the working of patents in India, different types of literature, websites and research reviews were analysed, and finally 64 companies/organizations were selected for the study, which had

also filed their patents at IPO. These companies/organizations belonged to different product/process/research subject domains, viz. agriculture, biotechnology, communication technology, engineering solutions, food processing, motor parts, pharmaceuticals, patent services, etc. Most of the selected companies are multinationals and a leading brand in their product range. To emphasize on the applicants from India, leading Indian group companies, and government-funded R&D organizations were also selected for this study. The patent data have been downloaded from the IPO website (data were accessed from the website during September to December 2016) and analysed according to patent filing and year of expiry, applicant organizations, working and non-working of patents, and their legal status at the IPO. The data had 40.73% duplication of information, which was removed after rigorous scrutiny of patent details. To know the worldwide IP portfolio of these companies/organizations with their legal status, Questel Orbit software was used (data were assessed during September 2016 and revised in March–April 2017), where data pertaining to only 57 companies/organizations were available. These data were analysed and presented in different heads, viz. granted, pending, revoked (a patent can be revoked on petition of any person interested or of the Central Government or on a counter claim in a suit for infringement of the patent by the High Court in India), expired (normally, a patent has a life of 20 years from filing; even when issued, a patent may expire early for a number of reasons) and lapsed (expired because maintenance fee was not paid on-time). The collected information was synthesized and compared with the different available databases, IP parameters, and paid and free search engines.

Theoretical orientation

Innovations are the building blocks of technological advancement, industrial development and economic welfare; which is possible through local working of inventions. The actual growth of S&T in a country depends upon the working of the patents rather than the number of patents granted in that country. Historically, patents were granted with an intention to encourage local application of the invention, through its industrial application.

An IP agreement is a written and enforceable contract that consummates and formalizes an agreement between two companies for the purchase and sale of IPRs¹⁷. IPRs are largely territorial rights, except copyright, which is global in nature in the sense that it is immediately available to all the members of the Berne Convention¹⁸. Patent is the strongest right among available IP tools, which gives exclusive right to the inventor for production, sale or use of the innovation in its stipulated time period, i.e. 20 years. It should be used to introduce new technology into the country for which the patent system has emerged.

Local working requirement and compulsory licenses enable the countries granting patents to force the foreign patentees to transfer technologies to their country. As a primary requirement, local working of patents has been the most efficient way of transfer of technology, although it has been noticed that these patents did not necessarily work locally¹⁹.

Local working of a patent is also known as commercial working of a patent in a country. It was first discussed in the Paris Convention, and Article 5(A), which deals with the working of patents and grant of compulsory licenses. It provides that importation of the patented articles should not result in forfeiture of the patent. This provision is similar to Article 27(1) of the Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement. It refers to the condition imposed on patentees or licensees that the patented product or process must be used or produced in the patent-granting country.

Article 27(1) of TRIPS states that the 'patents shall be available and patent rights enjoyable without any discrimination as to the place of invention, the field of technology and whether products are imported or locally produced'²⁰. Article 7 of TRIPS states that the 'protection and enforcement of IPRs should result in technological innovation and its transfer'²¹. Notably, Article 8(1) allows the member countries to promote public interest in sectors of vital importance to their socio-economic and technological development, e.g. food, health, biotechnology, etc.^{22,23}. It is noteworthy that the member states are free to define what they understand by 'failure to work'.

The Indian Patents Act 1970, imposes an obligation on the patentees and patent licensees to disclose information relating to the working of their patents in India; and has made it mandatory for all the patentees or patent licensees to submit information regarding commercial working of their patents in India. The term 'working' or 'local working' has not been defined under the Act. However, Sections 83(a), 83(b) and 85 refer to the working of patents in India. The working of patents falls under Section 146 of the Indian Patents Act, which authorizes the Controller General (CG) to call for information or periodical statement regarding the extent to which the patented invention has been commercially working in India from a patentee or patent licensee.

The patentee or patent licensee is required to furnish such information to the CG within two months from the date of such notice or such further period as the CG may allow. This information should be submitted in Form-27 in respect of every calendar year within three months of the end of each year. Form-27 comprises the following heads:

- Whether the invention has been working.
- If not working, the reasons for the same, and the steps being taken to work the invention.
- If working, quantum and value (in rupees) of the patented product: manufactured in India, imported

from other countries, giving details of the countries concerned.

- Licenses and sub-licenses granted during the year.
- Whether the public requirement has been met, at a reasonable price, either partly, adequately or to the fullest extent.

Section 84(1) of the Patents Act, 1970 enlists the various circumstances which constitute 'failure to meet the reasonable requirements', of the public in respect of a patent²⁴. The provision relating to local working has been incorporated with the wide objective of socio-economic welfare, i.e. to ensure the transfer of technology leading to industrial progress in addition to availability and affordability of patented goods. Such provision is more effective, particularly in the developing countries such as India, China, Brazil, etc. having a strong industrial set-up with the capacity to produce quality products at a cheaper rate. Prior to 2007, there was no study about local working of patented inventions in the annual reports of the Controller of Patents²⁵.

