



Patents Commercialization Profile of Universities and Higher Education Institutes in India

Mamta Bhardwaj,[†] Amandeep Sandhu and Navkiran Ghumman
DST-Centre for Policy Research, Panjab University, Chandigarh 160 014, Punjab, India

Received: 27th April 2021; accepted: 30th June 2021

Innovation is the key ingredient that drives the economic growth of the nation. Globalization has diminished barriers thereby, delivering a larger market area for these innovations. Countries like USA, China, South Korea, Japan, etc. have acknowledged this fact and are thriving through consistent innovation. They have a dynamic ecosystem that supports and encourages commercialization worthy research and development (R&D) through healthy engagements among the various stakeholders. Higher Education Institutes (HEIs), a vital component of this ecosystem, offer themselves as a cradle of fundamental research and a powerhouse of potential innovations. Countries like USA have banked heavily on their HEIs, such as, Stanford and Harvard, building a sustainable framework around them. Indian HEIs, which have long been in the practice of publication of their technological advancements, are also making the transition towards the patenting system. Although the IP movement at most HEIs in India is still in nascent stages, roots have already been formed at a few select institutes. This paper attempts to provide an overview of Indian HEIs leading in patents granted and their commercialisation status, based on the “Statements of Working filed” on Form-27 at the Indian Patent Office (IPO).

Keywords: Commercialization, Higher Education Institutes, Form-27, Indian Patent Office, Working Patents, Science, Technology and Innovation Policy, 2020, Translational Research Ecosystem

Over the last couple of decades, there has been a rising trend towards employing fundamental academic research to develop commercialization worthy innovations. Universities, apart from their traditional roles, are also taking up an entrepreneurial role to contribute to the national economy.¹ One of the crucial factors in academic IP commercialization is the formulation of a policy framework that facilitates the transfer of academic know-how to the industry, thus promoting its optimal exploitation.² These reforms in some way must also encourage the development of institutional instruments such as Intellectual Property (IP) Cell (and Policy), Technology Transfer Offices (and Policy) and Incubators to promote protection and commercialization of research in academic institutions.³ This is also reflected through the National IPR Policy⁴ released by the Government of India in 2016, which includes an objective to promote

IP as a viable commercial asset. Recently, in 2021 Govt. of India has drafted the new Science, Technology and Innovation Policy.⁵ With the deliberation and consultation with the IP experts and

policymakers, Section-10 has been added to new Science Technology and Innovation policy (STIP) 2020 to promote the IP regime in India. The policy will address the issues like IP ownership, commercialization, patent box regime, regulatory framework, and streamline the cost, time and process of patents filing and management, etc.

It has been mentioned in the policy draft that the STIP 2020 will address the issues related to IPRs in accordance with the National IPR Policy 2016 with the assistance of concerned departments. Indian academic institutes, although having made a mark for themselves in the research publication indicator,⁵ still have a long road ahead when it comes to taking the patent route for their inventions.⁵ In a previous exercise, the Department of Science and Technology (DST)-Centre for Policy Research (CPR) at Punjab University, Chandigarh had analysed data comprising of research publications and patents (filed and granted) of the 904 institutions in the country [HEIs: 351 + National Research Laboratories (NRLs): 553].⁶ The study was further extended to identify and analyse the patent commercialization of the leading HEIs in the country through their ‘Working Statements’ filed in Form-27 before the Indian Patent Office. The composite study shows that the

[†]Corresponding author: Email: mamta.bhardwaj1984@gmail.com

percentage of working patents concerning granted patents from the period 2010-17 for national research labs are 22% whereas for higher education institutions it is only 8%.⁷

In the study, it was found that the institutions having a notable Translational Research Ecosystem (TRE) have created dedicated IP and Technology Transfer Cells, to look after these activities and also have constituted dedicated IP policy to regulate patent regime in the institution. It was also noticed that the top position in patents generation was secured by NRLs which can be attributed to the different setup and budget distribution of both the fraternities. Moreover, the research organizations have IPR Cells in place within the campus. The current study is limited to HEIs only and excluded NRLs (which were part of the previous study).⁷ The authors wished to highlight the patents commercialization profile in universities and HEIs because, Firstly, the infrastructure, policies and administrative framework, funding, etc. of universities and HEIs are completely different from an NRL and Secondly, NRLs have multiple laboratories and all the patents generated from the laboratories are assigned to the parent organisations as per their policies.

