Department of Science & Technology
Govt. of India

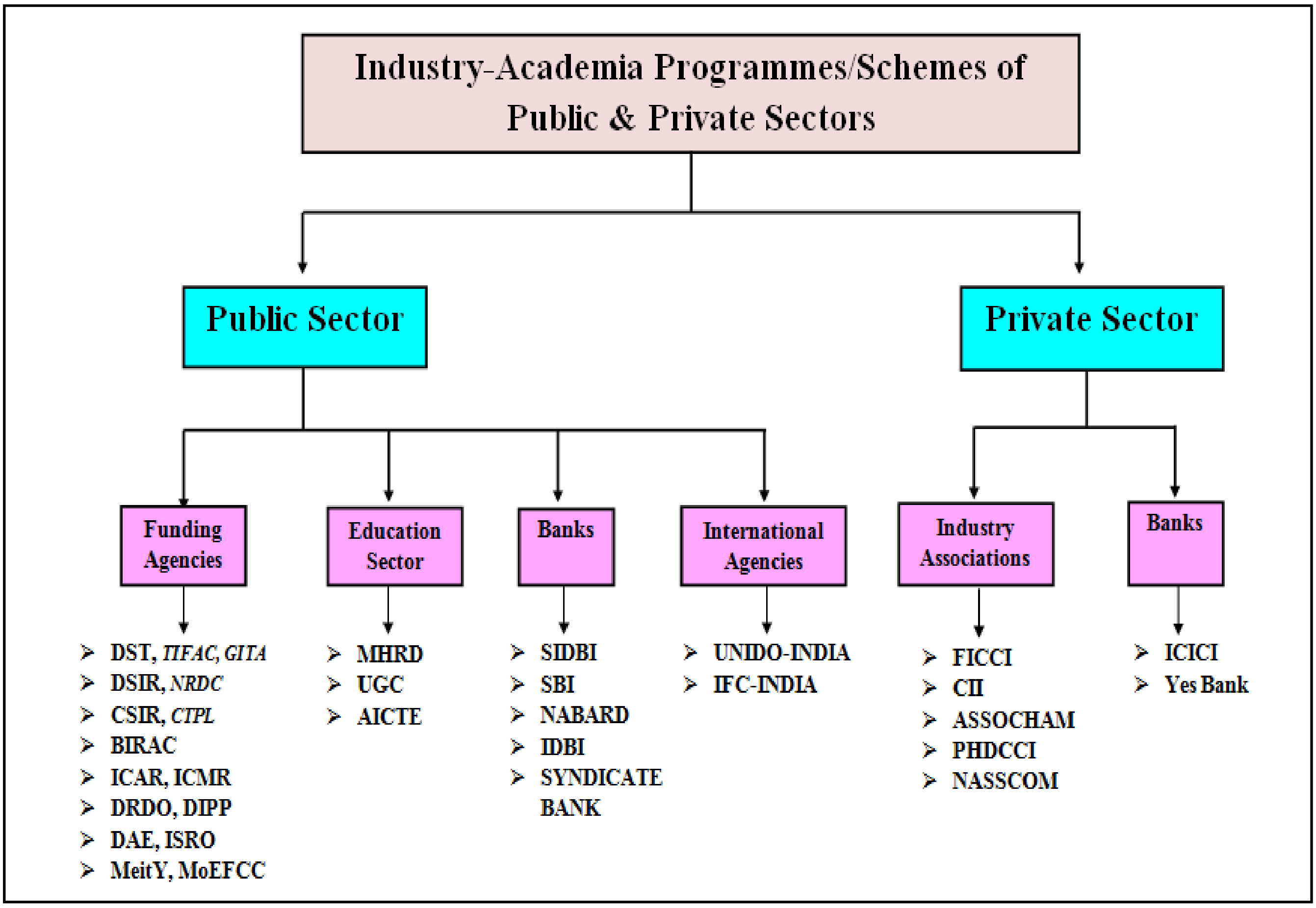
# DST-Centre for Policy Research at PU, Chd.

*(DST/PRC/CPR-03/2013)*

## <u>REPORT-1</u>

**(May, 2015-Aug., 2016)**

# *Industry-Academia Programmes/Schemes of Public and Private Sectors*



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# 1. Introduction

In the current century, the economic prosperity of a nation is associated with its scientific and technological competence. To achieve success in these parameters, it is imperative that academia and industry should forge a strong link to overcome the limitations of each other. In developed countries, number of research partnerships between industries and universities has increased considerably in the past 20 years. However, in India, the full potential of Industry-Academia (I-A) partnership is far from being exploited due to vital differences between industry and academia. Academicians give less priority to applied research and are not much inclined to leave the comfort zone of pure teaching. Academia is largely ignorant of national needs and industry desires and thus unable to commercialize/market its innovative research adequately. Industry, in general, has apathy for the tunnel vision of academia. Also, it is insensitive to the enormous academic resource potential and is dependent on foreign technologies which are easily available.

However, I-A synergy is a win-win situation for both the sectors and also for the progress (economical & societal) of the nation. Government, through its various organizations/agencies, have floated many programmes to promote I-A interactions leading to innovative research, technologies and patents. Private sector has also started acknowledging the importance of I-A collaborations and has initiated steps to promote collaborative R&D for commercial gains and addressing the scientific needs of the nation.

In India, a plethora of information exists on the I-A R&D regime of public and private sectors of India, but there is no single platform where all such information is available. DST-Centre for Policy Research at Panjab University, Chandigarh has made an attempt to compile information on programmes/schemes of different agencies promoting I-A collaborations. Figure 2.1 represents various public and private organizations that have floated I-A programmes/schemes in India.

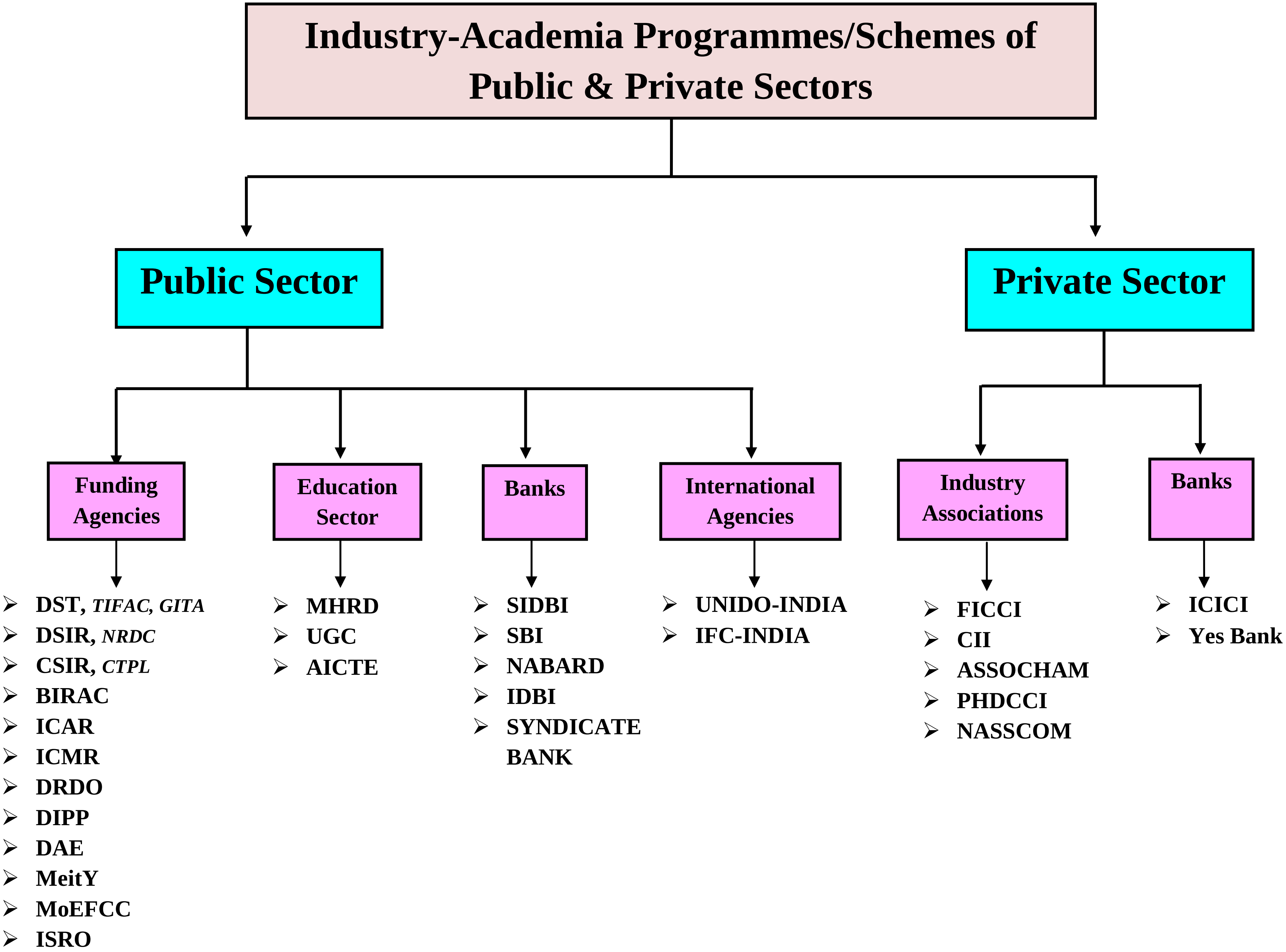


**Figure 2.1: Industry-Academia Programmes/Schemes of Public and Private Sectors**

*For meaning of abbreviations, please see symbols and Abbreviations (Page 68-72)*

# 2. I-A Programmes/Schemes of Public Sector

## 2.1 Funding Agencies

### A. Department of Science and Technology (DST); www.dst.gov.in

DST is a nodal agency that connects science sector to the government verticals. It was established in 1971 following the success of 'Green Revolution' that signified innovative deployment of scientific methodologies. Table 1 enlists the industry related programmes of DST.

**Table 1: Industry Related Programmes/Schemes of DST**

| S. No. | Programme/Schemes | Brief Details |
|---|---|---|
| 1. | **Technology Development Board (TDB)**<br>http://www.dst.gov.in/technology-development-board | This programme focuses on accelerating the development and commercialisation of indigenous technologies. Through TDB, adoption of foreign technologies to address domestic problems is also promoted. TDB provides financial assistance (equity, soft loans, or grants). It is also promoting industry to enter into hi- risk and hi- tech areas of R&D. |
| 2. | **Technology Systems Development Programmes (TSDP)**<br>http://www.dst.gov.in/technology-systems-development-programme-tsdp | New technologies in identified areas are promoted, developed and integrated. Promotion of advanced technology for valuable addition to the products having high demand is carried out by TSDP. |
| 3. | **National Science and Technology Entrepreneurship Development (NSTED)**<br>http://www.nstedb.com/ | Promotes entrepreneurs by providing hands-on training in field of indigenous technologies for enhancing commercial exploitation of technologies.<br>NSTED has started number of training programmes:<br>• Entrepreneurship Awareness Camp (EAC)<br>• Entrepreneurship Development Programmes (EDP)<br>• Faculty Development Programme (FDP)<br>• Technology based EDP (TEDP)<br>It has also promoted development of different institutions (mentioned below) for fostering entrepreneurship culture.<br>• Innovation and Entrepreneurship Development Centre (IEDC)<br>• S&T Entrepreneurship Development Project (STED)<br>• S&T based Entrepreneurship Development (i-STED)<br>• S&T Entrepreneurs Park (STEP)<br>• Technology Business Incubator (TBI) |
| 4. | **Schemes for Funding Industry Relevant R&D (Under SERB)** | Promotes industrial research by utilizing expertise from the academic sector to address industrial and societal problems. |

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| | http://www.serb.gov.in/home.php | SERB in association with CII, initiated '***Prime Minister's Fellowship Scheme***' for doctoral research to encourage young, enthusiastic and result-oriented scholars to pursue industry-oriented research. |
| 5. | **Drugs and Pharmaceutical Research Programme** http://www.dst.gov.in/drugs-pharmaceutical-research | Aims to synergies pharma industries and publicly funded R&D institutions and to establish close linkages. |
| 6. | **Start-Up Research Grant (Young Scientists)** http://serb.gov.in/srg.php | Floats schemes for promoting industrial research: <br>• Early Career Research Award (ECRA) <br>• National Post-Doctoral Fellowship (NPDF) |
| 7. | **International S&T Co-operation** http://www.dst.gov.in/international-st-cooperation | Promotes innovation and commercial R&D via I-A applied R&D projects/Public Private Partnerships (PPP) under Global Innovation and Technology Alliance (GITA) platform for facilitating tech development and its transfer in association with partner country. |
| 8. | **Nano Applications and Technology Advisory Group (NATAG)** http://nanomission.gov.in/org_stru.htm | Encourages implementation of industry oriented and application driven projects in the area of nano sciences. |
| 9. | **National Initiative for Developing and Harnessing Innovations (NIDHI)** ww.nstedb.com/New_Programmes/NIDHI-Accelerator.pdf | NIDHI is one of the umbrella programmes of DST which is working for enhancing innovation and entrepreneurship for generating successful start-ups. Under NIDHI, following initiatives are planned to be undertaken: <br>• NIDHI- Grand Challenges and Competitions for scouting innovations <br>• NIDHI-Promotion and Acceleration of Young and Aspiring technology entrepreneurs (NIDHI-PRAYAS) <br>• NIDHI-Entrepreneur in Residence (NIDHI-EIR) <br>• Startup-NIDHI through Innovation and Entrepreneurship Development Centres (IEDCs) in academic institutions; encouraging Students to promote start-ups <br>• Start-up Centre in collaboration with MHRD <br>• NIDHI-Technology Business Incubator (TBI) <br>• NIDHI-Accelerator- Fast tracking a start-up through focused intervention <br>• NIDHI-Seed Support System (NIDHI-SSS)- Providing early stage investment <br>• NIDHI Centres of Excellence (NIDHI-CoE)- A world class facility to help startups go global |
| 10. | **Instrumentation Development Programme** http://www.dst.gov.in/instrumentation-development-programme | Through this programme the concept of '***Hub***' is introduced that acts as the translational platform for academics, industries and related organizations to convert laboratory level prototypes into packaged models and help in transfer of technology and knowhow to appropriate industries at a later stage for commercialization |
| 11. | **Policy Research Centres (PRC)** | DST established five Centres for Policy Research with an |

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| | http://cpr.puchd.ac.in/ | aim of making evidence based recommendations for strengthening STI policy of India. One such centre has been established in Panjab University with a mandate to strengthen I-A linkages in India. |

***Source:*** *www.dst.gov.in*

Under the aegis of DST dedicated agencies like, TIFAC and GITA were established. These are briefed below.

- **Technology Information, Forecasting and Assessment Council (TIFAC); www.tifac.org.in**

TIFAC, an autonomous organization established in 1988 under the aegis of DST, is working with a mandate of assessing and supporting technology trajectories of various academic and private organizations. TIFAC is striving for sustainable innovations to lead technology development in the country through programmes run by TIFAC, keeping industry and academia in close association. The R&D promoting industrial programmes are enlisted in table 2.

**Table 2: Industry Related Programmes of TIFAC**

| S. No. | Programme | Brief Details |
|---|---|---|
| 1. | **Advanced Composites Programme** http://tifac.org.in/index.php?option=com | Through this programme close linkages are promoted between various centres of excellence from all over the country and industries for promoting technology absorption, and its development and dissemination. |
| 2. | **Revolving Technology Innovation Fund [under TIFAC-Small Industries Development of Bank of India (SIDBI) Programme]** http://www.sidbi.com/?q=tifac-sidbi-revolving-fund-technology-innovation-srijan-scheme | This programme aims to facilitate tech development, demonstration and commercialization leading to creation of new product or process and is mainly encouraging capabilities in MSMEs to bring high-risk innovations to the market. |
| 3. | **Technology Refinement and Marketing Programme (TREMAP)** http://tifac.org.in/index.php?option=com_ | Through TREMAP, country's innovation pool is promoted by bringing out innovative technologies from the prototype stage to market level through a network of Technology Commercialization Facilitators (TCFs). |
| 4. | **Home Grown Technology (HGT) Programme** http://www.tifac.org.in/index.php?option=com_content&view=article&id=48&Itemid=204 | HGT programme, a past initiative (implemented from 1992-2005) was initiated by TIFAC to support R&D institutions, academia, start-ups and SMEs to carry out their innovative technologies at pilot scale. |
| 5. | **Bioprocess and Bioproducts** | Through this programme, TIFAC is supporting |

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| | **Programme** http://tifac.org.in/index.php?option=com_content&view=article&id=65&Itemid=96 | technology development in field of biotransformation and enzyme technology in partnership with SMEs and in house R&D units, academic and research institutes. |
| 6. | **Collaborated Automobile R&D Core-Group** ifac.org.in/index.php?option=com_content&view=article&id=68&Itemid=99 | This group comprise of academia, industries and state ministries to form a core-group with an aim to built user friendly database of technologies and scientists to promote technology development and commercialization in field of automobile industry. |

***Source:*** *www.tifac.org.in*

TIFAC has established Patent Facilitation Center (PFC) under which Patent Information Centers (PIC) has been created in 19 states namely, Andhra Pradesh, Assam, Chhattisgarh, Goa, Gujarat, Haryana, Himachal Pradesh, Kerala, Madhya Pradesh, Manipur, Punjab, Rajasthan, Sikkim, Tripura, Uttaranchal, Uttar Pradesh and West Bengal. These PICs aid government departments, universities and scientist for patent search free of cost. The same services are open to attorneys, industry and public sector undertakings, with a levy of nominal charges. PFC has a scheme named '***Knowledge Involvement in Research Advancement through Nurturing (KIRAN)***' for the empowerment of women in R&D in field of IPR.

- **Global Innovation and Technology Alliance (GITA); www. gita.org.in**

To stimulate investments in R&D sector, GITA, an innovative pilot project was commenced in 2007, by DST in collaboration with CII. DST and CII hold 51% and 49% equity respectively. GITA is an industry managed body for promoting vigorous innovation clusters along with managing national innovation fund through PPP model. GITA is actively supporting emergence of open source innovations and venture capital industry for social inclusion. It also provides knowledge know-hows for IP acquisition and licensing social goods (non-exclusive) from the government. Hence, GITA by bringing industry and academia together not only in India but globally is strongly promoting innovation culture (Fig. 2.2).

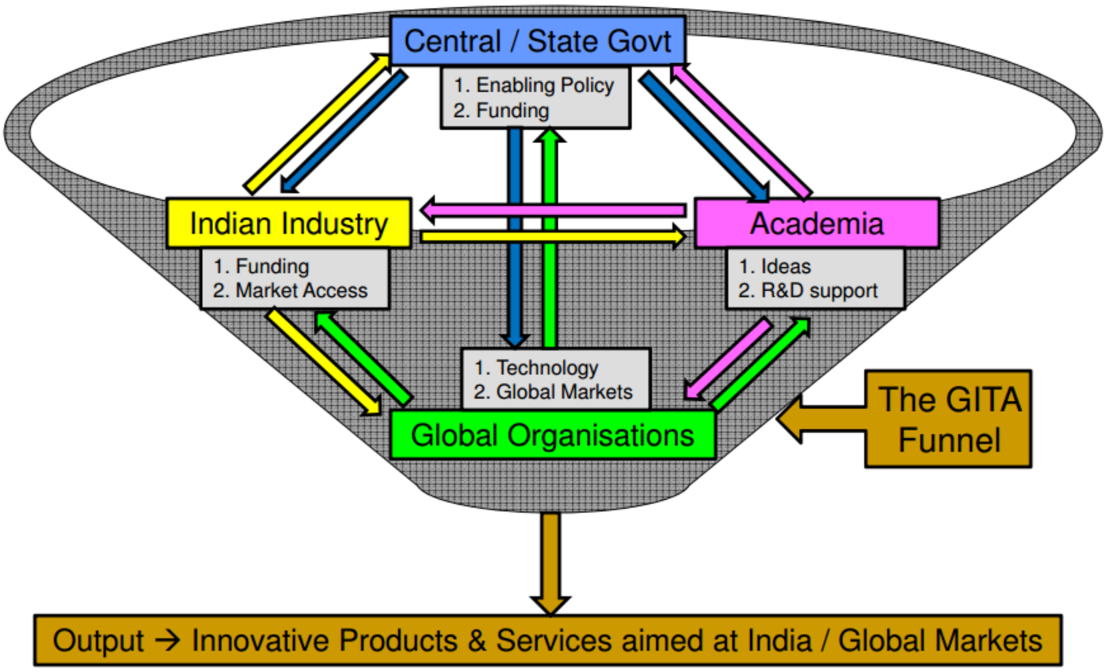


**Figure 2.2: GITA Innovation Ecosystem**
***Source***: *www.gita.org.in*

Various programmes of GITA promoting industrial research are listed in table 3.

**Table 3: Industrial Research Oriented Programmes of GITA**

| S. No. | Programme | Brief Details |
|---|---|---|
| **1.** | **Bilateral programmes** | Bilateral programmes of GITA are as:<br>• **Technology Acquisition and Development Fund** is the schemes launched by DIPP and is implemented by GITA. This scheme facilitates applicability of clean & green technologies available to Indian MSMEs sector.<br>• **India UK Collaborative Industrial Research Development Programme**: ₹ 1.50 crores grant available to Indian companies and upto £ 300000 to UK Companies for joint co-development of industrial R&D and innovation project in the areas of cleantech, use of ESDM technologies, affordable healthcare to provide solutions to societal challenges. |
| **2.** | **Multilateral programmes** | Multilateral programmes consist of network of foreign entities. Some of the multilateral programmes of GITA are as:<br>• **The Enterprise Europe Network (ENN):** ENN is a European Union initiative with an aim to provide innovation and business support to SMEs in Europe and India. In India, ENN is jointly coordinated by the European Business and Technology Centre (EBTC), GITA, CII, Federation of Indian Export Organizations (FIEO) and the Steinbeis Centre for |

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| | | Technology Transfer India (SCTI). Through this platform, companies who are looking for business improvement and expansion to new markets can use EEN's database of technology offers and requests, consist of ~7,000 profiles and is effectively correlating research and commercial applications together.<br>• **Innovation Driven Initiative for the Development and Integration of Indian and European Research (INNO INDIGO):** INNO INDIGO is a horizontal ERA-Net between Europe and India, funded by the European Commission (EC) for research and technological development. INNO INDIGO has 11 consortium partners from Europe and 3 from India, namely, CSIR, DBT and GITA. Its main objective is the implementation of transnational Indo-European Joint Call for Proposals in which funding agencies from India, EU member states and associated states can participate. |

***Source:*** *www.gita.org.in*

## B. Department of Scientific and Industrial Research (DSIR); www.dsir.gov.in

DSIR was established in 1985 as one of the agencies of Ministry of Science and Technology, with an objective to pursue activities relating to development of indigenous technologies and subsequently promoting and transferring these technologies to commercial level. I-A linked programmes of DSIR are presented in table 4.

**Table 4: Industry-Academia Linked Programmes and Initiatives of DSIR**

| S. No. | Programme/ Initiative | Brief Details |
|---|---|---|
| 1. | **Building Industrial R&D and Common Research Facilities (BIRD-crf)**<br>http://www.dsir.gov.in/12plan/bird-crf/bird-crf.htm | • **Industry R&D Promotion Programme (IRDP):** Various research laboratories are recognized to avail different types of fiscal incentives offered by government. It recognizes In-house R&D units (RDI); Scientific and Industrial Research Organization (SIRO) and Public Funded Research Organizations (PFRI)<br>• **Common Research and Technology Development Hubs (CRTDH):** are working with mandate to encourage technology development and research activities carried out by MSEs in collaboration with public funded laboratories.<br>• **Asian and Pacific Centre for Transfer of Technology (APCTT):** assists associated members of United Nations Economic and Social Commission for Asia and the |

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| | | Pacific (UN-ESCAP) in strengthening their innovation systems. |
| 2. | **Patent Acquisition and Collaborative Research and Technology Development (PACE)** http://www.dsir.gov.in/12plan/pace/pace.htm | PACE is supporting industries to acquire patentable technology from within the country or overseas and also to add value to the acquired technology for commercial exploitation in Indian/foreign markets. |
| 3. | **Promoting Innovations in Individuals, Start-ups and MSMEs (PRISM)** http://www.dsir.gov.in/12plan/prism/prism.htm | PRISM supports institutions/organizations to set up autonomous organization within host institutions for developing state-of-art technology solutions with an aim to help MSME clusters and individual innovators. |
| 4. | **Access to Knowledge for Technology Development and Dissemination (A2K+)** http://www.dsir.gov.in/12plan/a2k+/a2k+s.htm | This scheme is working for disseminating science, technology and innovation related information to the academic sector and industrial sector such as, in-house R&D units of industry, SIROs, consultants, industry associations, techno-entrepreneurs, government departments and others. |
| 5. | **Technology Development and Demonstration Program (TDDP)** http://www.dsir.gov.in/tpdup/tddp/tddp.htm | To make industry competitive, development and demonstration of innovative need-based technologies are undertaken by TDPP.<br>TDPP is also contributing to strengthening the interface between industry and R&D establishments. |
| 6. | **Technopreneur Promotion Programme (TePP)** http://www.dsir.gov.in/tpdup/tepp/tepp.htm | Under this programme micro technopreneurship support from DSIR are made available to budding entrepreneurs. |
| 7. | **Technology Development and Utilization Programme for Women (TDUPW)** http://www.dsir.gov.in/tpdup/tdupw/tdupw.htm | Under this programme adoption of new technologies developed by women are promoted.<br>It also promotes technological up gradation of tiny, small and medium enterprise run by women entrepreneurs. |
| 8. | **Technology Management Programme (TMP)** http://www.dsir.gov.in/tpdup/tmp/tmp.htm | Through this scheme, creation of dedicated resource centres for technology and innovation management are initiated. TMP programme can be availed by industry and related industrial associations, academic institutes, state level agencies, research organizations and government organizations, consultancy organizations and other government departments. |
| 9. | **Encouraging Development and Commercialization of Inventions and Innovations: A new impetus** http://www.dsir.gov.in/circulars/knowledge_equity_om_25may2009.pdf | Through this programme researchers are made to avail equity share in an enterprise. It is also encouraging creation of incubation centres in the scientific establishments and promotes mobilization of researcher/faculty from academics to industry and vice versa. |

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| 10. | **Consultancy Promotion Programme (CPP)** http://www.dsir.gov.in/tpdup/cpp/cpp.htm | This programme aims to promote uptake of consultancy services between academic and industrial sectors for technology acquisition and setting up of joint ventures. |
| 11. | **International Technology Transfer Programme (ITTP)** http://www.dsir.gov.in/tpdup/ittp/ittp.htm | ITTP is supporting activities related to promotion of international technologies and trade including export of technologies, services, projects and innovative products to enhance the reach of Indian industry. |

***Source:*** *www.dsir.gov.in*

- **National Research Development Cooperation (NRDC); www.nrdcindia.com**

NRDC, working under the administrative control of DSIR, was established by the GoI in 1953 with a mandate to develop and commercialize the technologies/inventions/patents generated/product and processes from various national R&D institutions/universities.

NRDC in its six decades of functioning has successfully forged strong linkages between scientific and industrial community in India as well as abroad and has also developed formal arrangements within academic and industrial segment for the commercialization of know-how developed in their laboratories. NRDC is also recognized as a large repository of technologies existing in all areas of industries.

NRDC undertakes number of activities under its structured promotional programme for encouragement and advancement of innovations, research and promotion of inventions technical and financial assistance for Intellectual Property Rights (IPRs) protection. Industry linked programmes of NRDC are listed in table 5.

**Table 5: Industry Linked Programmes of NRDC**

| S. No. | Programme | Brief Details |
|---|---|---|
| 1. | **Innovation Portal/ Technology Portal** http://www.nrdcindia.com/english/index.php/programmes/innovation-portal | This portal is an initiative to bridge the gap between inventor, manufacturers, industry and academia that provides complete information related to the technologies in different areas. |
| 2. | **Knowledge Management system for Technology Promotion** http://www.nrdcindia.com/english/index.php/programmes/knowledge-managment | This system is promoting development and commercialization of technologies under NRDC. Identification and evaluation of technologies is carried out by experts in self propelled mechanism for value addition leading to the complete technology package. |
| 3. | **Entrepreneurship Development Programme** http://www.nrdcindia.com/english | It is working for fostering entrepreneurship culture and skill up gradation of unemployed youth and is also working for capacity building of Non |

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| | /index.php/technology-management/innovator-s-support/entrepreneurship-development-programme | Government Organizations (NGOs) by promoting industry oriented projects. |
| 4. | **Patent Search Facility** http://ipindiaonline.gov.in/patentsearch/search/index.aspx | Through this facility inventors/scientists/technologists/industries can identify and search for patents in patent databases at global level. It also provides abstracts and bibliographic references from different sources for detailed analysis of desired sources for complete review of specific area. |

***Source:*** *www.nrdcindia.com*

NRDC is committed to provide IPR consultancy to interested academia, R&D organizations and industries. It also provides expert services in formulating and drafting the innovation, IP Policy and technology transfer of these organizations. In order to assist stakeholders for technology landscaping and market analysis, NRDC and Ministry of Micro, Small and Medium Enterprises (MoMSME) jointly started a project namely '***Intellectual Property Facilitation Centre (IPFC)***'. This centre aims to promote IPRs awareness and adoption by MSMEs and budding entrepreneurs. IPFC regularly organizes various training programs on explicit themes associated with IP. IPFC also commenced 'Free IP awareness talk for MSMEs' to educate and train MSMEs on 'How to protect Intellectual Property'. Numbers of IPR Services provided by NRDC are listed in table 6.

**Table 6: IPR Related Services Provided by NRDC**

| S. No. | Domain | Services |
|---|---|---|
| 1. | **Patents** | Pre filing services, prior art search, preliminary patentability assessment, patent filing support for filing with provisional specification or/and with complete specification advice for filing in other countries, advice on examination reports and queries for the patent office, post grant support, support for infringement proceedings, opposition proceedings, technology transfer agreements, patent valuation technology marketing and licensing. |
| 2. | **Copyright** | Guidance and assistance in preparation of documents required for registration. |
| 3. | **Trade Mark** | Guidance and assistance in preparation of documents required for registration. |
| 4. | **Industrial Designs** | Guidance and assistance in preparation of documents required for registration. |
| 5. | **Geographical** | Guidance and assistance in preparation of documents |

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| | **Indicators** | required for registration. |
| 6. | **General Consultation** | Guidance and assistance in identifying the possible IP protection for the creativity. |

***Source:*** *www.nrdcindia.com*

### C. Council of Scientific and Industrial Research (CSIR); www.csirhrdg.res.in

CSIR, a well known organization for pursuing cutting edge R&D activities in diverse areas of S&T, was constituted in 1942. CSIR is composed of vibrant network of 39 outreach centres, 38 national laboratories, 5 units and 3 Innovation Complexes (www.csir.res.in). CSIR is leading in India's intellectual property regime with a strong portfolio of patents, technologies developed and licensed. Amongst Indian patents filed in US, 90% of patents-granted belong to CSIR. On average, CSIR files 200 patent applications in India and 250 in foreign countries every year. Patents from CSIR are licensed at rate of 13.86% which is appreciable at global level.

CSIR has actively endorsed the industrial research through a unique initiative namely 'New Millennium Indian Technology Leadership Initiative' (NMITLI), one of the CSIR's most impactful and largest PPP efforts in R&D domain. NMITLI was conceptualized in 2001 and has generated 100 international patents and >150 publications in high impact journals. NMITLI has contributed significantly in R&D and national innovation system of India. It aims to catalyze innovative technological development for attaining global leadership position for Indian industries. It is working for synergizing the research competencies of academia, R&D organization and industries integrated to achieve industrial growth.

This programme is unique in following 'Inverse Risk Investment Profile' through which focus is given on low investment and high risk technology areas. Subsequently, investments increases as the project develops and risk decreases leading to higher innovation. NMITLI also provides IP mapping for continuous tracking of project potential for creating IP portfolio and aids in licensing of IP. Almost all the projects under NMITLI are built in PPP mode. Through this programme, financial support is provided to institutional partners in public domain as grant-in-aid and to industrial partners in form of soft loans with 3-5% interest rates. Till date around 60 network projects have been completed, involving 280 R&D groups from various research institutes, 1750 researchers and 85 industrial partners. These projects came out be at outlay of ₹550 crores. Table 7 lists down some of the notable innovative technologies and products generated from NMITLI supported projects.

**Table 7: Notable Technologies and Products Generated from NMITLI Supported Projects**

| S. No. | Technology/Product | Expertise Area |
|---|---|---|
| 1. | Biosuite- portable software for bioanalyses | Bioinformatics |
| 2. | Genocluster- package of software tools comprising of gene prediction software, proteome calculator and prediction software of virulent proteins | Bioinformatics |
| 3. | Darshee- 3D visualization software for complex bioprocess | Bioinformatics |
| 4. | SofComp and Mobilis-low cost computing platforms | Information Technology |
| 5. | Triple Play Braodband- first internet Protocol Television service | Information Technology |
| 6. | Weather Forecasting System- integrate software and hardware system for weather and monsoon prediction | Information Technology |
| 7. | Psoriasis- herbal formulation to be taken orally | Healthcare |
| 8. | Sudoterb- used for treatment of tuberculosis | Healthcare |
| 9. | Lysostaphin- biotherapuetic for treatment of *Staphylococcus* infections | Healthcare |
| 10. | Docosa Hexanoic Acid (DHA)- marine based nutrient product | Healthcare |
| 11. | XCyto Screen Kit- molecular diagnostic kit for detection of ocular infection | Diagnostics |
| 12. | Micro-Polymerase Chain reaction (PCR)- PCR system for identification of Hepatitis B Virus in situ | Diagnostic |
| 13. | New varieties of Mentha Piperita: CIM Indus and CIM Madhuras | Agricultural Biotechnology |
| 14. | Low lignin containing *Ochlandra travancoria* and *Leucaeina leucocephala* | Agricultural Biotechnology |
| 15. | Sugarcane Biorefinary- production of bioethanol from sugarcane bagasse | Agricultural Biotechnology |
| 16. | Mitigation of Environment Pollution- control of pollution associated with leather processing | Biotechnology |
| 17. | Fuel Cell- 1.00 KW polymer based electrolyte membrane fuel cell | Energy |
| 18. | Wind Energy- 500 KW wind turbine | Energy |

***Source:*** *http://www.csir.res.in/external/heads/collaborations/Nmitili/NMITLI%20Brochure%20and%20selected%20achievements.pdf*

There are several research and sponsor schemes of CSIR, promoting industry oriented research, such as 'CSIR Young Scientist Award' and 'Entrepreneurship Support Programme'. To assist industries, CSIR has created a knowledgebase of 642 technologies which can be readily taken up for commercialization (http://www.csir.res.in/PDF/knowledge_base_080716.pdf). This knowledgebase is accessible from the CSIR website. CSIR has also supported creation of organizations for enhancing industrial research, such as Indian Plywood Industries Research and Training Institute (IPIRTI), Bengaluru for strengthening Indian Plywood industry and Industry-Academia-Research/Government Interface (IARGI) to promote commercialization of technologies by facilitating strong I-A linkages.

- **CSIR-Tech Private Limited (CTPL); www.csirtech.com**

CSIR-Tech is one of the premier R&D organizations in India. It is a Pune based private limited company established in 2011. The major partners of CSIR-Tech are CSIR (a conglomerate of public funded R&D labs), State Bank of India (a public funded financial services company) and Venture Centre (a technology business incubator). CSIR-Tech has been established to promote entrepreneurship and commercialization of knowledge economy of academia and industry. It is located in the Innovation Park of National Chemical Laboratory (NCL), Pune. NCL is one of the premier institutes of CSIR organization.

CSIR-Tech works for the commercialization of Intellectual Property (IP), know-how and technology emerging from public and private R&D labs as well as academic institutions. CSIR-Tech works closely with R&D institutions in India such as the CSIR, IITs, DAE, DST, DBT and a few private R&D labs. It helps them to commercialize their intellectual property and technologies, by facilitating technology transactions and by creating funds for their spin-out businesses. CSIR-Tech represents over 9,000 of the 25,000 plus scientists working in publicly-funded R&D labs across India.

CSIR-Tech is governed by a board of directors whose composition is as follows: Chairman (1), CEO (1) and members (8) from industries, banking sector and research organizations. Day to day functioning of CSIR-Tech is in the hands of CEO and its team comprising of 10 members which are Venture Consultant (1), Chief Business Officer (1), Technology Transfer Associates (3), Technology Transfer Analysts (3) and consultants (2).

**CSIR-Tech Services**

- **Technology Venturing:** It invests in laboratory 'spinoffs' and other S&T based start-ups to capture a maximum portion of the capital generated by technology commercialization.
- A SEBI registered private equity fund which is known as India Science Venture Fund (ISVF- http://www.isvf.in/) is managed by CSIR-Tech.

- **India Science Venture Fund (ISVF):** This fund has been created to provide financial assistance for commercialization of lab R&D via sponsoring projects and technology transfer. This fund has been approved by Security and Exchange Board of India (SEBI) for registration, spin off businesses and science based start-ups with the target of ₹ 50 crore. ISVF targets mainly sectors belonging to Chemicals, Biomaterials, Engineering, Life Sciences and Healthcare.
- **Technology Commercialization:** CSIR-Tech Helps technology claimants to access technology assets across, India's leading academic institutions and R&D labs. CSIR-Tech catalyzes the process of technology transfer by facilitating technology appellants to build a business case and reduce time of techno-commercial negotiation with academic institutions and R&D labs.
- **Market Insights & Consultancy:** CSIR-Tech provides consulting services and market insights to enterprises, labs and government agencies as CSIR-Tech has deep understating of ecosystem of Indian R&D. CSIR-Tech helps spotter for technology, search for R&D partners, IP valuation, and technology transfer offices & create incubation centres.