Result and discussions

Worldwide IP filing trends

A total of 2.9 million patent applications were filed worldwide during 2015, which recorded a growth of 7.8% compared to those filed during 2014. About 10.6 million patents were recorded to be in force during 2015. India ranked 21st among different countries and recorded 47,000 patents in force in its jurisdiction. The four BRIC countries – Brazil, Russia, India and China, ranked among the top 10 patent filing offices (PFOs). The United States Patent and Trademark Office (USPTO) recorded 2.64 million patents (24.9% of the world total), followed by 18.3% at Japan Patent Office (JPO) in 2015. Panasonic of Japan was the top applicant worldwide, followed by Japanese companies Canon (29,036) and Toyota Jidosha (26,844), and Samsung Electronics (26,647) of the Republic of Korea. China was the leading country in patents, trademarks and designs in IP filing ranking (resident and abroad) during 2015, followed by USA and the Republic of Korea (only in designs); whereas India ranked 14th in patents, sixth in trademarks and 13th in designs. Notably, India ranked tenth in patents, sixth in trademarks and 11th in designs by origin during 2015 (ref. 1).

IP filing trend at the IPO

The IPO witnessed 4.40% growth in overall filing of IP applications during 2014–2015 (262,638) compared to that recorded during 2013–2014. The disposal of patent applications at the IPO increased by 25.5%, which led to the grant of 5978 patent applications; registered 7147

Table 1. Status of working of patents at the Indian Patent Office (IPO)

Item/activity	2010–11	2011–12	2012–13	2013–14	2014–15	Average
Patent in force	39,594	39,989	43,920	42,632	43,256	41,878.20
Form-27 received	34,112	27,825	27,946	33,088	31,990	30,992.20
Reported as working	6777	7431	6201	8435	7900	7348.80
% Information received	86.15	69.58	63.63	77.61	73.96	74.19
% Information not received	13.85	30.42	36.37	22.39	26.04	25.81
% Enforced patent working	17.12	18.58	14.12	19.79	18.26	17.57
% Reported patent working	19.87	26.71	22.19	25.49	24.70	23.79

designs, 41,583 trademarks and 20 geographical indications in 2014–2015. The IPO was found to receive IP applications from public and private organizations of India and abroad, and these were classified in five broad categories, viz. civil engineering, instruments, mechanical engineering, electrical engineering and chemistry. The Council of Scientific and Industrial Research (CSIR), New Delhi was found to head the list among the top 10 patent filing organizations in Indian R&D organizations; Indian Institutes of Technology (IITs) in states and universities; and Qualcomm Incorporated in foreign filing institutes respectively. CSIR led the list with 66 granted patents as Indian Patentee, whereas GM Global Technology Operations led with 267 patents as Foreign Resident Patentee¹⁶.

Status of working of patents at IPO

Extensive analysis of patent information published in the Annual reports of the IPO during the last five years revealed that 17.57% enforced patents were reported as working, whereas 23.79% were under the category of working domain. The IPO received information under Form-27 for 74.19% of granted patents. In 2014–2015, 43,256 granted patents were in force. Table 1 shows the year-wise trends (2010–2015) of growth in patent enforcement (8.46%) and working of patents (4.83%). At present, a total of 7561 Indian and 35,695 foreign patents are in force at the IPO.

Patent filing organizations at IPO and their subject domain

A review of the IPO annual reports indicates that inventors from all Indian states filed their innovations at the IPO through ordinary patent applications, whereas 10–12 states (Karnataka leading with 18 applications in 2014–2015) were involved in filing of conventional patent applications, and 17–20 states filed their patent applications through national phase (Maharashtra leading with 64 applications in 2014–2015). IPO is the recipient of patent applications from different countries around the globe, viz. Commonwealth countries (6), North and South

American countries (19), Europe (33), Africa (7) and Asia (17). The patent filing growth among residents and non-residents increased during the past 10 years by 167% and 68.48% (national phase applications under Patent Cooperation Treaty (PCT)) respectively. The IPO classified these inventions in 8 major (chemical, drug, food, electrical, mechanical, computer/electronics, biotechnology, general engineering) and 12 minor (biomedical, biochemistry, communication technology, physics, civil, textile, metallurgy/materials science, agricultural engineering, polymer science/technology, microbiology, agrochemical and traditional knowledge of biotechnology and chemistry) subject domains.

On the basis of the above subject areas and their relevance to other (on-line and offline) available literature, the collected datasets of 8944 granted patents were classified in the following ten subheads with their number of organizations: Agri-research companies (991/9), biotech organizations (136/4), communication technology companies (3519/11), engineering solutions companies (195/3), food processing companies (52/2), Indian group companies (1184/5), Indian R&D organizations (1497/13), motor companies (403/3), patent service providers (316/1), and pharmaceutical companies (651/13) (Figure 1). Communication technology companies topped the list with regard to granted as well as working and non-working patents (1927/1592). Figure 2 shows the working set of 64 organizations for their share in securing innovations by grant of patents and their actual use by licensing or working.

