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Research Publications and Commercialization of Patents Generated by the Academic and Research Sectors in India

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Abstract: According to international rankings, India is amongst the top 5 nations in the parameter of 'Research Publications'[1] but fares poorly (50th rank) in the generation of 'Patents'[2]. As the academic sector [Higher Education Institutes (HEIs) and National Research Laboratories (NRLs)] are the major contributor of publications and patents, it is imperative that, we understand the generation of research publications, patents and licensing of patents by the academic institutes. DST-Centre for Policy Research at Panjab University, Chandigarh undertook a study of 904 institutes, comprising of 351 HEIs (based on NIRF rankings) and all the national research labs (553) for the period of 2010-16[3]. The study revealed that, a large number of institutes publish a sizable number of research publications, however, only a handful of them namely, IISc-Bangalore, ICT-Mumbai, first-generation IITs, IICT-Hyderabad, NCL-Pune, NIPER-Mohali, etc. contributed significantly in the domains of research publications as well as patents generation (Granted patents). Field wise categorization of the patents revealed that IISc-Bangalore leads in the fields of Physics and Engineering, whereas, IICT-Hyderabad and NCL-Pune are the major contributors in the fields of Pharma/Drugs and Chemical Sciences respectively.

In the second phase, the study was extended to examine the commercialization status of the patents granted to the above mentioned institutions by checking the working/non-working status of the patents from the 'Form-27' filed by the applicants. A total of 1961 patents were granted to the institutes during the period 2010-17. However, this figure is abysmal by global standards. It was observed that, CSIR led in patents commercialization followed by DRDO, ISRO, IITs, ICAR and DBT. Low commercialization rate of patents could be largely attributed to poor Technology Readiness Levels (TRLs) of the technologies/products and less than desired efforts put in by the inventors and the applicants. In order to enhance the patents commercialization ecosystem in the country, there is a need to stimulate the Translational Research Ecosystem.

Keywords: Higher Education Institutions (HEIs), National Research Laboratories (NRLs), Patents Granted, Research Publications, Form-27, Working, Non-working.

Introduction: Universities and other higher education institutions (HEIs) are the prominent pillars for the economic development of a nation. A university is considered a successful institution if the knowledge being imparted to the students is converted into some tangible or intangible property. After USA and China, India is having the largest education system. As per University Grants Commission (UGC)[4] there are 399 State Universities, 126 Deemed to be Universities, 48 Central Universities and 334 Private Universities, 95 Institutions of National Importance (INIs)[5] and around 600 research labs under various ministries and independent departments. Policymakers and intellectual think tanks believe that the main focus of the universities and HEIs in India is to publish their research instead of securing it through the patents' rights given by the regional patent offices. The academic fraternity focuses only on imparting knowledge to students with least focus on converting that knowledge into a commercial commodity. This scenario can be attributed to some lacunas in governmental or institutional level policies and guidelines. However, countries like China, Singapore, Japan, USA, South Korea, Germany, Canada and Australia, focus more on converting knowledge into patents and technologies.

Table 1 depicts the comparison of India with its counterparts like Singapore, Japan and S. Korea. In the indicator of research publications, United States tops the ranking which is followed by China (2), United Kingdom (3), Germany (4) and 5th rank is secured by India whereas in the indicator of Intellectual Property Rights (IPRs) India is at 50th Position. Although India has all the wherewithal to compete with its counterparts, there is a need of change in some existing policies. In the indicator of 'R&D expenditure as a share of GDP (%)' India is ranking at 73rd position which is worse as compared to other nations. Although Singapore also stands at 71st position this can be attributed to the fact that Singapore is a very small country area-wise and population-wise. Considering 'R&D Manpower (Researchers per million people', India ranks at 69th position which is again poor as compared to other nations. Thus, there is a dearth of manpower dedicated towards research. Govt. of India needs to acknowledge these facts and moreover more individuals should to get into research.