As a requisite of The Patents Act, 1970, each patentee is mandated to file the 'Working Statement (commercialization)' in Form-27 prescribed by the Indian Patent Office, every financial year, irrespective of the fact, if the patent is worked or not, in India. As this extended study is aimed towards finding the top HEIs in the country in terms of patent commercialisation activities, the DST-CPR studied the Form-27 data filed by the patentees at the IPO. This data has been collected for the patents under the categories 'granted to' and 'maintained by' these institutes for the period from January 2010 up till December 2017.

The working status of the granted patents has been done from the official Indian Patent Advanced Search Engine (*inPASS*).⁸ Every patentee has to submit Form-27 every financial year before 31st March, failing to do that is a punishable offence. In Form-27, the patentee has to furnish the information like working/non-working status of the patent, if non-working, what is the reason of it, patents with joint applicants, etc. Only, the patents granted in India were considered for the study which were 1961 (HEIs+NRLs) for this period. This is because the working status of patents granted outside India was

not accessible and this provision is available only in India through Form-27 which states that:

As per the Section 146 (2) of the Patent Act, 1970 after the grant of a patent, the applicant must file the working statement of the patent before 31st March of every financial year. The information provided in these submissions is the basis of which, the Controller General of Patents, Designs & Trade Marks decides on granting a compulsory license to the interested party. In a case against a particular patent, the patentee has failed to furnish working information under Form-27, or in case the patentee submits the form but the Controller after examination feels that requirements of Section 146/ Rule 131 are not met, he may pass an order to grant a compulsory license under Section 84. Under Section 122, the punitive measures for non-compliance with Section-146 is punishable with fine which may extend to ten lakh rupees and 6 months imprisonment. Furnishing wrong information will be punishable with imprisonment with fine, or with both.

Highlights of the Composite Study

Of the 904 institutes, only 186 institutions had granted patents to their credit for the period studied, from January 2010 to December 2017. These institutions have been categorized as HEIs, NRLs and Others (others are Industry/PSU/Board/Council/Hospital, etc.). The count of institutions in each category is such that 42% have been granted to NRLs, 36% HEIs and 22% belonged to the 'others' category, comprising of industries, public sector undertaking (PSU), trusts, boards, corporations, hospitals, etc. Below mentioned in Fig. 1 are the top 10 patentees having the patents granted for the last 8 years.⁷

Institutes Leading in Patents Granted

The patents commercialization ecosystem in the top 10 institutes holding maximum patents granted in India only based on patents granted to them in 2010-17 is mentioned in Fig. 2 Maximum patents are secured by Indian Institute of Technology (IIT)-Bombay (76) followed by Indian Institute of Science (IISc)-Bangalore (47) and IIT-Kanpur (46). The first generation IITs occupy five of the 10 top positions considering HEIs with the maximum patents granted to their credit. It may also be remarked that all these 10 academic institutions are public institutes and are Government funded.

The HEIs ranked after these top 10 institutes as shown in Fig. 2, have 5 or fewer patents to their credit

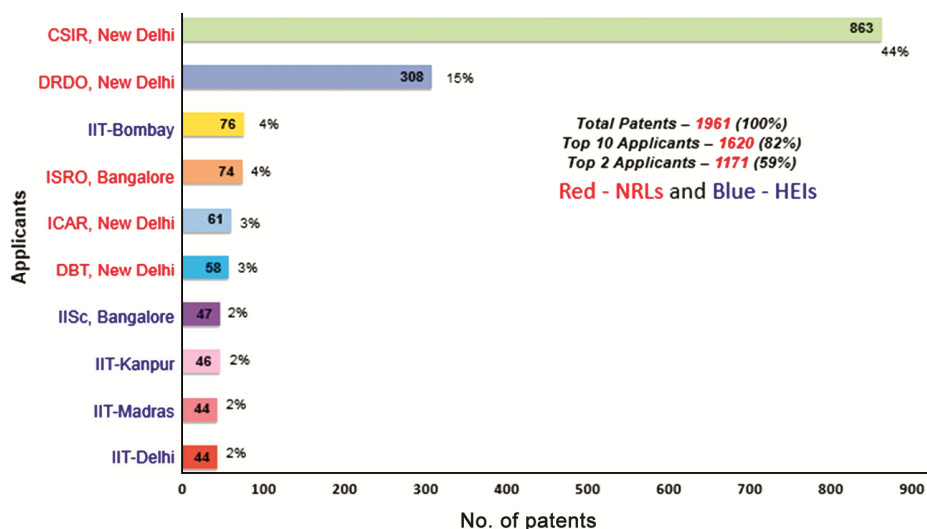


Fig. 1 — Top 10 patentees with maximum granted patents (January 2010 - December 2017)