Patent filing trends and their working status

According to the subject area, a total of 64 selected patentees were classified in the following 10 broad categories:

Agri-research companies: This group is mostly comprised of nine seed, pesticide and farm machinery-based multinational companies, except Excel and Indofil (which are Indian pesticide companies). These companies filed 991 (15 (1991–1995), 173 (1996–2000), 565 (2001–2005) and 238 (2006–2010)) patent applications at the IPO from 1991 to 2010. These applications were granted and will be in force up to 20 years (after the date of

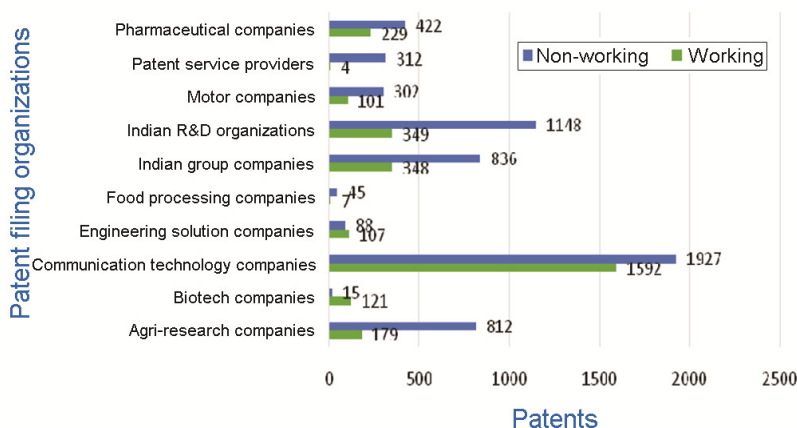


Figure 1. Subject domain of patent filing organizations and their intellectual property share in the Indian Patent Office (IPO).

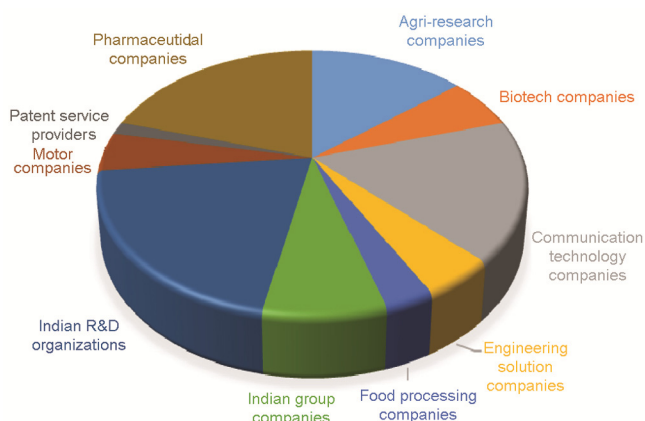


Figure 2. Subject domain of patent filing organizations in the IPO.

filing). Among these 15 have already expired after the 20-year period, and the remaining 173 (2016–2020), 565 (2021–2025), 238 (2026–2030) are in force. Bayer (314) and BASF (313) were the leading companies that received the highest number of granted patents, followed by Syngenta (169), Du Pont (101) and Monsanto (44). Du Pont had licensed its 44 patents followed by Monsanto (41), BASF (40), Bayer (22) and Syngenta (19), which have been instrumental in transferring their innovations in India. Indofil succeeded in licensing all its seven patents. This group had 11.08% share in total granted patents; 5.89% in the working of patents, and 13.74% in the non-working of patents. Table 2 indicates that most of working patents of this group are in force at the IPO.

Biotech companies: Four biotechnological research product-based companies were included in the working dataset belonging to Biotech companies. These companies filed a total of 136 patent applications (3 (1991–1995), 29 (1996–2000), 62 (2001–2005) and 42 (2006–2010)) at the IPO from 1991 to 2010. Among these, three had expired after the 20-year period, whereas the remaining (29 (2016–2020), 62 (2021–2025), 42 (2026–2030))

are in force. Novozyme (a Denmark-based company) received grant for 85 patents from the IPO, followed by Biocon (31), Panacea and Serum (10 each). Notably, Novozyme also succeeded in licensing of all its 85 patents. This group had 1.52% share in total granted patents; 3.98% in the working of patents and 0.25% in the non-working of patents. Table 2 indicates fact that most of working patents of this group are in force at the IPO.

Communication technology companies: This group is constituted by 13 multinational companies, which have a range of products in Indian communication technology market, viz. mobile phones, music systems, televisions, computers, software, etc. These companies filed a total of 3519 (56 (1991–1995), 509 (1996–2000), 1927 (2001–2005) and 1027 (2006–2010)) patent applications at the IPO from 1991 to 2010. These applications were granted and will be in force up to 20 years (after the date of filing). Among these, 56 have already expired after the 20-year period; whereas the remaining 3463 patents are in force. Qualcomm Inc., a world leader in 3G and next-generation mobile technologies²⁶, had the highest of number of granted patents (1113), followed by Samsung Group (705), Koninklijke Philips Electronics (352) and Telefonaktiebolaget Lm Ericsson (299). Qualcomm Inc had succeeded in the licensing of its 1111 patents, followed by Nokia (154) and Koninklijke Philips Electronics (130). This group had 39.38% share in total granted patents; 52.42% in the working of patents, and 32.62% in the non-working of patents. Table 2 indicates that most of working patents of this group are in force at the IPO.