Table 1: Global Rankings of Asian Countries in R&D Indicators

Indicator	**Global Rankings**				
	Singapore	**Japan**	**S. Korea**	**China**	**India**
Publications[1]	34	6	13	2	5

Citable Documents H-index[6]	23	6	18	13	21
IPRs[2]	14	5	26	49	50
R&D expenditure as a share of GDP[7](%)	71	4	2	13	73
R&D Manpower[7] (Researchers per million people	60	6	3	35	69

Table 2 shows the Patents filing Profile of India along with other Asian countries. China leads the chart followed by USA (2) and Japan (3). In this indicator, India has secured the position in top 10 nations but the number of total applications filed is low. Here the point of concern is that the percentage share of patents being filed by Indian residents is only 32.10% whereas, 67.90% of patents have been filed by non-resident applicants. Indian researchers are good in research which is evident by its ranking in research publications but they are reluctant to secure the research in the form of patent or technology. Moreover, there is a lack of awareness in IPRs and Indian researchers need to be made more IPR savvy. It is suggested that, IPR academies may be created in all regions of India to disseminate the importance of IPR and educate at least two faculty members from all institutes/universities in the country so that they can impart the same to the students of their respective institution.

Table 2: Patent Filing Profile of Asian Countries

Indicator	**Number of Patent Applications by Office of the Country**				
	Singapore	**Japan**	**S. Korea**	**China**	**India**
Overall Rank in Patent Applications	17	3	4	1	7
Total Applications	10,930	3,18,479	2,04,775	13,81,594	46,582
Applications by Residents (%age)	1,606 (14.69)	2,60,198 (81.70)	1,59,110 (77.70)	12,46,197 (90.20)	14,953 (32.10)
Applications by Non-residents (%age)	9,324 (85.31)	58,281 (18.30)	45,665 (22.30)	1,35,397 (9.80)	31,629 (67.90)

Source – *World Intellectual Property Indicators*[8]

India's dream of becoming a strong and developed nation cannot be fulfilled unless India improves its efforts towards patents and technology transfer. In order to achieve this, it is imperative that we understand the ecosystem of Research and Development (R&D) of Higher Education Institutes (HEIs) and R&D labs in India. Keeping this in mind, Department of Science & Technology (DST)-Centre for Policy Research (CPR) at Panjab University, Chandigarh undertook a study to analyse the research publications and patenting profile of more than 900 institutes of India comprising of HEIs (351) and all national R&D institutions

(553). The HEIs comprise of Institutions of National Importance (INIs), universities, engineering institutes, pharma institutes and private universities based on the national rankings released in 2016. The national R&D labs, included in this study, have been established under 27 ministries of Govt. of India and 2 independent departments under Prime Minister of India**.** The breakup of 904 institutes, considered in this study, is depicted in figure 1. The main mandates of the study were a) Identify institutes good in research publications as well as in the generation of patents. b) Identify institutes good in research publications, but low on the generation of patents and c) Understand the ecosystem for the generation of patents by the institutes.

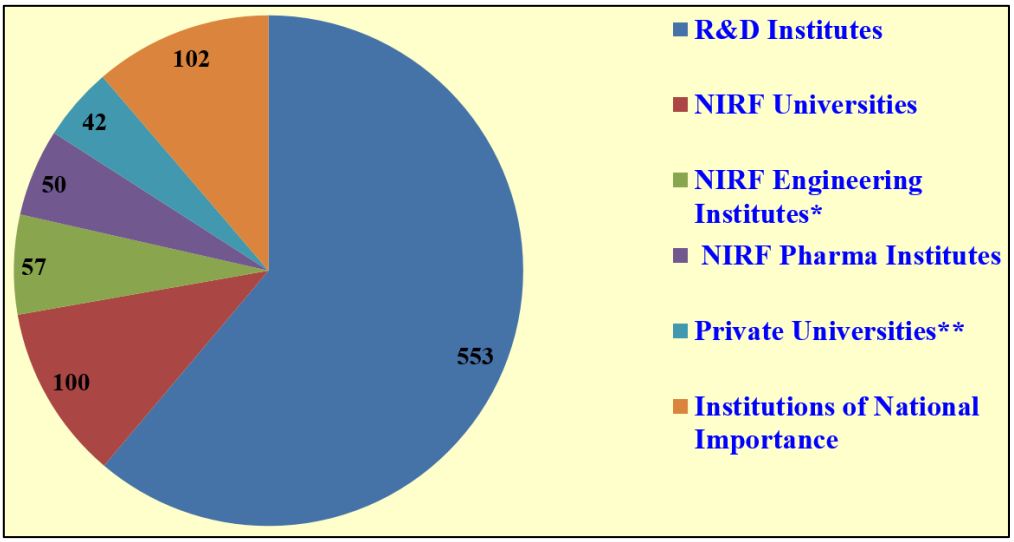

Figure 1: Break up of HEIs and R&D Labs considered for the study
**43 institutes from NIRF Engineering Institutes are included in INIs*
***8 Private Universities are included in the list of top 100 NIRF universities*

Data Collection and Methodology: First task to initiate the study was to select institutions for the study, which was done from the various sources mentioned below. The data pertaining to research articles' publication and patents granted was collected from some international and national databases mentioned in the further section.