**Offerings of CSIR-Tech**

CSIR-Tech’s output is of two folds i.e. 1) translation lab research to a commercial product 2) setting up a company (e.g. spin-off) as shown below:

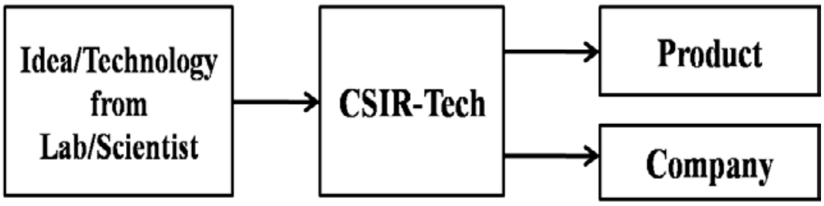



**Figure 3: CSIR-Tech Output**

The main offerings of CSIR-Tech are as follows:

- **Technology Transfer:** CSIR-Tech promotes the technology transfer process by identifying opportunities for technologies which are emanating from labs and are commercially relevant. It also identifies and engages with suitable industry partners to act as commercialization channels.

- **IP Licensing:** CSIR-Tech helps R&D labs by identifying licensing opportunities for their patents and also support industry partner to diagnose valuable IP assets which provide a strong competitive advantage, cost and access to global market.

**Other offerings of CSIR-Tech are:**

- Technology scouting, R&D partner search
- Market research and consulting
- Open innovation
- Technology/IP evaluation

*Industry advisory services*

- Capacity building
- Research
- S&T development
- Opportunity identification

*Government advisory services*

- Market penetration
- Technology de-risking
- Synthesis, aggregation and agreements
- Business planning and raising finances
- Virtual business incubation support

**Partners of CSIR-Tech**

**Partners of CSIR-Tech**

CSIR: is an autonomous society established in 1942. It consists of 38 national labs/Inst. 6 units, 3 innovation complexes and 39 outreach centres.

SBI: is a Govt. multinational banking and financial services company founded in 1806. It is largest banking and financial services company by assets in India.

VC: is a non-profit, probably India's only technology business incubator and initiative of CSIR. It provides facilities resources and networks for start ups and technology ideas.

## Networking with R&D Labs

CSIR-Tech aims to aid the labs to encourage academic entrepreneurs who want to get involved in knowledge intensive ventures inculcated at their research institutes. It caters to around 60 R&D labs comprising of CSIR labs, IITs, DAE, ICAR, Industry Association and universities (public & private).As per CSIR-Tech website (http://www.csirtech.com) CSIR-Tech also helps out in forging partnership between Industries and academia by

- Creating greater commercial visibility for CSIR labs, their services, technologies and scientists.
- Working in synergy with business development divisions at labs to develop their efforts.
- Setting up a 'system integrator' approach for catalyzing 'lab to market' journey.
- Stimulating translation of ideas & inventions into products and services.
- Providing insights cum industry feedback and market trends to help direct R&D efforts.
- Executing, Marketing and negotiating deals in technology transfers & IP licensing to enhance revenue generation for lab.

CSIR-Tech aims to encourage entrepreneurship in the academic institutes. CSIR-Tech has taken a few initiatives, such as:

- Identifying spin-off / joint venture creation opportunities around technologies of commercial value.
- Acting as a commercialization partner to Labs to increase reach to private enterprise by several folds/year.
- Attracting entrepreneurs and industry professional to translate lab IP into technology spin-offs.
- Creating capital gains for labs via enabling them to enter into equity arrangements in these spinoffs/start-ups'/joint ventures/enterprises.
- Supporting scientists and labs in realizing business benefits.

## CSIR-Technologies

CSIR-Tech offers a case of innovative technologies and know-how from recognized R&D labs and academic institutes. The technology offerings cover areas of biological, chemical, physical, environment, information sciences and earth, and their corresponding engineering discipline counterparts (Table 8). Technologies transferred and technologies providers are given in table 9.

**Table 8: Industries associated with CSIR-Tech**

| S. No. | Area of work | Number of Technologies |
|---|---|---|
| 1. | Chemicals | 174 |
| 2. | Drug discovery, Therapeutics | 143 |
| 3. | Clean Tech | 92 |
| 4. | Food and Nutrition | 70 |
| 5. | Healthcare | 66 |
| 6. | Agriculture | 65 |
| 7. | Construction and Industrial safety | 40 |
| 8. | Leather industry | 39 |
| 9. | Mining and Metallurgy | 32 |
| 10. | Mechanical Systems | 32 |
| 11. | Electronics and Instrumentation | 30 |
| 12. | Aviation and Defence | 29 |
| 13. | Oil and Gas | 26 |
| 14. | Automotive and Transportation | 22 |
| 15. | Rural and Social technologies | 20 |
| 16. | Software | 8 |
| 17. | Pharmaceuticals and Drugs | 4 |
| 18. | Others | 13 |
| | Total | 904 |

***Source**: www.csirtech.com*

**Table 9: Technologies Providers and Technologies Transferred**

| Technologies | | | Technologies | |
|---|---|---|---|---|
| **Providers** | **Transferred** | | **Providers** | **Transferred** |
| CSIR-NCL | 68 | | CSIR-CMERI | 13 |
| CSIR-NIIST | 42 | | Manipal University | 10 |
| CSIR-CLRI | 39 | | CSIR-CEERI | 10 |
| CSIR-CSIO | 36 | | CSIR-NIO | 9 |
| CSIR-NML | 32 | | CSIR-CIMAP | 9 |
| CSIR-IIP | 32 | | CSIR-NBRI | 9 |
| CSIR-IICT | 29 | | CSIR-IMTECH | 8 |
| CSIR-CSMCRI | 28 | | CSIR-AMPRI | 7 |

| | | | |
|---|---|---|---|
| CSIR-IHBT | 27 | CSIR-NGRI | 7 |
| C-Camp | 25 | CSIR-IIIM | 6 |
| CSIR-CFTRI | 24 | CSIR-CDRI | 6 |
| CSIR-NAL | 24 | CSIR-NEIST | 6 |
| CSIR-IMMT | 20 | IIT Kanpur | 5 |
| CSIR-CECRI | 20 | CSIR-CRRI | 5 |
| CSIR-CBRI | 18 | Science for society | 3 |
| CSIR-IICB | 16 | BTRA | 2 |
| CSIR-SERC | 16 | R.I.T. | 2 |
| CSIR-CGCRI | 16 | CSIR-NEERI | 1 |
| CSIR-IITR | 15 | Amrita Therapeutics | 1 |
| CSIR-NPL | 14 | Others | 4 |

***Source:*** *www.csirtech.com*

### Outcomes of CSIR-Tech

- Completed over 50 tech transfer deals.
- Developed database of technologies providers and technologies available in 3 major areas of a) Life science and healthcare; b) Advanced materials; c) Advanced engineering.
- Signed >45 partner laboratories.
- Access to technologies from over 8000 scientists (1/3rd of scientists from all government funded labs).

### Spinoff Success Stories

1. **A biotech spinoff focused on microbial technology for treatment of ischemic strokes.** In this venture CSIR-Tech's role, ranged from helping structure the capitalization of the venture, exploring different models of accessing technology from the R&D labs, identifying/evaluating suitable entrepreneurial teams to applaud the scientific team and designing an appropriate path to enterprise value creation.
2. **A material science spinoff focused on polymer membranes for a range of industrial applications and clean-tech.** CSIR-Tech helped this spinoff raise ₹50 lakh in seed investment, including review of the business plan, investor pitch, financial model and investment term sheet.
3. **A Bench to Bassinet (B2B) genomics start up which seeks to commercialize Indian and global technologies/products for diagnostics.** CSIR-Tech's main role is

to strategize the fund-raising plan and help raise pre - Series A investment *(Series A round is the name typically given to a company's first significant round of venture capital financing)* to help the company achieve rapid revenue growth and profitability.

4. **A water treatment SME with ₹1cr plus revenue, seeking to grow 10 times by leveraging R&D and risk capital**. One of CSIR-Tech's contributions is to scout for significant lab technologies in the water and waste water treatment industry that can be effectively commercialized via this enterprise. Given the capital expenditure (capex) intensive nature of this business, it is helping the company raise Series A investment to scale marketing and manufacturing in and outside India.

## Success Stories

Some examples of success stories of CSIR-Tech are given below in table 10.

**Table 10: Success Stories of CSIR-Tech**

| S. No. | Work area | Examples |
|---|---|---|
| 1. | **Technology Transfer Group** | Largest tech-transfer deal in the lab's history by value from DST-South India based publicly funded laboratory to Gujarat based company. Technology provides a know-how for preparation of an ultra-efficient, advanced material with broad industrial applications.<br><br>CSIR-Tech successfully facilitated a technology transfer deal between a constituent laboratory of the CSIR and a Bangalore based private company for the process of preparation of herbal formulation, having patent in India. The technology was licensed to the licensee for the period of three years on exclusive basis restricted to one southern state of India.<br><br>CSIR-Tech has contributed to the licensing of technology from DAE-BARC to a young SME operating in environmental technology business. The entrepreneur has initiated efforts to deploy this Clean technology into the vast network of government and public undertakings.<br><br>A SME approached CSIR-Tech with its requirement for biogas plant technology and the technology has been licensed successfully from one of the CSIR labs. |
| 2. | **Technology Scouting** | CSIR-Tech helped a global MNC to understand the technologies and capabilities available across various partner labs in specific technology domains.<br><br>An unnoticed need in the cashew import/export market was to check for cashew rancidity. On the requirement of a MSME's, CSIR-Tech escorted for the necessary |

| | | |
|---|---|---|
| | | expertise from across its network of labs which resulted into a joint development program to address the objective mentioned above. |
| 3. | **Generating Entrepreneurs** | CSIR-Tech helped an individual Gujarat based entrepreneur to understand and access the technologies available with various partner labs and shortlist the one that best fits with the entrepreneur's business goals. The innovation which relates to a food adulteration detection unit has provided the entrepreneur an opportunity to diversify his business, while the lab has been able to expand the reach and market visibility of the innovation.<br><br>CSIR-Tech, helped a Jamshedpur based company and a Delhi based entrepreneur to jointly launch a gold and silver cleaner liquid. That new product has considerable cost advantage over existing 'jewellery cleaning' solutions since it doesn't affect jewellery design and weight unlike traditional acidic cleaners which dissolve some precious metal during cleaning. |
| 4. | **Advisory Services** | CSIR-Tech provided advisory services for a private, autonomous educational institution to market the inventions which were developed by the faculty and students. This can bring early stage research into the market. |
| 5. | **Technology Validation** | CSIR-Tech enabled licensing of a corrosion inhibitor molecule technology for copper and silver based alloys to a Kolkata based company. |
| 6. | **In-house Analysis** | CSIR-Tech has provided services for evaluation of technology and facilitates sample products for further in-house analysis of the technology, prior to licensing of patents to a foreign client. The client is a salt manufacturing start-up, based out of US, funded by Khosla Ventures. |

***Source:*** *www.csirtech.com*

### D. Biotechnology Industry Research Assistance Council (BIRAC); www.birac.nic.in

India's biotech sector is one of the fastest growing sectors, growing at ~16% with net size of US $ 7 billion in the financial year 2014-15 (India Brand Equity Foundation, 2016). This fast pace growth in field of biotech in India is likely to continue as it is expected that biotech industry size will grow to ~US $ 11 billion by 2017. Indian biotech industry market share is composed of various sectors such as Bio-pharma, Bio-services, Bio-agri, Bio-industry, Bio-informatics and others out of which Bio-pharma are the leading one (Fig. 4).

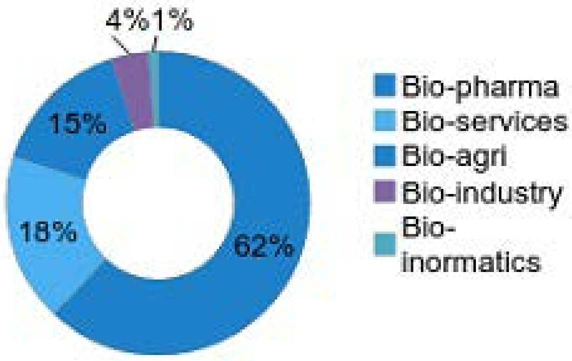



**Figure 4: Biotech Market Break-Up Based on Revenues (2014-15)**

***Source:*** *Indian Brand Equity Foundation Report on Biotechnology, 2015 (http://www.ibef.org/download/Biotechnology-August_15.pdf)*

India ranks 12th in biotech destinations all over the world. Biotech sector in India is moving ahead with a strong growth trajectory and play significant role in innovation and is accountable for enhancing India’s global economy profile (India Brand Equity Foundation, 2016). Indian biotech industry holds 2% share of world’s biotech industry and it comprises of close to 800 companies with an average growth rate of 20%. Since past two decades, high demand of various biotech products has led to increase in Research and Development (R&D) activities and investment from various national and international organization/ companies to set up base in India. Increase in innovation in biotech sector was kick-started by Department of Biotechnology (DBT) under Ministry of Science and Technology in year 1986 through creation of number of biotech institutes such as National Centre for Cell Science (NCCS), National Agriculture Biotechnology Institute (NABI), National Institute for Plant Genome Research (NIPGR), Centre for DNA Fingerprinting and Diagnostics (CDFD), National Brain Research Centre (NBRC), mainly introducing various schemes for promoting biotech research in Indian Education system. Transformation of biotech research to the market bench mark required strong Industry-Academia (I-A) collaborations through which various biotech entities have been commercialized in past few years. Gradually DBT recognized the need of well built industrial partnerships for taking research through translational phase to market the product. For stimulating I-A interface in biotech sector and mounting capabilities of Indian Biotech Industry, DBT formulated National Biotechnology Development Strategy in 2007 and announced that 30% of its budget will be set aside for Public Private Partnership (PPP) via creation of separate organization in order to execute and implement PPP. Keeping this in mind, Government of India (GoI) through DBT has led to the creation of autonomous not-for-profit public organization **“Biotechnology Industry Research Assistance Council**

**(BIRAC)"** in year 2012. BIRAC is registered as section 8 Company, scheduled B, public sector enterprise registered Indian Companies Act 1935. It is an exclusive I-A interface agency that is working for strategic R&D activities catering to national societal needs of emerging biotech enterprise to make them globally competitive. BIRAC is working with the following mandate:

- To foster innovation and entrepreneurship
- To promote creation of affordable innovation in key social sectors of India
- To empower start-ups and small and medium enterprises
- To contribute to capability enhancement and diffusion of innovation in collaboration with different stakeholder/ partners
- To enable commercialization of discovery/ innovation and technology developed
- To ensure global competitiveness of Indian biotech enterprises

BIRAC is working to fulfil three main objectives which are:

1. Supporting early and late stage innovation research
2. Enabling services for promoting the innovation ecosystem
3. Product innovation and commercialization for addressing grand challenges of national relevance

BIRAC has taken responsibility for targeted funding for easy access to risk capital, technology transfer and management of Intellectual Property (IP). BIRAC within 4 years of its existence has strongly connected with different stakeholders, both from academia and industry, who are contributing to tremendous growth of biotech sector.

BIRAC is a unique organisation working under PPP mode. Creation of BIRAC has greatly enhanced the technology development and generation of useful products in biotech sector. It is development agency in the field of biotechnology which addresses the national needs in terms of food security and health problems through competitive grants and product development programme in collaboration with the academic and industrial sector at national and international front.

**Organization of BIRAC**

BIRAC is governed by Board of Directors comprising of stakeholders from both DBT and Industry. Secretary of DBT, is the Chairman of BIRAC. The governing body along with chairman and managing director comprise of four non-executive independent directors, one government nominated non-executive director and one company secretary.

BIRAC's organizational structure is composed of diverse verticals with dedicated core functions that lead to its effective functioning (Fig. 5). These functioning groups are interlinked to each other to deliver the mandate of BIRAC. BIRAC has created horizontal and vertical groups to fulfil the core function of providing support for technology development and its diffusion across the country. Vertical group focuses on providing mentor and financial support at different stages of technological product development. It engages specialist/ scientists from different sectors to act as technical support for creation of technology. This group works in three areas, specialized with different domains which are as, a) Health Care (drugs and therapeutics, vaccine, diagnostics, biomedical devices, clinical trials and regulation); b) Agriculture (molecular biology, marker assisted breeding, RNAi) and; c) Green technology and industrial process (enzymes, fermentation, process optimization and chemical engineering).

On the other hand, horizontal group comprising of distinctive clusters as mentioned below, that assists the core functioning of vertical group:

- Investment cluster that takes care of funding through various schemes
- Specialized services cluster comprising of IP awareness, technology transfer facilitation and technology acquisition
- Strategic partnerships cluster that has responsibility of knowledge networking, resource mobilization and establishing national and international collaborations.
- Entrepreneurship cluster for providing infrastructural support in form of incubators and simultaneously mentorship via training and workshops to budding entrepreneurs.

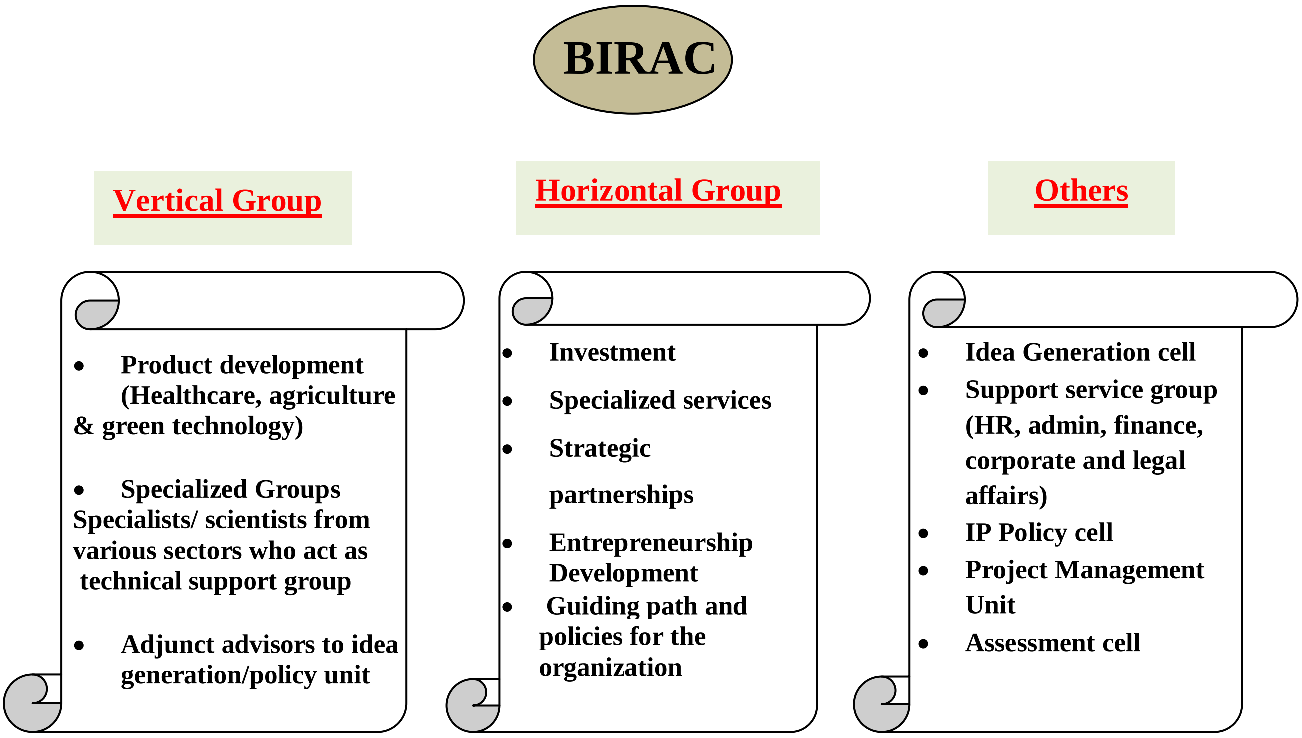



**Figure 5: Organization Structure of BIRAC**
***Source:*** *http://www.birac.nic.in/*

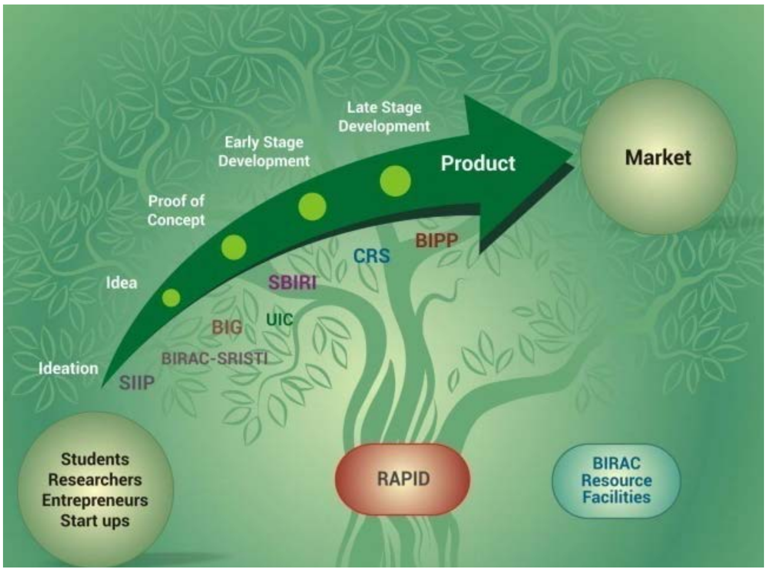
BIRAC also has dedicated in house Policy and Analysis Cell (PAC). This dedicated cell analyses different proposals in field of agriculture, healthcare, industrial biotechnology mainly from techno-commercial view. This cell has responsibility of identifying priority areas in biotech sector that requires BIRAC support to address societal needs. Key areas where PAC works are as:

- Strategy and policy discussion with different stakeholders
- Identification of niche areas in biotechnology sector
- In-house technical and project management support for various proposals
- Creation of technology transfer unit of BIRAC
- Market analysis
- Creation of global databases in various sectors of biotechnology
- Commissioning of the reports in accordance to the needs of identified niche areas in biotech sector.

In addition, BIRAC has established Secondary Agriculture Innovation Cell (SAIC) to facilitate growth of agro based small and medium industries using modern technologies to create a mark in international market. Main responsibility of this cell is to build successful agriculture enterprise.

## Programmes and schemes initiated by BIRAC

BIRAC is a nodal organization for developing I-A interface and it is implementing its mandate through various impact initiatives and has undertaken various schemes, built networks and created a single platform to bring academia and biotech enterprise in close association. BIRAC is involved in providing access to risk capital via targeted funding, IP management and technology transfer to make Indian biotech sector globally competitive. BIRAC is providing funding support through its different schemes to overcome intrinsic risk involved in innovation pathways right from the ideation to product development, scale up and market commercialization. Main focus of BIRAC is to a) support early and late stage innovation research; b) promotion of innovative ecosystem and; c) promoting product innovation and commercialization through partnerships. To achieve these goals BIRAC has introduced number of programmes/ schemes as presented in figure 6.



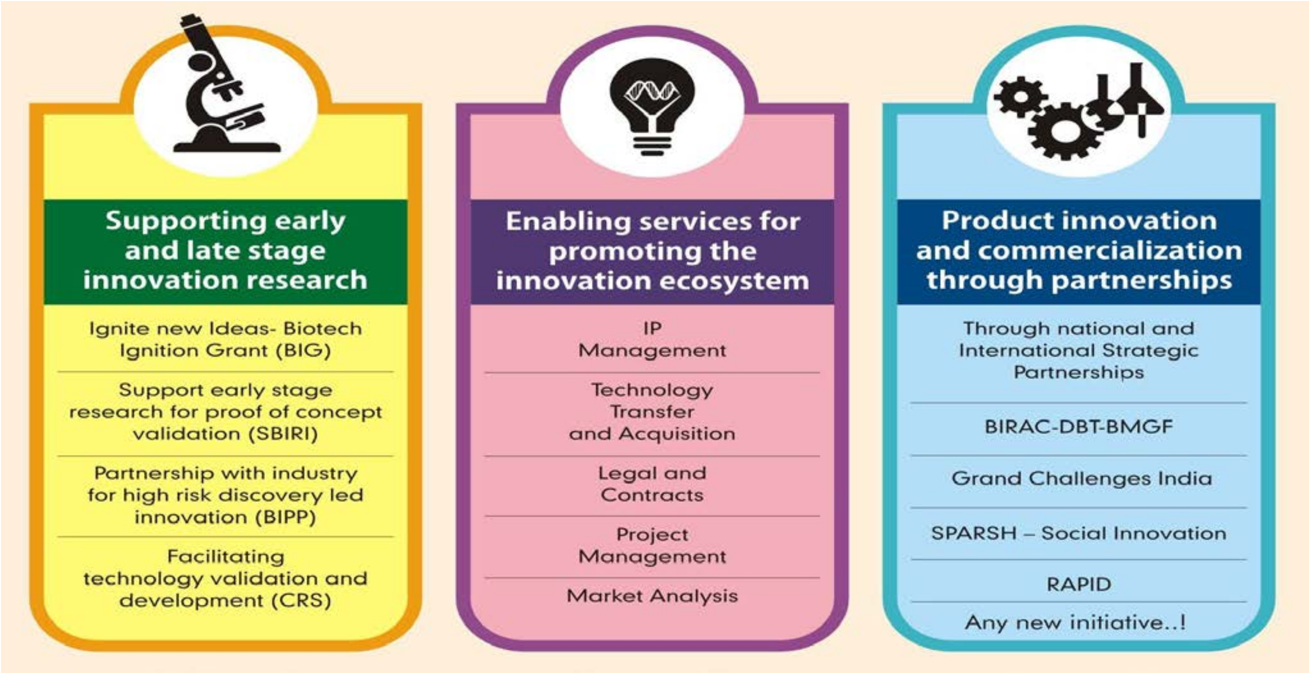



**Figure 6: BIRAC's Support for Commercialization of Biotech Research**

***Source:*** *http://www.birac.nic.in/*

*For meaning of abbreviations please see symbols and abbreviations (Page 68-72)*

Through different programmes of BIRAC, three major domains are addressed which are:

- Promotion of PPP in biotech sector
- Bridging I-A collaboration of biotech companies and academic institutes pursuing biotechnology
- Supporting entrepreneurship culture in India.

Programmes/ schemes started by BIRAC to address first two domains are described in table 11. Maximum amount of funding from industry has been obtained through SBIRI and BIPP (Fig. 7).


**Figure 7: Impact of SBIRI and BIPP on Funding and Monitoring Support to Public and Private Sectors.**

***Source:*** *http://www.birac.nic.in/*

**Table 11: BIRAC's Programmes/ Schemes for Promoting PPP and I-A Collaborations**

<table>
<tr><th>S. No</th><th>Programme/ Scheme</th><th>Brief details</th></tr>
<tr><td>1.</td><td>Small Business Innovation Research Initiative (SBIRI)<br><br>Outcome/ Impact</td><td>
<ul>
<li>Scheme started to boost PPP efforts in the country</li>
<li>It has facilitated innovation, risk taking by small and medium companies and bringing together the private industry, public institutions and the government under one roof to promote the research and innovation in the Indian Biotech Sector</li>
<li>It has consistently supported early stage funding for high risk innovative research in small and medium companies led by innovators with science backgrounds to generate products of societal relevance.</li>
<li>The proposals can be submitted solely by a Company incorporated under the Companies Act, 2013 or Limited Liability Partnership (LLP) incorporated under the Limited Liability Partnership Act, 2008 or Joint Ventures either in the form of Company/ LLP by any of the above entities jointly with other private or public partner(s) (Universities or Institutes)</li>
<li>The main industry applicant should have DSIR* recognized in-house R&D unit or patent granted or acquired, that will be used for the proposed project, alternatively the applicant should be incubated at an Incubation Centre/ Biotech Park which has a valid DSIR Certificate.</li>
</ul>
<ul>
<li>SBIRI is supporting 204 projects</li>
<li>Investment contribution from private company: ₹16.77 Cr.</li>
<li>Investment contribution from BIRAC: ₹16.30 Cr.</li>
<li>SBIRI till now has support 148 companies in diverse fields of biotechnology</li>
<li>Four technologies/ products developed under this scheme in year 2014-15 are
<ol>
<li>A rapid test for qualitative detection of malaria antigen (infection) in humans.</li>
<li>Technology to extract lycopene, a phytonutrient, from high yielding varieties of tomato</li>
<li>Easier purification of Escherichia coli K12 strain secreting variety of recombinant proteins of industrial and therapeutic importance</li>
<li>Production of dextranase (30000 du/ gm) using solid state fermentation</li>
</ol></li>
</ul></td></tr>
<tr><td>2.</td><td>Biotechnology Industry Partnership Programme (BIPP)</td><td>
<ul>
<li>BIPP is working for setting up government partnership with industries for support on a cost sharing for innovative research that can lead to production of affordable products in accordance to societal need.</li>
<li>BIPP supports high risk led technology development for futuristic technologies.</li>
<li>Through BIPP services such as product evaluation and validation</li>
</ul></td></tr>
</table>

| | | |
|---|---|---|
| | | through field trial for agriculture products and clinical trials (Phase I, II, III) for health care products are provided.<br>• The proposals can be submitted solely by an Indian Company* (Small, Medium or Large having DSIR recognized in-house R&D unit) or jointly by an Indian Company and National R&D Organizations and Institutions; or group of Indian Companies along with National Research Organizations. |
| | **Outcome/ Impact** | • In totality under this scheme 157 projects have been sponsored<br>• During 2014-15, BIPP supported 64 projects out of which 20 were collaborative<br>• 110 companies have received support for their high risk innovative R&D projects<br>• So far 134 agreements have been signed with 108 companies involving approximately 60 start-ups and Small and Medium Sized Enterprises (SMEs)<br>• Investment contribution from private companies: ₹12.70 Cr<br>• Investment contribution from BIRAC: ₹12.36 Cr<br>• Three national patents have been filed by the companies supported under the BIPP scheme<br>• Technology/ product generated through this scheme:<br>1. Process for albumin and intravenous immunoglobulin (IVIG) production at a scale of 2500 L with a purity of 95%. Two products launched: Albucel and Globuce (developed by Celestial Biologicals Limited, Ahmedabad)<br>2. Novel portable Electroencephalography (EEG) system<br>3. Affordable mannequin for effective Cardiopulmonary Resuscitation (CPR)<br>4. Development and production of Balloon catheter<br>5. Software for next generation sequencing data analysis<br>6. Microfluidic based flow analyser technology for Cluster of Differentiation 4 (CD4) cell counting at point-of-care locations<br>Technologies under pipeline:<br>1. Clinical trials of polysialylated erythropoietin<br>2. Clinical studies of Asia-specific 15-valent Pneumococcal vaccine |
| **3.** | **Contract Research Scheme (CRS)** | • It aims to facilitate I-A collaborations<br>• Through this scheme validation of academic research having potential of commercialization by contract research and manufacturing (CRAMS) industry is promoted.<br>• Funding is in the form of grant given to both the academic as well as industrial partners. While funding is provided to the academia for in-house research which forms a part of validation of the proof of concept, funds are provided to the industrial partner for validation.<br>• Although the IP rights reside with the academia, the industry |

| | | |
|---|---|---|
| | | partner has first right of refusal for commercial exploitation of the new IP.<br>• BIRAC facilitates FTO search, IP management, and preparation of Material Transfer Agreement (MTA) Memorandum of Understanding, (MoU), non-disclosure and IP protection contracts and licensing agreements as well as technology transfer for the academia.<br>• Academia has to be the primary applicant with one or more partners of whom at least one is a company having DSIR recognized in-house R&D unit. The proposers if so required can opt for additional partners from another industry and/or academia |
| | **Outcome/ Impact** | • Till date 181 proposals (198 academia and 193 industries were involved) have been received and out of them 131 proposal are accepted under CRS scheme and 20 projects are presently executed.<br>• Presently, 15 academia and 13 industrial partners have received grant of ₹13.48 Cr<br>• Technologies/ products in pipeline:<br>1. Recombinant vaccine for *Plasmodium vivax*<br>2. Production of laccase through a Bioreactor system<br>3. Development of a linkage map in castor using Genome wide SNP's |

**The Companies in the process of obtaining DSIR recognition may also apply along with the proof of application for DSIR. However, the final decision on such applications would be subject to their getting DSIR recognition.*

***Source:*** *http://www.birac.nic.in/; BIRAC Annual Report 2014-15*

BIRAC has also established dedicated facility/ cells for promoting I-A linkages. These are as follows:

- **Early Translational Accelerator (ETA):** BIRAC is supporting different ETAs focussing on catalyzing young academic discoveries (publications/patents) with possible societal and commercial impact to transform into economically viable and technology oriented endeavor. Through ETAs linkages between academic investigators, industry and international public and private translation ecosystems has been successfully executed. Although commercialization of some of the early stage technologies is quite difficult task, which adds to the translational component of establish proof-of-concept/validation which is a crucial step for attracting industry to take up these technologies which are validated further in terms of development. One ETA has been set up in C-CAMP, Bangalore and has evaluated 9 proposals till date.

- **Integrated Facility for Protein Therapeutics and Peptides:** This facility has been established in INTAS Pharmaceuticals Ltd., Uttarakhand and comprises of almost all the latest instruments and facilities for pursuing high end structural and functional characterization of proteins and peptides in.

Keeping in mind the importance of entrepreneurship as national asset that needs to be cultivated and motivated to bring out innovative goods and services along with generation of employment, BIRAC has evolved programmes that support development of entrepreneurship in biotech sector which are as follows:

1. Biotechnology Ignition Grant Scheme (BIG)
2. BIRAC-**Society for Research and Initiatives for Sustainable Technologies and Institutions (SRISTI)**
3. BIRAC AcE Fund
4. Social Innovation programme for Products: Affordable & Relevant to Societal Health (SPARSH)

BIRAC has also come forward to support entrepreneurship to young researchers and start-ups right from the idea generation to product development. It has initiated various schemes and programmes through which support in forms of grants, incubating space and mentoring to budding entrepreneurs working on idea of societal relevance is provided (Table 12).

BIRAC has also started an initiative under name "Grand Challenges" to find solutions for key global health problems of India (http://gcgh.grandchallenges.org/). Through this initiative, Bill and Melinda Gates Foundation funds public institutes, entrepreneurs and industries to solve problems reported in grand challenges of the world.

**Table 12: BIRAC's Programmes/ Schemes for Promoting Entrepreneurship**

| S. No | Programme/ Scheme | Brief details |
|---|---|---|
| 1. | **Biotechnology Ignition Grant (BIG)** | • BIG specifically provides early stage grants to bridge the gap between invention and technology development.<br>• Entrepreneurs from different research institutes, academia and start ups/ registered company with functional R&D Lab or must be incubatee to be eligible for this grant.<br>• Currently, there are five BIG partner institutions in the country who are involved in providing mentoring, networking, business development and monitoring to BIG innovative awardees, which are:-<br>1. IKP Knowledge Park, Hyderabad |

| | | |
|---|---|---|
| | | 2. Centre for Cellular and Molecular Platforms (C-CAMP), Bangalore<br>3. Foundation for Innovation and Technology Transfer, New Delhi<br>4. KIIT Technology Business Incubator, Bhubaneswar<br>5. Venture Center (Entrepreneurship Development Center), Pune |
| | **Outcome/ Impact** | • Through BIG scheme, BIRAC has provided funding support of ₹41 Cr to almost 100 entrepreneur ideas<br>• Presently, BIG is nurturing >150 entrepreneurial ideas (~28 women entrepreneurs) and has created 50 start-ups through its funding support<br>• BIG is also supporting 104 Start-ups to bring out innovations in the product/ process range<br>• BIG has led to generation of 553 employment opportunities and 65 IP<br>• Important technologies/ products developed under this schemes are as:<br>1. Development of an aptamer based platform to detect TB<br>2. Modular resilin mimetic elstomeric platform for wound healing and other uses<br>3. Ezymatic maceration of mango pulp to produce wine<br>4. Industrial application of a novel cancer drug screening method<br>5. Development of a fucose knockout technology platform in CHO S cell line for improved biotherapeutics`<br>6. Novel inhibitors of DNA gyrase for treatment of multidrug resistant infections<br>7. Pharmacological evaluation of N-oxide metabolite of antipsychotic drug for Type2 diabetes<br>8. Novel oncotherapeutic measles virus using eSame system<br>9. Fetal ECG and Uterine Activity signa extraction from maternal ECG eliminating the need for use of conventional transducers.<br>• Number of Innovators/ entrepreneurs supported under BIG at different BIG Partner institutes are:<br>➢ C-CAMP: 47<br>➢ IKP Knowledge Park: 40<br>➢ FITT: 34<br>➢ Venture Centre: 20<br>➢ KIIT-TBI:13<br>***Total number of support under BIG: 154*** |
| 2. | **BIRAC-Society for Research and Initiatives for Sustainable Technologies and** | • BIRAC in collaboration with SRISTI located at IIM Ahmedabad encourages entrepreneurship by awarding grass root level innovations (*under Gandhi Young India Innovation Awards*) of students at the university/college level from across |

| | | |
|---|---|---|
| | **Institutions (SRISTI)** | India with nurturing and grant of ₹15 lakh support in-situ. Also, ₹**1 lakh** to **100 young innovators was provided** to take their innovations to next level.<br>• Awardees of BIRAC - GYTI Awards<br>1. Flexicast: A Breathable, Washable and Customized Cast for Immobilization of Fractured Limb Innovator<br>2. Rightbiotic: The Fastest Antibiotic Finder Innovator<br>3. Redefined Spoon For Parkinson's Patient Innovator<br>4. Development of A Powerful New Antibiotic that kills all Drug-resistant Bacteria Innovator<br>5. Real Time Wound Management System Wound Segmentation and Analysis using Image Processing on Mobile Platform (Android) Innovator<br><br>**Some of the impactful initiatives of SRISTI are as:**<br><br>• **Honey Bee Network (http://www.sristi.org/hbnew/index.php):** It is a crucible of like-minded individuals, innovators, farmers, scholars, academicians, policy makers, entrepreneurs and non-governmental organizations (NGOs). This network is spanning whole country for innovative ideas and play crucial role in protection and value addition of local traditional knowledge, grassroots' innovations and assist in protection of their IP. Till date, this network has registered 1,000,000 innovative ideas which can be taken up by public / private sector for commercialization to generate products/processes as per societal needs.<br>• **Techpedia (http://techpedia.sristi.org/): SRISTI initiated a platform "Techpedia" with an aim of** putting the problems of micro, small and medium enterprises, informal sector, grassroots innovators and other social sectors on the agenda of the young technology students across the country. Techpedia comprise of project archive consisting of academia projects, industry defined projects, grassroot innovations for augmentation, assistive technologies and children innovations for augmentation.<br>• **Social Innovation Fund (http://sif.sristi.org/):** Social Innovation Fund (SIF) would be to provide mentoring, financial support, fabrication, validation, and value addition facilities in labs, fields, and R and D Institutions, part of honey bee network, for nurturing creativity in culture, education, technology and governance. |
| 6. | **BIRAC AcE Fund** | • This programme acts as co-founding model in which incubators, angel firms, business accelerators and early stage venture capitalists joined hands to provide funding (equity |

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|---|---|---|
| | | based) upto ₹1 Cr to entrepreneurs.<br>• This fund also provides an equity based support to entrepreneurs who have faced failure. Mentorship and guidance is also provided them to relocate their start-up business. |
| 7. | **Social Innovation programme for Products: Affordable & Relevant to Societal Health (SPARSH)**<br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br>**Outcome/ Impact** | • Through this programme BIRAC supports the development of innovative solutions for persisting social problems.<br>• SPARSH provides support to innovators in form of impact funding of biotech product innovations that can solve society problems and produce affordable biotech products [e.g. calls for solving challenges in Human Papillomavirus (HPV)]<br>• It also caters to creation of common platform where pool of social innovators in biotech can share their best practices and understand intricacies of business models in social innovations.<br>• SPARSH has initiated fellowship component [Social Innovation Immersion Programe (SIIP)] to promote entrepreneurial ideas and generating a pool of social innovators with a job to identify the specific needs and gaps in healthcare arena.<br>• SIIP is managed by four incubator centres [Venture Centre, Pune; Kalinga Institute of Industrial Technology (KIIT), Bhubaneswar; T*ranslational Health Science and Technology Institute* (*THSTI*), Faridabad and Villgro Possible, Chennai]<br>• SPARSH has led to initiation of 20 projects in the focus areas of maternal and child health, and 16 SIIP fellowships are granted.<br><br>• SPARSH has supported 7 individuals and 10 companies in last two years.<br>• Seed fund (₹113 lakhs to 695 lakhs for early translations) of SPARSH is created<br>• Technologies/ products under pipeline:<br>1. Microfluidics based On-chip RealTime PCR device for neonatal and maternal health.<br>2. A novel technique for monitoring foetal growth through volume imaging of the fundus and estimating the gestational age, amniotic fluid index and intra-uterine growth abnormalities of the foetus.<br>3. Non-invasive electrical device for transcutaneous iron replenishment.<br>4. Electricity-free Baby Incubator. |

***Source:*** *http://www.birac.nic.in/, BIRAC Annual Report 2014-15*

Along with the programmes for promoting entrepreneurship, BIRAC has taken initiative to set up several incubator facilities and innovation centres of world class level in different institutes of higher education, located in different parts of India.