Engineering solution companies: This group includes three engineering-based solution-providing companies. These companies filed a total of 195 (2 (1991–1995), 34 (1996–2000), 98 (2001–2005) and 61 (2006–2010)) patent applications at the IPO from 1991 to 2010. Among these, two have already expired after the 20-year period, whereas the remaining (34 (2016–2020), 98 (2021–2025),

Table 2. Subject-specific organizations with their patent share

Subject domain (organizations)	Patents at IPO		
	Granted	Working	Non-working
Agri-research companies			
BASF	313	40	273
Bayer	314	22	292
Deere and Company	20	0	20
Dow Agro	15	4	11
Du Pont	101	44	57
Excel	8	2	6
Indofil	7	7	0
Monsanto	44	41	3
Syngenta	169	19	150
Biotech companies			
Biocon	31	22	9
Novozyme	85	85	0
Panacea	10	7	3
Serum	10	7	3
Communication technology companies			
General Electric	113	30	83
Koninklijke Philips Electronics	352	130	222
LG Electronics	212	36	176
Microsoft	14	0	14
Motorola	295	11	284
Nokia	214	154	60
Panasonic	76	4	72
Qualcomm Incorporated	1113	1111	2
Samsung Group	705	15	690
Sony	126	23	103
Telefonaktiebolaget Lm Ericsson	299	78	221
Engineering solution companies			
Kriloskar	13	11	2
Robert Bosch	112	57	55
Siemens	70	39	31
Food processing companies			
Britania	3	3	0
Nestle	49	4	45
Indian group companies			
Bajaj	20	14	6
Godrej	43	14	29
Hindustan Lever	773	76	697
Reliance Groups	47	6	41
Tata Groups	301	238	63
Indian R&D Organizations			
Council of Scientific and Industrial Research (CSIR)	1085	198	887
Department of Biotechnology (DBT)	15	1	14
Defence Research and Development Organisation (DRDO)	50	16	34
Department of Science and Technology (DST)	29	17	12
Engineering India Ltd (EIL)	12	3	9
Indian Council of Agricultural Research (ICAR)	9	6	3
Indian Council of Medical Research (ICMR)	4	3	1
Indian Institute of Science (IISc)	36	7	29
Indian Institutes of Technology (IITs)	123	21	102
Indian Oil Corporation Ltd (IOCL)	44	17	27
Indian Petrochemicals Corporation Limited (IPCL)	10	1	9
Indian Space Research Organisation (ISRO)	49	41	8
Steel Authority of India Limited (SAIL)	31	18	13

(Contd)

Table 2. (Contd)

Subject domain (organizations)	Patents at IPO		
	Granted	Working	Non-working
Motor companies			
General Motors	8	8	0
Honda Motors	294	33	261
TVS	101	60	41
Patent service providers			
Thomson Solutions	316	4	312
Pharmaceutical companies			
Abott	26	1	25
Aurbindo	13	13	0
Aventis	60	7	53
Cadila	116	31	85
CIPLA	64	57	7
Glenmark	8	7	1
IPCA	53	42	11
Lupin	36	14	22
Nicholas Piramal	10	0	10
Novartis	149	24	125
Pfizer	82	17	65
Sunpharma	10	7	3
Torrent	24	9	15

61 (2026–2030)) are in force. Robert Bosch GmbH, or Bosch, is a German multinational engineering and electronics company headquartered in Gerlingen, Germany²⁷. It is the world's largest supplier of automotive components. This company secured a total of 112 patent applications at the IPO, followed by Siemens (70), a German conglomerate company headquartered in Berlin and Munich, and the largest manufacturing and electronics company in Europe, and Kriloskar (13; Pune, Maharashtra-based Indian company). Robert Bosch had also succeeded in the licensing of its 57 patents. This group had 2.18% share in total granted patents; 3.52% in the working of patents, and 1.49% in the non-working of patents. Table 2 indicates that most of the working patents (193) of this group are in force at the IPO.

Food processing companies: This group is led by Nestle, a Switzerland-based multinational company, which received 49 patents from the IPO, followed by an Indian company Britannia Industries Limited (3). The latter sells its Britannia and Tiger brands of biscuits throughout India. Britannia has an estimated market share of 38% (ref. 28). Britannia includes three engineering-based solution-providing companies, which filed 52 (14 (1996–2000), and 38 (2001–2005)) patent applications at the IPO during 1991 to 2010. All these applications are in force at the IPO. Britannia has transferred all three of its patents, whereas Nestle is continuing with its efforts with four innovations. This group had 0.58% share in total granted patents; 0.23% in the working of patents and 0.76% in the non-working of patents.

Indian group companies: Five Indian companies (viz. Bajaj, Godrej, Hindustan Lever, Reliance and Tata) were selected in this group, which are working through their associated companies in different enterprise groups. These companies have a range of products in India as well as in world market, viz. electronic items, furniture fixtures, food items, motor vehicles, garments, petroleum products, etc. These companies filed a total of 1184 (59 (1991–1995), 213 (1996–2000), 539 (2001–2005) and 373 (2006–2010)) patent applications at the IPO during 1991 to 2010. These applications were granted and will be in force up to 20 years (after the date of filing). Among these, 59 patents have already expired after the 20-year period, whereas the remaining 1125 will be in force. Hindustan Lever, an Indian consumer goods company based in Mumbai, Maharashtra²⁹, was the leading company receiving the highest number of granted patents (773), followed by Tata Group (301), Reliance (47), Godrej (43) and Bajaj (20). Notably, Tata had transferred its 238 patented innovations, whereas Hindustan Lever transferred only 76. This group recorded 13.23% share in total granted patents; 11.45% in the working of patents and 14.15% in the non-working of patents. Table 2 indicates that 1125 of the working patents of this group are in force at the IPO.