Institutions for the Study:

- **R&D Labs:** The list of R&D labs was retrieved from the official websites of respective ministries of GoI and Directory for R&D Institutes, published by National Science and Technology Management Information System (NSTMIS) of DST, GoI.
- **NIRF Institutions:** The National Institutional Ranking Framework (NIRF) was launched on 29th September 2015. This framework outlines a broad methodology to rank institutions across the country based on various parameters.

- **INIs:** INI is a status conferred to a premier government education institute in India by an Act of Parliament, INI 'serves as a pivotal player in developing highly skilled personnel within the specified region of the country/state'. For this study, the data was collected from (http://mhrd.gov.in/institutions-national-importance).
- **Private Universities:** A private university is a university established through a State/Central Act by a sponsoring body. For this study, data was gathered from 'CAREERS 360'.

Research Publications and Patents Granted:

- **Research Publications:** The research article publication data for HEIs and R&D labs was retrieved from Scopus owned by Elsevier (https://www.scopus.com/). Scopus is the largest abstract and citation database of peer-reviewed literature, scientific research articles, books and conference proceedings. For this study, we have considered only research article publications.
  - **Patents Granted:** The raw data for patents (published & granted) was procured from a well-reputed private firm, Talwar & Talwar (TT) Consultants (http://ttconsultants.com/xlpat-patent-search-tool.php) located in Mohali, Punjab, India. Data extraction was done using the following patents' search tools.
  - *XLPAT owned by TT Consultants*[9]
  - *Indian Patents Advanced Search System (InPASS) of Govt. of India*[10]
  - *Orbit owned by Questel*[11]
  - *Dervent Innovation owned by Clarivate Analytics*[12]

It is pertinent to mention that the patent data was collected based on '*Name of the Applicant'*, which, in general, is either an institute or a scientist/s, belonging to an institute. However, in the case of national R&D laboratories, the 'Applicant' is usually the parent organization such as CSIR, ICMR, DRDO, etc. In such a scenario, parent organizations were requested to provide the list of patents originating from their research laboratories. For the current study, only granted-patents were considered. The data pertaining to filed-patents was not taken into account, as many institutes are resorting to filing of patent applications without getting a proper evaluation of the application's patentability criteria (novelty, industrial application and non-obviousness to a person skilled in the related field) and patentability chances of such patent-applications are very low and ultimately get rejected by the competent authorities. For the purpose of this study, data for research articles' publications and patents (filed and granted)

was collected for the period 2010-16. The time span of 7 years is considered enough to analyse trends on parameters of articles' publications and patents of the institutes.

Results and Analyses: Analysis has been carried out in two parts as explained in the further section:

A. Research Publications & Patents Granted

B. Patents Commercialization

A. Research Publications & Patents Granted: After data collection for research articles' publications and patents granted to the Institutions, top institutes were identified based on both parameters. Below in Table 3, Top 20 institutions are mentioned which are leading in research publication and next Table 4, top 20 institutions are given based on patents granted to them for the period of 2010-16. The maximum research publications (15, 052) for this period were credited to Delhi University (DU), New Delhi followed by Indian Institute of Science (IISc), Bangalore (10852) and so on. Rest of the institutions' research publications are <9000 range from 8724 – 4534. It is evident from Table 3 that the indicator 'research publications' are dominated by higher education institutions. In the list of top 20 institutions based on research publications barring Bhabha Atomic Research Centre (BARC), Mumbai, Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh and Indian Institute of Chemical Technology (IICT), Hyderabad all institution are HEIs. On the other hand in Table 4, the list of top 20 institutions based on patents granted is dominated by national research laboratories mainly under the research organization CSIR. The maximum patents are granted to an autonomous institute namely IISc, Bangalore (174) for the period of 2010-16 followed by Central Food Technological Research Institute (CFTRI), Mysore with 144 patents granted and National Chemical Laboratory (NCL), Pune (114). The fourth position has been secured by an Institution of National Importance i.e. first-generation Indian Institute of Technology (IIT), Bombay securing 100 granted patents for the period 2010-16. The patents (granted) to the rest institutions in the list are '<100' rangeing from 76-21.