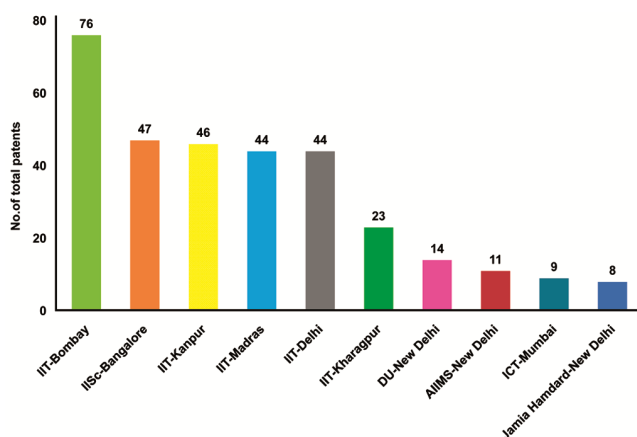


Fig. 2 — Top 10 HEIs based on total patents granted

for the period studied from January 2010 to December 2017. Therefore, the current analysis is focused on these top 10 institutes. It was observed that the institutions leading in the patents generation are having all the components such as IPR Cells/Technology Transfer Cells, dedicated IPR Policy/Guidelines for engaging in collaborative research with research laboratories and industries. Researchers/Scientists in educational institutions are doing good research but they are not familiar with the process and procedure of the patents filing and commercialization. The concerning institution or organization should establish the aforementioned elements and should facilitate researchers from the inception of the research to the commercialization of the invention.

Working Statements Filed through Form-27

The patentees have to file working/non-working statements for the granted patents, which are in force

and maintained by paying annuity as per the guidelines of Govt. of India. If any patentee could not file the form for some genuine reason, before 31st March, he/she can request the Patent Office for extension of a maximum of 6 months. For this study, the patents (granted) data from January 2010 to December 2017 have been taken. It is pertinent to mention that working statements submission for the patents (active or in force) from January 2010 to March 2011, were filed by 31st March 2011 as mandated by Govt. of India. Similarly, the submission of the working statement for the patents (active or in force) from January 2017 to 31st March 2018 was filed by 31st March 2018. The information from Form-27 was extracted for the period 2010-18. Fig. 3 shows that the first generation IITs like IIT-Bombay and IIT-Madras and IISc-Bangalore have a consistent number of active patents. The count of in-force patents of the 10 HEIs for the years studied is also depicted in Fig. 3.

The landmark case of ‘*Natco v Bayer*’, the first-ever case in India (2013) of compulsory licensing for a cancer drug, highlighted the statutory requirement of filing the working statement with the IPO, resulting in an increment in Form-27 filings, post-2013.⁹ But it was noted that even though filing of the form every year for active patents is mandatory in India and failing in doing so, is a punishable offence. This attitude can be attributed to the fact that Indian patentees are aware of the seriousness of this practice and the ones who are aware are taking it lightly. Filing of the working statement in the form should be promoted so that the industries can find the patents of

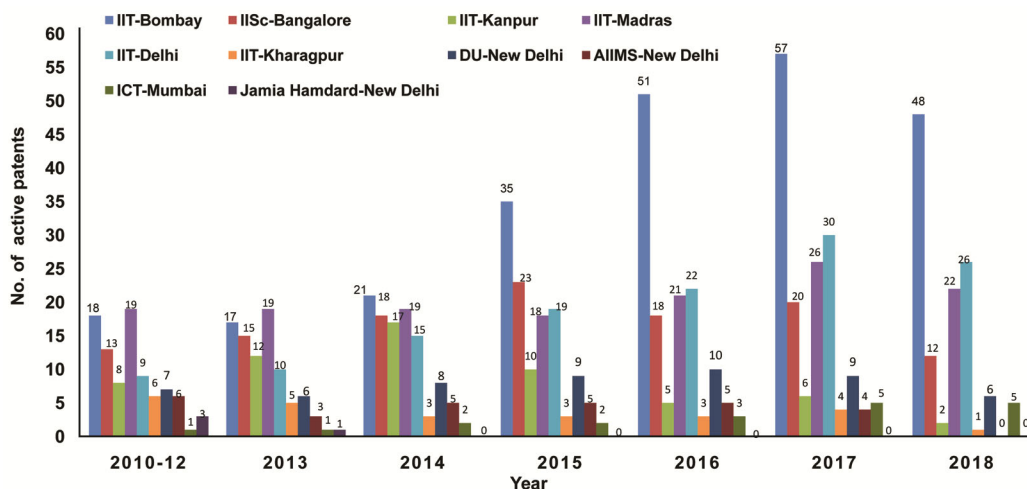


Fig. 3 — Year-wise 'In-force (active)' patents

their interest and the government can take actions to resolve the issues they are facing in commercialization. This is noted from Fig. 4 wherein, the percent of Form-27 filed (for the active patents) shoots up from 8% to 75% in the year 2013 and maximum of 90% for the year 2018. Each year represents the forms filed for that very year, i.e. 2013 represent the Forms filed for the year 2013, which were submitted in the ensuing year by March 2014. Patent information and Form-27 details extracted for the period 2010-18.