1. **BIRAC University Innovation Cluster (UIC):** In order to encourage techno-entrepreneurship in Indian education system, BIRAC has created University Innovation Cluster (UIC). UIC focuses on creating industry focused R&D by supporting postdoctoral and postmasters Innovation Fellowships in the area of biotechnology. So far, five UICs have been established at **Anna University, Chennai; Panjab University, Chandigarh; Tamil Nadu Agricultural University, Coimbatore; University of Rajasthan, Jaipur, and University of Agricultural Sciences, Dharwad.** These clusters provide pre-incubation support for translation product development to the innovators. Each UIC is composed of 5-6 students/young entrepreneurs to develop their ideas/discoveries. Through these centres, industries participation for training, mentoring and sponsored research and networking opportunities is also encouraged.

2. **BIRAC Regional Innovation Centre (BRIC) at IKP Knowledge Park**: BIRAC in collaboration with IKP Knowledge Park has set up the BIRAC Regional Innovation Centre (BRIC) at IKP to promote entrepreneurship in southern part of India. It has also facilitated network opportunities for budding start-ups with other academicians and industries.

   BRIC is working for mapping regional innovations of Andhra Pradesh, Karnataka, Tamil Nadu and Kerala. It has assigned a task of developing database of technologies for in and out licensing, IP and Technology evaluation and is also fostering the entrepreneurship in different research institutes.

3. **Bio-Incubators:** BIRAC's Bio-Incubator support, harnesses entrepreneurial potential of start ups by giving access to them for proper infrastructure and mentoring and required networking for developing their ventures. BIRAC has provided support to the existing biotech parks, IITs, research institutes/universities and biotech clusters (Fig. 8). Till date, BIRAC has strengthened the existing fifteen incubation facilities in the country to develop world class bio-incubation facilities which are as ICICI Knowledge Park (IKP), Hyderabad; Society for Biotechnology Incubation Centre (SBTIC), Hyderabad; The Gujarat Biotechnology Council (GSBTM), Savli; Kerala State Industrial Development Corporation (KSIDC), Trivandrum; Women Bio Park, Chennai; Healthcare Technology Innovation Centre (HTIC), Chennai; Foundation for Innovative and Technology Transfer (FITT), IIT Delhi; Bio-Incubator, IIT Madras;

The SIDBI Innovation and Incubation Centre (SIIC), IIT Kanpur; Zonal Technology Management and Business Planning and Development (ZTM-BPD), Indian Agricultural Research Institute (IARI), Delhi; Kalinga Institute of Industrial Technology-Technology Business Incubator (KIIT-TBI), Bhubaneswar; National Chemical Laboratory (NCL), Pune; B. V. Patel Pharmaceutical Education and Research Development (PERD), Ahmedabad; Centre for Cellular and Molecular Platforms (C-CAMP), Bangalore; Regional Centre for Biotechnology (RCB) Bio Cluster, Faridabad. Additionally, BIRAC has also indentified CCAM, Bangalore and NABI, Mohali for developing Bio-Incubator facility via bio-incubator support scheme.

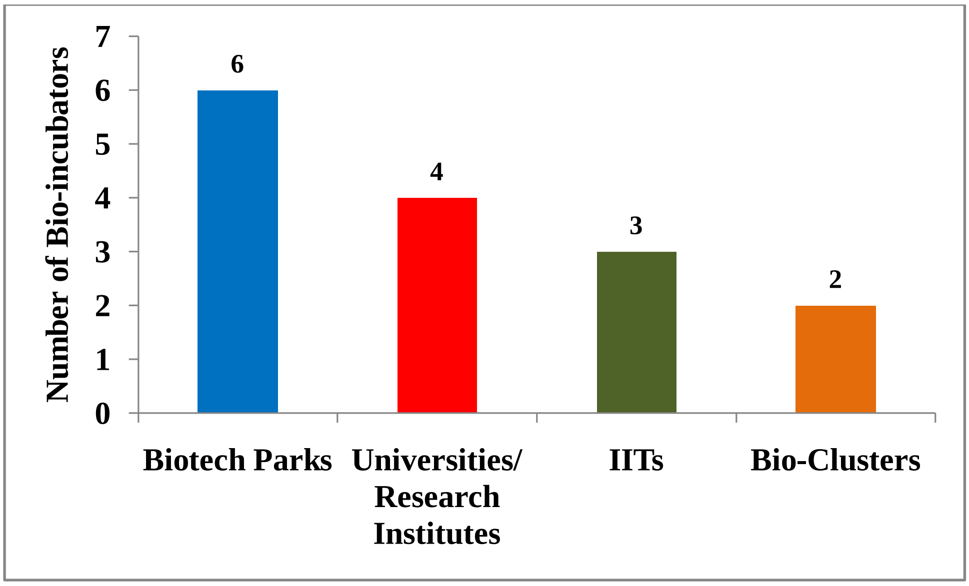


**Figure 8: Distribution of Bio-Incubators Created by BIRAC**
***Source:*** *http://www.birac.nic.in/*

**Outcome/ Impact of Bio-incubator support:**

- Through bio-incubator support ~1,24,000 sq. ft. of functional bio-incubation space is created and number of resident incubatees under them are given in table 13.
- These bio-incubation facilities have supported ~199 start-ups/entrepreneurs.
- They have provided access to cutting edge instrumentation, space for start-ups, mentorship for start-ups and aid in connecting them to different stakeholders- business and scientific advisors, angel firms and venture capitalists to bring out successful innovations.

**Table 13: Number of Resident Incubatees under Bio-incubators**

| Bio-Incubator | Resident Incubatees |
|---|---|
| C-CAMP, Bangalore | 6 |
| Venture Centre, NCL, Pune | 20 |
| ZTM & BPD Unit, IARI, New Delhi | 5 |
| IKP Knowledge park, Hyderabad | 22 |
| KIIT, Bhubaneswar | 5 |
| Alexandrial Knowledge Park, SBTIC, Hyderabad | 10 |
| BBIF, IIT Delhi | 7 |
| SIIC, IIT Kanpur | 6 |
| IIT Madras Research park | 10 |

***Source:*** *http://www.birac.nic.in/*

### Strategic Alliances and Partnerships of BIRAC

BIRAC has undergone alliance and partnerships with various national and international authorities to boost innovations in biotech sector. These partnerships have led to the promotion of Indian innovation ecosystem at global level. BIRAC has partnered with various global organizations to bring advancements in Indian biotech (Table 14).

**Table 14: Strategic Alliances and Partnership of BIRAC**

| S. No | Alliance/ partner | Description |
|---|---|---|
| | | **International Alliance** |
| 1. | **DBT-BIRAC-GATES foundation** | Directed research to support health research and innovation following under grand challenges of India<br>~200 farmers have applied improved technologies or management practise as result of programme assistance, 440 farmers are beneficiary and ~200 individuals have received food security training |
| 2. | **Welcome trust** | Grants provided by global charity organization of UK to support innovations in traditional medicines. |
| 3. | **CEFIPRA-BPI France** | Support high quality bilateral research and encourage Indo-French collaboration<br>BIRAC and Bpifrance financement a public investment bank, France jointly launch joint call for joint Expression of Interest (JEOI) for Indian & French SME / startup in the area of red biotechnology upto commercialization. |

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| 4. | **BIRAC-USAID+IKP** | Grant for US to IKP to carry out innovations in Tuberculosis control in India |
| 5. | **BIRAC-DBT-ICAR-USAID** | To support production of improved wheat for heat tolerance and climate resilience<br><br>RAPID programme for rapid development of nationally important technologies and products. |
| 6. | **BIRAC-Queensland University of Technology (QUT) Australia** | Bio-fortification and disease resistance in Banana under grand challenges of India |
| 7. | **BIRAC and Centre of Entrepreneurial Learning (CfEL) of Judge Business School, University of Cambridge** | Enables five BIRAC supported applicants to take part in CfEL's flagship intensive entrepreneurial boot-camp programme called "IGNITE", which is aimed at providing academics (PhDs, post-docs and scientists) entrepreneurial opportunities to explore their innovative ideas and transform them into a business project. CfEL provides one week intense mentorship and training to the BIRAC supported candidates and for second week encourage them to interact and learn from the Cambridge's entrepreneurial cluster. |
| | | **National Alliance** |
| 8. | **Department of electronics and informational technology (DeitY)-BIRAC Industry Innovation Programme** | **In year 2015, BIRAC** in association with Department of Electronics and Information Technology **(DeitY)** initiated Industry Innovation Programme on medical Electronics (IIPME) in order to generate significant investments in the medical devices sector to develop indigenous medical devices in healthcare sector. Through this scheme, BIRAC has supported more than 100 industries to develop medical devices in collaboration with DeitY and is also nurturing many ideas of young individual researchers, SME and large companies. |
| 9. | **Secondary agriculture Bio-cluster (SAB)** | Alliance with CIAB, Mohali; PSCT, Punjab and NIFTEM, Sonepat to developed agricultural strategies for farmers. |

***Source:*** *http://www.birac.nic.in/*

BIRAC has proposed a mission programme on anti-microbial resistance (AMR) with an aim to tackle the menance of antimicrobial resistance by focussing on discovery, development and diffusion of new drugs, diagnostics, and infection-treatment options under PPP consortia for promoting innovation research.

**BIRAC: A Successful Model**

In a short span of 5 years, BIRAC has nurtured the emerging biotech sector to take biotech industry to global excellence. BIRAC has successfully addressed the challenges of biotech industry in particular requirement of intense capital, high end infrastructure, regulatory scrutiny and long gestation phase for products to be market ready. Through various schemes and partnerships as mentioned in above sections, BIRAC has focussed on de-risking process of novel product formation. In totality, through BIRAC ~315 companies and ~89 institutes are benefitted (http://www.birac.nic.in/List_of_Beneficiaries.php). Table 15 presents the list of products generated with help of BIRAC funding having societal relevance:

**Table 15: List of Products Generated Under BIRAC Funding**

| S. No. | Product | Details | Collaborators/ Companies/ Start-ups |
|---|---|---|---|
| 1. | **Fluorescence reader to detect Multiple infection** | • Detects multiple infection simultaneously<br>• Ensures less medical waste in blood banks<br>• Detection of HIV, HCV, HBV, Syphilis and tuberculosis infection | [1]ICGEB, [2]DBT and University of Turku (http://www.utu.fi/), Turku, Finland. |
| 2. | **AINA Device** | • Measures blood glucose, HbA1C, lipids, creatinine and haemoglobin<br>• Commercialized by Janacare Solutions<br>• Company has already got pre orders for 25000 units from India | Janacare Solutions (www.janacare.com), [3]AIIMS and Narayana Hrudayalaya (http://www.narayanahealth.org/) |
| 3. | **Optra-SCAN** | • It is a digital oncopathology slide scanner<br>• Offers complete digital pathology solutions with ease of operations, scalability, security and integration with software image viewed and management at affordable costs | Optra Systems (http://optrahealth.com/) |
| 4. | **PDT Laser Systems** | Indigenous and low cost Photo Dynamic Laser system for cancer treatment | Vinvish Technologies (http://vinvish.com/) |
| 5. | **Maxico** | Device used for execution procedure for tumour ablation | Perfint Healthcare (http://www.perfinthealthcare.com) |

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|---|---|---|---|
| 6. | **POC Diagnostic Kit** | Diagnosis of multiple diseases such as malaria, dengue and typhoid | Bigtec Labs (http://www.bigteclabs.com/) |
| 7. | **Immunodiagnostic Kit** | Kit for detection of autoimmune diseases | Amar Immunodiagnostics (http://www.amarimmunodiagnostics.com/) |
| 8. | **Malaria Detection KIt** | Qualitative detection of Malarial parasite antigens in human whole blood | Genomix Molecular Diagnostics (http://www.genomixbiotech.com/) |
| 9. | **Fibroheal** | Use of silk protein based cosmaceutical product for burn wound management Already in use in AIIMS | Healthline (http://www.healthline.com/) |
| 10. | **Autochem Ingenious** | Low cost clinical chemistry analyser and helps early diagnosis | Span Diagnostics (http://www.span.co.in/) |
| 11. | **PCR Kit for Aquaculture Industry** | Robust and economical indigenous single tube nested PCR Kit | Aristogene Biosciences (http://www.aristogene.com/) |
| 12. | **Pandyflu** | H1N1 pandemic influenza vaccine using egg based technology | Panacea Biotech (http://www.panaceabiotec.com/) |
| 13. | **Rotavac** | Oral Rotavirus vaccine It is India's first indigenously developed vaccine and is included in publically funded universal immunization programme | Bharat Biotech (http://www.bharatbiotech.com/) |
| 14. | **Foligraf** | First recombinant FSH product important for development of follicles produced by ovaries | Bharat Serum and Vaccines (https://www.bharatserums.com/) |
| 15. | **OncoPrint** | Safe and affordable therapy to cancer patients in India. | Mitra Biotech and Anthem Biosciences (http://www.mitrabiotech.com/, http://www.anthembio.com/) |
| 16. | **Maleriscan** | A rapid test for the qualitative detection of Malarial parasite antigens | Bhat Biotech India (http://bhatbiotech.com/) |
| 17. | **Rasburicase (Tuly)** | It is recombinate uricase, used to control hyperuricemia in cancer patients undergoing chemotherapy | Virchow Biotech (http://www.virchowbiotech.com/) |

[1]International Centre for Genetic Engineering and Biotechnology, [2]Department of Biotechnology, [3]All India Institute of Medical Science.
***Source:*** *http://www.birac.nic.in/*

### E. Indian Council of Agricultural Research (ICAR); www.icar.org.in

ICAR is an autonomous organisation which was established in 1929, under the aegis of Department of Agricultural Research and Education (DARE), Ministry of Agriculture and Farmers Welfare, GoI. ICAR is composed of 101 institutes and 71 agricultural universities spread all over India, and is one of the world's largest national agricultural systems.

- **ICAR-Industry Interface in Agriculture**

In Indian scenario both the public and the private sectors have largely grown in isolation. Under the National Agricultural Technology Project (NATP) of GoI, ICAR made specific provision for funding of public-private collaborative research programmes under '***Competitive Grant Scheme'***. It has also organized various I-A meets/events/ brainstorming sessions and workshops for attracting industry and private sector in R&D activities in agriculture. Some of them addressing I-A interface in Indian agricultural sector are as:

1. Inducting Indigenous Technologies for Country's Growth (2016)
2. Training Programme on Financial Analysis of Business Plans and IP Valuation (2016)
3. International Design Structure Matrix Conference (2015)

- **MoU between ICAR and ABLE for Knowledge Partnership (year 2013)**

The objective of this MoU is to promote ICAR's mandates, along with its capabilities and achievements as an important stakeholder for addressing global issues in the agriculture areas. It has resulted in exploring collaborations and partnerships with the public and the private sectors in their endeavours and forging stronger linkages between academia and industry.

**F. Indian Council of Medical Research (ICMR); www.icmr.nic.in**

ICMR was set up in 1949 and holds the responsibility of formulating and coordinating promotion of biomedical research. ICMR has 26 national institutes with an aim to promote research in areas of medicine, public health and related areas in the country.

ICMR has introduced scheme by which it has stimulated ***Centres for Advanced Research*** as

- **Health Systems Research Cell (**http://icmr.nic.in/guide/nhrp.pdf**)**: Aimed at strengthening the Indian health systems to address the health needs of the citizen by encouraging research in health sector under public-private partnerships, public sector and NGO support.
- **Intellectual Property Rights (IPR) Unit:** Unit provides technical and legal support on IPR-related areas for ICMR sponsored intramural and extramural research. This unit holds the responsibility of displaying the list of patents and technologies ready for commercialization in form of seminars/symposiums/industrial meets/workshops. The

technologies generated in support of ICMR are also transferred/commercialized through dedicated agencies, such as National Research Development Corporation (NRDC), GoI, New Delhi and Biotechnology Consortium India Ltd. (BCIL), New Delhi.

ICMR has organized various events to address the need of strong I-A interaction in the field of medical research. Few of the meets are listed below:

1. **18th International Conference on Manufacturing Research (2016):** Key discussion with UK researchers and industrialists and Indian academicians and industrial partners were held with prime objective of enhancing I-A collaborations between both the countries.
2. **BIRAC-CDSO-ICMR Regulatory Meet (2013):** Workshop aimed at providing valuable information on regulatory and governing aspects for drug approvals in India to academic, scientists and industrial participants.

### G. Defence Research and Development Organization (DRDO); www.drdo.gov.in

DRDO, established in 1958 by Ministry of Defence, GoI and Department of Defence Research is dedicatedly working towards attaining self-reliance in Indian defence systems. From almost no industry base way back in the 1950s, it has now close collaboration with 1000 industries. Industry and academia linked programmes of DRDO are presented in table 16.

**Table 16: Industry and Academia Linked Programmes of DRDO**

| S. No. | Programme/Scheme | Brief Details |
|---|---|---|
| 1. | **The DRDO-FICCI ATAC Programme** http://drdoficciatac.com/ | This programme is working to create commercial pathway for delivering technologies developed by DRDO to industries. This is one of its kind programmes instituted by DRDO in association with FICCI to promote technologies developed at DRDO at national and international level. |
| 2. | **Extramural Research (ER) Scheme** http://drdo.gov.in/drdo/English/index.jsp?pg=grantinaid.jsp | The ER scheme supports the instrumentality of Memoranda of Collaboration between DRDO laboratories, industry and academia. |
| 3. | **Grant-in Aid scheme** http://drdo.gov.in/drdo/English/index.jsp?pg=grantinaid.jsp | Aeronautics R&D board has started grant-in aid scheme to nurture the scientific talent and to develop facilities in higher education institutes and other research centers including industry. |

***Source:*** *www.drdo.gov.in*

## H. Department of Industrial Policy and Promotion (DIPP); www.dipp.gov.in

This department was established in the year 1995 and reconstituted in 2000 on merging Department of Industrial Development comprising of Heavy Industries and Public Enterprises (HI&PE) and Small Scale Industries and Agro and Rural Industries (SSI&A&RI). DIPP holds the responsibility of formulating and implementing industrial policy and in past few years, it is also facilitating investment and technology flows from public to private sector, along with monitoring industrial development.

Key work areas of the department are as under:

- Formulation and implementation of comprehensive IPR policy on patents, geographical indicators (GIs), designs and trademarks of goods.
- IPR awareness by means of workshops/conference in collaboration with organizations like World Intellectual Property Organization (WIPO).
- Implementation of developmental measures for the industrial sector growth especially focusing socio-economic issues and national priorities.
- Facilitation of foreign technology collaborations with Indian companies and assisting in proceedings of bilateral economic cooperation agreements.
- Supervision and stimulation of industrial growth and encouraging industrial activity in rural and underdeveloped regions of the country.

In order to facilitate industrial growth DIPP has initiated various programmes and schemes for promoting I-A linkages. Industry related programmes and initiatives of DIPP are listed in table 17.

**Table 17: Industry Related Programmes and Initiatives of DIPP**

| S. No. | Programme/Scheme/Initiative | Brief Details |
|---|---|---|
| 1. | **Industrial Corridor Projects** http://dipp.gov.in/English/Schemes/DMIC/About_DMIC.aspx | • Central sector schemes involving industrial corridor projects such as Delhi-Mumbai corridor projects spanning six states have been initiated.<br>• Aims to generate strong economic base to enhance investments and accomplish sustainable development in both public and private sector. |
| 2. | **Rajiv Gandhi National Institute of Intellectual Property Management (RGNIIPM)** http://dipp.gov.in/English/Publications/Annual_Reports/AnnualReport_Eng_2015-16.pdf | It is a central government institute under the Ministry of Commerce and Industry, established in 2010 to create an institute at par with international levels to provide training for the IP professionals and officials. |

| | | |
|---|---|---|
| 3. | **Project Based Support to Autonomous Institutions** http://dipp.gov.in/English/Publications/Annual_Reports/AnnualReport_Eng_2015-16.pdf | This scheme provides grant-in aid support to autonomous institutions in order to strengthen them and provide technical support for enhancing industry competitiveness. Autonomous institutions like Central Pulp and Paper Research Institute (CPPRI), Central Manufacturing Technology Institute (CMTI), National Council for Cement and Building Materials (NCCBM), National Productivity Council (NPC), National Institute of Design (NID) and Quality Council of India (QCI) are supported under this scheme. |
| 4. | **Invest India** http://www.investindia.gov.in/ | It is a joint venture company (not for profit company) of DIPP, FICCI and various state governments with shareholding of 45%, 51% and 4% respectively. It holds the responsibility of facilitating investments in R&D in India. It has also created an investor facilitation cell to assist and guide investors for their project functioning. |
| 5. | **Atal Innovation Mission (AIM) with Self-Employment and Talent Utilization (SETU) Programme** http://dipp.gov.in/English/Publications/Annual_Reports/AnnualReport_Eng_2015-16.pdf | It aims to organize start-up fests to showcase innovations. It provides collaborative platforms and facilitates harnessing private sector expertise for incubator setup in association with NITI Ayog. In the year 2016, DIPP announced setting up of incubation centres and research parks by partnering with private sector for harnessing private sector expertise. |
| 6. | **Modified Industrial Infrastructure Upgradation Scheme (MIIUS)** http://dipp.gov.in/English/Publications/Annual_Reports/AnnualReport_Eng_2015-16.pdf | MIIUS was launched in 2003 with an aim to promote growth of domestic industries by giving access to infrastructure developed under PPP mode. Under MIIUS, some of the successful projects are as follows: Bamboo Technology Park, Guwahati; (ii) Kolhapur Foundry Cluster, Maharashtra; (iii) Marathwada Automobile Cluster, Aurangabad; (iv) Narol Textiles Infrastructure and Environment Management, Narol, Gujarat and (v) Readymade Garments Cluster, Jabalpur. |

***Source:*** *www.dipp.gov.in*

The department has also undertaken various technical cooperation programmes with WIPO for the up gradation and modernization of IPR administration and development of human resource. In addition, DIPP has issued a draft of ***National IPRs Policy*** on 12$^{th}$ May, 2016. The main mission of this policy is to foster creativity, innovation and entrepreneurship to enhance socio-economic upliftment and cultural development.

### I. Department of Atomic Energy (DAE); www.dae.nic.in

DAE, established in 1954 under the direct charge of the prime minister, consists of five public sector undertakings, five research centres, three industrial units and service organizations. DAE is actively engaged in promoting R&D in radiation technologies in the fields of basic and industrial research relating to agriculture, medicine and nuclear power technology. Table 18 lists the initiatives of DAE to bring R&D programmes in industry.

**Table 18: DAE's Initiatives to Promote Industrial Research**

| S. No. | Initiative | Brief Details |
|---|---|---|
| 1. | **Nuclear Fuel Complex (NFC)** http://www.nfc.gov.in/ | It is the major industrial unit of DAE. This complex provides the material, nuclear fuel reactors and bundles required for carrying out research in nuclear technology by the industries involved. |
| 2. | **Heavy Water Board (HWB)** http://www.hwb.gov.in/ | • It is a constituent unit of mineral sector and industries which holds the responsibility of producing and supplying heavy water for research purposes to the private industries.<br>• HWB also has been working with various educational and research institutions in further development heavy water based applications.<br>• HWB has also been offering value added services and spin off technologies to other chemical process industries. |
| 3. | **Board of Radiation and Isotope Technology (BRIT)** http://www.britatom.gov.in/ | • Aims to bring benefits of the radioisotope applications and associated technology to industrial sector, health sector and agricultural sector. BRIT is working in close collaboration with industries to provide various desired products and services. Several well known industries such as Apollo Agro Gujarat, Aligned Industries, Avantee Mega Food Park and Electromagnetic industries are closely associated with DAE. |
| 4. | **BARC Entrepreneur's Corner- Technology Transfer and Consultancy & Scientific Services** http://www.barc.gov.in/ | • Dedicated Entrepreneur's Corner Cell has been established in BARC and is responsible for interaction with industries, academic and research institutes for technology transfers and consultancy services.<br>• It has also instituted '***DAE Technologies Display and Dissemination Facility (DTDDF)***' to display technologies developed by DAE which can be readily taken up by industries. |
| 5. | **Patents and Technology Transfer Cell at Indira Gandhi Centre for Atomic Research (IGCAR)** http://www.igcar.gov.in/pttc/ | • This cell was established in IGCAR, Kalpakkam with an aim of displaying DAE's technologies to the industries which can be readily take up the technologies and commercialize them.<br>• The cell takes care of technology transfer mechanism, licensing and liaising with the industry and inventor for technology transfer process. |

***Source:*** *www.dae.nic.in*

### J. Ministry of Electronics and Information Technology (MeitY); www.deity.gov.in

Recently in July 2016, Department of Electronics and Information Technology (DeitY) which was previously known as Department of Information Technology set up in 2000, is converted into full fledged 'Ministry of Electronics and Information Technology (MeitY)'. MeitY is promoting e-governance for empowering Indian citizens leading to sustainable growth of industries in field of electronics and information technology. MeitY has greatly enhanced internet governance in India due to measures taken up by it for developing human resources, promoting innovation and ensuring a secure cyber space through digital services. MeitY's programmes for enhancing I-A collaborations are listed in table 19.

**Table 19: Programmes of MeitY Promoting Industry-Academia Collaborations**

| S. No. | Programme/ Scheme | Brief Details |
|---|---|---|
| 1. | **Visvesvaraya Ph.D. Scheme for Electronics and IT** http://deity.gov.in/content/schemes-projects | • Through this programme, industrial organizations get an opportunity to collaborate with academic institutes of their choice for R&D and to produce skilled Ph.D. candidates in the areas of their interest.<br>• An industrial organization and MeitY jointly funds Ph.D. candidates at academic institute, working in the research area identified by the industrial organization. The funding provided by industry and MeitY is in the ratio of 3:7 |
| 2. | **Funding and Support to Industry and Academic Institutions through GITA** http://deity.gov.in/content/gita | • This programme supports a R&D project that compose of academic, industrial and R&D organization as a research partners within India or abroad for initiating joint co-development for generation of innovative products, processes or services.<br>• It is the combined initiative of DST, MeitY and GITA in association with foreign agencies such as Global Affairs Canada, Canada; Centre for the Development of Industrial Technology (CDTI), Spain. |
| 3. | **Scheme of Financial Assistance for Setting Up of Electronics and ICT Academies** http://deity.gov.in/content/scheme-financial-assistance-setting-electronics-and-ict-academies | • Under this scheme financial assistance (₹148.47 crore) will be provided by MeitY for establishing 7 Electronics and ICT academies in IITs (IIT Guwahati, IIT Kanpur, IIT Roorkee), NITs (NIT Patna, NIT Warangal, MNIT Jaipur), IIIT (IIITDM Jabalpur) for enhancing technology development, up gradation of faculty and increase in employability.<br>• Two ICT academies have also been set up at Tamil Nadu (ICT Academy of Tamil Nadu located in Chennai) and Kerala (ICT Academy of Kerala locate d in Trivandrum) respectively, as not-for-profit autonomous organizations focusing to make faculty and students industry ready. |
| 4. | **Scheme for Financial Assistance to** | • Main objective of this scheme is to enhance skill |

| | | |
|---|---|---|
| | **Select States/UTs for Skill Development in Electronics System Design and Manufacturing (ESDM) sector**<br>http://deity.gov.in/content/schemes-projects | capacity in domain of ESDM through public and private partnerships. It will also facilitate resource sharing between the academia and industry partners.<br>• There are many other schemes to promote skill development in association with industries. These schemes are as:<br>➢ Scheme for '***Digital Saksharta Abhiyan'*** under 'Digital India'<br>➢ Capacity building in the areas of electronic product design and production technology<br>➢ Sector skill councils- Electronics, Telecom, Information Technology and its enabled services. |
| 5. | **Incubators for Electronics**<br>http://deity.gov.in/esdm/incubators | MeitY has approved setting up of an ***Electropreneur Park*** for development of ESDM industry. Some of the instituted incubators for technology generation and commercialization are:<br>• ***Software Technology Parks of India (STPI)***, New Delhi in association with India Electronics & Semiconductor Association (IESA) and Delhi University (DU).<br>• ***Incubation centre set up at IIT***, Patna for development of Product and IP creation with focus on medical electronics |
| 6. | **National Portal of India**<br>www.india.gov.in | • It is the government official portal designed by the National Informatics Centre (NIC).<br>• This portal acts as a single window access point for seeking information related to services offered by the government for all the stakeholders under various domains, such as agriculture, rural and urban development. |

***Source:*** *www.deity.gov.in*

## K. Ministry of Environment, Forests and Climate Change (MoEFCC); www.envfor.nic.in

MoEFCC, established in 1985, is supporting environmental research in academia, research institutes and private organizations including industries via funding grant-in-aid research projects for environment protection and management. Table 20 lists the MoEFCC initiatives and programmes for strengthening I-A collaborations.

**Table 20: Programmes and Initiatives taken under MoEFCC Promoting Industry-Academia Collaborations**

| S. No. | Programme/ Initiative | Brief Details |
|---|---|---|
| 1. | **Creation of Indian Plywood Industries Research and Training Institute (IPIRTI), Bengaluru** http://ipirti.gov.in/ | • IPIRTI was set up in 1962 as a co-operative research laboratory of Indian plywood industry, CSIR and MoEFCC. • It is working with a mandate of strengthening Plywood and wood panel industry in India by working under collaborated work by private and public sector under PPP mode. |
| 2. | **National Natural Resources Management System *(*NNRMS) Programme** http://envfor.nic.in/division/call-proposals-under-nnrms-programme | This programme aims to support research projects utilizing optimal utilization of techniques of remote sensing for addressing environmental and ecological issues. All academic institutes, national research laboratories and DSIR certified industries can send their proposals. Under this programme, proposals with public and private partnerships are also promoted. |

***Source:*** *www.envfor.nic.in*

## L. Indian Space Research Organization (ISRO); www.isro.gov.in

ISRO, a unit of Department of Space, was established in 1969, and pursues a systematic policy for generation and transfer of technologies developed by the Indian Space Centres, to draw maximum benefit of 'spin-offs' that are generated from such technologies. The objectives of ISRO lie in facilitating greater contribution of Indian industry in number of space projects. ISRO has strong IPR portfolio of 270 patents, 45 copyrights and 10 trademarks. ISRO is working with an approach to facilitate commercial exploitation at maximum of its resources through proper channel of technology transfers and licensing.

The '***Technology Transfer Mechanism***' started at ISRO in early eighties and has enabled licensing of number of technologies from different ISRO centres. More than 300 technologies have been productively licensed/transferred to industries in the fields of satellite communications, broadcasting, meteorology, speciality polymer chemicals and materials, electronics and computer based systems, mechanical equipments and electro optical instruments. It has also generated ~28 space spin-offs. ISRO has developed several initiatives to aid technology transfer from ISRO to corporate houses and Indian space industry (Table 21).

**Table 21: ISRO's Initiative to Aid Technology Transfer from ISRO to Indian Space Industry**

| S. No. | Initiative | Brief Details |
|---|---|---|
| 1. | **Antrix Corporation Limited** http://www.antrix.gov.in/ | • It is a commercial and marketing arm of ISRO established in 1992. It is a complete government undertaking company and aims to promote ISRO's technologies for commercial utilization of space products. It also provides consultancy services to industries for enhancing their industrial capabilities in space technology. |
| 2. | **Sponsored Research (RESPOND)** http://www.isro.gov.in/sponsored-research-respond | • This programme aims to provide financial support for conducting R&D activities (space science, space technology and space application) to academia and industries. |
| 3. | **ISRO Technology Transfer Group** http://www.isro.gov.in/isro-technology-transfer/contact-us | • ISRO has established dedicated Technology Transfer Groups all over India for nurturing the industrial sector leading to advancements in space program and encouraging wider participation of industries through technology transfer and industry cooperation for commercialization. |
| 4. | **Space Application Centre (SAC) Industry Portal and Industry Interface** www.sac.gov.in | • SAC is one of the major centres of the ISRO dealing with a wide variety R&D activities and capacity building in space technology.<br>• SAC has created SAC Industry Portal for displaying its technologies developed which can be readily taken up by industries by providing business opportunities in area of outsourcing, design and development of systems, technology transfer and consultancy. |

***Source:*** *www.isro.gov.in*

### 2.2 Educational Sector

#### A. Ministry of Human Resource Development (MHRD); www.mhrd.gov.in

MHRD was established in 1985 with an aim to promote education so as it reaches to masses. The Department of Higher Education under MHRD is working in direction to create world class institutes of higher learning with well-equipped and experienced professors for generating ample opportunities for research and skill development resulting in world's biggest skilled workforce. Ministry has integrated various new schemes which are taken up regularly. MHRD's programmes for promoting I-A linkages are listed in table 22.

**Table 22: Programmes of MHRD Promoting Industry-Academia Linkages**

| S. No. | Programme/ Scheme | Brief Details |
|---|---|---|
| 1. | **Council for Industry Higher Education Cooperation (CIHEC)**<br>http://mhrd.gov.in/collaboration | The CIHEC compose of an advisory group that consist of MHRD with members from industry, academia and other stakeholder ministries.<br>CIHEC aims to facilitate development of "***innovative instruments of collaboration between Industry and Academia***" as an endeavour to utilize resources to strengthen I-A linkages and to promote more of research to be taken up by students.<br>Initiatives undertaken by CIHEC are as following:<br>• Setting up of new institutions for science education and research.<br>• Creation of centres of excellence and facilities in emerging and frontline areas in academic institutes.<br>• Establishment of new and attractive fellowships.<br>• Strengthening of the infrastructure of R&D in universities.<br>• Encouraging public-private partnerships.<br>• Recognition of R&D units and national awards for outstanding R&D for industries. |
| 2. | **Research Parks**<br>http://www.itbhuglobal.org/chronicle/Report%20of%20the%20Expert%20Committee%20on%20Research%20Parks.pdf | This scheme aims to boost innovation ecosystem in higher education institutes in collaboration with industry and academia leading to development of cutting edge technology. |
| 3. | **Technical Education Quality Improvement Programme (TEQIP)**<br>http://mhrd.gov.in/technical-education-12 | This scheme aims to generate well trained post-graduate students in order to reduce the shortage of qualified faculty that can pursue industry oriented R&D projects. This programme is working in association with AICTE.<br>A total of 190 institutions i.e. (26 centrally funded, 127 state government funded and 37 private unaided institutions) have been selected for participation in the Project |
| 4. | **IMPRINT India**<br>http://imprint-india.org/ | It is a Pan-Indian Institute of Technology (IIT) and Indian Institute of Sciences (IISc) joint initiative to develop a roadmap for R&D addressing major engineering and technology challenges in specific technology domains relevant to India's societal relevance. |
| 5. | **Global Initiative for Academic Network (GIAN)**<br>http://www.sici.org/programmes/details/global-initiative-for-academic- | It is the network for attracting the talent pool of budding entrepreneurs and scientific fraternity to encourage utilization of academic resources to enhance India's technological capabilities to match |

| | | |
|---|---|---|
| | network-gian-programme/ | global excellence. |
| 6. | **Kaushal Kendras** http://mhrd.gov.in/sites/upload_files/ mhrd/files/lu3667.pdf | This scheme led to the creation of 100 Deen Dayal Upadhyay Centres for Knowledge Acquisition and Up-gradation of Skilled Human Abilities and Livelihood (KAUSHAL). These Kendras aims to design and formulate courses at undergraduate and postgraduate level in accordance to industrial needs. |
| 7. | **Rashtriya Ucchtar Aavishkar Abhiyaan (RUSA)** http://mhrd.gov.in/ | The scheme was initially started in IITs for promoting innovation as per industrial needs and thereby improving and stimulating competitive edge to Indian manufacturing sector. RUSA is now implemented in various universities and colleges. |

***Source:*** *www.mhrd.gov.in*

### B. University Grants Commission (UGC); www.ugc.ac.in

UGC was created by Indian Union Government in 1956 under UGC Act 1956 with an aim to determine, coordinate and maintain standards of higher education in India. UGC is functioning under MHRD, New Delhi. UGC is the nodal agency to endorse teaching and research in emerging areas of science, social sciences, pure sciences, engineering, pharmacy, medical, agricultural sciences, languages, humanities and literature. Although, the government has a network of S&T institutes for R&D, the major base of research and researchers lies with the universities. Programmes under UGC for strengthening I-A interface are presented in table 23.