Table 3: Top 20 Institutions based on Research Publications (2010-16)

S. No.	Institutes	Res. Publications	S. No.	Institutes	Res. Publications
1.	DU, New Delhi	15052	11.	VIT, Vellore	6267
2.	IISc., Bangalore	10852	12.	IIT, Roorkee	6028
3.	IIT, Kharagpur	8724	13.	IIT, Kanpur	5622
4.	BHU, Varanasi	8140	14.	AU,	5400

				Chidambaram	
5.	BARC, Mumbai	7887	15.	IIT, Hyderabad	5398
6.	UoH, Hyderabad	7649	16.	PGIMER, Chandigarh	5380
7.	IIT, Delhi	7148	17.	GU, Ahmedabad	4871
8.	AIIMs, New Delhi	6591	18.	PU, Chandigarh	4733
9.	IIT, Madras	6440	19.	AMU, Aligarh	4588
10.	IIT, Bombay	6300	20.	IICT, Hyderabad	4534

Table 4: Top 20 Institutions based on Patents Granted (2010-16)

S. No.	Institutes	Patents Granted	S. No.	Institutes	Patents Granted
1.	IISc, Bangalore	174	11.	IIT, Kanpur	44
2.	CFTRI, Mysore	144	12.	CDRI, Lucknow	42
3.	NCL, Pune	114	13.	NIIH, Maharashtra	41
4.	IIT, Bombay	100	14.	CSMCRI, Bhavnagar	40
5.	IICT, Hyderabad	76	15.	ICT, Mumbai	39
6.	IIT, Delhi	56	16.	IIP, Dehradun	38
7.	JNCASR, Bangalore	53	17.	NII, New Delhi	37
8.	CLRI, Chennai	50	18.	AIIMS, New Delhi	31
9.	IIT, Madras	48	19.	DU, New Delhi	26
10.	NML, Jamnagar	48	20.	NIPER, Mohali	21

On the basis of the study conducted, some institutions have been identified which were performing excellently in both parameters vis-à-vis research publications and patents granted (Table 5). These institutions are having excellent translational research ecosystem. Moreover, it was found that these institutions were having dedicated IPR Policy, technology Transfer guidelines, IPR/Technology Transfer/entrepreneurship cells in place. In addition, at least one or two faculty member from the institution was having qualified knowledge in the domain of IPR. The potential institutions mentioned in Table 6 can take these institutions as a role model and can adopt their model to enhance translational research ecosystem. The twenty institutions mentioned in Table 6, have a sizable number of research publications but are lagging in patents generation. These institutions have the potential to excel in patents and technology generation which can be achieved by following the model of institutions mentioned in Table 5.

Table 5: Institutes Excelling in both Parameters (research publications & Patents)

S. No.	Institute	Res. Publications	Patents Granted
1.	DU, New Delhi	15052	26
2.	IISc, Bangalore	10852	174
3.	IIT, Delhi	7148	56

4.	AIIMs, New Delhi	6591	31
5.	IIT, Madras	6440	48
6.	IIT, Bombay	6300	100
7.	IIT, Kanpur	5622	44
8.	IICT, Hyderabad	4534	76

Table 6: Institutes Excelling in Research Publications, but Low on Patents Granted

S. No.	Institute	Res. Publications	Patents Granted
1.	PGIMER, Chandigarh	5380	1
2.	IARI, New Delhi	3934	4
3.	Saha Institute of Nuclear Physics, Kolkata	2543	1
4.	IVRI, Izatnagar	2242	2
5.	BHU, Varanasi	8140	3
6.	UoH, Hyderabad	7649	5
7.	VIT University, Vellore	6267	3
8.	IIT, Roorkee	6028	1
9.	Annamalai University, Chidambaram	5400	1
10.	IIT, Hyderabad	5398	2
11.	Gujarat University, Ahmedabad	4871	0
12.	PU, Chandigarh	4733	2
13.	AMU, Aligarh	4588	2
14.	IIT, Guwahati	4205	0
15.	S.R.M Institute of S&T, Chennai	3509	4
16.	Sathyabama University, Chennai	3211	0
17.	Jawaharlal Nehru University, Delhi	2739	6
18.	IIT, Dhanbad	2323	3
19.	NIT, Rourkela	2275	0
20.	Bharath University, Chennai	2082	0

B. Patents Commercialization: Another crucial issue which, needs to be addressed is patents and technology commercialization ecosystem in Indian universities and HEIs. The research being conducted in academic institutions is limited to publications only. This is happening despite the fact that there are enough possibilities of commercial exploitation of

research. The worldwide percentage of patents commercialization is 4 to 5% which is very very poor.