The Form-27 filing trend for the institutions was also studied. The trend for the top ten institutions (based on patents granted) has been depicted below in Fig. 5. The Form-27 filing trend of these institutes is mainly in line with their in-force patents. The filings steadily increase for IIT-Bombay, IIT-Delhi and Institute of Chemical Technology (ICT)-Mumbai over the years from 2010 to 2018 whereas, they decrease for IIT-Kanpur, and include a couple of ups and downs for IISc-Bangalore and IIT-Madras.

However, the percentage of 'Form-27' filed with respect to total 'In-force' patents varies significantly (Table 1), with each institute hitting the zero and hundred percent mark at least once over the years. This reflects that the requirement for filing Form-27 details is known to these institutes; however, it is often taken lightly and is overlooked.

Working/Non-Working Status of Patents Granted to HEIs

The working patents (commercialized) of each institute are represented in Fig. 6. IIT-Madras has an impressive percent of worked patents, almost 32%,

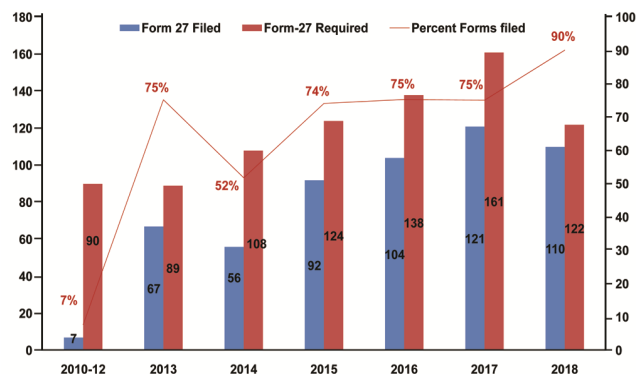


Fig. 4 — Form-27 filing trend over the years 2010-18

followed by Delhi University (DU)-New Delhi at 21%. Each institute that has working patents has 4% or more worked patents, which is in accordance with the world's average commercialisation rate of patents. Further, All India Institute of Medical Sciences (AIIMS)-New Delhi, ICT-Mumbai and Jamia Hamdard-New Delhi reported no working patents for the duration studied.

Figure 7 illustrates the year-wise trend of working patents. It is observed that apart from the years 2010-13 (for which no institute reported working patents), IIT-Bombay has working patents for all the years from 2014-18, and IIT-Madras (32%) has the maximum count of working patents followed by DU-New Delhi (21%).

Joint Applicants

Joint patent owners are, wherein, two or more institutions team up for carrying out R&D in a particular field or project. Collaboration can be in the form of researchers of one institute using the