**Table 23: Programmes of UGC for Promoting Industry-Academy Linkages**

| S. No. | Programme | Brief Details |
|---|---|---|
| 1. | **University-Industry Inter Linkage (UIL) Centres** www.ugc.ac.in | Scheme of setting up of UIL Centres in the universities which become an effective goal oriented and enriched entity to promote collaboration with industries for skill development, employability and pursuing collaborative research. |
| 2. | **The Council of Industry-Higher Education Collaboration (CIHEC)** http://mhrd.gov.in/collaboration | MHRD has instituted CIHEC in collaboration with UGC in order to promote innovation ecosystem and university-industry linkages in various universities all over India. |
| 3. | **Global Initiative for Academic Network (GIAN)** http://www.sici.org/programmes/details/global-initiative-for-academic-network-gian-programme/ | It is an initiative of MHRD, through which network for attracting the talent pool of budding entrepreneurs is created and updated for universities. GIAN aims to utilize university resources to set linkages with scientists, entrepreneurs and industries in order to promote technology development and commercialization. |
| 4. | **KAUSHAL Centres** http://mhrd.gov.in/sites/upload_files/ mhrd/files/lu3667.pdf | These Centres are established to encourage skill development in higher educational institutions in accordance to the industrial needs. |

***Source:*** *www.ugc.ac.in*

## C. All India Council for Technical Education (AICTE); www.aicte-india.org

AICTE, set up in 1945, is a national level advisory body for conducting survey on status of technical education in integrated manner. AICTE is the statutory authority for planning, formulation, maintenance and implementation of norms of higher education institutes in India. Programmes under AICTE to promote I-A collaborations are listed in table 24.

**Table 24: Industry Related Programmes of AICTE**

| S. No. | Programme | Brief Details |
|---|---|---|
| 1. | **Industry Institute Partnership Cell (IIPC)** http://www.aicte-india.org/schiipc.php | IIPC acts as focal point for setting up close collaboration between industry and academia, and to reduce gap between both the sectors. |
| 2. | **Research Park** http://www.aicte-india.org/schrp.php | This scheme aims to provide financial support to institutions for setting up research park in collaboration with the industry. |
| 3. | **Innovation Promotion Scheme (IPS)** http://www.aicte-india.org/schips.php | This scheme aims to provide financial support to institutions for accomplishing technical projects exhibition at union territory and state level. Through this scheme research activities for the industry are promoted for commercialization. |
| 4. | **AICTE – Indian National Academy of Engineering (INAE) Distinguished Visiting Professorship (DVP)** http://inae.in/aicte-inae-distinguished-visiting-professorship-scheme/ | • AICTE in association with INAE has launched DVP programme for promotion of industry-institute interaction by stimulating knowledge transfer from industry to academia and vice versa to synergize industrial experience with technical education.<br>• Under this programme, distinguished visiting professors who are eminent scholars/experts in their field working with an industry or R&D organization will visit the higher educational institutes to deliver mentoring sessions and lectures on the state-of-art of industry and its R&D needs. |
| 5. | **AICTE-CII Survey of Industry-Linked Technical Institutes 2016** http://www.aicte-india.org/CII-15.php | The AICTE-CII Survey is an online survey which is hosted on the server of AICTE at *www.aicte-india.org*. In the past, AICTE-CII survey on I-A linkages has analyzed institutes and colleges all over India for industry linkages. |
| 6. | **Global Initiative for Academic Network (GIAN)** http://www.sici.org/programmes/details/global-initiative-for-academic-network-gian-programme/ | GIAN an initiative of MHRD was applied to the technical institutes under AICTE for enhancement of innovation and development of technologies. It aims to build a network of talent pool of scientists, researchers and entrepreneurs to get associated with |

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|---|---|---|
| | | academic resources to boost their R&D efforts. |
| 7. | **Pradhan Mantri Kaushal Vikas Yojana (PMKVY)**<br>pmkvyofficial.org/ | AICTE under mentorship of MHRD has launched this scheme with an objective of promoting skill development via skill training sessions as per industrial needs in technical institutes during off hours. |

***Source:*** *www.aicte-india.org*

### 2.3 International Agencies

**A. United Nations Industrial Development Organization in India (UNIDO-India) www.unido.org**

UNIDO is an independent autonomous body, constituted in 1985 within United Nations (UN), which is playing the role of a catalyst in gearing up industrial development in the weaker economies of the world. Till date, UNIDO comprises of 170 member states and is composed of three units as mentioned in figure 9.

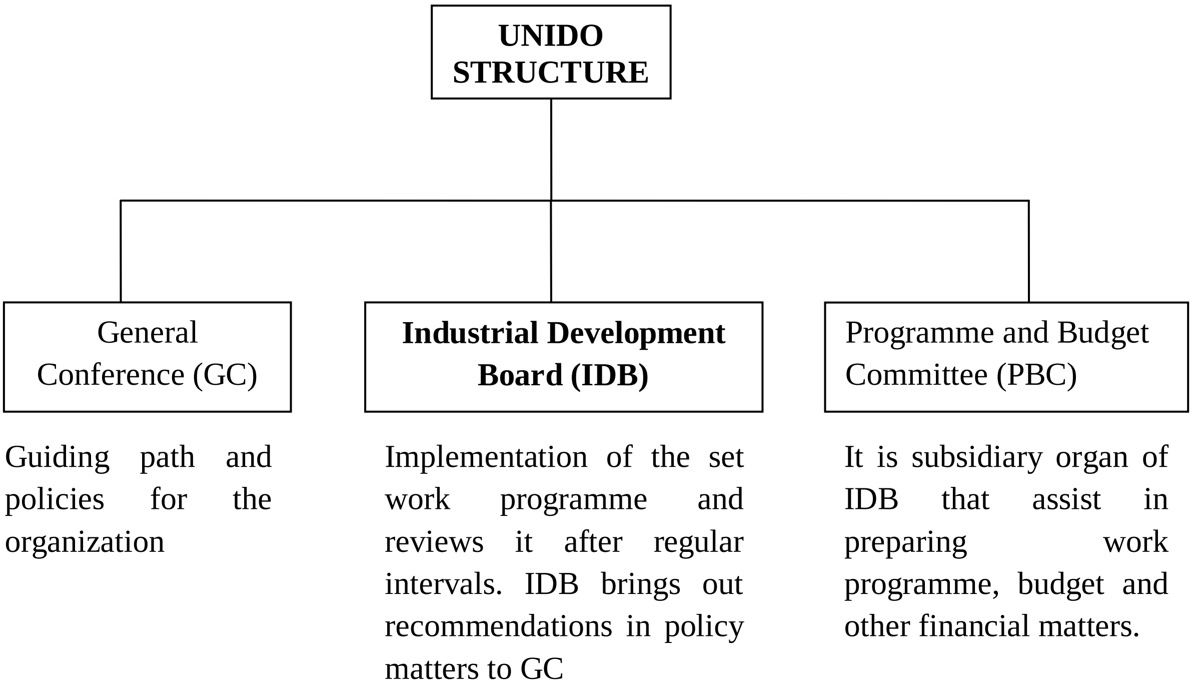


**Figure 9: Structure of UNIDO**

Presently, UNIDO is working for 2030 agenda ‘Sustainable Development Goals (SDGs)’ which calls for building infrastructure, fostering innovation and promoting inclusive and sustainable industrialization in weaker economic nations. Four thematic priority areas of UNIDO are listed in table 25.

**Table 25: Major Activities of UNIDO**

| S. No. | Thematic Areas | Activities *(Industry related activities are in bold)* |
|---|---|---|
| 1. | **Creation of Shared Prosperity** | • **Agribusiness and rural entrepreneurship development**<br>• Women and youth in productive activities<br>• Human security and post-crisis rehabilitation |
| 2. | **Advancing Economic Competitiveness** | • **Investment, technology and SME development**<br>• Competitive trade capacities and corporate responsibility<br>• **Entrepreneurship development *[Entrepreneurship Curriculum Programme (ECP)]*** |
| 3. | **Safeguarding the Environment** | • Resource-efficient and low-carbon industrial production<br>• Energy access for productive uses<br>• Implementation of multilateral environmental agreements |
| 4. | **Cross Cutting Services** | • Partnerships for prosperity<br>• **Industrial policy advice, research and statistics**<br>• Gender equality and the empowerment of women |

***Source:*** *www.unido.org*

The impact of UNIDO is brought forwards through four major functions (www.unido.org): (a) Technical cooperation, (b) Analytical and research functions, (c) Policy advisory services, normative functions and standards and quality-related activities, (d) Arranging and setting up partnerships within member countries for knowledge transfer, promoting networking and industrial cooperation.

**UNIDO-Delhi Centre:** India became member of UNIDO in 1985 and has it Head Office in New Delhi. It has been a successful initiative of UNIDO in collaboration with GoI that has brought industrial growth in different sectors. Subsequently UNIDO-Delhi also covers Afghanistan, Bangladesh, Bhutan, Nepal, Maldives and Sri Lanka. UNIDO-Delhi has played significant role in enhancing industrial development of India via number of programmes and initiatives of UNIDO (Table 26).

**Table 26: Activities of UNIDO-Delhi Centre**

| S. No. | Initiative | Brief Details |
|---|---|---|
| 1. | **India-Combining businesses** | UNIDO in support from the United Kingdom's Department for International Development (DFID) has initiated a dedicated programme for strengthening SMEs of India in field of handlooms, handicrafts and non-timber wood products. |
| 2. | **India-Gears of growth** | UNIDO in association with Indian Automotive |

| | | |
|---|---|---|
| | **[UNIDO-ACMA Automotive Component Supplier Development Programme]** | Components Manufacturers Association (ACMA) has assisted Indian SMEs in the field of automobiles and automotive related sector to meet challenges related to insufficient productivity, low quality, and scalability issues. |
| 3. | **CSR South East Asia** | UNIDO initiated Triple Bottom Line demonstration project for facilitating market access for potential suppliers of developing countries and provides global market access to the SMEs to increase their value chain. |
| 4. | **India-Climate-friendly refrigerators** | UNIDO in collaboration with the Swiss State Secretariat for Economic Affairs has supported Indian refrigeration manufacturers (Godrej & Boyce Mfg. Co. and Videocon Appliances Ltd.) for developing improved CDM methodologies in order to increase competitiveness and reduce environmental pollution. |
| 5. | **UNIDO Centre for South-South Industrial Cooperation (UCSSIC)** | Launched in New Delhi in collaboration with Indian government with the following aims:<br>• To provide platform to encourage closer industrial cooperation among developing countries<br>• Design practical and innovative projects to facilitate the transfer and diffusion of appropriate technologies<br>• Skill development and capacity enhancement in entrepreneurship, trade and investment |

***Source:*** *www.unido.org (http://www.unido.org/office/india.html)*

### B. International Finance Corporation (IFC)-India; www.ifc.org

IFC is one of the largest global development institutions established in year 1956. It consists of 184 member countries. IFC focuses on enhancement of private sector of developing countries to attain sustainable development of the country. IFC gives financial assistance along with technical expertise, global experience and innovations to address financial, political and operational challenges of the country. IFC also creates long term partnerships with various stakeholders of country to overcome constraints of finance, employee skills, infrastructure and regulatory environment.

India got associated with IFC in 1956 and since then IFC has supported ~346 companies by providing financial assistance worth 10.3 billion US$ and arranging 2.9 billion US$ from other stakeholders. For India, IFC has provided support to bring development of underserved, low income, rural and fragile regions in field of energy, roads, water, healthcare, education, waste management and sanitation.

IFC mainly invests in different ventures of early growth companies which are involved in innovative technologies to match demands of emerging markets. Early growth companies in field of healthcare, education, information technology mainly are supported by financial assistance from IFC. IFC also plays important role in promoting cross border technology transfer to spread the success of innovative technologies.

## 3. I-A Programmes/Schemes of Private Sector

### 3.1 Industry Associations

#### A. Federation of Indian Chambers of Commerce and Industry (FICCI); www.ficci.com

FICCI is the largest and oldest existing apex business organization of India. It was established in 1927. It is a not-for-profit, non-government organisation and holds the responsibility for drafting policy and its execution that mainly concerns industry. Schemes by FICCI to strengthen I-A interface in country are presented in table 27.

**Table 27: Programmes of FICCI for Promoting Industry-Academia Linkages**

| S. No. | Programme | Brief Details |
|---|---|---|
| 1. | **National Knowledge Functional Hub** http://ficci-nkfh.com/ | Creation of hubs to increase I-A interactions by creating mentoring services between industry and academia. |
| 2. | **FICCI Ladies Organization (FLO)** http://www.ficciflo.com/ | Women wing of FICCI that has developed all India forum for women. FLO represents over 4000 women entrepreneurs and professionals for promoting entrepreneurships. |
| 3. | **I-A-Research/ Government Interface (IARGI)** http://www.ficcifwi.com/ppts/rnd2.pdf | Industrial partner and FICCI or Ministry of Food Processing Industry (MFPI) or CSIR together has financed IARGI to promote I-A linkages and commercialization of technologies. |
| 4. | **DRDO - FICCI ATAC programme** http://drdoficciatac.com/ | FICCI in association with DRDO initiated this programme for creating active commercial pathway for DRDO's technologies to the commercial markets. |
| 5. | **Invest India** http://www.investindia.gov.in/ | It is a joint venture of FICCI, DIPP and state governments with shareholding of 51%, 45% and 4%, respectively. It holds the responsibility of enhancing R&D investments in India. |

***Source**: www.ficci.com*

#### B. Confederation of Indian Industry (CII); www.cii.in

CII is an industry managed not-for-profit organization. It was founded in 1895, having 8000 members both from private and public sectors including Multinational Corporations (MNCs) and SMEs. It possess indirect membership of over 2,00,000 entities from 240 national and regional sectored industrial bodies. CII is working with a mandate of creating sustained environment conducive for industrial growth in India, by encouraging partnering and close linkages between government and industry through consultative processes. CII's initiatives to enhance I-A interface in India are listed in table 28.

**Table 28: Programmes and Initiatives of CII for Promoting I-A Linkages**

| S. No. | Programme/ Initiative | Brief Details |
|---|---|---|
| 1. | **Recommendation of CII National Committee on Higher Education on New Education Policy** http://cii.in/WebCMS/Upload/CII%20Recommendations%20on%20New%20Education%20Policy%202015269.pdf | It was drafted in 2015 and specifically stressed on meaningful partnership of education sector with the private sector and engagement with industry to link education and employability |
| 2. | **Quality Enhancement in Engineering Education (QEEE)-CII Industry Bridge Programme** http://www.pilot.edureform.iitm.ac.in/phases.php | Programme was carried out in 2014 that is one of the models to bring industry and academia together. It focussed on industry bridge sessions on technology trends in the industry and the engineering applications in the industry |
| 3. | **AICTE-CII Survey of Industry-Linked Technical Institutes 2016** http://www.aicte-india.org/CII-15.php | • The AICTE-CII Survey is an online survey which is hosted on the server of AICTE at *www.aicte-india.org*. In past, AICTE-CII survey on I-A linkages has analyzed institutes and colleges all over India for industry linkages.<br>• The fifth edition of the survey is open to all degree and diploma granting institutes in engineering, management, pharmacy and architecture.<br>• At the end of the survey, awards and citations will be given for best industry linked institute/college in specific domain areas. |
| 6. | **Global Innovation & Technology Alliance (GITA)** http://gita.org.in/aboutus.aspx | CII in collaboration with DST instituted GITA for promoting innovations in Indian Industry. GITA holds the responsibility of making goal oriented national and international R&D collaborations involving industry and academia. |
| 7. | **Prime Minister Fellowship Scheme for Doctorate Research** http://primeministerfellowshipscheme.in/Home.aspx | CII in association with SERB, DST initiated Prime Minister Fellowship scheme for PhD students pursuing industry oriented research, who can avail double fellowship, 50% from the government and 50% from the sponsored industry. |

***Source****: www.cii.in; www.aicte-india.org*

## C. National Associations of Software and Services Companies (NASSCOM); www.nasscom.in

NASSCOM, established in 1988, is the industry association for the information technology sector in India. It is an industry funded, not-for-profit organization working with an objective to establish growth led business and service sector in the country.

NASSCOM in association with 'ICICI Knowledge Park (IKP)' is promoting "*The India Innovation Fund (IIF; http://www.indiainnovationfund.in/)*" created for strategic investors ranging from information technology to telecommunications and life sciences. IIF is the collaboration of diverse institutions (public and private) as anchor investors who along with investments also provide the investee with guidance for technology development and market access. It is one of the first kinds of PPP at this scale for providing funds to entrepreneurs. Major anchor investors under IIF are Tata Consultancy Systems (TCS), IKP Trust, DST and Bharti Airtel. Currently IIF has a corpus of around ₹ 40 crores.

## D. Other Industrial Associations

There are some of the industrial associations like *Associated Chambers of Commerce & Industry of India* (ASSOCHAM; www.assocham.org) and *PHD Chambers of Commerce and Industry* (PHDCCI; www.phdcci.in) which are strongly associated with industries all over in India and play role in stimulating and acknowledging educational institutes promoting I-A interface in country.

ASSOCHAM took an initiative through its various events for se promoting '*Mega Food Parks*' set up by Ministry of Food Processing in various parts of country to provide state of art infrastructure, technology and mentoring support to the enterprise engaged in food processing sector in association with higher educational institutes.

PHDCCI is a multi-state and proactive apex organisation functioning for creating strong linkages nationally and internationally. It acts as a catalyst for promoting industry, entrepreneurship and trade. PHDCCI is working for 'Skilling India for Global Competitiveness' and has significantly contributed to socio-economic development in the country.

### 4.I-A Programmes/Schemes of Banking Sector

### A. Small Industries Development Bank of India (SIDBI); www.sidbi.com

SIDBI, established in 1990 is one of the principal financial entities for the financing and promoting MSMEs development in India and is coordinating and supporting institutions which are engaged in similar activities. Major initiatives taken by SIDBI to promote industrial R&D are listed in table 29.

**Table 29: SIDBI Initiatives to Promote Industrial R&D**

| S. No. | Initiative | Brief Details |
|---|---|---|
| 1. | **Creation of SIDBI Innovation and Incubation Centre (SIIC) at IIT Kanpur** http/www.iitk.ac.in/siic/d/about-siic | SIIC was established in collaboration with SIDBI to foster innovation and entrepreneurial activities in IIT Kanpur. It provides support (financial and developmental) to the MSME sector. |
| 2. | **Financing Schemes for Sustainable Development Including Energy Efficiency and Cleaner Production of MSMEs** | SIDBI started four different schemes to support R&D in MSMEs. These schemes are as follows:<br>• JICA -SIDBI financing scheme for MSME projects<br>• Financing End to End Energy Efficiency Investments in MSMEs<br>• Green Loan Scheme for health sector<br>• Sustainable finance Scheme<br>• Global Environment Facility in association with the World Bank. |
| 3. | **TIFAC-SIDBI Revolving Fund for Technology (SRIJAN Scheme)** http://www.sidbi.com/?q=tifac-sidbi-revolving-fund-technology-innovation-srijan-scheme | This scheme provides financial aid to MSMEs to develop, demonstrate, upscale and commercialize their innovative technology based projects. |
| 4. | **Technology and Quality Upgradation Support to Micro, Small and Medium Enterprises (TEQUP)** | It aims to encourage the Indian MSMEs to improve their manufacturing processes in direction of energy efficient technologies in order to reduce emission of Green House Gases. Financial support under TEQUP is provided by SIDBI along with other banks. |
| 5. | **Scheme for Food Processing Industries** | This scheme was launched in collaboration with Ministry of Food Processing Industries, GoI, to promote technology up gradation, modernization of food processing industries by giving financial assistance. |
| 6. | **Technology Upgradation Fund Scheme for The Textile Industries (TUFS)** | This scheme was launched to promote technology up gradation and modernization in textile industries |
| 7. | **Integrated Development of Leather Sector Scheme (IDLSS)** | This scheme was launched in association with leather sector of DIPP to promote technology up gradation for strengthening leather industry to compete with global markets. |

***Source:*** *www.sidbi.com*

### B. State Bank of India (SBI); www.sbi.co.in

SBI, India's largest public bank was constituted in 1955. It actively participates in large number of welfare activities of community and is playing important role in nation building. Various initiatives of SBI for promoting industrial research and development in India are listed in table 30.

**Table 30: Initiatives of State Bank of India to Promote Industrial Research and Development**

| S. No. | Initiative | Brief Details |
|---|---|---|
| 1. | **CSIR-Tech** http://www.csirtech.com/ | Founded in 2011, as the initiative of CSIR. The ownership of CSIR-Tech lies with Entrepreneurial Development Centre of CSIR-National Chemical Laboratory (CSIR-NCL), Pune; CSIR-Scientists Welfare Trust (CSIR-SWT) and the State Bank of India. Bank provides the funding support for carrying out different activities of CSIR-Tech. |
| 2. | **Entrepreneurship Development Institute of India (EDI)** www.ediindia.org | It is an autonomous not-for-profit institute established in 1983, in association with number of financial institutions support. SBI provided financial support of ₹ 20 Lakhs. |

### C. Industrial Credit and Investment Corporation of India (ICICI); www.icicibank.com

ICICI Bank, established in 1994 is India's largest private sector bank. It is engaged in human and economic developmental activities at national level. Bank has created '***ICICI Foundation***' that works for supporting innovation across diverse programmes and sectors. Programmes and initiatives of ICICI bank to promote industrial R&D activities are listed in table 31.

**Table 31: Industrial Research Oriented Programmes and Initiatives of ICICI Bank**

| S. No. | Programme/ Initiative | Brief Details |
|---|---|---|
| 1. | **Creation of Sponsored Research and Development Board (SPREAD)** | SPREAD was created in collaboration with the World Bank, ICICI Bank and the Indian Government for supporting industry oriented research in academic institutions. |
| 2. | **Social Initiatives Group (SIG)** http://www.icicicommunities.org/sig.html | SIG was established in 2000, a non-profit group for encouraging research in field of primary health and elementary education by providing access to finance. Under this group further, '***ICICI Foundation for Inclusive Growth*** (ICICI Foundation; http://www.icicifoundation.org/)' was founded in 2008 |

| | | |
|---|---|---|
| | | for promoting inclusive scientific and technological growth. |
| 3. | **Creation of ICICI Knowledge Park (IKP)** http://www.ikpknowledgepark.com/ | ICICI has also played substantial role in creation of Innovation Knowledge Progress (IKP; http://www.ikpknowledgepark.com/) also know and ICICI Knowledge Park providing incubation support to budding entrepreneurs. |
| 4. | **Entrepreneurship Development Institute of India (EDI)** www.ediindia.org | It is an autonomous not-for-profit institute established in 1983, in association with number of financial institutions support. ICICI provided financial support of ₹ 28 Lakhs |
| 5. | **Technology Finance Group (TFG)** http://www.icicibank.com/corporate/technologyfinance/technology-finance.page | ICICI bank has dedicated TFG that implements many other programmes in association with World Bank and USAID to help industry and institutions to undertake collaborative research and technology oriented projects. Programmes presently implemented by TFG are:<br>• **Agricultural Commercialization & Enterprise (ACE) Title III Programme**: This programme activity focuses primarily on promoting agribusiness innovations and diversity by linking technology and labour requirements, reduction of post-harvest losses and encouraging projects that are highly visible and replicable.<br>• **Technology Institution (TI) Programme:** This programme aims strengthen institutional potential for technology development, marketing and business development ability and commercialization. Under this programme sensitization of training scientists, up gradation and expansion of facilities is promoted by collaborating with national and international TIs. Till date programme has supported 50 such projects. |

***Source:*** *www.icicibank.com*

**C. National Bank for Agriculture and Rural Development** (NABARD); www.nabard.org

It is leading development bank of India with corpus fund of ₹ 50 Crores for R&D. This dedicated fund aims at promoting research in field of agriculture and rural development. Bank provides grant in support of carrying out research projects, workshops, conference, publication cost, chair units and internship programmes. In the year 2014-15, NABARD R&D fund has supported 14 research projects all over in India.

**D. Others:** Many other banks have introduced various schemes for promoting industrial R&D which are listed in table 32.

**Table 32: Bank Schemes for Promoting Industry R&D**

| S. No. | Bank | Schemes |
|---|---|---|
| 1. | **Industrial Development Bank of India** hwww.idbi.com | Technology financing scheme for commercialization of indigenous technology and start-ups related to indigenous technologies. Gives financial assistance to STEPs scheme introduced by *NSTEDB.* |
| 2. | **YES Bank** www.yesbank.in | In collaboration with IFC India, YES Bank has introduced schemes for elevating women owned technology business in India's priority area. |
| 3. | **Industrial Finance Corporation of India (IFCI)** www.ifciltd.com | • IFCI in collaboration with Ministry of Social Justice and Empowerment launched a scheme for credit enhancement facility for budding entrepreneurs especially for lower strata of society.<br>• IFCI also contributed to the creation of Entrepreneurship Development Institute of India (EDI) by providing financial support of ₹ 28 Lakhs. |
| 4. | **Punjab National Bank (PNB)** www.pnbindia.in | ***'PNB Mahila Udyam Nidhi Scheme, PNB MAHILA Samridhi Yojna, PNB Mahila Sashakitaran Abhiyan and PNB Kalyani card scheme'*** are the schemes available for budding women entrepreneurs. |
| 5. | **Oriental Bank of Commerce** www.obcindia.co.in | Under ***'Oriented Mahila Vikas Yojana'*** women entrepreneurs can avail financial support from the bank. |
| 6. | **Bhartiya Mahila Bank** www.bmb.co.in | Bank has commenced various women entrepreneurship funding schemes. |
| 7. | **Syndicate Bank** www.syndicatebank.in | It has created ***Syndicate Bank Entrepreneurship Research and Training Centre at the Indian Institute of Technology, Kanpur (SBERTC–IITK)***. This centre is promoting cutting edge research, training and teaching in entrepreneurship by utilizing the facilities and intellectual pool of IIT Kanpur. |

## 5. Summary

In the present chapter, an overview of various schemes/programmes/organizations of public and private sectors has been presented for enhancing I-A interactions, under the following sub-heads:

a) ***Funding Agencies*** (DST, DSIR, CSIR, BIRAC, ICAR, ICMR, DRDO, DIPP, DAE, MeitY, MoEFCC, ISRO)
b) ***Educational Sector*** (MHRD, UGC, AICTE)
c) ***Financial Institutions*** (ICICI, Yes Bank, SIDBI, SBI, NABARD, IDBI, Syndicate Bank)
d) ***Industrial Associations*** (FICCI, CII, NASSCOM, ASSOCHAM, PHDCCI)
e) ***International Agencies*** (UNIDO-INDIA, IFC-INDIA)

- ***Funding Agencies:***

**DST** has floated maximum number of schemes/programmes. There are dedicated I-A research schemes for individuals e.g. ‘Prime Minister’s Fellowship Scheme’, as well as theme based programmes like ‘Drug and Pharmaceutical Research Programme’ and ‘Nano Application and Technology Advisory Group’ (NATAG). For the promotion of innovative products and technologies and enhancing I-A collaborative R&D, DST has introduced programmes like ‘Technology Systems Development Programmes’ (TSDP), ‘Instrumentation Development Programme’ (IDP) and many more. The schemes for the promotion of entrepreneurship ‘National Scheme for Technology Development Programme’ (NSTED) and ‘Start-Up Research Grant’ are very popular amongst young and enthusiastic researchers for shaping their ideas into commercial success. DST provides funds for the setting up of ‘Technology Business Incubators’ (TBIs) all over India to promote industry oriented, technology oriented and patent oriented research in the universities and research labs. belonging to public and private sectors. Recently, DST has introduced ‘National Initiative for Developing and Harnessing Innovation’ (NIDHI) scheme, through which it proposes to set up accelerators in various parts of India to boost up start-up culture in the country. DST has also established ‘Policy Research Centres’ in five institutes to collect evidence-based data for strengthening I-A partnership, entrepreneurship and innovation ecosystem in India. DST has led to the creation of autonomous organizations, such as **‘TIFAC’** and ‘**GITA’**. TIFAC is striving for technological advancement of the country. It has initiated programmes such as ‘Advanced Composites Programme’, ‘Revolving Fund’ and ‘Technology Refinement and Marketing Programme’ (TREMAP) to strengthen technological development of academia and industries. TIFAC has also created ‘Patent Facilitation Centres’ in 19 states for providing patent related services to public and private sectors. GITA, a joint initiative of DST and CII, is working with a specific mandate for (a) the promotion of applied and innovative research, and (b) creating international research collaborations amongst the scientists/institutes/industries of different countries.

Ministry of Science and Technology created a dedicated department **‘DSIR’** for promoting scientific and industrial research in the country. It has effectively promoted industrial R&D via different schemes, such as ‘Building Industrial R&D and Common Research Facilities (BIRD-crf)’ through which recognition to ‘Industrial R&D Units’ and ‘Scientific and Industrial Research Organization’ (SIRO) is carried out. DSIR recognized R&D units avail fiscal benefits such as tax relaxation from the government. DSIR promotes I-A collaborative research and entrepreneurship through its different programmes namely ‘Patent Acquisition and Collaborative Research and Technology Development’ (PACE), ‘Promoting Innovations in Individuals, Start-ups and MSMEs’ (PRISM), ‘Access to Knowledge for Technology Development and Dissemination’ (A2K+) and ‘Consultancy Promotion Programme’ (CPP). It has been playing important role in technology development in industries and academia through ‘Technology Development and Demonstration Program’ (TDDP), ‘Technopreneur Promotion Programme’ (TePP), ‘Technology Development and Utilization Programme for Women’ (TDUPW), ‘Technology Management Programme’ (TMP) and ‘International Technology Transfer Programme’ (ITTP). Under DSIR, a dedicated agency **‘NRDC’** has been established which provides assistance to R&D institutes and universities, in developing and commercializing patents/technologies. It is acting as large repository of patents and technologies available for commercialization. It also provides IPR consultancy services and supports programmes for entrepreneurship development.

**CSIR** started one of its kind programme ‘New Millennium Indian Technology Leadership Initiative’ (NMITLI) to synergize academia, R&D laboratories and industry. CSIR has also led to the creation of an organization **‘CSIR-Tech’** which provides assistance in commercialization of lab research by helping the scientists/institutions in IPR issue and scouting market for their products/technologies. Many public funded research laboratories including CSIR, DRDO, DAE, IISc and industries avail the services of CSIR-Tech.

Another public funded organization, DBT, has created a nodal agency **‘BIRAC’** for promoting R&D activities in the biotechnology sector. BIRAC is effectively implementing Public-Private-Partnership (PPP) mode for collaborative research leading to technology development and commercialization for market and societal benefits. It has implemented schemes, such as ‘Small Business Innovation Research Initiative’ (SBIRI), ‘Biotechnology Industry Partnership Programme’ (BIPP) and ‘Contract Research Scheme’ (CRS) to promote I-A linkages in biotech research. BIRAC is also stimulating entrepreneurship development in the country via programmes such as ‘Biotechnology Ignition Grant’ (BIG), creation of ‘University Innovation Clusters’ (UICs) and ‘Bio-incubators’. BIRAC has collaborated with voluntary organization ‘**Society for Research and Initiatives for Sustainable**

**Technologies and Institutions'** (SRISTI) with an aim to strengthen creativity and innovation at grass root level.

**DRDO**, the premier institute for defense research has initiated 'DRDO-FICCI ATAC programme', 'Grant-in Aid' and 'Extramural Schemes' to promote I-A interface in defense related research.

**DIPP**, one of the foremost institutes dealing with industry policy design and formulation has introduced programmes, such as 'Industry Corridor Projects', 'Invest India', 'Atal Innovation Mission' (joint initiative of DIPP and NITI AYOG) and 'Modified Industrial Infrastructure Upgradation Scheme' (MIUS) to support industrial growth by synergizing academia and industry for collaborative research. DIPP also provided support for creation of institutes, such as 'Rajiv Gandhi National Institute of Intellectual Property Management' (RGNIIPM), 'Quality Council of India' (QCI), 'National Institute of Design' (NID), 'National Productivity Council' (NPC) and many more for IPR management and technology development in order to enhance industry competitiveness.

**DAE** has created industrial units, such as 'Nuclear Fuel Complex', 'Heavy Water Board' and 'Board of Radiation and Isotope Technology', where government, academia and industries are working collaboratively to address industrial problems. DAE has also introduced schemes for 'Enhancing Entrepreneurship and IPR Awareness' in field of atomic energy.

The 'Ministry of Electronics and Information Technology' **(MeitY),** acts as I-A interface in fields of electronics and information technology. It has led to the setting up of Electronics, and Information and Communication Technologies (ICT) academies all over India and incubators for electronics-related R&D entrepreneurship. MeitY has also commenced 'National Portal' for displaying of technologies that can be readily taken up by industries for commercialization.

**ISRO** via its initiative of sponsored research programmes named 'RESPOND', 'Technology Transfer Group' and 'SAC Industry Portal' and creation of unique corporation arm 'Antrix Corporation limited' has aided in technology development and technology transfer to space industry.

- ***Educational Sector***: **MHRD** has instituted Council for Higher Education Cooperation (CIHEC) comprising of advisory members from industry, academia and stakeholder ministries. CIHEC council is working with special task of bringing industry and academia closer to each other to pursue collaborative R&D activities. MHRD has also initiated programmes for setting up of 'Research Parks' to promote innovation ecosystem in higher educational institutes. 'TEQIP' programme was commenced by MHRD with an aim of making post graduate students industry ready by involving industries with TEQIP centers located in universities and other HEIs. MHRD also initiated a programme 'IMPRINT India' to promote innovations and technology commercialization in specific target research areas at pan IITs level. To generate skilled manpower and entrepreneurship culture, MHRD in association with its regulatory bodies, UGC and AICTE, has initiated programmes like GIAN and Kaushal Kendras.

- ***Financial Institutions***: Banking sector of India, both public and private, has significantly contributed for the promotion of research in the industrial sector especially MSMEs, entrepreneurship and creation of institutes for promoting culture of innovation. Amongst the public banks, **SIDBI**, through its various programmes has contributed towards technology development and incubation support for start-ups. SIDBI has also played crucial role in the creation of 'SIDBI Innovation and Incubation Centre' (SIIC) at IIT Kanpur. **ICICI**, a private sector bank, as a part of their corporate social responsibility is playing an important role in promoting innovation through creation of dedicated 'Innovation Fund'. ICICI has a dedicated 'Technology Finance Group' to support technology development and creation of technology based institutions. In addition, ICICI played a crucial role in establishing 'Knowledge Park' in Hyderabad for promoting entrepreneurship. **SBI** has played crucial role in the creation of an organization CSIR-Tech which meant for promoting technology development and commercialization. Other public banks, such as NABARD and Syndicate Bank are also doing their bit in supporting innovations at higher educational institutes.
- ***Industrial Associations***: Industrial associations, such as **FICCI, CII** and **NASSCOM** are contributing to the growth of I-A interactions and innovations by conducting national and international level workshops/conferences/I-A meets. These associations are also playing an important role by assisting the government and its agencies in formulating national policies in the areas of reforms in higher education system and carrying out surveys in the domains of academia and research.
- ***International Agencies:*** India being a member of United Nations has received funding support from international agencies, such as **UNIDO** and **IFC** for promoting

industry oriented research and technological advancements to compete with rest of the world.

## 6. Conclusion

The economic prosperity of a nation is linked to its scientific and technological competence. To achieve success in these parameters, it is essential that industry and academia forge linkages to overcome the limitations of each other for commercializing R&D into innovative products/technologies. To bring government, industry and academia together, various public and private organizations have floated I-A programmes/schemes. In India, majority of R&D is being carried out by the funds provided by public sector funding agencies, such as DST, CSIR, DBT, BIRAC, DAE, DRDO, ISRO, MeitY, ICAR, MHRD and so on. In addition, government has set up dedicated agencies which aid in the promotion of applied research. IPO, NRDC and TIFAC assist public and private sectors in patent related matters; DSIR provides accreditation to R&D labs (public and private), which then become eligible for seeking incentives and R&D programmes from the government. CSIR-Tech assists many research labs, universities and entrepreneurs at all stages leading to commercialization of their research. BIRAC has been established for promoting entrepreneurship and R&D of MSMEs in the domain of biotechnology. GITA is engaged in enhancing R&D by forging national and international alliances. Financial institutions are contributing by way of providing financial assistance for creation of *Centres of Excellence* and *Technology Parks* and soft loans to entrepreneurs. Industry associations have set up dedicated research institutes with financial assistance from the public sector. All these industry-academia associated activities suggest that there is plethora of I-A related activities/schemes/programmes existing in India. However, there is no single platform where such information is either available or compiled. It is suggested that a national level centre be created where all the information pertaining to industry-academia regime of India is available. Such information will be helpful in identifying gaps and overlaps in the domain of I-A ecosystem in India. This piece of information will also be of great importance to policy makers for designing futuristic plans for Science, Technology and Innovations for India. This centre may be termed as National Industry-Academia Centre (NIAC) and governed by a council comprising of eminent scientists, industry personals, heads of funding agencies and representatives of NITI Ayog. The council should be responsible for designing as well as implementation of I-A Policy.