Indian R&D organizations: This group is a cluster of 13 Indian R&D organizations which are working on their subject-specific research mandates, viz. basic science, biotechnology, medical science, agriculture and allied science, defence research, space research, engineering, oil

and gas, petroleum, steel, etc. By and large, these organizations are funded by the Government of India through different plan and non-plan schemes/programmes. The mandate of these organizations is to work for public welfare through applied and basic research. These organizations are also involved in cutting-edge advanced and targeted research, e.g. Indian Space Research Organisation (ISRO), Defence Research and Development Organisation (DRDO), CSIR, etc. These organizations filed a total of 1500 (66 (1991–1995), 435 (1996–2000), 890 (2001–2005) and 109 (2006–2010)) patent applications at the IPO during 1991 to 2010. These applications were granted and will be in force up to 20 years (after the date of filing). Among these, 66 patents had expired after the 20-year period, whereas the remaining 1434 will be in force. CSIR received 1085 patents from the IPO, and is known for its cutting-edge R&D knowledge base with its pan-India presence³⁰. A group of 13 IITs received 123 patents from the IPO, followed by DRDO with 50 patents. CSIR transferred a total of 198 patented innovations, although with regard to the percentile success of working of patents, ISRO topped the list with 83.67%, followed by Indian Council of Medical Research (75.00%) and Indian Council of Agricultural Research (66.67%). This group had 13.23% share in total granted patents; 16.77% in the working of patents and 11.49% in the non-working of patents. Table 2 indicates that 1434 of the working patents of this group are in force at the IPO.

Motor companies: This group is led by Honda Motor Co Ltd, which is a Japanese public multinational conglomerate corporation, primarily known as a manufacturer of automobiles, aircraft, motorcycles and power equipment³¹. Honda Motors received 294 patents from the IPO, followed by TVS Motor Company (101), which is the third largest two-wheeler manufacturer in India³². General Motors (GM), is an American multinational corporation that designs, manufactures, markets and distributes vehicles and vehicle parts, and sells financial services³³. This leading giant filed eight applications at the IPO and received grant. These companies filed a total of 403 (6 (1996–2000), 212 (2001–2005) and 185 (2006–2010)) patent applications at the IPO during 1991 to 2010. These applications are in force at the IPO. GM transferred all of its eight patents, whereas Honda Motors is continuing its efforts with 33 and TVS with 60 innovations respectively. This group had 4.50% share in total granted patents; 3.32% in the working of patents and 5.11% in the non-working of patents.

Patent service providers: This group has only one company, i.e. Thomson Solutions, which is involved in managing, protecting and driving the value of IP assets with solutions that power the IP life cycle. Thomson Solutions reportedly filed 316 (8 (1991–1995), 71 (1996–2000),

223 (2001–2005) and 14 (2006–2010)) patent applications at the IPO from 1991 to 2010. Among these, 308 applications are in force at the IPO. Thomson Solutions succeeded in transferring only four patents.

Pharmaceutical companies: The past two decades witnessed the revolution in patenting and licensing in the Indian pharmaceutical sector. There has been significant development in this field due to greater demand for generic drugs in the developed countries, patent expiry and the growing importance of biologics. There has been a decline globally in the demand for patented and branded drugs due to the growing importance of generic drugs. In 2010, the share of patented drugs was 70% in the global market and it declined to 53% in 2015. A total of 67,342 patents were granted in India during 2006–2015, among which 56,727 were foreign and 10,615 were Indian inventors³⁴. This group is a cluster of 13 major drug research-based companies, comprising national as well as international giants of the pharmaceutical field. The group is led by Novartis, which is a global healthcare company based in Switzerland (it has a branch at Hyderabad, India) that provides solutions to address the evolving needs of patients worldwide³⁵. Novartis received 149 patents from the IPO, followed by Cadila Healthcare (116; fourth largest pharmaceutical company in India; <http://zyduscadila.com/>) and Pfizer (82; an American global pharmaceutical corporation and among the world's largest pharmaceutical companies)³⁶. These companies filed a total of 651 (8 (1991–1995), 93 (1996–2000), 392 (2001–2005) and 158 (2006–2010)) patent applications at the IPO from 1991 to 2010. These applications were granted and will be in force up to 20 years (after the date of filing). Among these, eight patents have already expired after the 20-year period, and the remaining 643 patents will be in force. Aurobindo Pharma Limited is an Indian pharmaceutical company, which manufactures generic pharmaceuticals and active pharmaceutical ingredients³⁷. The company transferred all of its patented innovations, followed by CIPLA (89.06%), Glenmark (87.50%) and Sunpharma (70%). This group had 7.27% share in total granted patents; 7.54% in the working of patents and 7.14% in the non-working of patents. Table 2 indicates that 643 of the working patents of this group are in force at the IPO.