In the first phase, the potential institutions were analysed on the basis of research publications and patents generation. The study can be accessed from the official website of the centre[3]. In the second phase of the research, the institutions were studied on the basis of patents commercialization status of the patents granted to them. The list of the patents (granted) to 904 institutions were updated till December 2017. The task was outsourced to the same agency to maintain consistency and accuracy. The centre has compiled data on working and non-working status of patents granted to these institutions for the last 8 years (January 2010 – December 2017). The main objective of the study was to identify the patents commercialization ecosystem and draw recommendation for the rest of the institutions, which have granted patents to their credit but are not able to exploit them commercially.

In the time period of January 2010 to December 2017, the total number of patents granted to institutions was 1961. These were either granted in this period or were being maintained by the patentees by paying the maintenance fee for the patent. The information pertaining to the working/non-working status was extracted from InPASS[10] and the Form-27 of Indian Patent Office, Govt. of India. The information extracted from the search engine are Patents In-force, Patents for which Form-27 was filed, Patents for which Form-27 was not filed, working (commercially exploited) and non-working patents. Here it is pertinent to mention that for every patentee it is mandatory to file the Form-27 with information regarding working and non-working status of the patent. During the research, it was found that the patentees (considered for the study) started filing Form-27 after 2013. Before 2013, filing of Form-27 was not a regular practice there were a handful of patentees who filed the Form-27 in the patent office. A very renowned case 'Natco Vs. Bayer' was the sparking case in this regard[13]. In 2012, India granted a compulsory license to a Hyderabad based drug maker firm NATCO. This was a landmark decision in the history of Indian Patent regime. Delhi High Court gave the decision in the favour of NATCO to make and sell similar version of an advanced kidney cancer drug by Bayer's Nexavar. The Judge imposed a condition on the NATCO Company to pay Bayer royalty of six percent of the profit.

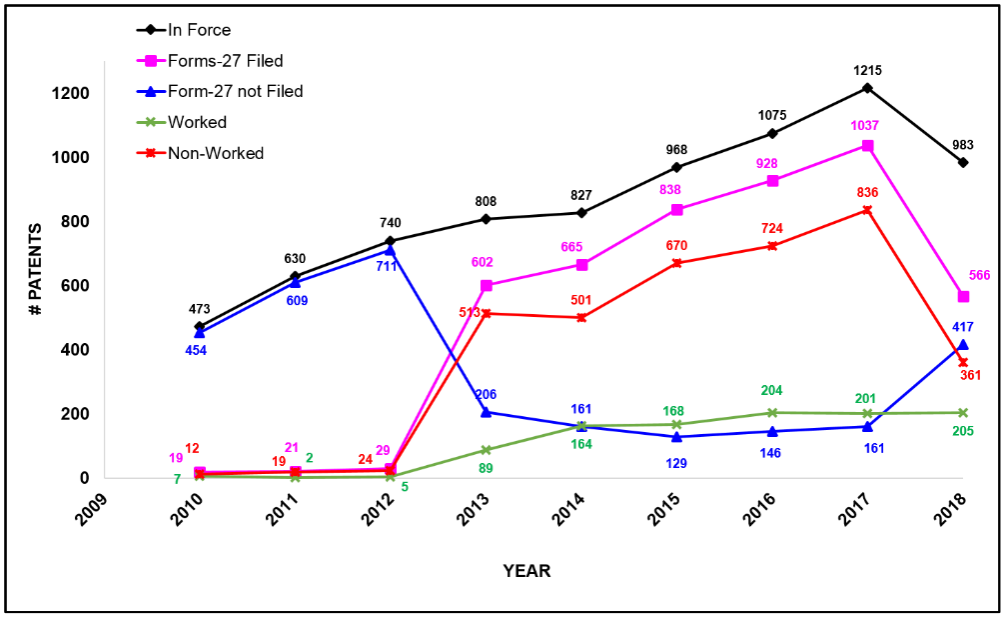

Figure 2: Year-wise statistics for parameters studied

The figure 2, shown above gives the complete picture of the patents granted to the institutions considered for the study. Before 2012 the 'Form-27' was filed for very limited patents and resultant the number of working/non-working patents are also low. After 2013 the statistics are depicting increase in all indicators namely 'patents In-force for the respective years (black), the number of patents for which the Form-27 was filed (purple), the patents for which the form-27 was not filed (blue), patents marked as 'worked' by the patentee (green) and the patents marked as non-worked (red) for the respective year. The dip in the patents for every indicator was observed in 2018 (the Form-27 were filed from January-March 2018 for the patents which were in force in 2017).