Asian countries like China and S. Korea have a single body responsible for designing and implementation of policy-programmes.

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# Symbols and Abbreviations

| | |
|---|---|
| $ | Dollar |
| ~ | Approximate |
| ₹ | Rupees |
| ABLE | Association of Biotechnology Led Enterprises |
| ACE | Agricultural Commercialization & Enterprise |
| ACMA | Automotive Components Manufacturers Association |
| Agri | Agricultural |
| AICTE | All India Council for Technical Education |
| AIIMS | All India Institute of Medical Science |
| AIM | Atal Innovation Mission |
| AIRAC | Agriculture Industry Research Assistance Council |
| AMR | Anti-Microbial Resistance |
| APCTT | Asian and Pacific Centre for Transfer of Technology |
| ASSOCHAM | The Associated Chambers of Commerce of India |
| BCIL | Biotechnology Consortium India Ltd. |
| BIG | Biotechnology Ignition Grant Scheme |
| Biotech | Biotechnology |
| BIPP | Biotechnology Industry Partnership Programme |
| BIRAC | Biotechnology Industry Research Assistance Council |
| BIRD-crf | Building Industrial R&D and Common Research Facilities |
| BRIC | BIRAC Regional Innovation Centre |
| BRIT | Board of Radiation and Isotope Technology |
| CCAM | Congenital Cystic Adenomatoid Malformations |
| C-CAMP | Centre for Cellular and Molecular Platforms |
| CDFD | Centre for DNA Fingerprinting and Diagnostics |
| CDTI | Centre for the Development of Industrial Technology |
| CEFIPRA | Indo-French Center for the Promotion of Advanced Research |
| CfEL | Centre of Entrepreneurial Learning |
| Chd | Chandigarh |
| CIAB | Center of Innovative and Applied Bioprocessing |
| CIC | Cluster Innovation Centre |
| CIHEC | Council for Industry Higher Education Cooperation |
| CII | Confederation of Indian Industry |
| CMC | Christian Medical College |
| CMTI | Central Manufacturing Technology Institute |
| CPP | Consultancy Promotion Programme |
| CPPRI | Central Pulp and Paper Research Institute |
| Cr | Crore |
| CRAMS | Contract Research and Manufacturing Systems |
| CRS | Contract Research Scheme |
| CRTDH | Common Research and Technology Development Hubs |
| CSIR | Council of Scientific and Industrial Research |
| CTPL | CSIR-Tech Private Limited |
| DAE | Department of Atomic Energy |
| DARE | Department of Agricultural Research and Education |
| DB | Development Business |
| DBT | Department of Biotechnology |

| | |
|---|---|
| DeitY | Department of Electronics and Information Technology |
| DFID | Department for International Development |
| DIPP | Department of Industrial Policy and Promotion |
| DNA | Dexoynucleic Acid |
| DRAC | Deity Research Assistance Council |
| DRDO | Defence Research and Development Organization |
| DSIR | Department of Scientific and Industrial Research |
| DST | Department of Science and Technology |
| DTDDF | DAE Technologies Display and Dissemination Facility |
| DVP | Distinguished Visiting Professorship |
| EAC | Entrepreneurship Awareness Camp |
| EBTC | European Business & Technology Centre |
| ECP | Entrepreneurship Curriculum Programme |
| ECRA | Early Career Research Award |
| EDC | Entrepreneurial Development Centre |
| EDI | Entrepreneurship Development Institute |
| EDP | Entrepreneurship Development Programmes |
| EEN | Enterprise Europe Network |
| EIRAC | Environment related Industrial Research Assistance Council |
| ER | Extramural Research |
| ESDM | Electronics System Design and Manufacturing |
| ETA | Early Translational Accelerator |
| FAO | Food and Agriculture Organization |
| FDP | Faculty Development Programme |
| FICCI | Federation of Indian Chambers of Commerce and Industry |
| FITT | Foundation for Innovative and Technology Transfer |
| FLO | FICCI Ladies Organization |
| FTO | Freedom to Operate |
| GC | General Conference |
| GIAN | Global Initiative for Academic Network |
| GIs | Geographical Indicators |
| GITA | Global Innovation and Technology Alliance |
| GoI | Government of India |
| GSBTM | The Gujarat Biotechnology Council |
| HBN | Honey Bee Network |
| HI&PE | Heavy Industries and Public Enterprises |
| HR | Human Resource |
| HTIC | Healthcare Technology Innovation Centre |
| HWB | Heavy Water Board |
| I-A | Industry-Academia |
| IARGI | I-A-Research/ Government Interface |
| IARI | Indian Agricultural Research Institute |
| ICAR | Indian Council of Agricultural Research |
| ICGEB | International Centre for Genetic Engineering and Biotechnology |
| ICICI | Industrial Credit and Investment Corporation of India |
| ICMR | Indian Council of Medical Research |
| IDB | Industrial Development Board |
| IDBI | Industrial Development Bank of India |
| IDLSS | Integrated Development of Leather Sector Scheme |
| IEDC | Innovation and Entrepreneurship Development Centre |

| | |
|---|---|
| IFAD | International Fund for Agricultural Development |
| IFC | International Finance Corporation |
| IFCI | Industrial Finance Corporation of India |
| IGCAR | Indira Gandhi Centre for Atomic Research |
| IIF | India Innovation Fund |
| IIPC | Industry Institute Partnership Cell |
| IIPME | Industry Innovation Programme on medical Electronics |
| IIT | Indian Institute of Technology |
| IKP | Industrial Credit and Investment Corporation of India Bank Knowledge Park |
| IMPRINT | Impacting Research Innovation and Technology |
| INAE | Indian National Academy of Engineering |
| INNO INDIGO | **I**nnovation Driven Initiative for the Development and Integration of Indian & European Research |
| IP | Intellectual Property |
| IPFC | Intellectual Property Facilitation Centre |
| IPIRTI | Indian Plywood Industries Research and Training Institute |
| IPR | Intellectual Property Rights |
| IPS | Innovation Promotion Scheme |
| IRDP | Industry R&D Promotion Programme |
| i-STED | S&T based Entrepreneurship Development |
| ITRAC | Information Technology Research Assistance Council |
| ITTP | International Technology Transfer Programme |
| JEOI | Joint Expression of Interest |
| KAUSHAL | Knowledge Acquisition and Up-gradation of Skilled Human Abilities and Livelihood |
| KIIT | Kalinga Institute of Industrial Technology |
| KIIT-TBI | KIIT-Technology Business Incubator |
| KIRAN | Knowledge Involvement in Research Advancement through Nurturing |
| KSIDC | Kerala State Industrial Development Corporation |
| M.Sc | Masters in Science |
| MEIT | Ministry of Electronics and Information Technology |
| MFPI | Ministry of Food Processing Industry |
| MHRD | Ministry of Human Resource and Development |
| MIIUS | Modified Industrial Infrastructure Upgradation Scheme |
| MIRAC | Medical Industry Research Assistance Council |
| MMP | Mission Mode Project |
| MNCs | Multinational Corporations |
| MoEFCC | Ministry of Environment, Forest and Climate Control |
| MoMSMEs | Ministry of Micro, Small and Medium Enterprises |
| MoU | Memorandum of Understanding |
| MTA | Material Transfer Agreement |
| NABI | National Agriculture Biotechnology Institute |
| NASSCOM | National Association of Software and Services Companies |
| NATAG | Nano Applications and Technology Advisory Group |
| NATP | National Agricultural Technology Project |
| NBRC | National Brain Research Centre |
| NCCBM | National Council for Cement and Building Materials |
| NCL | National Chemical Laboratory |
| NEGP | National E-Governance Plan |
| NFC | Nuclear Fuel Complex |
| NGOs | Non Government Organizations |

| | |
|---|---|
| NIC | National Informatics Centre |
| NID | National Institute of Design |
| NIFTEM | National Institute of Food Technology Entrepreneurship and Management |
| NIPGR | National Institute for Plant Genome Research |
| NMITLI | New Millennium Indian Technology Leadership Initiative |
| NNRMS | National Natural Resources Management System |
| NPC | National Productivity Council |
| NPDF | National Post-Doctoral Fellowship |
| NRDC | National Research Development Corporation |
| NSTED | National Science and Technology Entrepreneurship Development |
| PAC | Policy and Analysis Cell |
| PACE | Patent Acquisition and Collaborative Research and Technology Development |
| PBC | Programme and Budget Committee |
| PERD | B. V. Patel Pharmaceutical Education and Research Development |
| PFC | Patent Facilitation Center |
| Pharma | Pharamceutical |
| PHDCC | Progress Harmony Development Chambers of Commerce |
| PIC | Patent Information Centers |
| PNB | Punjab National Bank |
| PPP | Public Private Partnership |
| PRC | Policy Research Centres |
| PRISM | Promoting Innovations in Individuals, Start-ups and MSMEs |
| PSCT | PowerShares S and P SmallCap Inform |
| PU | Panjab University |
| QCI | Quality Council of India |
| QEEE | Quality Enhancement in Engineering Education |
| QUT | Queensland University of Technology |
| R&D | Research and Development |
| RAPID | Research Alliance for Product Innovation and Development |
| RCB | Regional Centre for Biotechnology |
| RGNIIPM | Rajiv Gandhi National Institute of Intellectual Property Management |
| RUSA | Rashtriya Ucchtar Aavishkar Abhiyaan |
| SAB | Secondary agriculture Bio-cluster |
| SAC | Space Application Centre |
| SAIC | Secondary Agriculture Innovation Cell |
| SBERTC–IITK | Syndicate Bank Entrepreneurship Research and Training Centre at the Indian Institute of Technology, Kanpur |
| SBI | State Bank of India |
| SBIRI | Small Business Innovation Research Initiative |
| SBTIC | Society for Biotechnology Incubation Centre |
| SCTI | Steinbeis Centre for Technology Transfer India |
| SDGs | Sustainable Development Goals |
| SERB | Schemes for funding industry relevant R&D |
| SETU | Self-Employment and Talent Utilization |
| SIDBI | Small Industries Development Bank of *India* |
| SIG | Social Initiatives Group |
| SMEs | Small and Medium Sized Enterprises |
| SPARSH | Social Innovation Programme for Products: Affordable and Relevant to Societal Health |
| SPREAD | Sponsored Research and Development Board |
| Sq.ft. | Square Feet |

| | |
|---|---|
| SRISTI | Society for Research and Initiatives for Sustainable Technologies and Institutions |
| SSI&A&RI | Small Scale Industries and Agro and Rural Industries |
| STED | S&T Entrepreneurship Development Project |
| STEP | S&T Entrepreneurs Park |
| STI | Science, Technology and Innovation |
| STPI | Software Technology Parks of India |
| SWT | Scientists Welfare Trust |
| TBI | Technology Business Incubator |
| TCFs | Technology Commercialization Facilitators |
| TCS | Tata Consultancy Systems |
| TDB | Technology Development Board |
| TDDP | Technology Development and Demonstration Program |
| TDUPW | Technology Development and Utilization Programme for Women |
| TEDP | Technology based EDP |
| TePP | Technopreneur Promotion Programme |
| TEQIP | Technical Education Quality Improvement Programme |
| TFG | Technology Finance Group |
| TI | Technology Institutions |
| TIFAC | Technology Information, Forecasting and Assessment Council |
| TMP | Technology Management Programme |
| TREMAP | Technology Refinement and Marketing Programme |
| TSDP | Technology Systems Development Programmes |
| TUFS | Technology Upgradation Fund Scheme for The Textile Industries |
| UCSSIC | UNIDO Centre for South-South Industrial Cooperation |
| UGC | University Grants Commission |
| UIC | University Innovation Cluster |
| UIL | University-Industry Inter Linkage |
| UIRPAC | University's Industry Research Promotion and Assistance Council |
| UN | United Nations |
| UNDP | United Nations Development Programme |
| UNEP | United Nations Environment Programme |
| UN-ESCAP | United Nations Economic and Social Commission for Asia and the Pacific |
| UNIDO-India | United Nations Industrial Development Organization in India |
| US | United States |
| WIPO | World Intellectual Property Rights Organization |
| ZTM-BPD | Zonal Technology Management and Business Planning and Development |

सत्यमेव जयते
Department of Science & Technology
Govt. of India

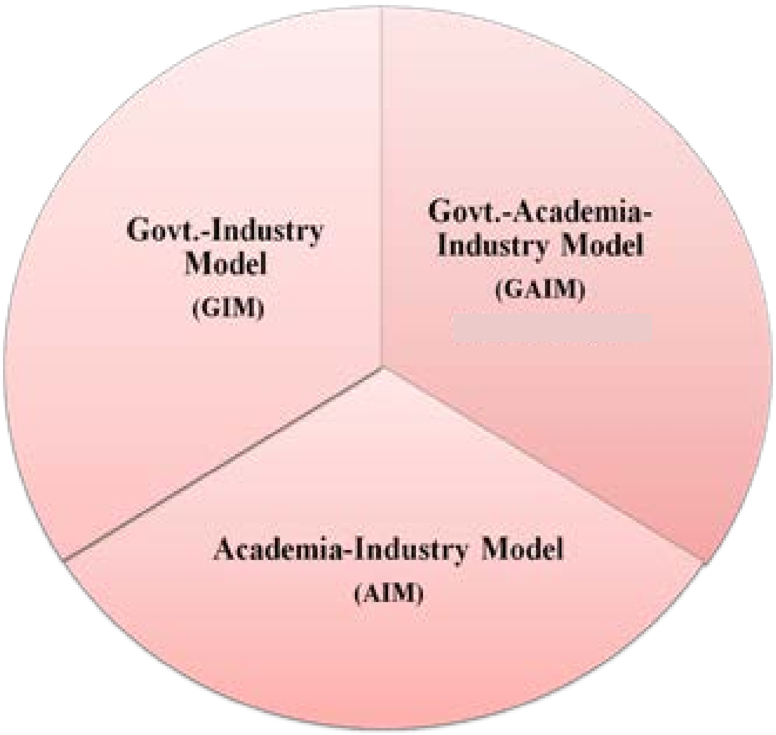
# DST-Centre for Policy Research at PU, Chd.

***(DST/PRC/CPR-03/2013)***

# <u>REPORT-2</u>

**(May, 2015-Aug., 2016)**

# *Existing Models of R&D under Public Private Partnership (PPP) Mode*



## CONTENTS

## Introduction

In this era of competitiveness, national economic growth needs to compete with rest of the world by means of creating strong and powerful national innovation system. A robust innovation system is essential for wealth creation, economic and societal development of the country. Since the beginning of the 21st century, the emphasis of the Indian government has been to develop national infrastructure under PPP mode. The emergence of India as a major global economic power calls for high levels of technological freedom but unfortunately the growth of technology has remained disunited and unlinked. This is due to the fact that the R&D activities of both the public and the private sector have remained disconnected from each other thereby creating a large gap in technology development and technology deployment. Synergies between academic basic research and industrial applied research have to be established to generate mutual added worth. To achieve this synergy it is imperative to create a PPP framework engaging both the public and the private sectors leading to multivariate use of knowledge, innovations, technologies and value creation of R&D activities. Government of India has instituted various R&D schemes at national level to promote innovations leading to technology development and utilization. But on the other hand, private sector role in R&D has remained superficial. Government is making continuous efforts for adoption of Public Private Partnership (PPP) by launching various innovation and technology development support programmes. Government efforts have catalyzed creation of robust interface between public owned research and academic institution and industry. Indian private sector needs to be incentivized to invest in R&D activities. In present Indian scenario, public funded research institutes and higher educational institutes are skewed towards basic and fundamental research rather than applied research. To attract the industry to drive PPP in R&D domain, research should be equally focussed for fundamental and applied areas. Innovations result of Industry-Academia interface can lead to knowledge creativity and productivity that will lead to socio-economic benefits.

In this decade of innovation (2010-20), government's thrust relies on PPPs to foster innovative ecosystem in India and PPPs are acting as one of the effective measures for industry to contribute to national innovation system. Keeping in mind the importance of PPPs in R&D, it is imperative to study existing models of PPP in R&D and associated PPP programmes of government funding agencies to present a successful examples of R&D under

PPP that can be replicated and promoted at different levels such as state and central universities, public owned research institutes and government funding agencies.

In the present chapter, detail overview of existing PPP models for promoting R&D activities is presented. Figure 1 presently the overlay of the chapter. Under each category, existing PPP mechanisms are elaborated. PPP models are discussed under three categories which are:

- Government-Industry Model (GIM)
- Academia-Industry Model (AIM)
- Government-Academia-Industry Model (GAIM)

# Existing PPP Models of R&D in India

## 1. Government-Industry Model (GIM)

- **A. Autonomous Institutes**
- **B. Industry Oriented Programmes of Funding Agencies**
- **C. Incentivization of Private Sector by DSIR**

## 2. Academia-Industry Model (AIM)

- **A. Industrial Set Ups in Academic Sector**
- **B. Scholarships/Fellowships/ Industrial Chairs/ Scientist Specific**
- **C. Industry Supported I-A Cells**

## 3. Government-Academia-Industry Model (GAIM)

***Triple Helix Model***

- **A. Autonomous Academic**
- **B. Creation of Dedicated Agencies**
- **C. Government Funding Schemes/Programmes and Government Initiatives**

# Existing PPP Models of R&D in India

## 2. Government-Industry Model (GIM)

- B. Autonomous Institutes
- B. Industry Oriented Programmes of Funding Agencies
- C. Incentivization of Private Sector by DSIR

## 2. Academia-Industry Model (AIM)

- B. Industrial Set Ups in Academic Sector
- B. Scholarships/Fellowships/ Industrial Chairs/ Scientist Specific
- C. Industry Supported I-A Cells

## 3. Government-Academia-Industry Model (GAIM)

***Triple Helix Model***

- B. Creation of Dedicated Agencies
- C. Government Funding Schemes/Programmes and Government Initiatives

# 1. Government-Industry Model (GIM)

## A. Research Institutes (Public and Private)

- **Research Institutes Established by Government and Industrial Sector**

  First category focuses on PPP models instituted by government and industry together leading to initiation of industry oriented research institutes, such as Indian Plywood Industries Research and Training Institute (IPIRTI); Bengaluru (www.ipirti.gov.in) and Automotive Research Association of India (ARAI), Pune (www.araiindia.com) which are discussed in the coming sections. These institutes were established by Government with an aim to provide technological support to industries and are now working in close association with industrial associations.

### (i) Indian Plywood Industries Research and Training Institute (IPIRTI); Bengaluru; *www.ipirti.gov.in*

IPIRTI is an autonomous body established in 1962, under the Ministry of Environment, Forests and Climate Change (MoEFCC), GoI. The Institute is a co-operative research association of the Plywood Industry and the Council of Scientific and Industrial Research (CSIR), and has evolved into a dynamic and creative organization dedicated in developing new environment friendly technologies for wood based industry. IPIRTI has been closely associated with the development of wood panel industry in the country and is also instrumental in its growth from its infant stage to the technical competence for producing high level of plywood. It has become industry driven organization. IPIRTI formulates projects based on the needs of the plywood industries. Funding support for projects is provided by various industries, national agencies like DST, NRDC, Bureau of Indian Standards (BIS), Building Materials and Technology Promotion Council (BMTPC) and international agencies like *International Tropical Timber Organization* (ITTO), International network for Bamboo and Rattan (INBAR), Department for International Development (DFID)/Timber Research and Development Association (TRADA). It has established field station/centre in Kolkata in year 1963 and Mohali in 2008 to meet the needs of industry in these regions.

IPIRTI is working with a mandate of carrying out a) R&D activities; b) education and training; c) testing and standardization services and d) extension services such as technical consultancy to academia and industries in field of wood and panel products such as lignocelluloses and agro residues. IPIRTI is recognized by BIS for testing and licensing/certification programme of wood and related products. IPIRTI has created a notable intellectual property profile. IPRTI is credited with 5 granted patents and 9 filed patents (Table 1). It has carried out 28 in house projects, 13 sponsored projects and 3 consultancy projects. It has successfully transferred 18 technologies to various organizations (Table 2).

**Table 1: List of Patents Granted to IPIRTI and Filed by IPIRTI**

| S. No. | Title | Status |
|---|---|---|
| **1.** | Development of Matchstick from Bamboo | Granted |
| **2.** | Bamboo Mat Corrugated Roofing Sheets | Granted |
| **3.** | Nn improved process for the preparation of water impermissible resings | Granted |
| **4.** | Improvements in relating to a process for making composite boards from rice husk | Granted |
| **5.** | An adhesive based on natural polyphenols | Granted |
| **6.** | Earthquake resistant Bamboo Housing System | Filed |
| **7.** | Improved method of manufacture of Bamboo Mat Board [BMB], and Bamboo Mat Veneer Composite [BMVC] | Filed |
| **8.** | Method of manufacture of Bamboo Mat Trays and Coir trays | Filed |
| **9.** | A process for manufacture of Cardanol Phenol Formaldehyde Resin | Filed |
| **10.** | Development of mechanized E-Tester | Filed |
| **11.** | Compregs from Bamboo Mats/Veneers of Plantation Timber or a combination and a process for the preparation thereof | Filed |
| **12.** | A process for the manufacture of Bamboo mat moulded skin board doors from Bamboo mats | Filed |
| **13.** | A process for the manufacture of Bamboo mat Ridge Cap roofing with Bamboo Mat Corrugated Sheets | Filed |
| **14.** | A process for gluing preservative treated veneer with improved Phenol Formaldehyde Resin | Filed |

**Table 2: Technologies Transferred from IPIRTI**

| S. No. | Technology | Transferred to |
|---|---|---|
| | **Industries** | |
| 1. | Development of 50mm Compreg using Gurjan species | Indeustch International, Noida |
| 2. | Manufacture of High Density Bamboo Mat Board | Divine Industries, Maharastra |
| 3. | Manufacture of Bamboo Mat Corrugated Sheet | Brahmaputra Forest Industries, Lakhimpur, Assam |

| | | |
|---|---|---|
| 4. | Instru-ments for Peeling Lathe adjust-ments | Kalyan Industries, Haryana |
| 5. | Finger Jointing Machine | Lakshmi Industries, Ahmedabad |
| 6. | Light coloured PF | Shivhari Plywood, Nanital |
| 7. | Shuttering grade plywood | TATA Coffee Ltd., Mysore |
| 8. | Bamboo technology (BMT) | Natura Pvt. Ltd., Bangalore |
| 9. | Bamboo technology (BMB and BMCS) | Timpack Pvt. Ltd., Meghalaya |
| 10. | Bamboo technology (BMB) | Supernatural Plywood, Chandapur |
| 11. | Bamboo technology (BMB & BMVC) | Cosmicraft Industries, Meghalaya |
| **Government organizations** | | |
| 12. | Bamboo technology (BMB & BMVC) | Kerala State Bamboo Corpn. Angamally, Kerala |
| 13. | Bamboo technology (BMB) | Gramvikas, Berhmapur |
| 14. | Bamboo technology (BMT) | BAIF, Pune |
| 15. | Coir Tray | Coir Board, Bangalore |
| 16. | Pine Needle Particle Board | Himachal Pradesh Forest Development Corpn. H.P. |
| 17. | Establishment of Bamboo Composite Centre | Rain Forest Research Institute, Jorhat, Assam |
| **International** | | |
| 18. | Manufacture of Bamboo Mat Corrugated Sheet | Habitat for Humanity International, Nepal |

Till date major technological achievements of the Institute are listed below:

- Development of processes for various resin systems
- Development of layered composites
- Development of Non-wood products
- Development in Solid Wood Products
- Protection and Enhancement of service life of wood and panel products
- Development of instruments, accessories and equipments

Moreover, for proper functioning of IPIRTI in terms of its IP profile, it has designed set of rules and regulations for IPR, technology transfer and consultancy (http://ipirti.gov.in/Rule_for_%20Patenting.pdf).

IPIRTI has also started various academic programmes in association with government agencies and industries to provide education and training in field of wood and panel industry. Various courses instituted in year 2014-15 are presented in table 3.

**Table 3: Short Term Courses Conducted by IPIRTI in 2014-15**

| S. No. | Name of the course | Duration and no. of candidates | Sponsored by |
|---|---|---|---|
| | **IPIRTI, Bangalore** | | |
| 1. | The Post Graduate Diploma Course in Wood and Panel Products Technology | 1 year, 25 | IPIRTI |
| 2. | Plywood Manufacturing Technology-II | 5 days, 9 | Plywood industry |
| 3. | Testing of plywood and bloack boards as per internationals tandards | 5 days, 1 | Plywood industry |
| 4. | IFS Training Course: Contribution of forests plantation in livelihood support and industrial production | 2 days, 10 | MoEF&CC, RT Division, New Delhi |
| 5. | Special Training: Sawmilling & Saw-doctoring and Wood working and wood finishing | 10 days, 8 | Kannur University |
| 6. | International Nepal's Training course: Plywood Manufacturing Technology-I | 3 days, 3 | Ganpati & Shikhar Plywood, Nepal |
| 7. | International Nepal's Training course: Plywood Manufacturing Technology-II | 3 days, 3 | Ganpati & Shikhar Plywood, Nepal |
| 8. | IPIRTI-NID Bamboo Training | 4 days, 45 | IPIRTI & NID, Bangalore |
| | **IPIRTI Field Station, Kolkata** | | |
| 9. | Plywood manufacturing Technology | 1 month, 7 | Plywood industry |
| 10. | Low cost and special Resin for manufacture of plywood | 4 days, 6 | Plywood industry |
| 11. | Testing of Plywood Block board and Flush Door | 4 days, 8 | Plywood industry |
| 12. | Plywood Manufacturing Technology | 1 month, 5 | Plywood industry |
| | **IPIRTI Centre, Mohali** | | |
| 13. | Testing of block board and flush door As per IS: 1659& IS:2202and Resin manufacturing conventional PF & UF resin | 10 days, 1 | Plywood industry |

***Source:*** *IPIRTI Annual Report (2014-15)*

IPIRTI is the only institute in India dealing with wood and panel industry. There are number of member industries of IPIRTI who are availing services offered by IPIRTI as mentioned in table 4.

**Table 4: IPIRTI Services to its Member Industries**

| S. No. | Service |
|---|---|
| 1. | Providing trained man power industries through one year post graduate diploma course and different short term vocational training course sponsored by industries and MoEFCC. |
| 2. | Providing solutions to common problems of the industries and their needs through regional workshops/meetings. |
| 3. | Extending technical support services related to processing and production of plywood |
| 4. | Formulating specifications for the new products developed by the industry and issue of draft amendments to existing standards. |

***Source:*** *www.ipirti.gov.in*

Till date, sixty eight industries have attained IPIRTI membership. Some of the notable member industries are:

ARCL Organics Ltd., Kolkata; Aditya Industries., Navsari; Century Plyboards ( I ) Ltd., West Bengal; Fine Wood Products Pvt. Ltd., Tamil Nadu; Greenply Industries Ltd., West Bengal; Hero Plywoods & Boards, Kerala; Indian Timber Products (P) Ltd., Hyderabad; The Indian Plywood Manufacturing Company Pvt. Ltd., Mumbai; Kanara Wood & Plywood Industries Ltd., Mangalore; Kaziranga Wood Products Pvt. Ltd., Guwahati; Madras Chipboard Ltd., Rajapalayam; Plystone Plywoods Pvt. Ltd., Ernakulam; The Western India Plywoods Ltd., Kannur.

### (ii) Automotive Research Association of India (ARAI), Pune

*www.araiindia.com*

ARAI, a Pune based co-operative industrial research unit, was established by the automotive industry in association with the Ministry of Industries (GoI) in 1966. ARAI is playing an essential role in designing less polluting, safe and more efficient vehicles. It provides technical assistance in domains of R&D along with testing, homologation, framing and certification of vehicle regulations. ARAI is known for its finest services and it is accredited with ISO 9001, ISO 14001, Occupational Health and Safety Management (OHSAS) 18001 and National Accreditation Board for Testing and Calibration Laboratories (NABL). Various kinds of services provided by ARAI are listed in table 5.

**Table 5: Services Offered by ARAI**

| S. No. | Service | Brief Details |
|---|---|---|
| **1.** | **R&D Services** | Pursuing research in fields, such as:<br>• Power Train<br>• Structural Dynamics<br>• Safety<br>• Electronics<br>• Materials<br>• Noise, Vibration and Harshness<br>• Computer aided engineering<br><br>ARAI has successfully developed indigenous LPG and CNG conversion kits, especially for two and three wheelers to meet EURO IV emission norms.<br><br>ARIA through its research activities in field of powertrain and electronics has generated key products of industrial importance, some of the key products are listed below:<br>• EURO - 4 CRDI Diesel Development<br>• CNG HCV For Bus Application<br>• LPG Passenger Car For OEM Application<br>• In-vehicle Duty Cycle and Operation Pattern Recorder<br>• Conversion of legacy sensors data to CAN messages |
| **2.** | **Education and Training** | ARAI has built ARAI Academy to develop world-class eco-friendly education institute for masters, doctoral and professional improvement courses in automotive engineering in collaboration with National and International Universities.<br>• VIT University, Vellore<br>• VELTEC University, Chennai<br>• College of Engineering Pune<br>• University of Alabama, Birmingham<br>• Braunschweig University, Germany |
| **3.** | **Forging Industry Division (FID)** | With its world class testing and validation laboratories for metallurgical and fatigue testing, product and process simulation and computer aided engineering, ARAI – FID is all set to make Indian forging a strong “Made in India” brand.<br>ARAI – FID understands training requirements of the industry very well and has developed full-fledged advanced training facility.<br>FID is supported and promoted by Ministry of Heavy Industries &Public Enterprises, Government of India, ARAI and Association of Indian Forging Industry (AIFI) |
| **4.** | **Certification** | ARAI provides certification for vehicles, engines, safety components, genset, agricultural equipments, construction equipments, bus body builders, Population Check Equipment |

| | | |
|---|---|---|
| | | (PUC) equipment, CNG Retro fitment, LPG Retro fitment, Conformity of Production (COP), export homologation, *Central Motor Vehicles Rules* (CMVR) Test Approval (TA) status. |
| 5. | **Testing and Calibration** | Under testing and calibration service, ARAI offers testing services to the auto component, auto electronics, embedded and IT industry in the following areas:<br>• Electromagnetic interference (EMI)/ Electromagnetic compatibility (EMC)<br>• Material; Chemical; Environment testing; Swirl testing Drop testing; Security product testing; Engine durability |
| 6. | **Standard Formulation** | Standard formulation are designed by ARAI under:<br>• Automotive Industry Standards Committee (AISC) set up under Central Motor Vehicles Rules-Technical Standing Committee (CMVR - TSC) by Ministry of Road Transport & Highways,(Dept. of Road Transport & Highways) (MoRT&H and DoRT&H) in the year 1997 to review the safety in the design, construction, operation and maintenance of motor vehicles.<br>• United Nations Economic Commission for Europe (UN-ECE) is an international body having its headquarters at Geneva, Switzerland. Under the Inland Transport Committee (ITC) of UN-ECE, there are several groups which deal with transport related technical and administrative matters. The group WP.29 (World Forum for Harmonization of Vehicle Regulations) deals with the subject of worldwide harmonization of automotive regulations.<br>• CMVR TAP |
| 7. | **Web based services** | ARAI provides web based services in field of homologation and regulations for DELTA application and TA certification. Along with this they provide expert advice in field of homologation. |

***Source****: www.araiindia.com*

ARAI has completed its 50 years of establishment. In these years, ARAI has progressed in terms of total income generated. In the year 2013-14, ARAI's total income was reported to be ₹19014 Lakhs. Figure 2 represents the total income of ARAI from 2008-2014. In these 7 years ARAI has revealed continuous growth in its income profiles. ARAI is credited with 12.8% growth in its operational income and 55% of its operational income comes from non-certification business which mainly lies on its R&D activities. Year 2012 onwards, learning and training centre also contributed to the operational income of ARIA. Figure 3 depicts the breakup of ARAI's operational income in 4 sections a) sponsored projects (government and industry funded); b) certification and routine testing; c) development testing and d) learning and training centre.

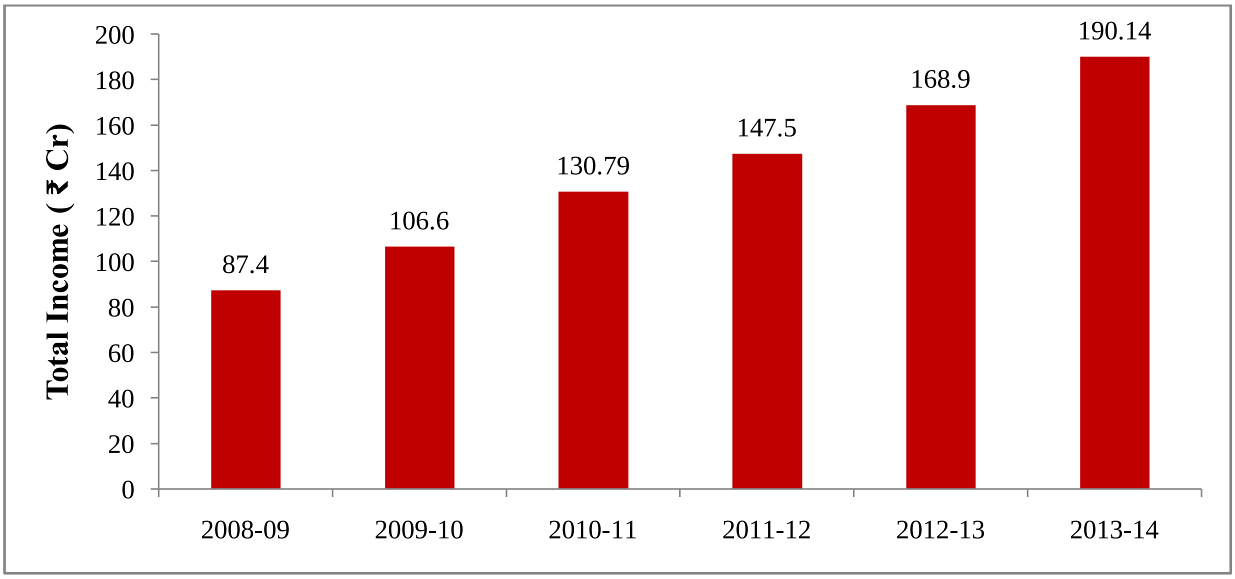
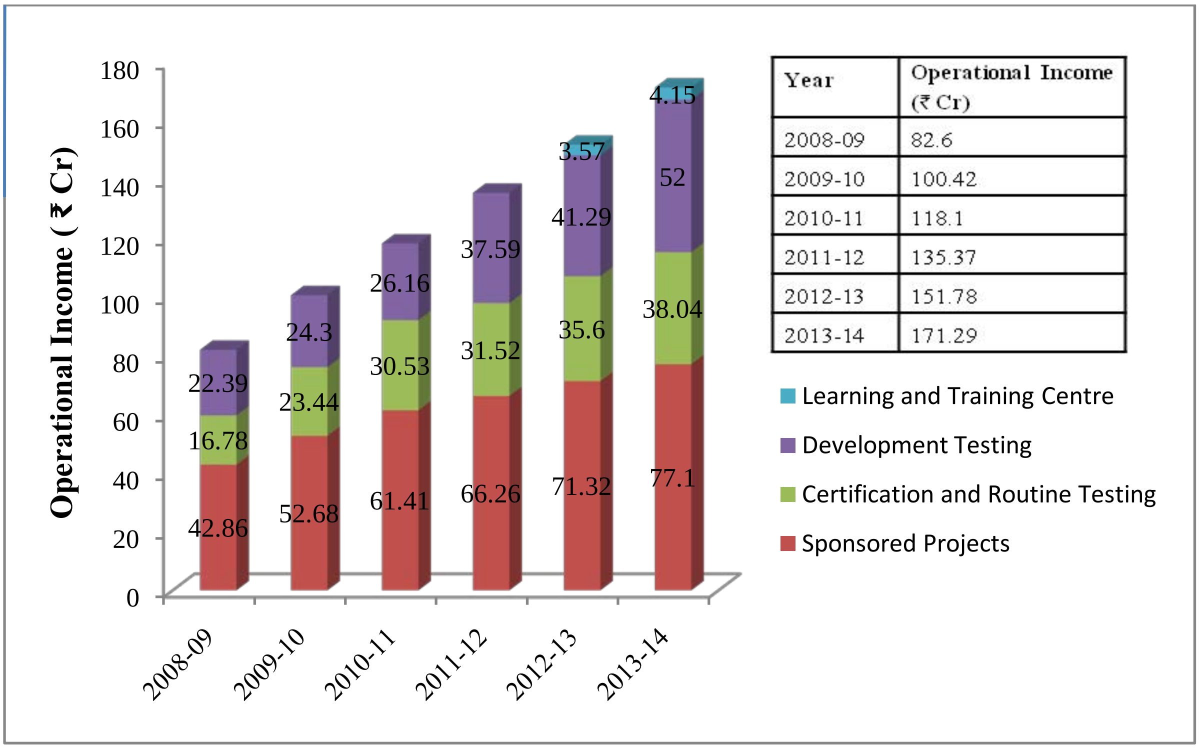



**Figure 2: Total Income Profile of ARAI from 2004-2014.**

***Source**: 44th Annual Report of ARAI (2013-14)*




| Year | Operational Income (₹ Cr) |
|---|---|
| 2008-09 | 82.6 |
| 2009-10 | 100.42 |
| 2010-11 | 118.1 |
| 2011-12 | 135.37 |
| 2012-13 | 151.78 |
| 2013-14 | 171.29 |

**Figure 3: Operational Income of ARAI from 2008-2014**

***Source**: 44th Annual Report of ARAI (2013-14)*

ARAI has strong industrial linkages. It has 73 member industries who are availing different services offered by ARAI. List of important member companies is presented below:

Ashok Leyland Ltd., Bajaj Auto Ltd., Bharat Forge Ltd., Bosch Ltd., Cummins Technologies India Pvt. Ltd., Delphi-TVS Diesel Systems Ltd., Eicher Motors Ltd., Fiat India Automobiles Pvt. Ltd., Ford India Pvt. Ltd., General Motors India Pvt. Ltd., Greaves Cotton Ltd., Hero Electric Vehicles Pvt. Ltd., Honda Cars India Ltd., Hyundai Motor India Ltd., Kirloskar Oil Engines Ltd., Lombardini India Pvt. Ltd., Mahindra & Mahindra Ltd., Maruti Suzuki India Ltd., Mercedes-Benz India Pvt. Ltd., Piaggio Vehicles Pvt. Ltd., Power Electronics, Skoda Auto India Pvt. Ltd., Tata Cummins Pvt. Ltd., Tata Motors Ltd., Toyota Kirloskar Motor Pvt. Ltd., TVS Motor Co. Ltd., Volkswagen India Pvt. Ltd., Volvo India Pvt. Ltd.