Legal status of patents

Legal status of working of patents at IPO: The legal status of the total 8944 patents, which were granted to 64 organizations was analysed from the IPO website. It revealed that 69.85% of the total patents are in force, 21.33% were ceased, and 5.63% patents were lapsed owing to expiry after 20 years. As shown in Table 3, working patents are more in force (80.92%), rather than non-working patents (63.98%); 26.02% non-working and

Table 3. Legal status of working of patents at IPO

Legal status	Working	% Share	Non-working	% Share	Total	% Share
In force	2418.00	80.92	3610.00	63.98	6028.00	69.85
Ceased	373.00	12.48	1468.00	26.02	1841.00	21.33
Term expired	143.00	4.79	343.00	6.08	486.00	5.63
Under extension period	47.00	1.57	221.00	3.92	268.00	3.11
Revoked	1.00	0.03	0.00	0.00	1.00	0.01
Data not available	6.00	0.20	0.00	0.00	6.00	0.07
Grand total	2988.00	100.00	5642.00	100.00	8630.00	100.00

12.48% working patents have already been ceased due to non-payment of renewal fee.

Legal status of patents filed at different PFOs: Out of these 64 organizations, 57 had filed their innovations at different PFOs, including the IPO, viz. EPO, JPO, KPO, SIPO, USPTO, etc. To know the patent portfolio of these organizations with their legal status at different PFOs, data were collected from Questel Orbit (a paid search engine) and analysed accordingly. Table 4 shows the portfolios and their legal status.

Agri-research companies: Nine companies of this group filed 251,185 patent applications at different PFOs. Byr was the leading company with 73,433 patent applications; followed by Du Pont (69,279) and BASF (66,374). The legal status of these patents showed that 51.57% of the granted patents were expired (due to completion of patent life span, i.e. 20 years), 20.73% patents were lapsed because of non-payment of maintenance fee on time and 16.36% granted patents were in force; the remaining applications were revoked (6.37%), pending (4.80%) and some were not known due to different administrative or technical reasons (0.17%). These companies filed their 89.66% innovations as single applicant/assignee, and the remaining were in collaboration with other companies/organizations.

Biotech companies: Only one company, viz. Panacea had filed 366 patent applications at different PFOs, of which 127 patents were in force and 119 were in process at different stages of grant. The remaining patents were lapsed (82), expired (28) and revoked (10) due to different technical reasons. Panacea had filed its 91.80% applications as the lead assignee.

Communication technology companies: Eleven companies of this group filed a total of 1,679,302 patent applications at different PFOs. Panasonic (593,674), Samsung Electronics (271,195), Sony (203,609), LG Electronics (173,415) and General Electric (137,207) were the leading patent filing organizations in this group. The combined legal status of this group indicated that 46.08% patents were lapsed due to non-payment of maintenance

fee on time; 17.17% granted patents were expired (due to completion of patent life span) and 21.60% granted patents are in force. Remaining applications were pending (8.84%), revoked (5.73%) and some were not known due to different administrative or technical reasons (0.04%). These companies filed their 87.80% patent applications as single applicant/assignee, and the remaining were in collaboration with other companies/organizations.

Engineering solution companies: Three companies of this group filed 96,722 patent applications at different PFOs. Robert Bosch was the leading company with 96,122 patent applications followed by Siemens (474), and Kirloskar (126). The combined legal status of this group showed that 25.22% patents were expired (due to completion of patent life span), 23.26% granted patents were in force, 23.79% patent applications were pending at different PFO; and 22.16% patent applications were lapsed because of non-payment of maintenance fee on time. Remaining applications were revoked (6.52%) and some were not known due to different administrative or technical reasons (0.04%). These companies filed their 78.63% patent applications as single applicant/assignee, and the remaining were in collaboration with other companies/organizations.

Food processing companies: Only one company, viz. Nestle had filed 4025 patent applications at different PFOs, of which 1374 patents were in force, whereas 1344 applications were expired, 805 lapsed, and 153 patent applications are in process at different stages of grant. Remaining patents were revoked (346) due to different technical reasons. Nestle had filed its 81.54% applications as the lead assignee.

Indian group companies: Five companies of this group with their sister/subsidiary companies had filed 13,466 patent applications at different PFOs. Tata Group of Companies was in the lead with 5073 patent applications, followed by Hindustan Uniliver (4637), Reliance (3292), Bajaj (268) and Godrej (196). The combined legal status of this group showed that 32.96% granted patents were in force, whereas 26.03% patent applications

Table 4. Legal status of patent portfolios at different patent filing offices (PFOs)