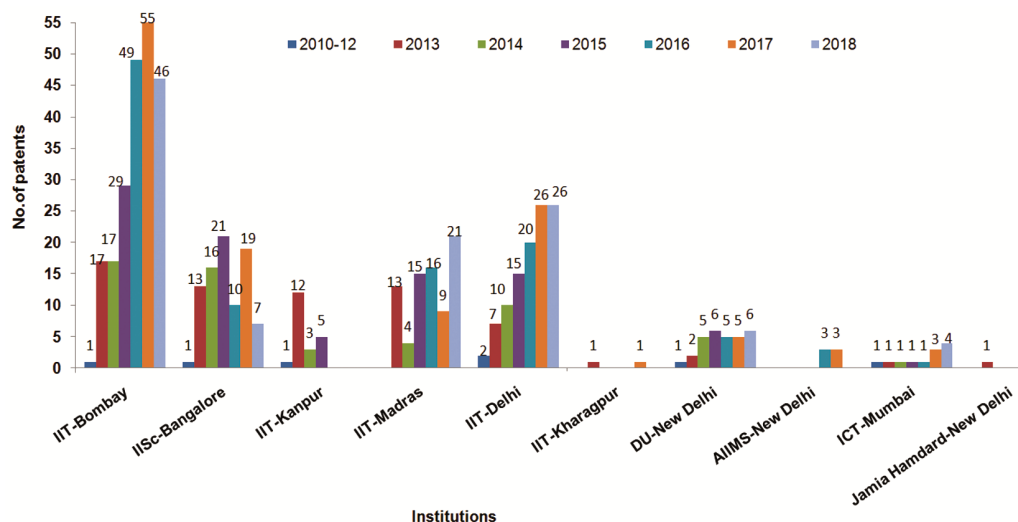


Fig. 5 — Year-wise trend of Form-27 filing of top 10 institutions

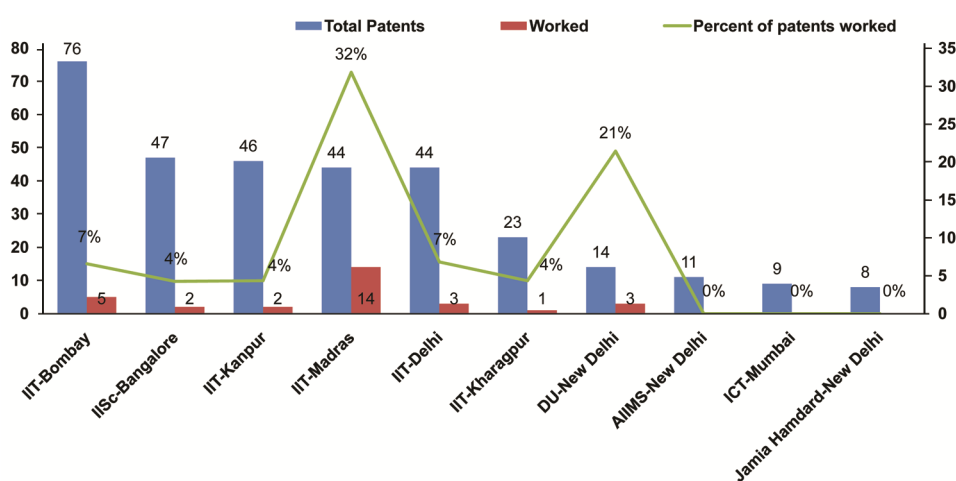


Fig. 6 — Working patents*

Table 1 — Percentage (%) of Form-27 Filed v Inforce patents

Applicant	2010-12	2013	2014	2015	2016	2017	2018
IIT-Bombay	6	100	81	83	96	96	96
IISc-Bangalore	8	87	89	91	56	95	58
IIT-Kanpur	13	100	18	50	0	0	0
IIT-Madras	0	68	21	83	76	35	95
IIT-Delhi	22	70	67	79	91	87	100
IIT-Kharagpur	0	20	0	0	0	25	0
DU-New Delhi	14	33	63	67	50	56	100
AIIMS-New Delhi	0	0	0	0	60	75	na
ICT-Mumbai	100	100	50	50	33	60	80
Jamia Hamdard-New Delhi	0	100	na	na	na	na	na

resources of another, or one institute providing funds to researchers of another institute, or two or more institutes are working on the same project, etc. Collaborations can provide benefits in terms of

sharing expenses, knowledge and experiences towards reaching a common goal.¹⁰ All HEIs in the top 10, except Jamia Hamdard-New Delhi, have two or more patents filed either along with another applicant or