Figure 3 represents the trend of working patents of top 5 applicants (having maximum patents granted). The patents data for the years 2010-12 has been combined because the number of working patents was very less. Defence Research and Development Organization (DRDO), New Delhi is the most consistent organization having working patents to their credit and the trend is increasing over the years. Council for Scientific and Industrial Research (CSIR), New Delhi also has a good profile of patents commercialization but a dip was noticed in the year 2018. In the top 5 positions, 4 positions are secured by public research organizations and the only HEI having the secured space in top 5 is IIT, Bombay.

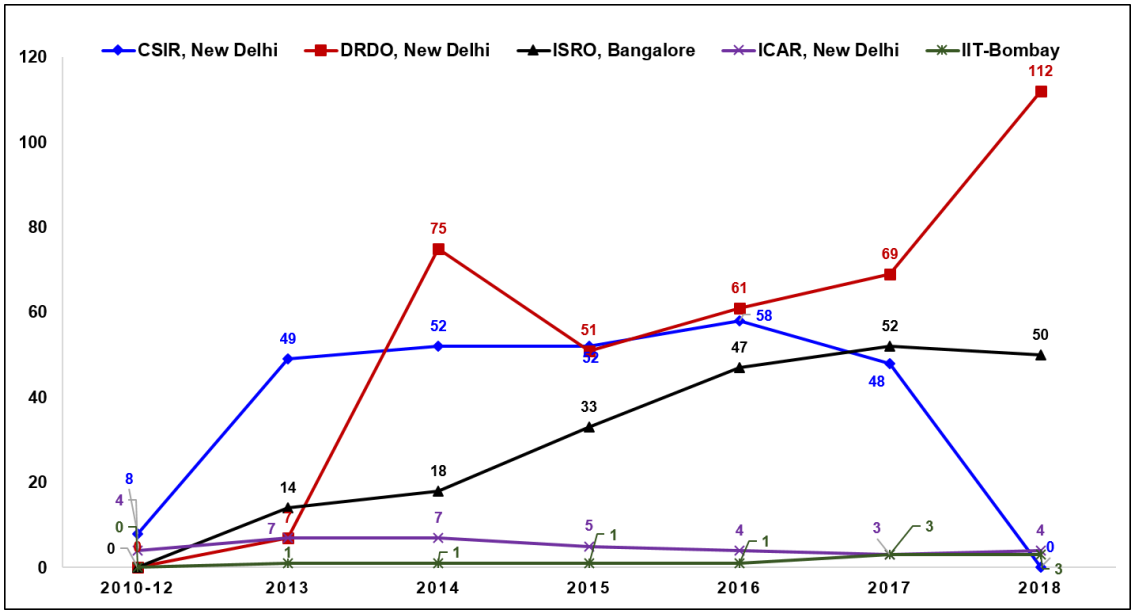

Figure 3: Year-wise Trend of Working Patents of Top 5 Applicants

The patents data for working patents was further classified for the various fields such as Figure 4 illustrates the Chemical Sciences, Engineering (Electronics, Electrical & Mechanical), Food/Agriculture, Physics, Pharma/Drugs, Medical Science and rest have been combined under the category of other fields as illustrated in Figure 4. Maximum working patents fall under the domain of Chemical Sciences throughout the years 2010 to 18 followed by Engineering.