Organizations	Legal status at different PFOs						Total	Assignee %
	Granted	Pending	Revoked	Expired	Lapsed	Unknown		
Agri-research companies								
BASF	11,701	4502	7529	25,138	17,434	70	66,374	87.61
Bayer	8506	2954	4511	37,547	19,777	138	73,433	61.46
Deere	3333	842	351	6394	1268	24	12,212	95.29
Dow Agro	26	2	1	0	2	0	31	91.18
Du Pont	10,352	2605	2676	43,592	9932	122	69,279	89.32
Excel Industries	23	6	5	47	47	1	129	92.25
Indofil	12	8	0	3	1	0	24	100
Monsanto	4201	418	646	16,471	2398	42	24,176	93.25
Syngenta	2933	723	276	351	1217	27	5527	96.62
Total	41,087	12,060	15,995	129,543	52,076	424	251,185	89.66
% Share	16.36	4.8	6.37	51.57	20.73	0.17	100	
Biotech companies								
Panacea	127	119	10	28	82	0	366	91.8
Communication technology companies								
Ericsson	18,896	6961	1426	6890	6712	7	40,892	72.42
General Electric	20,671	7720	2904	89,906	15,906	100	137,207	90.09
LG Electronics	48,671	14,799	15,199	9315	85,363	68	173,415	81.5
Microsoft	27,047	6286	300	1303	5606	3	40,545	99
Motorola	9129	1163	1464	10,400	9539	24	31,719	77.96
Nokia	12,319	4933	1082	2228	7878	24	28,464	83
Panasonic	67,411	45,813	35,081	79,195	366,053	121	593,674	94.18
Philips	26,293	8790	6736	62,747	26,157	96	130,819	80.06
Qualcomm	18,246	7610	199	419	1288	1	27,763	96.33
Samsung Electronics	78,410	28,668	15,280	12,633	136,155	49	271,195	97.62
Sony	35,669	15,772	16,500	22,350	113,125	193	203,609	93.66
Total	362,762	148,515	96,171	297,386	773,782	686	1,679,302	87.8
% Share	21.6	8.84	5.73	17.71	46.08	0.04	100	
Engineering solution companies								
Kirloskar	15	58	1	38	12	2	126	86.51
Robert Bosch	22,140	21,975	6294	24,276	21,407	30	96,122	97.9
Simens	345	10	15	79	12	13	474	51.48
Total	22,500	22,043	6310	24,393	21,431	45	96,722	78.63
% Share	23.26	22.79	6.52	25.22	22.16	0.05	100	
Food processing companies								
Nestle	1374	153	346	1344	805	3	4025	81.54
Indian group companies								
Bajaj Group companies	65	121	1	38	41	2	268	84.33
Godrej	75	76	3	20	20	2	196	97.96
Hindustan Uniliver	2477	468	313	486	886	7	4637	100
Reliance	772	530	77	1341	569	3	3292	66.56
Tata Group companies	1049	2310	99	805	809	1	5073	93.95
Total	4438	3505	493	2690	2325	15	13,466	88.56
% Share	32.96	26.03	3.66	19.98	17.27	0.11	100	
Indian R&D organizations								
CSIR	3883	1621	98	2922	1252	33	9809	97.28
DBT	101	145	0	4	17	3	270	81.48
DRDO	149	370	0	1	6	0	526	92.97
DST	53	29	0	2	27	1	112	62.5
EIL	18	16	0	5	2	0	41	90.24
ICAR	63	417	1	0	55	0	536	92.35
ICMR	27	70	0	3	6	1	107	100

(Contd)

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Table 4. (Contd)

Organizations	Legal status at different PFOs						Total	Assignee %
	Granted	Pending	Revoked	Expired	Lapsed	Unknown		
IISc	168	174	0	41	40	0	423	90.72
IITs	525	1420	2	43	140	1	2131	97.23
ISRO	108	98	0	47	40	0	293	99.66
SAIL	216	286	0	25	74	0	601	98.84
Total	5311	4646	101	3093	1659	39	14,849	91.21
% Share	35.77	31.29	0.68	20.83	11.17	0.26	100	
Motor companies								
General Motors	15,726	4924	694	32,163	6696	3	60,206	97.66
Honda Motors	29,606	9968	4686	10,209	32,600	45	87,114	99.01
TVS	161	944	0	0	21	0	1126	99.73
Total	45,493	15,836	5380	42,372	39,317	48	148,446	98.8
% Share	30.65	10.67	3.62	28.54	26.49	0.03	100	
Patent service providers								
Thomson	230	109	0	15	20	0	374	85.83
Pharmaceutical companies								
Abbott	4473	960	447	5730	2428	26	14,064	72.21
Aventis	1215	268	347	332	703	12	2877	70.98
Cadila	222	574	5	4	62	1	868	98.87
CIPLA	213	187	24	13	165	0	602	88.21
Glenmark	102	261	4	0	200	0	567	99
IPCA	76	39	0	0	11	0	126	100
LuPIN	158	272	9	25	62	0	526	89.92
Nicholas Piramal	37	5	0	0	6	0	48	45.83
Novartis	4282	1646	847	9038	3794	46	19,653	86.17
Pfizer	4122	1606	2048	8670	7744	96	24,286	89.52
Sun Pharma	33	40	0	0	19	0	92	92.45
Torrent Pharmaceuticals	52	118	3	0	51	2	226	98.23
Total	14,985	5976	3734	23,812	15,245	183	63,935	85.95
% Share	23.44	9.35	5.84	37.24	23.84	0.29	100	
Overall	498,307	212,962	128,540	524,676	906,742	1443	2,272,670	87.98

were pending at different PFOs, 19.98% patents were expired (due to completion of patent life span) and 17.27% patent applications were lapsed because of non-payment of maintenance fee on time. The remaining applications were revoked (3.66%) and some were not known due to different administrative or technical reasons (0.11%). These companies filed their 88.56% patent applications as single applicant/assignee and the remaining were in collaboration with other companies/organizations.