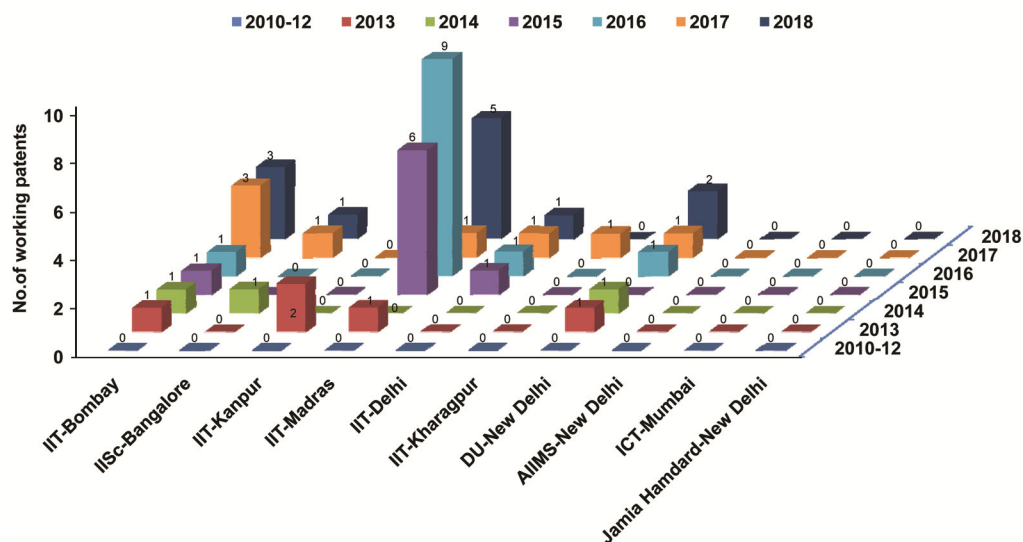


Fig. 7 — Year-wise working patents for top 10 Institutes



Fig. 8 — Patents filed as joint applicants

with an individual inventor(s) from another institution or by receiving research funds from the industry or government funding organizations like Council of Scientific and Industrial Research (CSIR), Defence Research and Development Organisation (DRDO), Department of Biotechnology (DBT), and Department of Science and Technology (DST), etc. The majority of the co-applicants are Government funding agencies or NRLs, mainly due to central-funded projects, followed by industry/PSUs (Fig. 8). However, only 6 of the total 63 patents were worked (patents marked as 'worked' atleast for one year have been considered as worked). Further, there are only 5 patents wherein the 'applicants' are three or more.

Discussion and Recommendation

The activities relating to technology generation, patent filing to patent grant and subsequently patent commercialisation are generally carried out through dedicated cells that are housed within the institutes. As being practiced in some IITs and IISc, there can be

separate cells such as IPR Cell, Technology Transfer Cell, Entrepreneurship Cell, Industry-Academia Collaboration Cell, etc. each having dedicated functions to perform or one cell carrying out all the functionalities.

Each of the 10 leading institutes studied herein has IPR Policy/Guidelines, IPR/Technology Transfer Cells and faculty members having formal knowledge of IPR. Moreover, it was also noticed that institutes facilitate researchers by giving them sabbatical leaves and financial help for conducting research and securing patents. Specific importance is also given to industry-academia collaborations and entrepreneurship, through dedicated cells/policies. This indicates that these institutes are taking extensive initiatives to provide an innovation-driven environment for students/researchers, thus resulting in better commercialisation of their inventions.

It has been reported by many national and international publications that India holds a very good rank in research publication but lagging in IP generation. Although, the think tanks believe that the country holds the entire wherewithal to convert the research in patent/technology/know-how, etc but some discrepancies need to be addressed by introducing reforms in teaching and with collaborative approach.

Reforms in Teaching

The universities/HEIs are a very crucial part of the economy in this knowledge era. They can change the economic status of the country by thinking and acting in an entrepreneurial way along with providing

education. The same can be achieved by changing the conventional way of imparting knowledge and intensifying the research and innovation in academics. The need of the hour is enhancing the translational research ecosystem in the academic sector.

Collaboration

Instead of working in silos, the academic institutes should collaborate with research institutions as well as industries. This practice will enhance the commercial activities and wealth of the nation along with increase in the job creation resulting in creation of innovation ecosystem in the country and can address the 'AtmaNirbhar Bharat' mission in the true sense. Some selected examples of the successful technologies created by HEIs (as a sole assignee or in collaboration) in India and has been successfully commercialized are:

- (i) Development of fast cure underwater epoxy coating (Assignee: IIT-Bombay)
- (ii) A hybrid transmission system (Assignee: IIT-Bombay)
- (iii) A device and a process for conversion of biogas to a fuel gas with enhanced thermal efficiency (Assignee: IIT-Delhi)
- (iv) Soil analysis by image processing of chromatograms (Assignee: IIT-Madras, Shri AmmMurugappa Chettiar Research Center, Chennai)
- (v) Fibre optic liquid level detector (Assignee: IISc-Bangalore)
- (vi) A process of determining the state of charge and state of health of a battery (Assignee: Banasthali Vidyapith, Rajasthan)
- (vii) A process for the preparation of waste plastic modified bitumen useful for rust-resistant and water-resistant bituminous mix for road construction (Assignee: IIT-Madras)
- (viii) An augmentative communication device for individuals with multiple disabilities (Assignee: IIT-Madras)
- (ix) A DNA construct for gene silencing in rice (Assignee: Delhi University)

Funding Criteria

The funding system of the universities and HEIs are very different from the research organizations in India. The universities/HEIs utilize the maximum of the funds in creating infrastructure on the other hand the funding received by the research institutions are

used to carry out research activities. The funds received by universities in the form of the fee are not enough to fulfil the need to file the patent or to commercialize it.