ARAI has successfully utilized its state-of-art laboratories, developed technologies and skilled manpower for generation of engineers to meet the demands of automotive industry. It has stretched it arms in industry as well as academia and has drawn immense benefits for the automobile industry in India.

**(iii) Government Supported Organization for Industrial Development**

Many other organization/institutes have been established by GoI for assisting industrialization of MSMEs (Table 6).

**Table 6: Organizations/Institutes established by GoI for Assisting Industrialization of MSMEs**

| S. No. | Institute | Brief Details |
|---|---|---|
| **1.** | **Mahatma Gandhi Institute for Rural Industrialization, Wardha, Maharashtra**<br>*A National Institute under the Ministry of Micro Small & Medium Enterprises, GoI*<br>http://www.mgiri.org/ | The institute is working with an aim of developing novel technologies for rural industries, entrepreneurs and enterprises to bring industrialization and technology up-gradation. It provides S&T support and R&D guidance to enterprises to compete globally. |
| **2.** | **National Institute for Micro, Small and Medium Enterprises**<br>*An organization under Ministry of Micro Small & Medium Enterprises, GoI*<br>http://nimsme.org/ | It is ISO 9001:2008 certified organization promoting advancement of MSMEs. Through its expertise in field of entrepreneurship development, technology development and management and informative services it has contributed to the promotion of MSMEs in India. It provides services, such as consultancy, research, training and extension to enterprises. It has carried out 885 research and consultancy projects.<br>It is pursuing intellectual facilitation |

| | | |
|---|---|---|
| | | services to MSMEs via schools of excellence which are: <br>• School of Enterprise Development (SED) <br>• School of Enterprise Extension (SEE) <br>• School of Enterprise Information and Communication (SEIC) <br>• School of Enterprise Management (SEM) |
| **3.** | **National Small Industries Corporation** <br>*Facilitating growth of small enterprises* <br>*GoI enterprise under Ministry of Micro, Small and Medium Enterprise* <br>http://www.nsic.co.in/SCHSERV.ASP | It is an ISO 9001:2008 certified government enterprise. It is working with an aim to promote growth of MSMEs. It provides marketing support, credit support, technology support and consultancy services for MSMEs. They have established 106 training cum incubation centres all over India for assisting technology growth of MSMEs. |
| **4.** | **Central Manufacturing Technology Institute (CMTI)** <br>http://cmti-india.net/ | CMTI is an R&D organization supported by DIPP is focusing its efforts mainly on harnessing know-how in the manufacturing technology sector to practical purposes and assisting technological growth in the country. CMTI has the role of being a Catalyst and a Key Player in manufacturing technology growth in the country. |
| **5.** | **Central Pulp & Paper Research Institute (CPPRI)** <br>http://www.cppri.org.in/ | The institute was established as a autonomous body under administrative control of DIPP, GoI, to promote R&D in the field of pulp & paper. |
| **6.** | **National Council for Cement and Building Materials (NCB)** <br>http://www.ncbindia.com/ | NCB is the premier body under the administrative control of Ministry of Commerce and Industry, Govt. of India, for technology development, transfer, continuing education and industrial services for cement and construction industries. |

## B. Industry Oriented Programmes of Funding Agencies

Various funding agencies have initiated number of programmes/schemes to support R&D in industries. Industrial association and GoI has together created a dedicated agency such as GITA (http://gita.org.in/), a joint initiative of DST, GoI and CII, for promoting industrial development globally by providing funding support and capacity building for industrial

R&D. Industrial association FICCI and DIPP, GoI created a joint initiative 'Invest India' (http://www.investindia.gov.in/) for facilitating investments in R&D. Industry and DST also joined hands for starting a unique fellowship programme 'Prime Minister Fellowship Programme' for researchers pursuing industrial R&D, where industry and SERB, DST contributes equally for fellowship.

Table 7 lists down the programmes/schemes initiated by government funding agencies for promotion of industrial R&D contributing to the growth of Indian industry.

**Table 7: Industry Oriented Programmes of Government Funding Agencies**

| S. No. | Programme/Scheme | Government Funding Agency |
|---|---|---|
| 1. | Technology Development Board (TDB) http://tdb.gov.in/ | DST |
| 2. | Drugs and Pharmaceutical Research Programme http://www.dst.gov.in/drugs-pharmaceutical-research | DST |
| 3. | Patent Acquisition and Collaborative Research and Technology Development (PACE) http://www.dsir.gov.in/12plan/pace/pace.htm | DSIR |
| 4. | Promoting Innovations in Individuals, Start-ups and MSMEs (PRISM) http://www.dsir.gov.in/12plan/prism/prism.htm | DSIR |
| 5. | Access to Knowledge for Technology Development and Dissemination (A2K+) http://www.dsir.gov.in/12plan/a2k+/a2k+s.htm | DSIR |
| 6. | Technology Development and Demonstration Program (TDDP) http://www.dsir.gov.in/tpdup/tddp/tddp.htm | DSIR |
| 7. | Technology Management Programme (TMP) http://www.dsir.gov.in/tpdup/tmp/tmp.htm | DSIR |
| 8. | International Technology Transfer Programme (ITTP) http://www.dsir.gov.in/tpdup/ittp/ittp.htm | DSIR |
| 9. | National Agricultural Technology Project (NATP) http://www.agriinfo.in/default.aspx?page=topic&superid=7&topicid=1472 | ICAR |
| 10. | The DRDO-FICCI ATAC Programme http://drdoficciatac.com/ | DRDO |
| 11. | Extramural Research (ER) and Grant-in-aid Schemes http://drdo.gov.in/drdo/English/index.jsp?pg=grantinaid.jsp | DRDO |
| 12. | Industrial Corridor Projects http://dipp.nic.in/English/default.aspx | DIPP |
| 13. | Modified Industrial Infrastructure Upgradation Scheme (MIIUS) | DIPP |

| | | |
|---|---|---|
| | http://dipp.nic.in/English/Schemes/IIUS.aspx | |
| 14. | Antrix Corporation Limited<br>http://www.antrix.gov.in/ | ISRO |
| 15. | Biotechnology Industry Partnership Programme (BIPP)<br>http://www.birac.nic.in/desc_new.php?id=76 | BIRAC |
| 16. | Technology Upgradation Fund Scheme for the Textile Industries (TUFS)<br>http://www.sidbi.com/?q=government-subsidy-schemes | SIDBI |
| 17. | Technology and Quality upgradation Support to Micro, Small & Medium Enterprises (TEQUP)<br>http://www.sidbi.com/?q=government-subsidy-schemes | SIDBI |
| 18. | Credit Linked Capital Subsidy Scheme (CLCSS)<br>http://www.sidbi.com/?q=government-subsidy-schemes | SIDBI |
| 19. | Integrated Development of Leather Sector Scheme (IDLSS)<br>http://www.sidbi.com/?q=government-subsidy-schemes | SIDBI |
| 20. | Scheme for Food Processing Industries<br>http://www.sidbi.com/?q=government-subsidy-schemes | SIDBI |

## C. Incentivization of Private Sector by DSIR

DSIR, nodal agency under Ministry of Science and Technology, New Delhi which is working with a mandate of promoting industrial research, supporting indigenous technology development and faster commercialization. DSIR has taken an initiative of "***Building Industrial R&D and Common Research Facilities (BIRD-Crf)***". Under this initiative, DSIR has commenced granting recognition to **In-House R&D Units** established by corporate companies and Scientific and Industrial Research Organizations (SIRO). Recognition of In-House R&D Units (RDI) is the solitary scheme in the entire Government sector for benchmarking R&D pursued by industrial sector. Through this DSIR recognition, industries pursuing research and innovation practices can avail fiscal incentives from the government sector which are categorized as a) Funding for R&D from Government Agencies and b) Tax Rebate and Customs /Excise Duty Waiver on Inputs for R&D.

**Incentives provided to private sector by GOI, as on Nov. 2015**

- **Incentives based on direct taxes (Income-tax Act, 1961)**

- 100% write off of revenue expenditure on R&D; (Section 35(1)(i) of IT Act).

- 100% write off of capital expenditure on R&D in the year the expenditure is incurred; (Section 35(1)(iv) of IT Act).
- Weighted tax deduction @175% (to the sponsor) for payments made to approved national laboratories, universities and IITs or a specified person, with a specific direction that the said sum shall be used for scientific research under a programme. (Section 35(2AA) of the IT Act).
- Weighted tax deduction @200% on expenditure (other than land & buildings) incurred on approved in-house R&D facilities of companies engaged in the business of biotechnology or in any business of manufacture or production of any article or thing, not being an article or thing specified in the list of the Eleventh Schedule. [Expenditure on scientific research in relation to drugs and pharmaceuticals, includes expenditure incurred on clinical drug trials, obtaining approvals from any regulatory authority under any Central, State or Provincial Act and filing an application for a patent under the Patents Act, 1970 (39 of 1970). (Section 35(2AB) of the IT Act.)]
- Accelerated depreciation allowance for investment on plant and machinery, made on the basis of indigenous technology (Rule 5(2) of IT Rules, 1962).

➢ **Incentives based on indirect taxes**

- Customs duty exemption to in-house R&D units established by corporate companies, other than a Hospital for capital equipment and consumables needed for R&D. (Notification No.24/2007-customs, dated 01 March, 2007 as amended from time to time).
- Central excise duty exemption to in-house R&D units established by corporate companies, other than a Hospital for capital equipment and consumables needed for R&D. (Notification No.16/2007-central excise, dated 01 March, 2007 as amended from time to time).
- Central excise duty waiver for 3 years on goods designed and developed by a wholly owned Indian company and patented in any two countries out of: India, USA, Japan and any one country of European Union (Notification No.15/96-CE dated July 23, 1996, amended vide Notification No.13/99-CE dated 28 February, 1999).
- Exemption from customs duty on imports made for R&D projects funded by Government in industry. (Notification No. 50/96-Customs dated 23 July 1996).

- Goods specified in List-28 (comprising of analytical and specialty equipment) for use in pharmaceutical and biotechnology sector allowed to be imported duty free {notification No. 26/2003-Customs dated 1 March 2003 (entry substituted at S. No. 248 of the table in the said notification)} Subject to conditions mentioned in the notifications.

## 2. Academia- Industry Model (AIM)

Academic institutions are the store house of the R&D activities. They possess handsome amount of resources that can lead to generation of novel technologies that can be readily commercialized contributing to economic and societal benefits. Whereas, industrial sector in order to progress and compete globally need to bring innovation in their existing systems. Therefore, it is imperative for academia and industry to come in close collaboration in order to pursue directed research that can be successfully transferred to industries.

In this category, successful industry-academia initiatives are briefed in following sections:

### A. <u>Industrial Setups (Research Laboratories) in Academic Sector</u>

Industries are coming forward to collaborate with academic sector to pursue collaborative research. Various industries have set up specialized laboratories/units in academic institutions where industry personals and academicians (faculty and researchers) together carry out industry oriented research activities. Table 8 represents some of the notable industrial sets ups in different academic institutes where academia and industry in partnership are pursing R&D activities.

**Table 8: Laboratories Set Up by Industry in Academic Sector**

| **Industrial Set up** | **Academic Institution** |
|---|---|
| • M. K. Rangnekar Memorial Laboratory<br>• Ramesh Banatwala Memorial Industrial Pharmacy Laboratory<br>• E- Merck Laboratory and Chemistry Laboratory<br>• Nihchal Israni Microbiological Laboratory | BCP Mumbai |
| • Xilinx FPGA Laboratory<br>• The Tata Infotech Laboratory<br>• Intel Microelectronics Laboratory<br>• Laboratory for Intelligent Internet Research<br>• Tata Consultancy Services Laboratory for VLSI Design and Device Characterisation<br>• Texas Instruments Digital Signal Processing (TI-DSP) Laboratory<br>• Wadhwani Electronics Laboratory<br>• Cummins Engine Research Laboratory<br>• Applied Materials Nano manufacturing Laboratory<br>• VLSI Design Consortium | IIT Bombay |

| | |
|---|---|
| • Intel set up a Planet Labs in E&C Dept.<br>• Cisco set up equipment for a Telephony and Security Lab in E&C Dept. | IIT Roorkee |
| • Bharti School Of Telecommunication Technology And Management | IIT Delhi |
| • General Motors-IIT Kharagpur Collaborative Research Laboratory on Electronics, Controls and Software | IIT Kharagpur |
| (iv) Autodesk, Microsoft and Intel have established Centres of Excellence and sponsored research laboratories in the campus. | IIT Madras |
| (v) Ricoh Company- Centre for Design and Innovation at the Institute.<br>(vi) Analog Teaching Lab and C2000 Micro Controller Lab Setup by Cranes Software International Limited | IIT Gandhinagar |

## B. Scholarships/Fellowships/Industrial Chairs/Scientists Specific

Industry-Academia has collaborated for pursuing R&D and for this industry has come up with the grant of special fellowships and scholarships for researchers doing industrial research. List of some of the notable fellowships from industry to researchers for pursuing I-A collaborative projects is presented below:

**Table 9: Fellowships/Scholarships Sponsored by Industry**

| S. No. | Fellowship/Scholarship |
|---|---|
| | Prime Minister Fellowship Scheme- Industry and government funding agency to pay equal amount of fellowship to the researcher pursuing industrial research |
| | Industry oriented fellowships in IITs<br>IIT Kharagpur:<br>• Google India Fellowship<br>• Aditya Birla Fellowship<br>• TCS Research Scholarship<br>• Singapore Technologies Engineering Scholarships<br><br>IIT Bombay:<br>• Infosys fellowship |

| | |
|---|---|
| | • Intel India Fellowship<br>• TCS Research Scholarship<br><br>IIT Madras<br>• Aditya Birla Fellowship<br>• Nissan Scholarship<br>• TCS Research Scholarship<br>• Singapore Technologies Engineering Scholarships |
| | ICT Mumbai<br>• Pidilite Industries Ltd, Visiting fellow in Dyestuff Science & Technology<br>• Marico Industries Visiting Fellowship<br>• ICT - Lupin Visiting Fellowship for Bioprocess Technology<br>• CIPLA Distinguished Visiting Fellowship in Pharmaceutical Sciences |

Various industries are in collaboration with academia in sponsoring industry chair through which they support scientist pursuing industrial research. Table 10 lists some of the notable industrial chairs in HEIs.

**Table 10: Industrial chairs in HEIs in India**

| S. No. | Industrial Chair | Academic Institution |
|---|---|---|
| 1. | TATA Chair | IIT Bombay |
| 2. | Praj Industries Chair | IIT Bombay |
| 3. | Forbes Marshall Chair | IIT Bombay |
| 4. | Bajaj Group Chair | IIT Bombay |
| 5. | USV Chair | IIT Kanpur |
| 6. | ABB Chair | IIT Delhi |
| 7. | Microsoft Chair | IIT Delhi |
| 8. | Henry Ford Chair | IIT Delhi |
| 9. | Bharti Airtel Chair | IIT Delhi |
| 10. | Reliance Chair | IIT Bhubaneswar |
| 11. | Bharat Petroleum Distinguished Professor of Chemical Engineering | ICT Mumbai |
| 12. | V.V. Mariwala Chair in Chemical Engineering | ICT Mumbai |
| 13. | J.G. Kane Chair of Oil Technology | ICT Mumbai |
| 14. | R. A. Mashelkar Chair of Chemical Engineering | ICT Mumbai |

On individual basis faculty/scientist of the HEIs also collaborates with industries to carry out collaborative research projects.

## C. <u>Industry supported I-A cells</u>

Various industries have supported academic institution for creation of dedicated Industry-Academia cells. One such I-A cell is Pfizer-Foundation for Innovation and Technology Transfer (FITT). Details of FITT as a successful model of academia industry initiative for PPP is given below.

- ***Pfizer-Foundation for Innovation and Technology Transfer (FITT)***
  *http://fitt-iitd.in/*

GoI established FITT in 1995 in the campus of Indian Institute of Technology, Delhi (IIT-D), a premier engineering institute of India by GoI as the first I-A interface (FITT Annual Report, 1994-95). The GoI at that time provided an amount of ₹ 16.2 million as an aggregated fund to IIT-D for initiation and build up of FITT. The centre was set up as an autonomous and self governing body, to act as a single window utility to the industrial sector with complete professionalism and function as a marketing arm for the IIT-D developed technologies (Sengupta, 2009).

The broad organizational structure is composed of a) Governing Council and b) Research Council. The governing council consists of representatives from industries; industrial associations and nominee from MHRD, selected nominated members from IIT-D senate and its board of governors. On the other hand, research council is composed of selected faculty members of IIT-D having experience in I-A collaborations. The management is vested with the managing director of the organization, guided by governing council and research council. Details are given in Annexure I

# 3. Government-Academia-Industry Model (GAIM)

***Triple Helix Model***

In third category of PPP, three sectors government academia and industry together in partnership in a form of triple helix are discussed below in 4 sections.

## A. Autonomous academic institutions

Autonomous academic institutions, such as Bombay College of Pharmacy and Institute of Chemical Technology were created on industry demands by getting support from government and industry. These institutes are working in close collaboration with industries and have significantly contributed to the industrial growth. These institutes are explained in following section.

### (i) *Bombay College of Pharmacy, Mumbai*

*www.bcpindia.org*

Bombay College of Pharmacy (BCP) affiliated to University of Mumbai, is one of the premier pharmacy colleges in India, imparting quality pharmacy education and research. It was established in 1957 by the Indian Pharmaceutical Association-Maharashtra State Branch (IPA-MSB) with financial assistance from several pharmaceutical conglomerates and Government of Maharashtra to address the needs of pharma industry. Within few years of its establishment, number of graduate, master and doctorate programmes were started in particular branches of pharmaceutical sciences. Since its inception, BCP has grown in stature, and has generated more than 3500 pharmacists, ~700 M. Pharma and ~100 Ph.D. graduates.

BCP is providing master’s and Ph.D. programmes through which research in various domains such as Pharmaceutics, Pharmacology and Toxicology, Pharmaceutical Chemistry, Pharmacognosy and Pharmaceutical Analysis is carried out. BCP has formed the research society which is recognized by DSIR, GoI. It has established world class facilities, state of the art instruments and equipments. Research is highly promoted in the college, faculty members have received number of research grants worth ₹100 million from Government funding agencies (DST, DBT, ICMR, UGC and AICTE) and ~₹10 million from private sector. Number of Industry-Academia (I-A) collaborative projects are undertaken in BCP. Till date, More than 300 industry sponsored projects have been successfully completed by BCP. The college has built up effective interface with the industrial sector in term of industrial trainings, industry sponsored projects, consultancy and faculty exchange.

BCP has been accredited with the "Best Industry-Linked Institution in Pharmacy" according tp the national survey carried out by AICTE in collaboration with CII, consecutively from past three years (2013 onwards). Details of BCP are given in Annexure II.

### (ii) *Institute of Chemical Technology, Mumbai*

*www.ictmumbai.edu.in*

The Institute of Chemical Technology (ICT), Mumbai was established in 1933 with active industrial participation, as University Department of Chemical Technology (UDCT) under University of Mumbai, with the noble intention of enhancing India's knowledge base in chemical science and technology. Based on its continuous progress in academics and translational research, UDCT was upgraded to Deemed-to-be-University and renamed as Institute of Chemical Technology in 2008. Recently (2016), ICT-Mumbai has been ranked as number 2 university, under the National Institutional Ranking Framework (NIRF) of MHRD, (GoI). Details of ICT Mumbai is given in Annexure III.

## B. Creation of dedicated agencies promoting PPP

Government has created specialized agencies for promoting investments in R&D from both industrial and academic sector in PPP mode. One of such agency is BIRAC which was established by DBT, GoI with a mandate of strengthening Indian Biotech Sector by bringing industry and academia together and enhancing entrepreneurship in biotech field. On the other hand, CSIR supported the creation of CSIR Tech as a commercialization arm for various academic institutions including R&D institutions and universities by collaborating with potential industries.

### (i) ***Biotechnology Industry Research Assistance Council (BIRAC),***

*www.birac.nic.in*

BIRAC is a not-for-profit Section-8, schedule B, public sector enterprise registered under Indian Companies Act 1956 and was established in 2012 by Department of Biotechnology, GoI, (DBT; http://www.dbtindia.nic.in/). DBT created BIRAC as an I-A interface agency to stimulate emerging biotech enterprises in India by supporting R&D activities addressing the national societal needs to make the biotech sector globally competitive. Various schemes of BIRAC promoting I-A interface are presented in table 11.

**Table 11: Industry-Academia Programmes Offered by BIRAC**

| S. No. | Programmes | Brief details |
|---|---|---|
| 1 | **Small Business Innovation Research Initiative (SBIRI)** http://www.birac.nic.in/desc_new.php?id=75 | Scheme was started to boost PPP functioning in the country by facilitating innovations, risk taking ability by small and medium companies and bringing together the industries, public institutions and the government under one roof to promote research in the Indian biotech sector. |
| 2 | **Biotechnology Industry Partnership Programme (BIPP)** http://www.birac.nic.in/desc_new.php?id=76 | BIPP promotes government partnership with industrial sector for supporting path-breaking research in futuristic technological areas along with societal importance. |
| 3 | **Contract Research Scheme (CRS)** http://www.birac.nic.in/desc_new.php?id=104 | It aims to enable promotion of academia research having commercial potential to engage the Contract Research and Manufacturing Systems (CRAMS) industry for validating a process or a prototype. |
| 4 | **Biotechnology Ignition Grant Scheme (BIG)** http://www.birac.nic.in/desc_new.php?id=83 | BIG is made available to scientist entrepreneurs working in research institutes, academia to initiate their own start-ups. |
| 5 | **BIRAC University Innovation Cluster: (UIC)** http://www.birac.nic.in/desc_new.php?id=95 | Five universities possess Cluster Innovation. **These centres are working to promote entrepreneurial cultures and pursue industry oriented research having commercial importance.** |
| 6 | **BIRAC Regional Innovation Centre (BRIC) at IKP Knowledge Park** http://www.birac.nic.in/desc_new.php?id=94 | It is working for mapping regional innovation ecosystem for Southern India to bring out technologies of commercial importance. |
| 7 | **Bio-Incubator Support** http://www.birac.nic.in/desc_new.php?id=92 | Bio-incubation support is harnessing entrepreneurial potential of start-ups and is providing access to well-developed infrastructure networking platforms. **Till now BIRAC has extended support to15 Bio incubators.** |
| 8 | **BIRAC-SRISTI (Society for Research and Initiatives for Sustainable Technologies and Institutions)** http://www.birac.nic.in/desc_new.php?id=98 | This scheme is promoting indigenous and grassroot innovations. For example:<br>• Development of **Honey Bee Network** (HBN; http://www.sristi.org/hbnew/index.php) for extracting, protecting and promoting innovative ideas from all over the country.<br>• Creation of **Techpedia** (http://techpedia.sristi.org/) as a platform to put problems of small and medium enterprises and locate solutions for them. Academicians, industries, researchers, students and entrepreneurs can register and draw services that come under techpedia. |

| | | |
|---|---|---|
| | | • Creation of **Social Innovation Fund** (http://sif.sristi.org/) for providing mentoring, financial and fabrication support to academicians, industries and budding entrepreneurs to carry forward their innovations. |
| 9 | **BIRAC AcE Fund - Accelerating Entrepreneurs** http://www.birac.nic.in/desc_new.php?id=99 | This scheme provides access to equity based fund for budding entrepreneurs. |

***Source:*** *www.birac.nic.in*

### (ii) *CSIR-Tech Private limited, Pune,* www.csirtech.com

CSIR-Tech, a for-profit private limited company established in 2011 by CSIR, is a private sector company dealing in commercialization of Intellectual Property from public funded R&D labs and various academic institutions in India. CSIR-Tech is providing entrepreneurial and flexible organization functioning in a competitive environment to ensure the best outputs from R&D investments. The ownership of CSIR-Tech lies with Entrepreneurial Development Centre (EDC) of CSIR-National Chemical Laboratory (CSIR-NCL), Pune; CSIR-Scientists Welfare Trust (CSIR-SWT) and the State Bank of India (SBI). Its major focus area is to act as catalyst for journey of technology transfer from lab to market and encouraging set up of new technology ventures like spin-offs and start-ups by means of collaboration with R&D labs. CSIR-Tech provides different services as mentioned in table 12.

**Table 12: Major Offerings of CSIR-Tech**

| S. No. | Offerings | Focus Area |
|---|---|---|
| 1 | **Technology Promotion** | Provides assistance to associated industries and CSIR research laboratory for opportunity identification, technology transfer and technology de-risking in different areas of R&D. |
| 2 | **IPR Management** | CSIR-Tech also provides support in IP related issues such as IP filing and IP licensing. |
| 3 | **Industry Advisory Services** | Industry gets mentorship and financial support from CSIR-Tech for technology scouting, R&D partner search, market research and consulting, open innovation, technology/IP evaluation and forming industry clusters. |
| 4 | **Government Advisory Services** | Provides government advisory services to various government bodies for capacity building, research, S&T development especially for strengthening I-A interactions under triple helix model. |
| 5 | **Incubation Support** | Provides incubation support to budding entrepreneurs and start-ups for business planning and raising finances and analysing market penetration |

***Source:*** *www.csirtech.com*

## C. Programmes and Initiatives of Public and Private Sector

Government funding agencies and various industrial associations have instituted various programmes and schemes for bringing government, industry and academia together. Moreover, funding agencies have taken impactful initiatives such as creation of Centre of Excellence, TBIs and S&T parks for enhancing MSMEs growth and entrepreneurship in India.

**Table 13: Programmes for Stimulating Industry-Academia Linkages**

| S. No. | Programme/Scheme/initiative | Government Funding Agency |
|---|---|---|
| 1. | Schemes for Funding Industry Relevant R&D (Under SERB) http://www.serb.gov.in/home.php | DST |
| 2. | International S&T Co-operation http://www.dst.gov.in/international-st-cooperation | GITA |
| 3. | Advanced Composites Programme http://tifac.org.in/index.php?option=com | TIFAC |
| 4. | Collaborated Automobile R&D Core-Group ifac.org.in/index.php?option=com_content&view=article&id=68&Itemid=99 | TIFAC |
| 5. | Promoting Innovations in Individuals, Start-ups and MSMEs (PRISM) http://www.dsir.gov.in/12plan/prism/prism.htm | DSIR |
| 6. | Consultancy Promotion Programme (CPP) http://www.dsir.gov.in/tpdup/cpp/cpp.htm | DSIR |
| 7. | New Millennium Indian Technology Leadership Initiative' (NMITLI) http://www.csir.res.in/external/heads/collaborations/nmitli.htm | CSIR |
| 8. | Small Business Innovation Research Initiative (SBIRI) http://www.birac.nic.in/desc_new.php?id=75 | BIRAC |
| 9. | Contract Research Scheme (CRS) http://www.birac.nic.in/desc_new.php?id=104 | BIRAC |
| 10. | BARC Entrepreneur's Corner- Technology Transfer and Consultancy & Scientific Services http://www.barc.gov.in/ | DAE |
| 11. | Visvesvaraya Ph.D. Scheme for Electronics and IT http://deity.gov.in/content/schemes-projects | MeitY |
| 12. | Scheme for Financial Assistance to Select States/UTs for Skill Development in Electronics System Design and Manufacturing (ESDM) sector http://deity.gov.in/content/schemes-projects | MeitY |
| 13. | Scheme of Financial Assistance for Setting Up of Electronics and ICT Academies http://deity.gov.in/content/scheme-financial-assistance-setting- | MeitY |

| | | |
|---|---|---|
| | electronics-and-ict-academies | |
| 14. | Council for Industry Higher Education Cooperation (CIHEC)<br>http://mhrd.gov.in/collaboration | MHRD |
| 15. | Technical Education Quality Improvement Programme (TEQIP)<br>http://mhrd.gov.in/technical-education-12 | MHRD |
| 16. | Global Initiative for Academic Network (GIAN)<br>http://www.sici.org/programmes/details/global-initiative-for-academic-network-gian-programme/ | MHRD |
| 17. | Kaushal Kendras<br>http://mhrd.gov.in/sites/upload_files/mhrd/files/lu3667.pdf | MHRD |
| 18. | University-Industry Inter Linkage (UIL) Centres<br>www.ugc.ac.in | UGC |
| 19. | Industry Institute Partnership Cell (IIPC)<br>http://www.aicte-india.org/schiipc.php | AICTE |
| 20. | AICTE – Indian National Academy of Engineering (INAE) Distinguished Visiting Professorship (DVP)<br>http://inae.in/aicte-inae-distinguished-visiting-professorship-scheme/ | AICTE |
| | **Industry Association** | |
| 21. | National Knowledge Functional Hub<br>http://ficci-nkfh.com/ | FICCI |
| 22. | I-A-Research/ Government Interface (IARGI)<br>http://www.ficcifwi.com/ppts/rnd2.pdf | FICCI |

**D. Initiatives (Centre of Excellence, Technology Business Incubators, S&T Parks and Accelerators)**

In order to promote R&D activities in HEIs, government has undertaken initiatives, such as creation of Centre of Excellence, Technology Business Incubators, S&T Parks and Accelerators where industries, academicians, government and budding entrepreneurs are placed under single roof. Other than these, various specific scholarships/fellowships and industrial chairs were promoted to bring academia and industry close to each other. These initiatives taken for promotion of R&D to bring industry and academia together are briefed below.

- **Centres of Excellence (CoEs)**

CoEs are the organizational set ups for pursuing high standards of research addressing number of socio-economic objectives. Creation of such CoEs in HEIs and research institutes has contributed to the stimulation of technological innovations in different sector. Government introduced various schemes for established of CoEs. One such CoEs working under PPP mode is Telecom Centres of Excellence (TCOEs). These are the perfect examples of academia, industry and government working together to achieve excellence in field of R&D. They were created with an objective to promote generation of IPRs, development of new technologies, incubating innovations and entrepreneurship in telecom sector. TCOEs were conceptualized in 2007 and came into existence in 2008. Various telecom industries became sponsors for establishing TCOE in premier institutes in India such as IIT and IISc (Table 14).

**Table 14: Telecom Centres of Excellence in India**

| S. No. | TCOE | Research Focus Area |
|---|---|---|
| a. | Aircel TCOE at IISc Bangalore | Information security and Disaster Management of Telecom Infrastructure |
| b. | Bharat Sanchar Nigam Ltd. (BSNL) TCOE at IIT, Kanpur | Multimedia and Telecom, Cognitive Radio and Computational Mathematics |
| c. | Bharti Airtel TCOE at IIT Delhi | Telecom Technology and Management |
| d. | Idea Cellular TCOE at IIM Ahmedabad | Telecom Policy, Regulation, Customer care |
| e. | Reliance Communications TCOE at IIT Madras | Telecom Infrastructure (Active and Passive) and Energ |
| f. | Tata Teleservices TCOE at IIT Bombay | Rural Telecom Technology |
| g. | Vodafone Essar TCOE at IIT Kharagpur | Next Generation Networks and Technology |
| h. | RailTel TCOE at IIT Roorkee | ICT and Broadband Applications |

Numbers of CoEs were created by government funding agencies with an objective to develop a dedicated facility in particular research domain to promote innovation and technology development in association with industry. One such centre created by DBT is the Centre for Cellular and Molecular Platforms (C-CAMP). C-CAMP is acting as technology platform for industry interaction/collaboration, innovations and incubations. They provide number of services for research, technology development and entrepreneurship to various stakeholders such as academia, other research institutes and industries. MHRD has also created CoEs under the scheme of ‘Training and Research in Frontier Areas of Science and Technology’ (FAST). These centres possess world class infrastructure and facilities and are pursuing research as per industrial needs. 36 centres of excellence were created by MHRD in different parts of India. MHRD also established 30 CoEs under the scheme ‘Technical Education Quality Improvement Programme’ (TEQIP). Government has also announced setting up of more CoEs, to be run under PPP mode for adoption of industry oriented technologies. For instance, announcement for creation of CoE in lot technology in association with

NASSCOM, MeitY and Education and Research Network (ERNET), which was announced by government in 2016.

There are some of the industrial units who have also established CoEs for technology upgradation. They strive for technological solution from government and academia. Examples of such CoE are 150 IBM Software CoEs, created in 20 different locations in India to create generations of IT innovators.

- **Technology Business Incubators (TBIs)**

National Science and Technology Entrepreneurship Development Board (NSTEDB) under the aegis of DST , New Delhi has taken impactful“Institution Mechanisms Building Initiative” by building Technology Business Incubators (TBIs) all over India to incubate indigenous technology for creating technology based new enterprises, facilitating transfer of technologies and entrepreneurship development. NSTEDB has established 66 TBIs (http://www.nstedb.com/institutional/tbi.htm) in different parts of India in collaboration with host institute and DST. Each TBI has dedicated thrust areas and are working with mandate to build efficient technologies in their respective domains. Each TBI are acting as a role model for enhancing industrial involvement in academic research, hence leading to PPP R&D. Other then NSTEDB under DST, New Delhi, there are some other agencies which support establishment of Incubators and support technology incubation at various educational institutes and R&D organizations. For instance, BIRAC has initiated a programme of Bio-Incubators with an aim to harnesses technology generation and entrepreneurial potential of start ups by giving access to them for proper infrastructure and mentoring. Till date, BIRAC has strengthened the existing fifteen incubation facilities in the country to develop world class bio-incubation facilities. Under Atal Innovation Mission at NITI Ayog, scheme for creating Atal Incubation Centres (AICs) at different educational institutes in order to promote incubation and entrepreneurship culture has been announced. Ministry of Electronics and Information Technology (MeitY) has also established an incubation centre at Patna and Cochin, Kerala for development of Product and IP creation.

Table 15 lists of notable TBIs in different parts of India working for technology enhancement and simultaneously addressing the gap in PPP.

**Table 15: Technology Business Incubators (TBI) working for PPP**

| S. No. | TBI | Brief Details |
|---|---|---|
| 1. | **IKP Knowledge Park-Life Science Incubator** www.ikpknowledgepark.com | It was established with an aim to boost technological advancements in field of life science, pharmaceutical and biotech areas and addressing needs of industries in these respective areas. |
| 2. | **Technology Business Incubator at Shriram Institute of Industrial Research (SRI-TBI)** www.shriraminstitute.org | SRI-TBI is acting as unique networking and technology resource centre which is equipped with latest facilities and is supported by highly skilled knowledge providers. |
| 3. | **Society for Innovation and Entrepreneurship (SINE) at IIT Bombay** http://sineiitb.org/sine/home | Initiated with the support of IIT-Bombay alumni, SINE is a platform for promotion of entrepreneurship and administers business incubator that supports technology based entrepreneurship and industrial growth. |
| 4. | **Venture Centre, Pune** www.venturecenter.co.in | Dedicated towards technology start-ups and generating products and services by exploiting scientific expertise in the fields of materials, chemicals and biological sciences and engineering. It is a collective initiative of NSTEDB, CSIR and TDB and is a not–for-profit company which is hosted by National Chemical Laboratory (NCL), India, through which support to technological enterprises is provided by leveraging scientific competencies of the institutions in the Pune region. |
| 5. | **Kalinga Institute of Industrial Technology Business Incubator (KIITTBI), Bhubaneswar** www.kiitincubator.in | KIITTBI is an initiative of KIIT University with support of NSTEDB and it offers incubation facilities and enables the incubatees to work in a secure, innovative and entrepreneurial environment as they progress through various stages of entrepreneurial development. |

- **Science, Technology and Innovations Park**

Science, Technology and Entrepreneurship parks (STEP) were instituted by NSTEDB with a mandate of creating an environment for entrepreneurship and innovation. NSTEDB has established 15 such STEP at different locations in India in different HEIs (Table 37).The major objectives of STEP are to forge linkages among academic and R&D institutions on one hand and the industry on the other and also promote innovative enterprise through S&T persons. The department has so far catalysed 15 STEPs in different parts of the country, which have promoted nearly 788 units generating annual turnover of around ₹ 130 crores and employment for 5000 persons. More than 100 new products and technologies have been developed in by the STEPs/STEP promoted entrepreneurs and industrial collaborators. In addition, over 11000 persons have been trained through various skill development programmes conducted by STEPs.

**Table 16: List of STEPs created by NSTEDB**

| S. No. | STEPs | Technology Thrust Area |
|---|---|---|
| 1. | STEP-Birla Institute of Technology, Ranchi | Mechanical engineering |
| 2. | JSS Technical Institutions Campus, Mysore | Electronics and IT |
| 3. | National Institute of Technology, Surathkal | IT |
| 4. | Science & Technology Entrepreneurs Park (BEC-STEP), Bagalkot | Food processing, textiles and building technology |
| 5. | Science and Technology Park, Pune | IT and innovative technologies |
| 6. | Maulana Azad National Institute of Technology, Bhopal | IT and innovative technologies |
| 7. | Thapar University, Patiala | Agribiotechnology, biofertilizer, food biotechnology, tissue culture |
| 8. | Guru Nanak Dev College of Engineering, Ludhiana | Mechanical and IT |
| 9. | TREC-STEP, NIT Campus, Tiruchirappalli | Mechanical and IT |
| 10. | PSG-STEP, Coimbatore | Mechanical and IT |
| 11. | Harcourt Butler Technological Institute, Kanpur | Paints, chemical and IT |
| 12. | Indian Institute of Technology , Roorkee | Environment, Materials and IT |
| 13. | Indian Institute of Technology Kharagpur | ICT, big data analytics, advanced manufacturing, agriproducts and machinery, healthcare devices , bioprocess and bioproducts |
| 14. | NSIC Technical Services Centre, Rajkot | Energy and pumps |
| 15. | National Small Industries Corporation Limited, New Delhi | Energy and pumps |

Apart from NSTEDB, there are other organizations [Ministry of Communications and Information Technology (Software Technology Parks of India), ASSOCHAM (Mega Food Parks); Reliance ADA Group (Dhirubhai Ambani Knowledge City)]that have created number of science and innovation parks. These science, technology and innovation parks via their R&D activities are bridging the gap between industry and academia. Table 38 lists down some of the science, technology and innovations park which are actively involved in PPP.