Indian R&D organizations: This group comprised of 11 Indian government-funded educational, scientific and product-specific organizations, which had filed 14,849 patent applications at different PFOs. CSIR was the leading organization with 9809 patent applications followed by the IITs (2131), SAIL (601) and ICAR (536). The combined legal status of this group showed that 35.77% granted patents were in force, whereas 31.29% patent applications were pending at different PFOs, 20.83%

patents were expired (due to completion of patent life span), and 11.17% patent applications were lapsed because of non-payment of maintenance fee on time. The remaining applications were revoked (0.68%) and some were not known due to different administrative or technical reasons (0.26%). These companies filed their 91.21% patent applications as single applicant/assignee, and the remaining were in collaboration with other companies/organizations.

Motor companies: Three companies of this group filed 148,446 patent applications at different PFOs. Honda Motors was the leading company with 87,114 patent applications, followed by GM (60,206) and TVS (1126). The combined legal status of this group showed that 30.65% granted patents were in force, whereas 28.54% patents were expired (due to completion of patent life span) and 26.49% patent applications were lapsed because of non-payment of maintenance fee on time. The remaining applications were pending (10.67%) at different

PFOs; revoked (3.62%) and some were not known due to different administrative or technical reasons (0.03%). These companies filed their 98.80% patent applications as single applicant/assignee and the remaining were in collaboration with other companies/organizations.

Patent service providers: Only one company, viz. Thomson Reuters filed 374 patent applications at different PFOs, of which 230 patent were in force and 109 patent applications were in process at different stages of grant. Remaining patents were either lapsed (20) or expired (15). Thomson Reuters had filed its 85.83% applications as the lead assignee.

Pharmaceutical companies: This cluster of 12 companies filed 63,935 patent applications at different PFOs. Pfizer (24,286), Novartis (19,653) and Abbott (14,064) were the leading patent filing organizations in this group. The combined legal status of this group showed that 37.24% granted patents were expired (due to completion of patent life span), 23.84% patents were lapsed due to non-payment of maintenance fee on time and 23.44% granted patents were in force. Remaining applications were pending (9.35%), revoked (5.73%) and some were not known owing to different administrative or technical reasons (5.84%). These companies filed their 85.95% patent applications as single applicant/assignee and the remaining were in collaboration with other companies/organizations.

Conclusion

The objective of this study was to determine the workability of patents in India, and the results indicate that all the seven patents granted to Indofil were in working condition, which apparently signified that the firm had effectively transferred the innovations for production and for the end-user. Qualcomm (99.82%), CIPLA (89.06%), Glenmark (87.50%), Kirloskar (84.62%) and ISRO (83.67%) were also reported to adopt progressive efforts in workability of their patents at the IPO.

The patent portfolio of these companies/organizations at different PFOs provided us with a broader knowledge with regard to the patents filed by the various organizations, Panasonic topped the list with 593,674 applications, followed by Samsung Electronics (271,195), Sony (203,609), LG Electronics (173,415), and General Electric (137,207). The legal status of this patent portfolio also showed that Panasonic had 45,813 patent applications pending at different PFOs, followed by Samsung Electronics (28,668), Robert Bosch (21,975), Sony (15,772) and LG Electronics (14,799). Due to non-payment or various irregularities in the maintenance of patent applications, PFOs have been empowered (the regulations are different in various countries) to revoke the patents. In this line, 35,081 applications of Panasonic

were revoked, followed by Sony (16,500), Samsung Electronics (15,280), LG Electronics (15,199) and BASF (7529). Some of the patents were expired due to completing their life span, i.e. 20 years in most of the countries; 89,906 patents of General Electric were expired, followed by Panasonic (79,195), Philips (62,747), DuPont (43,592), and Bayer (37,547).

The subject domain of patent applications emphasizes that the highest patent applications have been filed in the area of communication technology (1,679,302); followed by agri-based research companies (251,185), motor companies (148,446), engineering solution companies (96,722) and pharmaceutical companies (63,935). The IPO was preferred as an important PFO by different national and international companies. Thomson Reuters topped the list in filing patents with 89.49% patent applications at the IPO, followed by Dow Agro (43.89%), IPCA (34.92%), EIL (29.27%) and Indofil (29.17%). The IPO was preferred as an important PFO by different national and international companies for filing their innovations, and this apparently revealed the importance of Indian market and the demand for innovations. The results of this study could provide an opportunity for the inventors, market players, researchers and consumers to be acquainted with the innovations field at various PFOs. The legal status of patent applications is important, which can facilitate researchers in their planning and execution. This study also provides an opportunity to understand the trend of worldwide patent filing with reference to 57 companies/organizations of international importance at the IPO, as well as in other PFOs in 10 subject-specific areas.

Conflict of interest: The authors declare that they have no conflict of interest, including any financial, personal or other relationships with other people or organizations that could inappropriately influence, or be perceived to influence the present work.

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