It will not be wrong to say that for universities/HEIs, filing a patent is a money and time losing affair. Because a very small fraction of the patents get commercialized so the expenses made to get a patent is very hard to recover the expenses.¹¹ Some of the universities/HEIs have established dedicated cells and allotted the special funds for such activities, but as per the study it was found that only 14% of the patents granted in India in the last 8 years was commercialized. Therefore, it is very crucial for the academic sector to work on this aspect strategically. More revenues can be generated from commercialization by adopting the model of institutions like IIT-Madras, IIT-Bombay and DU-New Delhi like:

- (i) Creating dedicated technology transfer, and IP cells to facilitate students in IP filing and commercialization.
- (ii) Setting up a separate fund for research activities.
- (iii) Hiring a full-time legal adviser for continuous support and counseling on IP issues
- (iv) Collaboration between industry-academia-research organizations
- (v) Signing MoUs and contracts with the industries for sponsored research
- (vi) Incorporating media in promoting the research and technologies created in the academic sectors, etc.

IP Advertising

The HEIs and NRLs are major portions of patents and technologies generation. A researcher devotes a lot of effort and time to reach the grant of the patent since the inception of the idea conceived. The entire process is time-consuming and an expensive affair too, so the researcher should receive rewards for his hard work and dedication. This is achievable through encouraging IP commercialization and collaboration with the industries. Patents, technologies and know-how generated at HEIs and NRLs should be disseminated by putting the details on the official websites, flyers, conferences, seminars, technology fairs, etc. so that industries can reach out to the patentees for licensing and commercialization.

Patents and Technology Fairs

The measures need to be taken for popularizing the licensing through organizing patents and technology

fairs, conducting workshops in HEIs in collaborations with the industries. Collaborative research, contract research/sponsored research can play a crucial role in the enhancement of IP licensing. Universities can establish dedicated cells to take care of activities related to sponsored research. A most suitable example of such kind of initiatives can be witnessed in first-generation IITs such as Kharagpur, Madras, Delhi, Roorkee, Kanpur, Bombay, etc. These institutions can act as role models for the other HEIs/universities in India as these institutes are leading in patents generation and commercialization. Recently IIT, Bombay has received the 'National Intellectual Property Award', 2019, under the category of 'Top Academic Institution for Patents and Commercialisation' given by the Department for Promotion of Industry and Internal Trade (DPIIT), Ministry of Commerce and Industry, Government of India.¹² These institutions also have established close linkages with the industries for knowledge creation and technology development, to identify new and emerging areas, to address real-time problems, for impactful quality of research and to design the curriculum as per the industry perspective.

Policies Creation

Creating dedicated technology transfer cells or setting up a separate fund to commercialize the patents/technology generated is paramount but to achieve high efficiency of technology transfer, universities/HEIs need to create supportive IP and technology transfer. Additionally, they need to change internal stricture, priorities, focus on applied research, focussed research objectives and work culture.

Appropriate Legislative Framework

To enhance the patent/technology transfer profile in Indian universities/HEIs, there is a need for an appropriate legislative framework. Some of the countries have established such systems in place like 'Bayh Dole Act' in USA, Innovation Law in Brazil and Industrial Revitalization Law in Japan. The Act should specifically address the issues like ownership of public-funded research as well as privately funded research, resources sharing, technology transfer, royalty sharing, promoting industry-academia collaboration, etc. In 2008, 'The protection and Utilization of Public-Funded Intellectual Property Bill (PFIP)' was presented in the parliament but was rejected due to some issues. The main objective of the bill was to encourage universities/HEIs self-sufficient

and to encourage innovations in small and medium-sized enterprises. Also, there was a focus on promoting the government, private enterprises and non-governmental organizations. The issues which created a negative buzz about the bill were informing the government within 30 days of the creation of IP before doing public disclosure and fear of ignoring the research which does not possess the commercial value. This practice could affect the research qualities and attitudes in the academic sector. This kind of bill should be discussed again by resolving the issues that occurred before with the involvement of stakeholders like industries, academia and public and private IP agencies.

The current study emphasizes that patenting of research is being recognised as a more lucrative option by academic institutions, however, the trajectory of growth still is picking up momentum at a slower pace. It maybe remarked that there is an urgent need for a shift in the mind-set of the academic fraternity, from publication towards patenting. Further, even the institutes performing reasonably well in getting patents granted, are not able to commercialise or take full benefits of the patents. There is still a dearth of IPR awareness in the academic sector in India, which is crucial to graduate from publication to patenting and commercialization. One of the most common reasons for the non-working of patents is the limitation of research to 'Lab-Scale Work', which can only be overcome once we start focusing not only on basic research but also on advanced technological research.