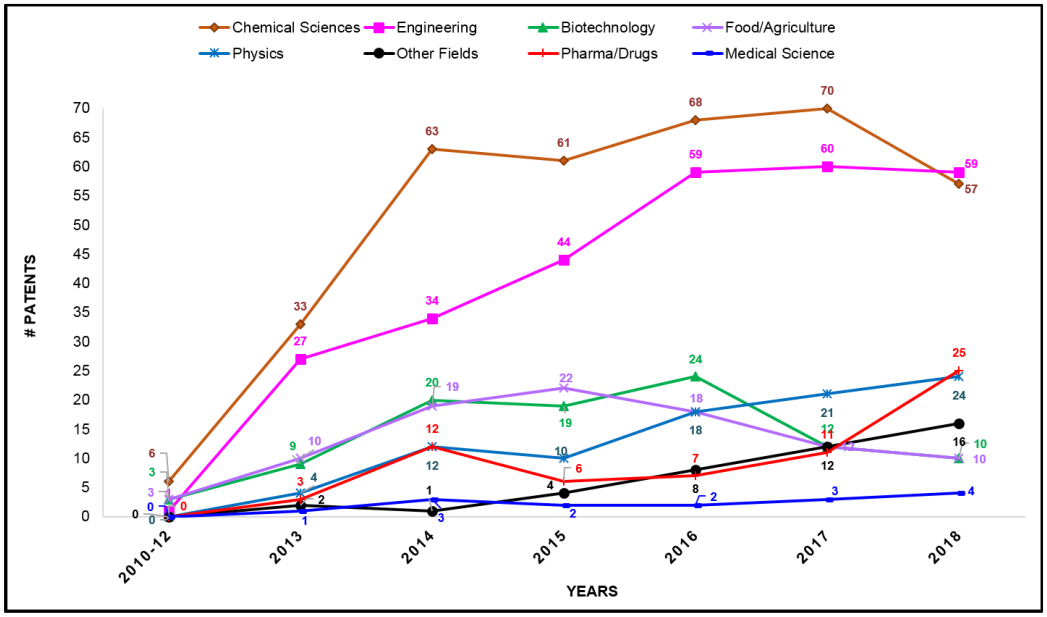

Figure 4: Year-Wise Break-up of Working Patents for Various Fields

Discussion and Conclusion: The institutions considered for the study are pertaining to all types of institutions vis-a-vis state universities, central universities, deemed to be

universities, private universities, autonomous institutes and national research institutes/labs. Therefore study gives a picture of pan India ecosystem of patents commercialization. The research reveals that the patentees are reluctant to furnish the information regarding working and non-working of the patents In spite of the fact that it is a punishable offence. It was also found that the patentees are hesitant to reveal the details in the public domain that's why some of the patentees are submitting the Form-27 without filling the information. For the enhancement of patents commercialization ecosystem in India, all stakeholders need to work in tandem. The academic sector is rich in knowledge but acquiring limited funds whereas, the industrial sector doesn't have financial constrains but lacks in knowledge and time for executing R&D. The Govt. plays a crucial role by introducing, implementing and monitoring the policies to enhance commercialization ecosystem. There is a need to bridge the gap between these three entities as they are mostly working in silos. Moreover, Govt. can incentivise institutions for doing research in collaboration mode[14]. The DST-Centre for Policy Research has drawn some recommendations to enhance the translational research ecosystem and patents commercialization ecosystem in India.

- There is a need for the creation of an 'Indian Patent Trust System' to deal with lapsed patents and Non-working patents in the line of Patents Trust system (PTS) being practised in S. Korea. This model can be adapted for the management, utilization, or disposal of the dormant and non-working patents.
- Patents and Technology fair should be organised wherein all the stakeholders working in the field of patents can come together in order to display their success stories and discuss their challenges so as to promote the culture of IP.
- Similar to the National IP Awards, each institution must incentivize its teaching faculty/research scholars who have generated patents/technologies (through cash award, salary-hike, financial assistance for visits to national/international events and so on) so as to boost them and assist them in taking steps towards commercialization of their patents.
- The IP related activities in the research institutions under public research organizations such as CSIR, DRDO, ICMR, etc. are funded by the parent organizations. In order to promote IP activity in HEIs, it is suggested that MHRD may create 'IP Fund' which could be used for IP related activities of the universities.
- A clause may be added in the Form-27 to ask patentee about specific requirements and potential industry which can take up that patent, like the provision provided by WIPO

for PCT applications wherein an Applicant can highlight his interest in concluding licensing agreements. Similarly, USPTO also provides the Applicants with an option to put their patents for sale or license.

- The patentee should have the option to categorise reasons for not working, like the reasons beyond the control of 'Patentee', such as awaiting government clearance or regulatory issues. These reasons can then be looked into by a dedicated cell.

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Note: *The data presented in this paper is under DST-CPR at PU, Chd.'s published book entitled 'Mapping Patents and Research Publications of Higher Education Institutes and National R&D Laboratories of India published by Publication Bureau, Panjab University, Chandigarh.*