**Table 16: Science, Technology and Innovation Parks under PPP mode in India**

| S. No. | Park | Brief Details |
|---|---|---|
| 1. | **Science and Technology Park, Pune**<br>www.scitechpark.org.in | It was established by NSTEDB with an objective to create wealth from innovation and R&D activities. It has various linkages with European union and DST for skill enhancement, USAID-India and UNEP. It has various industry association as its members like Indo-Japan Business Council to promote industry, trade and commerce; Indian Green Building Council. |
| 2. | **Science and Technology Entrepreneur's Park (STEP) at IIT Kharagpur**<br>http://www.step-iit.org/ | STEP was established in IIT Kharagpur with support from Government of West Bengal, DST and financial assistance from IDBI, IFCI, ICICI. It is working in harmony with other incubation programmes of IIT Kharagpur such as technology Business Incubator, Technology Incubation and Entrepreneurship Training Society (TIETS) to facilitate technology transfer to the industrial segment. |
| 3. | **Indian Science and Technology Entrepreneurship Parks and Business Incubator Association (ISBA), Noida, UP, India**<br>www.isba.in | ISBA is the only pan India network of Business Incubators and has an abundance of expertise and knowledge base in technology business Incubation. A unique feature is its diversity, with member organisations coming from academic institutions / universities of repute such as IIM-A, IIT Bombay, IIT Kanpur, University of Pune, NIT Trichy, NIT Surathkal, NID, VIT University, PSG etc., R&D organisations such as NCL, ICRISAT, NDRI etc. and other technology parks such as ICICI Knowledge Park, technopark etc. |
| 4. | **IKP Knowledge Park, Hyderabad**<br>www.ikpknowledgepark.com | It is ICICI Knowledge Park and is India's premier science park, facilitating business driven R&D for over a decade now. IKP Knowledge Park has promoted 65 companies so far, and is currently associated with 47 of them. It has also facilitates technology transfer between Indian research organizations and local and global industries. Moreover, it educates local industries, entrepreneurs for IP rights and technology licensing. |

## ➢ Accelerators

Accelerators are the entrepreneurship grooming organizations that promote indigenous start-up culture. It is comparatively new concept that India is following. Setting up of accelerators has aided in enhancing start-up culture in India. Some of the accelerators instituted in India are as follows:

**Table 17: Accelerators in India**

| S. No. | Accelerator | Brief Details |
|---|---|---|
| 1. | **Times Internet Limited Labs (Tlabs), New Delhi and Bengaluru**<br>http://tlabs.in/about-us/ | • It aims to develop entrepreneur's ideas to their potential and bridge the gap between entrepreneur and investor community.<br>• It provides access to more than 100 experts to mentor entrepreneurial idea. It also provides seed capital fund to develop the idea into reality.<br>• The programmes occurs in phases which start with hypothesis development, deep validation, strategic direction and business planning and financing to make an individual or group of individuals ready to set up a venture |
| 2. | **GSF Global Accelerator, Gurgaon, Bengaluru and Chennai**<br>http://www.gsfindia.com /accelerator/ | • It composes of 13 weeks programme in order to foster innovation and start up culture in country in area of digital economy. It was designed to support product-oriented start-ups.<br>• This Accelerator invests around $50k at 7-8% equity into product oriented start-ups which are inducted into the Accelerator program. |
| 3. | **Microsoft Accelerator, Bengaluru**<br>https://www.microsoftaccelerator.com/locations/bangalore | • It is 4-6 months programme where Microsoft representatives and associated partners provide tools, resource, connection and knowledge expertise to budding start-up to get converted into successful company. |
| 4. | **Startup Village, Kochi**<br>https://www.sv.co/?redirect_from=startupvillage.in | • It is run by Indian government to support start ups in field of agriculture.<br>• It mentors the start-ups till the end when they start earning revenues and provides them start-up village angel fund<br>• It is working impressively with portfolio of launching ~1000 companies in last 10 years |

| | | |
|---|---|---|
| 5. | **iAccelerator, Ahmedabad**<br>http://www.ciie.co/ | • It is an initiative of IIM, Ahmedabad for promoting innovation in field of internet and mobile technologies.<br>• Expertise support in areas of technology development, product development and management, marketing and customer acquisition is provided along with seed fund to develop idea into reality. |

These accelerators give good exposure the network of angel investors in India, budding ventures and number of industry services and support mechanisms for emerging R&D start-ups. These accelerators provide hand holding services for formation of company at any critical point of their growth. More of such accelerators should come up which can be run by either government agencies or industry representatives/venture capitalist or under PPP mode. Such accelerators are quite common in Israel where they have contributed to the development of R&D Based MSMEs.

## 4. Summary

The emergence of India as a major global economic power calls for high levels of technological freedom but unfortunately the growth of technology has remained disunited and unlinked. This is due to the fact that the R&D activities of both the public and the private sector have remained disconnected from each other thereby creating a large gap in technology development and technology deployment. Synergies between academic basic research and industrial applied research have to be established to generate mutual added worth. To achieve this synergy it is imperative to create a PPP framework engaging both the public and the private sectors leading to multivariate use of knowledge, innovations, technologies and value creation of R&D activities.

Present chapter focuses on different PPP models existing in India, under three broad categories as:

1. **Government-Industry Initiatives (GII)**
2. **Industry-Academia Initiatives (IAI)**
3. **Government-Academia-Industry Initiatives (GAII): Triple Helix Model**

Under Government-Industry Initiatives, initiatives taken by government and industry for mutual benefits are presented. Research institutes, such as ‘Indian Plywood Industries

Research and Training Institute' (IPIRTI), Bengaluru and 'Automobile Research Association of India' (ARAI), Pune were created collaboratively by industry and government organizations and are working exclusively for enhancing industrial sector in their respective domains. IPIRTI was created by Ministry of Environment, Forests and Climate Change in association with plywood industries. The institute carries out R&D activities, training, testing and standardization services for industries. It has carried out 28 in house projects for collaborated industries, 13 sponsored projects and 3 consultancy projects of industries. It is in fact the only research institute dealing with plywood industries. ARAI was established as co-operative industrial research unit by automobile industry and Ministry of Industries, GoI. It is dealing with R&D activities in field of automobiles. ARAI is advancing in its income profile. In the year 2013-14, ARAI's income was of total worth ₹ 19014 lakhs and major chunk of its income comes from R&D activities carried out for industries. Many government organizations have created dedicated institutes that are working for industrial growth. Examples of such institutes, such as Ministry of Micro, Small and Medium Sized Enterprises (MSMEs) established institutes like 'Mahatma Gandhi institute for Rural Industrialization', 'National Institute for Micro, Small and Medium Enterprises' and 'National Small Industries Corporation' for assisting development of MSMEs in India. On the other hand, Department of Industry Policy and Promotion, GoI, has supported various autonomous institution, such as 'Central Pulp and Paper Research Institute' (CPPRI), 'Central Manufacturing Technology Institute' (CMTI) and 'National Council for Cement and Building Materials' (NCCBM) for assisting industrial research in respective domains. Under government-industry initiatives, number of programmes floated by government agencies for strengthening industrial sector is presented. Few of such schemes are 'Technology Development Board' instituted by Department of Science and Technology, New Delhi; 'Promoting Innovations in Individuals, start-ups and MSMEs' (PRISM) AND Technology Development and Demonstration Programme'(TDDP) initiated by Department of Scientific and Industrial Research (DSIR); 'DRDO-FICCI-ATAC' Programme of Department of Research and Development Organization (DRDO) and many more. Other government-industry initiatives include the incentivization of private sector which are recognized by DSIR to avail government benefits in form of tax rebate and custom/excise duty waiver on R&D inputs of industries. Moreover, government organizations like Department of Atomic Energy (DAE) have also established exclusive industrial units to supply hazardous and radioactive material to industries for R&D.

Second category of PPP includes Industry-Academia Initiatives. Under this category, industrial role in academia is reviewed. Industries have set up close collaboration with academia in terms of R&D activities. For example, industries have set up laboratories and dedicated units in academia, introduced number of scholarships and fellowships and sponsored chairs in academia. These steps undertaken by industries are one of the successful models of Industry-Academia Partnerships. Industry has also supported creation of specific cells in academia for assisting R&D activities and technology development and deployment from the academia to the industry along with enhancing entrepreneurship culture. Amongst Higher education institutes, IITs are leading in above mentioned Industry-Academia Initiatives. On the other hand, academia has also created I-A enablers, such as I-A cells which deal with Sponsored Research And Industrial Consultancy Cells, Entrepreneurship and innovation Cells for stimulating entrepreneurship and Technology Development and Intellectual Property Cells.

Existing PPP models were further studies under category of Government-Academia-Industry Initiatives that comes under Triple Helix Model. Under this section, creation of autonomous academic institutes by government on demands of industry and their support are reviewed. For example, Bombay College of Pharmacy (BCP), Mumbai and Institute of Chemical Technology (ICT), Mumbai was established on demands of industries and central and state government supported the creation of these institutes. Bothe these institutes are ranked top in Industry-Academia linkages in pharma and chemical sector by survey carried out by AICTE-CII. BCP has established dedicated Industry Institute Interaction Cell that coordinates with industries getting associated with BCP. Industry representatives are part of governing body and curriculum design committee of BCP and have resulted in functioning and course structure of BCP is in accordance with industry needs. BCP has delivered more than 300 industrial R&D projects. In last four years (2012 onwards), BCP has carried out 81 industrial projects worth ₹ 1 Cr. Revenue generated from industrial sponsored and consultancy projects are utilized for faculty salary and institute development. Strong industrial collaborations of BCP have resulted into establishment of various laboratories in BCP by industrial units. On the other hand, ICT-Mumbai is a premier institute of India which has been ranked number 2 under the National Institutional Ranking Framework (NIRF) as declared by MHRD, GoI during April 2016. Since inception it has generated more than 500 entrepreneurs. It has successfully completed around 320 government sponsored projects and 318 industry sponsored projects. The number of Industry consultancies conducted till date is around 269 and many of the scientists actually earn their salaries through the consultation fees paid by the collaborating industry. During the last 10 years, ICT-Mumbai has filed a total of 310 patents and in the year 2014-15, ICT-Mumbai with faculty strength of 82 published 382 international publications. ICT-Mumbai enjoys various industry sponsored faculty positions and industry endowments. Under the Government-Academia-Industry Partnerships, creation of dedicated agencies by government, such as ‘Biotechnology Industry Research Assistance Council’ BIRAC and CSIR-Tech are also briefed. These organizations are effectively bringing industry and academia together for R&D activities and boosting entrepreneurship culture. BIRAC provides funding support in form of grants to SMEs in order to stimulate R&D activities and promoting innovation amongst SMEs (funds were created involving ₹1300 Cr from BIRAC and ₹750 Cr from Industry). BIRAC has also promoted I-A collaborations to explore innovations in biotech sector to be identified and commercialized for generating affordable products of social relevance [BIRAC through its schemes (SBIRI, BIPP and CRS) has led to 121 collaborative projects, out of which 108 I-A collaborative projects and 13 Industry-Industry collaborative projects]. CSIR-Tech is Pune based private Limited company established in 2011. The major partners of CSIR-Tech are CSIR (a conglomerate of public funded R&D labs), State Bank of India (a public funded financial services company) and Venture Centre (a technology business incubator). CSIR-Tech works for the commercialization of Intellectual Property (IP), know-how and technology emerging from public and private R&D labs as well as academic institutions. CSIR-Tech provides services like, Technology Venturing, India Science Venture Fund, Technology Commercialization, Market Insights and Consultancy. CSIR-Tech is associated with CSIR labs, IITs, DAE, ICAR, Industry Association and universities (public & private) to aid them to encourage academic entrepreneurs who want to get involved in knowledge intensive ventures. Government funding agencies have also commenced various programmes for supporting Industry-Academia collaborative research such as ‘New Millennium Indian Technology Leadership Initiative’ (NMITLI) sponsored by CSIR, ‘Schemes for Funding Industry Relevant R&D’ (Under SERB) by DST and ‘Advanced Composite Programme’ by TIFAC and many more. Moreover, initiatives taken by government and private sector for establishing Technology Business Incubators, Centre of Excellences, S&T Parks and Accelerators have catalysed the Government-Academia-Industry Partnership in promoting R&D activities and technology development.

# Annexure I

## Pfizer-Foundation for Innovation and Technology Transfer (FITT)
http://fitt-iitd.in/

GoI established FITT in 1995 in the campus of Indian Institute of Technology, Delhi (IIT-D), a premier engineering institute of India by GoI as the first I-A interface (FITT Annual Report, 1994-95). The GoI at that time provided an amount of ₹ 16.2 million as an aggregated fund to IIT-D for initiation and build up of FITT. The centre was set up as an autonomous and self governing body, to act as a single window utility to the industrial sector with complete professionalism and function as a marketing arm for the IIT-D developed technologies (Sengupta, 2009).

The broad organizational structure is composed of a) Governing Council and b) Research Council. The governing council consists of representatives from industries; industrial associations and nominee from MHRD, selected nominated members from IIT-D senate and its board of governors. On the other hand, research council is composed of selected faculty members of IIT-D having experience in I-A collaborations. The management is vested with the managing director of the organization, guided by governing council and research council.

**Programs and Services at FITT**

Since the inception of FITT, a large number of programs and initiatives have been introduced in an effort to catapult the I-A linkages to the next level. The programs initiated by FITT can broadly be categorized as the following:

a) Incubation Centers
b) Research/Technology Development Projects
c) Knowledge Augmentation Courses
d) IPR Management Programmes
e) Corporate Partnership for the Industrial Sector
f) Government Schemes
g) Memorandum of Understandings (MoUs) with Private Sector
h) FITT Awards and Recognitions

### a) Incubation Centers

In an endeavor to promote entrepreneurship and start-up companies, FITT initiated the task of setting up incubators on the campus of IIT-D. These incubation centers were set up with the aim of providing the entrepreneurs with space for a prototype laboratory and other basic infrastructural and instrumentation facilities, without getting into the hassle of paper work. In addition, FITT also promotes start-ups having credible business plan(s) with focused knowledge. The incubator centre provides facilities such as product innovation, product development, software testing, pilot experimentation, prototype development, industrial training etc. and works in close coordination with the institute. Major activities of incubation centers are Technology Business Incubation Unit (TBIU), Bio-Incubator Facility, Science Parks and the units set up under Bio-Accelerator Programme.

Various incubation facilities provided by FITT are as under:

- **Technology Business Incubation Unit (TBIU)**

TBIU was started in 2000 under the aegis of Technology Institution Program (TIP), as a part of the Industrial Credit and Investment Corporation of India (ICICI)/World Bank Funded TIP at IIT-D (Bhattacharya, 2005).

Under this scheme, the start-ups/technology entrepreneurs are provided with an initial seed money and space for converting new ideas/concepts/service into a business opportunity that is commercially viable. TBIU, permits activities such as innovative product development, software development and testing, simulation and prototyping, pilot scale experimentation and training. FITT not only provides modern infrastructure but also provides for hand-holding, managerial and material support for establishing themselves. In return, minimal space utilisation charges and equity share of the company rests with FITT.

A list of resident companies in TBIU in the year 2014-15 is mentioned in Table 1.

**Table 1: Start-Ups Resident at TBIU during the Financial Year 2014-15**

| S. No | Start-Up | Work Area |
|---|---|---|
| 1. | **Novo Informatics Pvt. Ltd.**<br>(http://novoinformatics.com) | Bridging the gap between bio-informatics and experimentation |
| 2. | **Wring Nano Systems Pvt. Ltd.**<br>(http://www.truehb.com/team.php) | Advanced bioelectronics technologies (e.g. hemometer) |

| | | |
|---|---|---|
| 3. | **PLANiN Innovation and Consultancy Services Pvt. Ltd.** | Basket of innovative products with proprietary technologies (e.g. vehicool, smart wipes and flexible notice board) |
| 4. | **Silver Knight Technologies Pvt. Ltd.**<br>(http://www.silverknight.info/) | Development of Anti-theft bag with unique features like pilfer proof casing, unique zip and lock mechanism & track and trace system |
| 5. | **Carbon Neutral Technologies Pvt. Ltd.** | Develop an alternative manufacturing process for isoprene |
| 6. | **Kentellus Welding and Manufacturing Pvt. Ltd.** | Production of welding electrodes of better quality using green technology |
| 7. | **Ekam Eco Solutions Pvt. Ltd.**<br>(www.ekamecosolutions.com) | Ecological solutions in the field of sanitation, water conservation, nutrient recovery and sustainable habitat |
| 8. | **Inkilab Technologies Pvt. Ltd.**<br>(http://www.inkilabtechnologies.com) | Diagnostics based technologies to facilitate process design |
| 9. | **Credext Technologies Pvt. Ltd.**<br>(http://www.credextechnologies.com) | Development of falcon virtual PC device that enables a user to access his/ her desktop at remote locations |
| 10. | **Creditas Solutions Pvt. Ltd.** | Developing online platform for debt negotiation and settlements |
| 11. | **Innovator Lab Consultants India Pvt. Ltd.**<br>(http://www.innovatorlabindia.com) | Development of mechanical heart valve fixation system |
| 12. | **VM Trans Innovations Pvt. Ltd.** | Development of intelligent online platform for road transport management and exchange system |

***Source:*** *FITT Annual Report, 2014-15*

The above-mentioned list of start-up companies is just a glimpse of what TBIU has done in order to promote entrepreneurship via the I-A interface. In the last two decades, there have been innumerable start-ups and incubatees at TBIU and quite a few of them have graduated and are working independently as successful, self-sufficient, profit generating companies (Table 2).

**Table 2: List of a Few TBIU Start-Ups Graduated into Successful Companies**

| S. No. | Name of the Incubating Unit | Technology /Product /Process in incubation | Residency | |
|---|---|---|---|---|
| | | | Entry | Exit |
| 1 | **M/s eCapital Solutions Pvt. Ltd. / Trigyn Technologies (I) Pvt. Ltd.** | Telecommunication and internet application | 1999 | 2001 |

| | | | | |
|---|---|---|---|---|
| 2 | **Sintex ESCO** | R&D on insulated lightweight prefabricated building structures for thermal comfort and energy conservation | 2001 | 2003 |
| 3 | **M/s INRM Consultants Pvt. Ltd.** (http://inrm.co.in) | GIS based integrated watershed management | 2002 | 2004 |
| 4 | **M/s KritiKal Solutions Pvt. Ltd.** (http://www.kritikalsolutions.com) | Computer vision and image processing, wireless adhoc networks | 2002 | 2005 |
| 5 | **M/s Mechartes Researchers Pvt. Ltd.** (http://www.mechartes.com) | Software products for simulation of product development in auto component industry | 2005 | 2008 |
| 6 | **M/s SM OnYoMo Infotech Pvt. Ltd.** | Consumer searches over the internet | 2005 | 2009 |
| 7 | **M/s LeadInvent Technologies** (http://www.leadinvent.com) | Novel drug discovery & computational biology | 2007 | 2010 |
| 8 | **M/s Appin Software Security Pvt. Ltd.** (http://www.appinonline.com) | Software security | 2007 | 2009 |
| 9 | **M/s Care-pro Biotechnologies Pvt. Ltd.** (http://www.careprobio.com) | Fermentation based biomolecules | 2007 | 2010 |
| 10 | **M/s. Sunurja Renewable Energy Pvt.** Ltd. (http://www.sunurja.com) | Design and development of renewable energy solutions | 2008 | 2011 |
| 11 | **M/s. Faros Technologies Pvt. Ltd.** (http://www.farosindia.com) | Development of simulator sub components, simulators and providing simulation services | 2008 | 2013 |
| 12 | **M/s. Innovative Transport Solutions Pvt. Ltd.** (http://www.itrans.co.in) | Scientific and technical solutions for traffic and transport systems and development of models for sustainable transport for cities | 2008 | 2012 |
| 13 | **Gram Vaani Community Media Pvt. Ltd.** (http://www.gramvaani.org) | Building innovative models of media delivery for rural areas of india | 2009 | 2013 |
| 14 | **Yonyx Infomedia Pvt. Ltd.** | Building teacher replication platform to enable teachers to pack instruction with predicted student interaction | 2010 | 2012 |
| 15 | **Innovative Mechatronix Solutions Pvt. Ltd.** | Design, development and manufacture of micromachining system, mass production finishing processes and mechatronic embedded systems | 2010 | 2013 |
| 16 | **Simplyfeye Softwares Pvt. Ltd.** (http://www.simplyfeye.com) | User-friendly operating platform for biopharmaceutical manufacturers to capture, share and analyze information from biopharmaceutical processes | 2010 | 2013 |
| 17 | **Genesis Location Services Pvt. Ltd.** (http://genesis-locationservices.com) | Location based products and services | 2011 | 2014 |
| 18 | **Novo Informatics Pvt. Ltd.** (http://novoinformatics.com/) | Scientific software application products/tools | 2011 | 2014 |
| 19 | **Wring Nano Systems Pvt. Ltd.** (http://www.truehb.com/team.php) | Advanced blood haemoglobin testing | 2012 | 2014 |

| | | | | |
|---|---|---|---|---|
| 20 | **Ekam Eco Solutions Pvt. Ltd.** (http://www.ekamecosolutions.com) | Ecological solutions in the field of sanitation, water conservation, nutrient recovery and sustainable habitat | 2013 | 2015 |
| 21 | **Inkilab Technologies Pvt. Ltd.** (www.inkilabtechnologies.com) | Analytics to the manufacturer on defective parts and processes | 2013 | 2014 |

***Source:*** *http://www.fitt-iitd.org*

Some of the successful examples of the start-ups graduated from FITT:

- ***Ekam Eco Solutions Pvt. Ltd.***

  Ekam Eco Solutions Pvt. Ltd. (www.ekamecosolutions.com) was initiated in financial year 2013-14 with the aim of developing and providing solutions in the field of nutrient recovery, water conservation, sanitation and sustainable habitat (FITT Annual Report 2013-14). Ekam has successfully commenced its objectives by addressing the gap in innovation and product development and is in the process of delivering out a number of innovative solutions which could be implemented at rural and urban levels.
- ***Kritikal Solutions India Pvt. Ltd.***

  The first faculty-student led business incubation unit, KritiKal Solutions India (Pvt.) Ltd. (http://www.kritikalsolutions.com), was founded in 2002. The company started functioning as a full-scale commercial venture by the year 2005 (Annual Report, 2005-06). The main focus of the company is embedded system design and real time computer vision and imaging solutions. As of date, KritiKal can boast of significant presence in India and United States and is also extending to Europe, Africa and other parts of Asia.
- ***Gram Vaani Community Media Pvt. Ltd.***

  Another successful spin-off from TBIU is GramVaani (http://www.gramvaani.org), based at IIT-D since 2008. The basis of this company is social technology and it provides information and community technology based solutions. This company works in collaboration with the institute and encourages interns/trainees to work on real-life problems and situations. The company is now a 35 employee strong group.

- **FITT as a Biotech Ignition Grant (BIG) Partner**

BIG is one of the highly successful I-A interface programmes of Biotechnology Industry Research Assistance Council (BIRAC), an autonomous body of Department of Biotechnology (DBT), GoI, New Delhi. The BIG scheme, which aims to invite proposals for the ignition grant twice a year, supports entrepreneurs from the academia and research institutes for the commercialization of technologies resulting from research in the area of biotechnology, which has been recognized as an emerging and conspicuous area for growth. BIG has identified a few institutes, including FITT, as official partners. FITT holds the responsibility of screening the applications received; review the projects that have been shortlisted, provide mentoring in issues related to IPR, legal affairs and other business development related issues, facilitate interaction with experts of the field and other academic partners of the institute.

This is a one of a kind scheme, which aims at establishing and validating proof of concept ideas and thereby enabling spin-offs, which is now gaining pace. Some of the key projects under BIG partnerships are:

- Cutting Edge Medical Devices Pvt. Ltd. (http://www.cemd.in) developed portable analyzer SCINTILLA for detection of protein levels in urine samples.
- Sakosh Biotech Pvt. Ltd. is working on development of lateral flow immunoassay based rapid diagnostic tests for various infectious diseases.

- **Bio-Accelerator Programme**

In 2013, FITT in association with National Institute of Immunology (NII) at New Delhi and BIORx Venture Advisors (http://www.biorxventureadvisors.com) started a Bio-accelerator programme, which laid emphasis on “accelerating innovation to marketplace” (FITT Annual Report, 2013-14). It is a joint initiative to strengthen the bio-economy of the nation by composing a ‘Master Class on Bio-entrepreneurship’. This programme is devised for working executives, research scholars and post-doctoral scientists who aspire to work towards a path of commercialization for their discovery.

- **Biotech Incubator Facility**

DBT, GoI, has recommended supporting the setting up of a Biotech Incubator Facility at FITT, IIT-D (FITT Newsletter, October 2014). A sanction of ₹ 87 million has been granted for the incubator, for a period of initial three years. This facility, like other incubators, will support start-ups and provide incubation facilities for R&D work at minimal charges so as to promote innovation in the field of biotechnology.

FITT, with funding from BIRAC, has also established a **Biotechnology Business Incubator Facility (BBIF)** in 2014.BBIF provides incubator facilities such as specialized equipments, experimental facility, IP guidance and market linkages to the budding bio-tech start-ups (FITT Annual Report 2014-15).

- **Science and Technology Parks**

The most recent endeavour of FITT is to set up S&T Parks. These parks have been conceptualised in a way such that they will have all facilities for start-ups as well as well established firms. These facilities include legal, banking, R&D, consultancy, networking spaces and so on (IIT-D eNewsletter, April 2013).

### b) Research/Technology Development Projects

FITT is mainly involved in the transfer of technologies to the industry, initiation of joint research programs, consultancy assignments from the industry. The centre has aided the licensing of technologies developed at the institute (Table 3).

**Table 3: List of Technologies Developed at IIT-D and Licensed Through FITT Since 2002**

| S. No. | Year | Technology Licensed |
|---|---|---|
| 1. | **2002-03** | Know how transfer of fiber optics educational kit |
| | | Low molecular weight organic compound using liquid carbon dioxide |
| | | Pilling tester based on digital image processing |
| 2. | **2003-04** | Three phase watt hour meter |
| | | RUSTGARD (Industrial grade & superior grade) |
| | | Microwave Integrated Circuit (MIC) Kit |
| 3. | **2004-05** | Local FE stress analysis and know how transfer of ASME Div-two reactors for Panipat refinery expansion |
| | | Transfer of technology for *Trichoderma* |
| | | Drape meter based on digital image processing |
| 4. | **2005-06** | Technology transfer- VCO and detector |
| | | Technology for manufacture of alluritic acid |
| 5. | **2006-07** | High pressure bio gas (Gobar Gas) enrichment and bottling system |
| | | Statistical scenario analysis software package |
| | | Vehicle under side scanner |
| | | Design & development of reusable pilfer proof currency carrying FRP cases |
| 6. | **2007-08** | Computer aided design of components at microwave frequencies |
| | | Design and development of active microwave integrated circuit trainer kit |
| 7. | **2008-09** | Limiting torque bolt mechanism |
| | | A smart cane for obstacle detection for the physically impaired |

| | | |
|---|---|---|
| | | A novel back panel design for efficient heat transfer in solar cells |
| | | Polymer composite sheets with enhanced properties |
| 8. | **2009-10** | RF magnetron target holder |
| | | Selective and sensitive detection of mercuric ion by novel dansyl-appended Calix[4]arene molecules via fluorescence quenching |
| | | An apparatus and method for packet error correction in networks |
| | | System and method for decorticating hard shell seeds and fruits |
| 9. | **2010-11** | Development of the iontophoratic kit for a transdermal delivery of methotrexate and insulin and validation of iontophoratic parameters for diclofenac |
| | | Odourless, waterless urinal traps and associated structures |
| 10. | **2011-12** | An apparatus for measuring fabric hand value |
| 11. | **2012-13** | Real time based supervisory control of AC drive |
| | | A method for preparation of cross- linked protein coated micro-crystal |
| 12. | **2013-14** | Knowhow for the technologies on drug discovery and proteomics |
| | | In-plane wicking measurement system |
| 13. | **2014-15** | A small chaperone |
| | | Thermal NDE: Modelling framework for crack detection |
| | | A process of generating magnetically controlled ball and smart abrasive laden shape for finishing 3D intricate shaped surface |
| | | Odour prevention device |
| | | Concrete vibration sensor technology |

***Source:*** *FITT Annual Reports, 2002-15*

One of the most successful projects has been the development of the ‘Smart Cane for the Visually Impaired’, which was developed as an improvement to the white cane and defeats the limitation of white cane by detecting knee above and hanging obstacles (Singh *et al.,* 2010). This unique device was developed in collaboration with Phoenix Medical Systems, Chennai (industrial partner) and Saksham Trust, Delhi (NGO working for the visually impaired). Some other successful technologies that have been developed and commercialised are “FruWash” and “EnNatura”.

FITT devotes itself to problem solving (short term) projects that help in developing better working relations with the industrial sector and confidence amongst the two and is continuously working on transferring technologies outside. During the financial year 2014-15, 96 technology development/ transfer projects of worth ₹ 168 million have been contracted. Out of these projects, 5 intellectual property (IP) licenses were executed in financial year 2014-15 (Table 4).

**Table 4: IP Licenses Executed During 2014-15**

| S.No. | Title | Client |
|---|---|---|
| 1. | A small chaperone | Theramyst Novobiologics Pvt Ltd, Bangalore |
| 2. | Thermal NDE: Modelling framework for crack detection | GE India Technology Centre Pvt Ltd, Bangalore |
| 3. | A process of generating magnetically controlled ball and smart abrasive laden shape for finishing 3D intricate shaped structure | Innovative Mechatronix Systems Pvt. Ltd. |
| 4. | Odour prevention device | Ekam Eco Solutions Pvt. Ltd., New Delhi |
| 5. | Concrete vibration sensor technology | Central Electronics Ltd., Delhi |

***Source:*** *FITT Annual Report, 2014-15*

FITT also undertakes selected investigative projects involving foreign contribution that aid in technology development and asset share between national and foreign research partners. Some of the successful foreign collaborated projects of year 2014-15 are listed in table 5.

**Table 5: Select Foreign Collaborative Projects (2014-15)**

| S. No. | Title | Client |
|---|---|---|
| 1 | Optimization and growth of pyroelectric thin film stack | Ultrasolar Technologies, Inc, U.S.A |
| 2 | Optimization of chromatography process steps for purification of monoclonal antibody based therapeutics | Purolite Limited, U.K |
| 3. | On line Devanagri handwritten character recognition on a smartphone through touch interface | Qualcomm Inc, U.S.A |
| 4 | Polypropylene foaming and recyclability | Borealis AG, Australia |
| 5 | Advice for development of long term monitoring | Asada Lab, University of Tokyo, Japan |
| 6 | EEG signal based recognition module with low computational load | Safran, France |
| 7 | Algorithmic framework for MEMS sensor fusion applications | ST Microelectronics, U.S.A |

***Source:*** *FITT Annual Report, 2014-15*

**c) Knowledge Augmentation Courses and Professional Development Programmes**

FITT understands that higher education is a continuing process and there is no limit to the enhancement of one's qualifications and in order to facilitate this increasing demand and providing a platform for working professionals, FITT in association with IIT-D, introduced several knowledge augmentation & skill enhancement courses as well as a number of short-term courses devised on emerging technologies.

- One such programme initiated was **Professional Candidate Registration (PCR).** This course involves registration of the candidate for one semester (as per the course chosen) and is certified at the end of the program. This program is confined to the Delhi region as of now due to accessibility issues although a few selected courses are covered under the on-site delivery program by a two-way audio-video link.

- Another programme that was initiated was **Knowledge Augmentation and Skill Enhancement programme**. Various add-on courses for professionals and students have been commenced with the aim of honing the students to be job ready.

Other programmes conducted by FITT for academicians and industry employees are as follows:

- Frost & Sullivan's Technology Partnership Program: Initiated by IIT-D has access to the Frost & Sullivan's portal thereby getting useful market, technology and econometric information along with the latest updates on technology trends across a broad range of industry sectors (FITT Annual Report; 2014-15).
- Technology Incubation and Development of Entrepreneurs (TIDE) and Entrepreneurial and Managerial Development of SMEs through Incubators (MSME scheme): Adopted by FITT to endow the entrepreneurial environs and efforts to commercialize technology being made at the institute.
- FITT in association with BIRAC and Association of Biotechnology Led Enterprises (ABLE) conducted short courses on Economic and Financing of Renewable Energy Technologies and Nascent Entrepreneurship Development Programme (FITT Annual Report, 2014-15).

**d) Intellectual Property Rights (IPR) Management Programmes**

Another responsibility taken up by FITT is the IPR management of the institute's academic community. A number of campaigns were initiated at FITT for promoting IPR filing for novel inventions/technologies/research outputs amongst the academic community. Complete assistance for filing of applications was provided by FITT by way of evaluation of proposals for patents and other IPR applications for the final submission to Indian Patent Office (IPO) and other establishments. The decisions pertaining to the application of technologies are taken by the IPR standing committee. The licensing policy followed by FITT is pliable and the payment terms are mutually secured. A comprehensive list of the technologies developed and being developed can be accessed from FITT website (http://www.fitt-iitd.org). This makes it extremely easy for the industry to search for any technologies of their interest and contact the person in question hence boosting the institute's technology commercialization.

Since the inception of IPR body in 1995, FITT has seen enormous growth with respect to IP generation and technology transfer and in the process it has become more than self-sufficient financially. In the past two decades, more than 200 IPR applications have been filed in the form of patents, copyrights and designs as opposed to a mere count of 15 patent applications filed from IIT-D between the years 1963 and 1995 i.e. before the inception of FITT (Fig. 1).

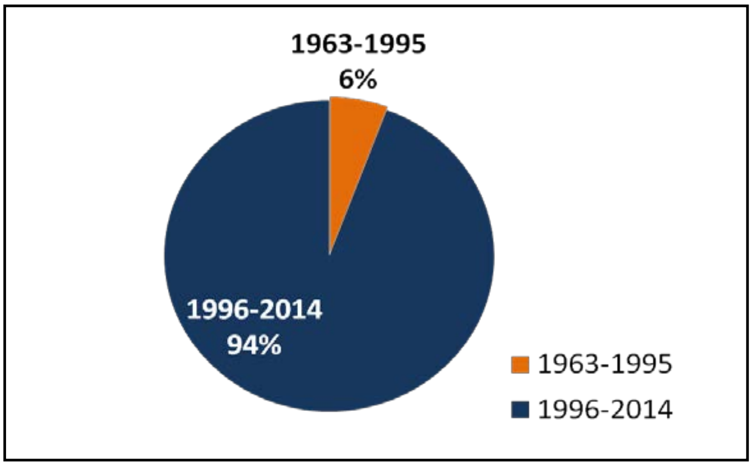



**Figure 1: Patents Filed Before and After the Inception of FITT**

***Source:*** *FITT Annual Report, 1994-95, 2012-15*

**e) Corporate Partnership**

FITT has also started a corporate partnership program on the payment of nominal annual fee, for public and private sector industries, ministries and organizations and industry associations and financial institutes, and offers the advantage of concessional services to its members. The corporate members are regularly updated with the information of various programs at the institute and other opportunities of collaboration. The corporate members receive, among other benefits, advance notifications of all patent applications/technologies available and marketed by FITT, customized research presentations and seminars, industrial trainings and workshops, newsletters and select information. Most significant, however, is the advantageous working relation that the member develops with FITT thereby allowing them to gain access to research performed at IIT-D, as well as a variety of local businesses and services.

As of date, more than 250 companies worldwide have benefited from the programs of FITT (http://www.fitt-iitd.org). This number speaks volumes not only about the success of the organization but also about the way in which the industry is ready to collaborate with the academia. Some corporate members that are a part of this are: Pfizer India Pvt. Ltd., L'Oreal India Pvt. Ltd., LG Electronics India, Fresenius Kabi Oncology Ltd., Samsung Research Institute, Delhi, Dabur Research Foundation, Cube Software Pvt. Ltd., Reliance Industries Ltd., National Thermal Power Corporation, Bharat Heavy Electricals Ltd, Munjal Showa Ltd., JCB India, Canon India, Danfoss Industries, Carborundum Universal, Tata Chemicals, Jubilant Organosys Ltd., National Research and Development Corporation and Indian Grameen Services.

Recently, FITT has collaborated with one of the leading pharmaceutical company Pfizer for promoting healthcare innovations in country by commencing IP programme for young entrepreneurs (Laha, 2015) to provide training and short courses in IP related issues and also to support development of technologies in healthcare sector. Under this corporate collaboration individual support system for healthcare innovations are provided. This programme needs direct involvement of BBIF of FITT which was set up only a year ago to meet growing demands among biotechnology/ healthcare sector. The collaboration has resulted into "the Pfizer IIT Delhi Innovation and IP Programme (PIDIIP)" which will provide funding support of upto ₹ 4.8 million, mainly into two sectors one is from idea to IP and other is IP support. Gamut of advantages can be availed by health science innovators in this facility where technical manpower from different fields such as engineering, life sciences and healthcare are engaged towards finding solutions for demanding assignments and to develop innovative healthcare products which will cater to some of the critical issuesthat our country faces in the healthcare sector (Laha, 2015).