By and large, the patents generated by academia are commercialized by the industries and SMEs. Therefore, research being undertaken in the research laboratories of HEIs should be communicated to the industry. Also, a mechanism needs to be devised through which knowledge sharing, especially IP sharing, happens between academia and the industry regularly so that they can collectively exploit each other's innovation and knowledge for the generation of quality patents and technologies. Keeping these factors in mind, industry-academia linkage becomes important for aiding in licensing-out patents from universities to industries and generation of futuristic innovations/patents. This partnership will get a big boost if angel investors, venture capitalists and/or financial institutions can also be roped in, especially when financially limited industries like SMEs are involved in industry-academia collaborations.

Conclusion

There is a direct relationship between R&D levels and the patent ecosystem of a nation. In other words, to stimulate the patent filing and commercialization profile of the nation, there is a need to support the R&D ecosystem prevailing in the universities, R&D institutes and industries, in a way to bring out each of them from working *in silos* towards collaborating as a system. Such partnerships will help the scientists of the public sector (universities and R&D institutes) to work on real-life scientific challenges being faced by the private sector (industries) i.e. industries. In return, the industry would be benefitted from the intelligentsia of the public sector for the development of futuristic innovations for commercial and societal gains. Universities have enormous scientific talent and enthusiastic manpower but limited scientific infrastructure. This limitation can be overcome by developing linkages with national research laboratories, which are equipped with sophisticated instruments but have scanty manpower. Such tripartite partnership will boost the levels of applied research/patents/technologies in India, without pumping in additional funds by the funding agencies. To start with, industries having Department of Scientific and Industrial Research (DSIR) accredited R&D Units may be roped in to forge this tri-partite linkage.¹³ However, the funding provided to academic institutes should have a component for IP related matters like filing, commercialization, consultancies, licensing, etc., so that researchers do not have to rely on their university policy to get funds for the activities, such as patent searches, filing, commercialization and prosecution.¹⁴

References

- 1 Rothaermel F T, Agung S & Jiang L, University entrepreneurship: A taxonomy, *Industrial and Corporate Change*, 16 (4) (2007) 691–791.
- 2 Riccardo F & Nicola L & Scott S, Inside or outside the IP system? Business creation in academia, *Research Policy*, 39 (8) (2010) 1060-1069.
- 3 Geuna A and Rossi F, Changes to university IPR regulations in Europe and the impact on academic Patenting, *BIROn - Birkbeck Institutional Research Online*, 40 (8) (2011) 1068-1076.
- 4 National Intellectual Property Rights, Department of Industrial Policy and Promotion (Ministry of Commerce and Industry), Govt. of India, 2016.
- 5 SJR — *SCImago Journal & Country Rank*, June 2020, <https://www.scimagojr.com/index.php>.
- 6 Tewari R & Bhardwaj M, *Mapping Patents and Research Publications of Higher Education Institutes and National R&D Laboratories of India*, 2018, Panjab University, Chandigarh, <http://cpr.puchd.ac.in/>.
- 7 Bhardwaj M & Sandhu A, Working/non-working status of patents granted, *Current Science*, 120 (1) (2021) 34-42.
- 8 Office of the Controller General of Patents, *Indian Patent Advanced Search System (inPASS)*, <http://ipindiaservices.gov.in/publicsearch/> (accessed during May-September 2019).
- 9 Singhai M & Singhai A, A study of *Natco v Bayer* case: Its effect and current situation, *MIT International Journal of Pharmaceutical Sciences*, 2 (2) (2016) 21–23.
- 10 Lerner E L J, Collaboration in intellectual property: An overview, *WIPO Magazine, Harvard Business School and National Bureau of Economic Research*, 2012, https://www.wipo.int/wipo_magazine/en/2012/06/article_0008.html.
- 11 Yaakub N I *et. al*, Challenges for commercialization of university, *World Applied Sciences Journal*, 2011, ISSN no. 1818-4952, 132-138.
- 12 Indian Institute of Technology, Bombay, 2019, <https://rnd.iitb.ac.in/news/iit-bombay-won-national-intellectual-property-award-2019>.
- 13 Leydesdorff L & Etzkowitz H (Eds.), The Triple Helix of Innovation, *Triple Helix Issue of Science and Public Policy*, 25 (6) (1998).
- 14 Tahmooresnejad L & Beaudry C, Do patents of academic funded researchers enjoy a longer life? A study of patent renewal decisions, *PLOS ONE, Public Library of Science*, 13 (8) 2018 1-22.