#### f) Government Schemes

FITT is also actively involved in the facilitation of all technology based government schemes. It provides for background checks on government technology development projects. Some of the prominent government schemes that are facilitated by FITT are listed below

- *N-WISE:* The National Information System for Science and Technology [NISSAT–Department of Scientific and Industrial Research (DSIR)] Window to Information Services to Entrepreneurs was initiated in 2001-02.
- *Technopreneur Promotion Program (TePP)* by DSIR and Technology Information, Forecasting and Assessment Council (TIFAC) of the DST: FITT has taken up various modules to enhance the environment of entrepreneurship and technology transfer at the institute, one of them being TePP. FITT is a partner in the program initiated by DSIR & TIFAC and also one of the TePP Outreach Centres (TUCs), wherein a financial support of up to ₹ 1.5-4.5 million is provided by DSIR and all the technical support & mentoring for development of an idea/prototype of the project is provided by FITT.
- *Entrepreneurial and Managerial Development of Small and Medium scale Enterprises (SMEs) through Incubators:* This scheme was started for the promotion of knowledge/technology based innovative ventures, in all fields of science and technology, to improve the competitiveness of SMEs, through a financial support of up to ₹ 40.1 million.
- *PRISM (Promoting Innovation in Individuals, Start-ups and MSMEs):* This program initiated under the aegis of DSIR, aims to support one of the most crucial agenda of the XII$^{th}$ Five Year Plan (2012-17) i.e. inclusive growth and development. This program, which is offered in two phases, promotes the development of technologies needed in the market and the transfer of IP of such developed technologies, which is where a major gap lies, mainly due to the lack of funds by start-up firms. FITT as a confederate, through this scheme helps in promotion of the development of such technologies, which could otherwise be shelved only due to lack of resources.
- *Department of Information Technology-Technology Incubation and Development Entrepreneurs (DIT-TIDE):* Department of Information Technology (DIT) has introduced Technology Incubation and Development of Entrepreneurs (TIDE) for providing seed support in the area of IT. FITT has partnered for promoting this scheme, which provides incubators during early stages of the development of various IT and ITES enabled firms.

**g) Memorandum of Understanding (MoU)**

Formal agreement between FITT and other institutes/industrial partners has been set up to promote innovation and technology transfer. Some of the advantageous MoUs (2014-15) are mentioned below

- MoU with the **American Society for Quality (ASQ) India Pvt. Ltd**: An MoU was signed with ASQ India Pvt. Ltd., with a central agenda of achieving forwardness in knowledge/adeptness and its implementation for the benefit of IIT-D community in fields of engineering and management sciences
- MoU with **Security Printing and Minting Corporation of India Ltd. (SPMCIL),** New Delhi for focusing on research collaborations in the domain of common interest. Vide this memorandum, the training and exchange of expertise shall also be undertaken amongst the two stakeholders.
- MoU with **Wallonia Foreign Trade and Investment Agency (AWEX)**, Belgium. The main aim of this MoU was to evolve strong and globally competitive companies from path breaking start-ups with Wallonia as a hub for their expansion in Europe for obtaining market access in the European Union.

**h) FITT Awards and Recognitions**

FITT, in order to promote the spirit of innovation and entrepreneurship has launched various appreciation ceremonies in the form of awards and rewards. These activities are generally carried out in collaboration with various corporate players and are as follows.

- **Launch of Industrial Credit and Investment Corporation of India (ICICI)-Trinity program**: The program launched by ICICI for budding entrepreneurs is an initiative of the bank to reward innovation and entrepreneurship amongst the youth community in India. The ICICI Trinity programme comprises of three stages – idea generation, prototype and be an entrepreneur. This program has been launched in several top institutes across the country, with IIT-D being one of them.
- **POSOCO power system award (PPSA)-2015:** The Power System Operation Corporation (POSOCO), a wholly owned subsidiary of Power Grid Corporation of India Ltd., launched these awards, in the form of cash prizes, to recognise the outstanding contribution made in the field of power systems and its related fields. The collaboration with FITT encompasses the IITs and National Institute of Technologies

(NITs). This award aims to bring about cutting edge research in the field of power systems by cultivating and nurturing the individuals for the same.

FITT has instituted awards for Ph.D and M.Tech/ M.S projects. The best industry relevant projects(in both the programmes) are provided financial and marketing assistance to incubate their project.

**Financial Synopsis**

FITT has not only promoted the intellectual and infrastructural facilities of IIT-D but also added industrial relevance and commercial value to the academic knowledge/ research being performed at IIT-D. Among the many functions and objectives of FITT, marketing and business development is one of the most important aspects of FITT. It is the only way of advertising the expertise available at IIT-D that led to enormous asset generation for FITT and IIT-D.

FITT has bank deposits and bonds worth ₹ 356 million in financial year 2014-15. Major earnings of FITT came from interests (₹ 33 million), project activities (₹ 6.6 million) and corporate membership fees (₹ 0.1 million) for the year 2014-15. On the other hand, total expenditure of FITT cost around ₹ 13 million. Thereby, leading to an operational growth worth ₹ 177 million from projects and other activities performed in financial year 2014-15.

Financial assets generated by FITT were achieved by conducting I-A summits, active participation in industry exhibitions at national and international level, publication of a quarterly bulletin, regular propagation of knowledge about IIT-D and FITT through means of articles and write ups in newspapers/magazines and occasional promotional advertisements, initiating corporate membership scheme for the industry, establishment of relationships with associations like Federation of Indian Chambers of Commerce and Industry (FICCI), Associated Chambers of Commerce & Industry of India (ASSOCHAM), Confederation of Indian Industry (CII) and so on. Figures 5.5 and 5.6 depicts the asset and resource generation for IIT-D by FITT since 2002.

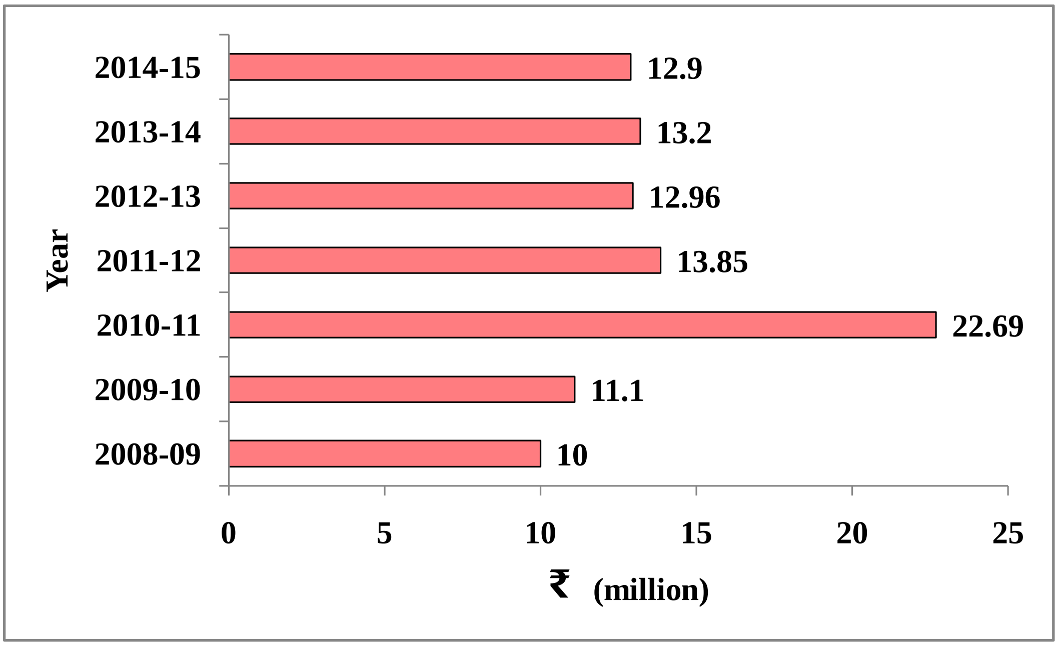



**Figure 2: Asset Generation (Infrastructure, Equipments and Transfer of Funds) from FITT for IIT-D**

***Source:*** *FITT Annual Report, 2008-15*

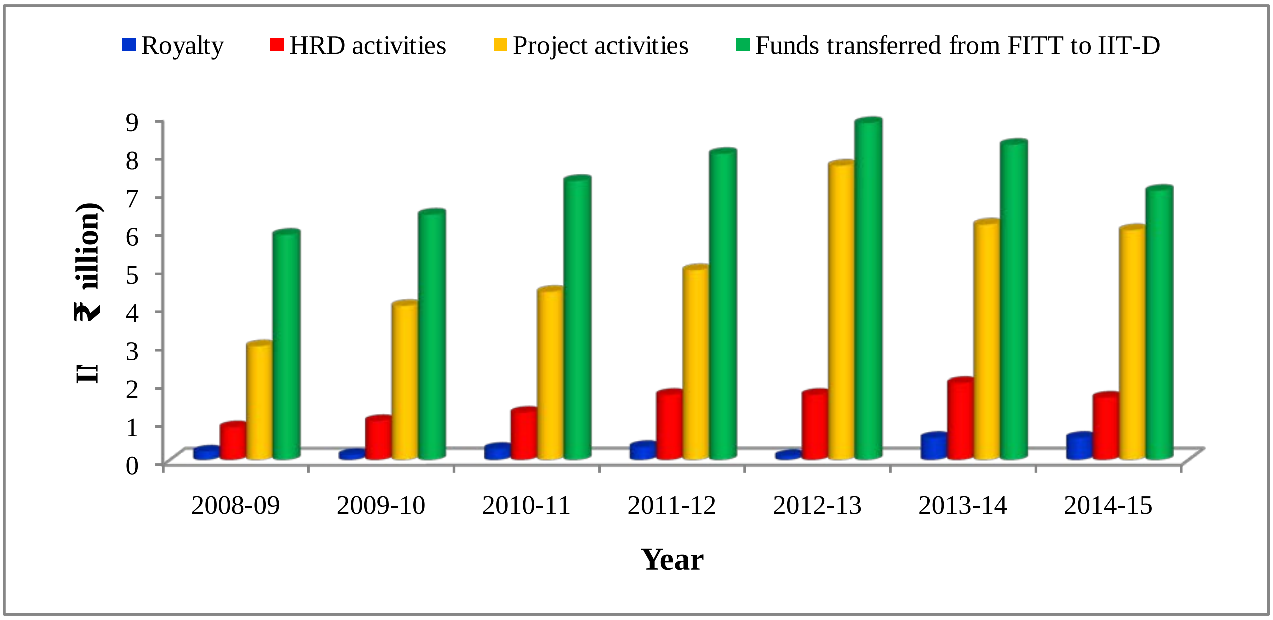



**Figure 3: Resource Generation for FITT and IIT-D**

***Source:*** *FITT Annual Report, 2008-15*

## D. I-A Enablers

HEIs possess various R&D enablers for enhancing industry collaborated research in academic institution. These enablers are listed below

1. Industrial Research Cell (Sponsored and Consultancy)
2. Intellectual Property Cells
3. Technology Development Cell
4. Entrepreneurship and Innovation Cells

Notable examples of each in academic institutions are given in table below.

**Table 6: R&D Enablers in Higher Education Institutes (HEIs)**

| S. No. | HEIs | I-A Cell / Centre |
|---|---|---|
| 1. | IIT Kharagpur | Sponsored Research & Industrial Consultancy (SRIC) Cell |
| 2. | IIT Bombay | Industrial Research & Consultancy Centre (IRCC) |
| 3. | IIT Madras | Industrial Consultancy and Sponsored Research (IC&SR) Centre |
| 4. | IIT Kanpur | SIDBI Innovation and Incubation Centre (SIIC) |
| 5. | IIT Patna | Sponsored Research and Industrial Relations Unit (SRIRU) |
| 6. | IISc Bangalore | • Centre for Scientific and Industrial Consultancy (CSIC)<br>• Society for Innovation and Development (SID)<br>• Intellectual Property (IP) Cell |
| 7. | Panjab University, Chandigarh | Centre for Industry Institute Partnership Programme (CIPP) |
| 8. | Amity University, Noida | Industry Interaction Cell |
| 9. | Anna University, Chennai | Centre for Intellectual Property Rights (IPR) |
| 10. | Punjab Agriculture University, Ludhiana | Technology Marketing and IPR Cell |
| 11. | Jadavpur University, Kolkata | Industry Institute Partnership Cell |
| 12. | University of Agricultural Science, Bangalore | University Consultancy Cell |

# Annexure II

## Bombay College of Pharmacy, Mumbai

www.bcpindia.org

Bombay College of Pharmacy (BCP) affiliated to University of Mumbai, is one of the premier pharmacy colleges in India, imparting quality pharmacy education and research. It was established in 1957 by the Indian Pharmaceutical Association-Maharashtra State Branch (IPA-MSB) with financial assistance from several pharmaceutical conglomerates and Government of Maharashtra to address the needs of pharma industry. Within few years of its establishment, number of graduate, master and doctorate programmes were started in particular branches of pharmaceutical sciences. Since its inception, BCP has grown in stature, and has generated more than 3500 pharmacists, ~700 M. Pharma and ~100 Ph.D. graduates.

BCP is providing master's and Ph.D. programmes through which research in various domains such as Pharmaceutics, Pharmacology and Toxicology, Pharmaceutical Chemistry, Pharmacognosy and Pharmaceutical Analysis is carried out. BCP has formed the research society which is recognized by DSIR, GoI. It has established world class facilities, state of the art instruments and equipments. Research is highly promoted in the college, faculty members have received number of research grants worth ₹100 million from Government funding agencies (DST, DBT, ICMR, UGC and AICTE) and ~₹10 million from private sector. Number of Industry-Academia (I-A) collaborative projects are undertaken in BCP. Till date, More than 300 industry sponsored projects have been successfully completed by BCP. The college has built up effective interface with the industrial sector in term of industrial trainings, industry sponsored projects, consultancy and faculty exchange.

BCP has been accredited with the "Best Industry-Linked Institution in Pharmacy" according tp the national survey carried out by AICTE in collaboration with CII, consecutively from past three years (2013 onwards).

### Industry-Academia Interface

BCP has developed strong industrial linkages and is documented as one of the successful I-A linked institute of the country. BCP was constituted on the demand of industry which led to the full fledged functioning of BCP and it is providing continuous support to Indian pharma industry. In return, faculty receives incentives from their industrial collaborations. 20% of total project cost for research projects and 67% of total consultancy cost for individual consultancy is paid to the faculty, who is carrying out the research project consultancy.

**Dedicated Industrial Cell**

BCP has dedicated Industry Institute Interaction Cell (IIIC) whose main objective is to act as a liaison between industries and the college. Following are the major activities of the IIIC:

- Maintenance, coordination and promotion of consultancy services
- Distribution of funds that are obtained from industrial consultancy services for strengthening college's infrastructure and resources.
- Encouraging industry to start "Industry Study Tour Programme (ISTP) internship programme" and enhancing student's placement.
- Assist industries in obtaining tax incentives from Government by collaborating with them for R&D activities.
- Training of industry personnel.
- Exchange of personnel between the industries and BCP (such as industry personnel in delivering lectures on the latest technological development; development of curricula as per industrial needs and evaluation of projects).

BCP has also constituted '***Research Society***' in association with Indian Pharmaceutical Association which is recognized by DSIR. This society manages and co-ordinates various industrial research collaborations for related industries.

**Industrial Linkages**

- **Governing Body and Executive Curriculum Committee**

BCP has developed close linkages with industries, through which industries have become an important component of the Executive Curriculum Committee and play essential role in curriculum and course structure designing. Eighteen industrialists from notable pharma industries are presently part of BCP's Governing Body.

- **Industrial Representatives as Faculty Members**

In BCP, there are notable industry representatives as faculty of BCP. They share their valuable knowledge, experiences and industry challenges with the students. They also make the students aware of the industry needs. A few of the eminent industrialists in the faculty of BCP are listed in table 1.

**Table 1: Industrial Representatives as Faculty Members of BCP**

| S. No | Faculty Member | Present Designation in the Industry |
|---|---|---|

| | | |
|---|---|---|
| 1. | Dr. Rao VSVV | Vice President, Nektar Therapeutics India Pvt. Ltd. |
| 2. | Dr. Arun Bhatt | President, ClinInvent Research Pvt. Ltd. |
| 3. | Dr. C.N. Potkar | Director, Clinical Research and Regulatory Affairs, Pfizer India Ltd. |
| 4. | Dr. Chitra Lele | Executive Vice President, Sciformix Technologies, India |
| 5. | Dr. Shekhar S Dawkar | Clinical Operations Manager, Amgen Technology Pvt. Ltd. |
| 6. | Dr. Viraj Rajadhyaksha | Senior Medical Advisor, Pfizer India Ltd. |
| 7. | Dr. Aakash Ganju | Director Clinical Operations, Johnson and Johnson, India |
| 8. | Ms. Aditi Andrade | GCQA Specialist, Asia Pacific Global Clinical Quality Assurance, Johnson & Johnson Pharma Res. |
| 9. | Dr. Anupama Ramkumar | Director, Arkus Clinical Trial Support Solutions, Ahmedabad |
| 10. | Dr. Arun Nanivadekar | Medical Research Consultant, Mumbai |

Moreover, numbers of guest lectures are arranged from the industry side as well. Students pursuing their final year of B. Pharma course are readily taken up by industries for internship programme where they get associated with industrial requirements and in return industry gets access to the manpower.

- **Industry Participation in R&D**

- **R&D Collaborative Projects**: Many R&D projects at the college are funded by pharma industry. BCP has successfully completed over 300 industrial projects. Each department of BCP has collaborations with the industry (Table 2).

**Table 2: Industrial Collaborations in Each Department of BCP**

| Department | Industrial Collaborators | Details |
|---|---|---|
| **Pharmacology and Toxicology** | Shreya Lifesciences; Yasham P2D; Marico Ltd; ACTREC; Haffkin Institute; PCP (BDVU) | Faculty Member: 2; Patents: 3<br>Consultancy Services *(In Last 5 Years)*: ~7 |
| **Pharmaceutics** | Unichem Labs. Bayer (I) Ltd; Bombay Drug House; Novartis; Bristol Maver Squibb; SPDS Lab India; USV Ltd; Abott India Ltd; Hanschen Probiotics; Famy Care; Glenmark Ltd; Getz Pharma; Cipla Ltd. | Faculty Member: 6; Patents: 15<br>Consultancy Services *(In Last 5 Years)*: ~8 |
| **Pharmaceutical Chemistry** | Astrazeneca Research Foundation; Bristal Mayer Squib; Biocon Ltd; Alchemy Research Centre; Ciba Speciality Chemicals Ltd; Unichem Labs. | Faculty Member: 4; Patents: 6<br>Consultancy Services *(In Last 5 Years)*: ~2 |
| **Pharmacognosy** | Omniactiv; Anazeal; Marico Ltd. | Faculty Member: 2; Patents: 1<br>Consultancy Services *(In Last 5 Years)*: ~3 |
| **Pharmaceutical Analysis** | Marico Ltd; Spring Bank Pharmaceuticals Inc. | Faculty Member: 3; Patents: 3<br>Consultancy Services *(In Last 5 Years)*: ~2 |

- **Industry Initiated Laboratories**: BCP in association with pharma industries has set up number of laboratories and dedicated research centres such as Drug Testing Centre, Bio-

Availability Centre and Clinical Excellence Academy (Table 3). Industries have also promoted Research Fellowships e.g., Amrut Mody Research Fund (AMRF) was created at BCP out of donation from Unichem Laboratories Ltd. The main objective of this fund is to recognize and encourage research carried out in the field of pharmaceutical and allied science in the BCP and some other pharmaceutical institution in India.

**Table 3: Research Laboratories Created in BCP in Association with Industry**

| Research Laboratory | Inaugurated year |
|---|---|
| The Vividhlaxi Audyogik Samshodhan Vikas Kendra (VASVIK) Research Wing | 1987 |
| M. K. Rangnekar Memorial Laboratory | 1988 |
| Bioavailability Centre | 1990 |
| Ramesh Banatwala Memorial Industrial Pharmacy Laboratory | 1995 |
| E- Merck Laboratory and Chemistry Laboratory | 1996 |
| Academy for Clinical Excellence (ACE) in Collaboration with Pfizer Global Research | 2002 |
| Nihchal Israni Microbiological Laboratory | 2005 |

In addition, AMRF has also supported BCP for payment of faculty salary (Table 4).

**Table 4: Contribution of AMRF to Payment of Salaries to Faculty**

| S. No. | Amount of Salary (₹) | Year |
|---|---|---|
| 1. | 9,78,215 | 2012-13 |
| 2. | 12,55,571 | 2013-14 |
| 3. | 11,63,716 | 2014-15 |
| 4. | 13,04,798 | 2015-16 |
| **Total Amount 47,02,300/-** | | |

- **Industrial Partners:** BCP has signed MoUs with many industries for providing education, training, consultancy and research projects. Table 5 represents the name of industrial collaborators of BCP in last four years.

**Table 5: Industrial Collaborators of BCP, 2012 Onwards**

| S. No. | Industrial Collaborator | Year |
|---|---|---|
| 1. | Anazeal Analytical Pvt. Ltd., Omni Active Health Technologies Ltd., Marico Ltd., Shreya Life Sciences Pvt. Ltd., IPCA Laboratories Ltd., Omniactives Health Technologies Pune, Enem Nostrum Remedies Pvt. Ltd., Zytex Biotech Pvt. Ltd., Bristol Myers Squibb, Ambernath Organics Pvt. Ltd., Glenmark | 2012-13 |

| | | |
|---|---|---|
| | Pharmaceuticals Ltd., Evonik Degussa India Pvt. Ltd., Piramal Life Science Ltd., Gattefosse India Pvt. Ltd., Panacea Biotech Ltd., USV Ltd., Franco-Indian Pharmaceutical Pvt. ltd., Cymbiotics Biopharma Pvt. Ltd., Bharat Serums and Vaccines Ltd., Abbott India Pvt. Ltd.,Getz Pharma Research Pvt. Ltd., Glenmark Ltd., Famy Care Ltd., Getz Pharma Ltd. **(25)** | |
| 2. | Marico Ltd., Getz Pharma Research Pvt. Ltd., Cipla Ltd., Bajaj Healthcare Ltd., Evonik Degussa India Pvt.Ltd., Neon Labs, Piramal Life Science Ltd., Enem Nostrum Remedies Pvt. Ltd., Ankum Drugs and Pharmaceuticals Ltd., Bharat Serums and Vaccines Ltd., Piramal Enterprises Ltd., Ipca Laboratories Ltd., Ambernath Organics Pvt. Ltd., BASF SE, Germany. **(17)** | 2013-14 |
| 3. | Getz Pharma Research Pvt. Ltd., J M B Pharmaceuticals, Piramal Healthcare Ltd., Gattefosse India Pvt. Ltd., Enem Nostrum Remedies Pvt. Ltd., Panacea Biotech Ltd., Marico Ltd., Bharat Serum Vaccines Pvt. Ltd., Vinayak Ingredient India Pvt. Ltd., Naprod Life Science Pvt. Ltd., Anazeal Analytical & Research Pvt. Ltd., Vaidya Patankar Pharmacy Pvt. Ltd., Sandu Pharmaceutical Ltd., Ambernath Organics Pvt Ltd., BASF SE, Germany **(15)** | 2014-15 |
| 4. | Gattefosse India Pvt. Ltd., Fusion Scientific Laboratories Pvt. Ltd., Pioma Chemicals, Naprod life Sciences Pvt. Ltd., Vinayak Ingradient India Pvt. Ltd., Bharat Serums Vaccines Pvt. Ltd., Marico Ltd., Fusion Scientific Laboratories Pvt. Ltd., Gutam Exports, Anazeal Analytical & Research Pvt. Ltd., Sandu Pharmaceutical Ltd., Ambernath Organics, Spring Bank Pharmaceuticals , BASF SE, Germany **(14)** | 2015-16 |

Several industries as mentioned below are partner with BCP for curriculum design and academic teaching along with pursuing collaborative research:

Pfizer Ltd., Mumbai; Bhavan's SPARC, Mumbai; ClinInvent Research, Mumbai; Fulford India Ltd., Mumbai; Dr. Reddy's Laboratories Ltd., Hyderabad; Goldsheild Services, Mumbai; Lambda Therapeutic Research Pv.t Ltd., Mumbai; Neeman Medical International Asia Ltd., Delhi;Novartis India Ltd., Mumbai; Quintiles Spectral India Ltd., Mumbai; Ranbaxy Research Laboratories, Gurgaon; Sanofi-Aventis Pharma Ltd., Mumbai; Spectra Clinical Research Center, Hyderabad; SIRO Clinpharm Pvt. Ltd., Mumbai; SRL Ranbaxy, Mumbai; Wockhardt Ltd., Mumbai; Wyeth Lederle Ltd., Mumbai and Zydus Byk Healthcare Ltd., Mumbai.

- **Role of Industry in Institute Development and Revenue Generation:** Industry is actively contributing to the growth of BCP by providing finances for faculty salary, institute development and revenue generation. Figure 1 represents the amount of revenue generated from industries, 2012 onwards and table 6 lists the revenue generated from individual project and its corresponding collaborator. Department wise distribution of institutional share from industrial projects is presented in table 7.

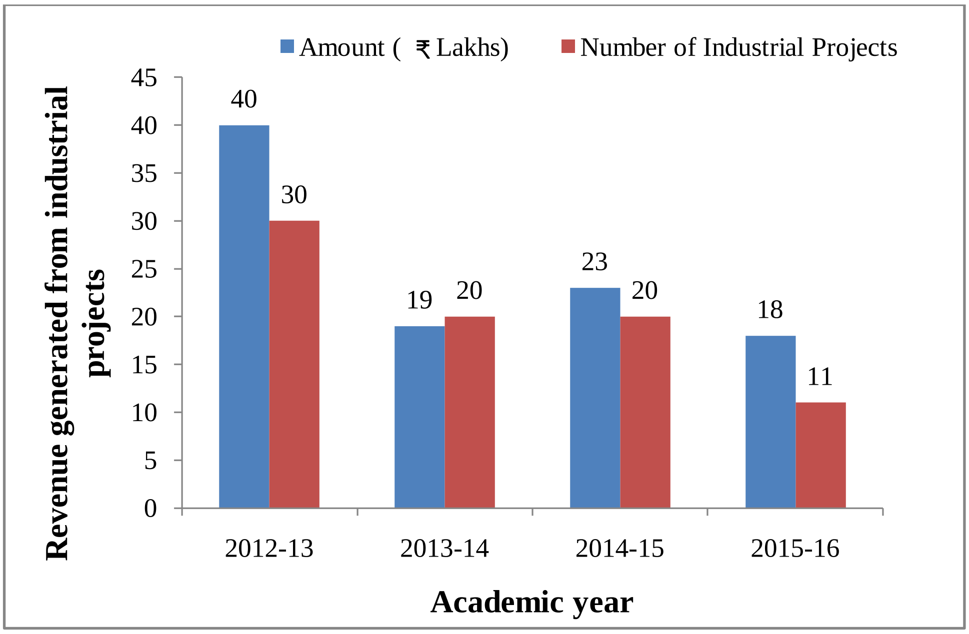



**Figure 1: Revenue Generated from Industrial Projects in BCP since 2012.**

**Table 6: Revenue Generation from Industrial Collaborations (≥ ₹ 1 Lakh)**

| S. No. | Project Title | Industry | Amount Received (₹) |
|---|---|---|---|
| | **Academic year (2012-13)** | | |
| 1. | Comparison of Dry Powder Inhalation Devices | Glenmark Pharmaceuticals Ltd | 4,10,000 |
| 2. | Fellowship/Manpower towards project entitled " Novel formulation stratagies for New Chemical Entities | Piramal Life Science Ltd | 2,80,000 |
| 3. | "Extension of SR Project " | Gattefosse India Pvt Ltd | 1,00,000 |
| 4. | BAE Project of Gelucires Part I | | 2,65,000 |
| 5. | Particle size and Zeta Potential Analysis of formulations | Panacea Biotech Ltd | 1,00,000 |
| 6. | BMS-Fellowship | Bristol Myers Squibb | 4,59,000 |
| 7. | Evaluation of Gardcef-1500 Injection for Anaphylactic Reaction Potential | IPCA Laboratories Ltd | 1,02,600 |
| 8. | Pharmacological evaluation of drugs using carrageenan induced paw edema and croton | Enem Nostrum Remedies Pvt Ltd | 1,65,000 |

| | | | |
|---|---|---|---|
| | oil/Oxazolone induced ear edema method | | |
| 9. | Preclinical studies of Nattokinase | Zytex Biotech Pvt Ltd | 1,81,500 |
| 10. | Use of SOTAX USP type IV- Apparatus (Single cell unit) for Dexamethasone and Tobramyein Ophthalmic suspension. | Getz Pharma Research Pvt. Ltd | 3,70,000 |
| 11. | Three way, three period, cross over bioequivalence study of single oral dose of three brands of 300 mg phenytoin sodium tablets marketed in India, on healthy volunteers. | Abbott India Ltd | 5,04,250 |
| 12. | Use of SOTAX USP type IV- Apparatus (Tablets) | Glenmark Ltd | 2,00,000 |
| 13. | Dissolution studies using SOTAX USP Type IV apparatus | Famy Care Ltd | 3,00,000 |
| 14. | Use of USP type IV- Flow through Cell Dissolution Apparatus 2nd Extension Feb 2012 to April 2012 | USV Ltd | 1,00,000 |
| **Academic Year (2013-14)** | | | |
| 15. | In-silico Resistance Estimation - Assessment and development of computational methods for predicting which amino acids in a target protein binding-site are most likely to mutate in order to generate resistance against specific crop protection agents | BASF SE, GERMANY | 6,07,925 |
| 16. | Effect of some NCEs on Aspirin induced ulcers in rats | Ipca Laboratories Ltd. | 4,06,000 |
| 17. | Particle size and zeta potential analysis | Bharat Serum and Vaccines Ltd. | 1,37,000 |
| 18. | Use of SOTAX USP type IV- Apparatus (Single cell unit) for Betoxolol hydrochloride Opthalmic suspension. | Getz Pharma Research Pvt. Ltd. | 3,03,000 |
| **Academic Year (2014-15)** | | | |
| 19. | In-silico Resistance Estimation - Assessment and development of computational methods for predicting which amino acids in a target protein binding-site are most likely to mutate in order to generate resistance against specific crop protection agents | BASF SE, GERMANY | 6,07,925 |
| 20. | In vitro studies of Bilagyl, Berbenterone tablets and Berbenterone paediatric suspension for antiamoebic, antibacterial and antifungal activity for proof of concept in infectious diarrhoea therapy | Sandu Pharmaceuticals Ltd | 1,53,302 |
| 21. | Bioanalysis of Disulfiram and its metabolites by HPLC | Nerlikar Hospital | 2,00,000 |
| 22. | Stability studies of Doctor Mom Herbal Cough | Anazeal Analytical Pvt | 2,00,000 |

| | | | |
|---|---|---|---|
| | Lozenges | Ltd | |
| 23. | BAE Project of Gelucires Part I | Gattefosse India Pvt Ltd | 1,00,000 |
| 24. | Design of lipsomal formulations | Panacea Biotech Ltd | 2,21,000 |
| 25. | Particle size and zeta potential analysis | Bharat Serum and Vaccines Ltd | 1,40,500 |
| | | Marico Ltd | 1,38,000 |
| 26. | Particle size and Zeta Potential Analysis of formulations | Panacea Biotech Ltd | 1,00,000 |
| 27. | Use of SOTAX USP type IV- Apparatus (Single cell unit) for Dexamethasone and Tobramyein Ophthalmic suspension. | Getz Pharma Research Pvt. Ltd | 2,30,000 |
| **Academic Year (2015-16)** | | | |
| 28. | In-silico Resistance Estimation - Assessment and development of computational methods for predicting which amino acids in a target protein binding-site are most likely to mutate in order to generate resistance against specific crop protection agents | BASF SE, GERMANY | 6,08,925 |
| 29. | Expression, Purification and X-ray structure determination of plasmid RIG-1 | Spring Bank Pharmaceuticals, Inc., MA 07157, USA | 6,37,800 |
| 30. | Bioanalysis of Disulfiram and its metabolites by HPLC | Nerlikar Hospital | 2,28,000 |
| 31. | BAE Project of Gelucires Part I | Gattefosse India Pvt Ltd | 2,65,000 |

**Table 7: Institutional Share from Industrial Projects**

| S. No. | Name of the Department | Amount (₹) | | | | |
|---|---|---|---|---|---|---|
| | | **2012-13** | **2013-14** | **2014-15** | **2015-16** | **Total** |
| 1 | Pharmaceutics Department | 6,25,270 | 2,52,726 | 3,34,277 | 1,54,850 | 13, 67,123 |
| 2 | Pharmaceutical Chemistry | - | 83,000 | 83,000 | - | 1,66,000 |
| 3 | Pharmacognocy | 18,000 | 7,850 | 18,875 | 21,550 | 66,275 |
| 4 | Pharmacology | 1,10,320 | 81,200 | 24,244 | 65,738 | 2,81,502 |
| 5 | Pharmaceutical Analysis | 12,000 | 22,100 | 58,200 | 58,500 | 1,50,800 |
| **Total Amount (₹)** | | **7,65,590** | **4,46,876** | **5,18,596** | **3,00,638** | **20,31,700** |

It is clearly highlighted that BCP is having close collaboration with pharma industries for collaborative research projects and consultancy, which has largely contributed to institution growth for example revenue generated from industries are utilized for providing salary component of the faculty, instrumentation purchase and institute infrastructure development. Hence, collaborated pharma industries have led to the overall growth of BCP as the pioneer institute in field of pharmacy.

## Annexure III

## Institute of Chemical Technology, Mumbai

www.ictmumbai.edu.in

The Institute of Chemical Technology (ICT), Mumbai was established in 1933 with active industrial participation, as University Department of Chemical Technology (UDCT) under University of Mumbai, with the noble intention of enhancing India's knowledge base in chemical science and technology. Based on its continuous progress in academics and translational research, UDCT was upgraded to Deemed-to-be-University and renamed as Institute of Chemical Technology in 2008. Recently (2016), ICT-Mumbai has been ranked as number 2 university, under the National Institutional Ranking Framework (NIRF) of MHRD, (GoI).

**Table 1: Brief Profile of ICT-Mumbai**

| Attributes | Details |
|---|---|
| Status of University | Deemed University (University under Section 3 of UGC) |
| Source of funding | State government |
| Date of establishment of university | 12th September, 2008 |
| Elite status by Government of Maharashtra | 12th April 2012 |
| University departments:<br><br>Undergraduate<br>Postgraduate (including Ph.D.)<br>Research centres on the campus (PG) | <br><br>7 (983*)<br>11 (1015*)<br>2 (72*) |
| Academic programmes<br>UG courses<br>PG courses<br>Ph.D. courses<br>Integrated Ph.D. | <br>9<br>20<br>29<br>29 |
| Faculty Strength | 82 |
| Faculty involved with industrial consultancy | 80% |
| Patents (in last 10 years)<br>Filed | <br>310 |
| Research paper in international journal (2011-15)<br>Average papers per faculty | 2806<br>4.5 |
| Industrial collaborators (MoUs signed) | ~56 |
| Government sponsored projects (Completed) | ~320 |
| Industry sponsored projects (Completed) | ~318 |
| Industrial consultancy | ~269 |
| Entrepreneurs generated (till date) | >500 |

*number of students
**Source:** *www.ictmumbai.edu.in*

## Centres of Excellence

Three Centres of Excellence related to R&D have been established in ICT- Mumbai to promote quality education and research through the support of central agencies. These are:

1. **DBT-ICT-Centre for Energy Biosciences:**

   The Centre's main focus is on developing biofuels from renewable resources to reduce India's rising dependence on petroleum fuels. The team of faculty working under this Centre comprises of Professor (1), Assistant Professors (2), Research Scientists (6) and Research Associates (8). Currently the Centre has more than 50 research scholars. The total grants received by this Centre from various sources amounts to ₹ 49 crores (approx). This Centre also has a dedicated unit for IP management and commercialization.

**Table 2: List of Select Research Projects Sponsored by Public and Private Sectors**

| S. No. | Title | Funding Agency | Amount (₹) in Lacs | Duration |
|---|---|---|---|---|
| **Public Funded Projects** | | | | |
| 1 | Green enzymatic fat splitting technology for production of fatty acids and acyl glycerols | DST, India | 847.53 | 2014-2016 |
| 2 | Improved production of Biogas and Bio-CNG from lignocellulosic biomas | MNRE, India | 515.61 | 2013-2015 |
| 3 | Centre for energy biosciences: New and extension proposals | DBT, India | 1800.00 | 2013-2018 |
| 4 | Transnational approaches to resolving biological bottlenecks in macroalgal biofuel production | DBT-BBSRC (Joint Indo-UK Scheme) | 471.02 | 2013-2016 |
| 5 | Integrated technologies for economically sustainable bio- based Energy | AISRF Indo-Australia Grand Challenge Program, DST, India | 444.00 | 2013-2016 |
| **Private Funded Projects** | | | | |
| 6 | Microbial biotransformation for aromatic chemicals | Nagar Haveli Perfumes & Aromatics, Mumbai | 15.00 | 2014-2015 |

| | | | | |
|---|---|---|---|---|
| 7 | Generation of purified phytoene from yeast cell mass | Wacker Chemie AG, Mumbai | 14.49 | 2014-2015 |
| 8 | Mass cultivation of algae for aqua feed | Godrej Agrovet Ltd, Mumbai | 115.00 | 2014-2016 |

**Table 3: Inter Institutional Collaborative Projects**

| **S. No.** | **Title** | **Collaboration** | **Grant (₹) in Lacs** |
|---|---|---|---|
| | | **International** | |
| 1 | Design of selective nanoporous membrane bioreactor for efficient production of biobutanol from lignocellulosic sugars | • Fraunhofer Institute for Ceramic Technologies & Systems, Hermsdorf, Germany | 115.40 |
| 2 | Transnational approaches to resolving biological bottlenecks in macroalgal biofuel production | • Durham Energy Institute, Durham University, UK<br>• Centre for Advanced Research in International Agricultural Development (CARIAD), Bangor University, UK<br>• Institute of Biological, Environmental and Rural Sciences. Aberystwyth University, UK | 471.02 |
| 3 | Engineering enzymes, bacteria and bioconversion processes for advanced biofuels from waste grain straw | • Clostridia Research Group/ Life Sciences, University of Nottingham, UK<br>• Centre for Novel Agricultural Products, Department of Biology, University of York, UK<br>• Institute for Cell and Molecular Bioscience, Newcastle University, UK<br>• Faculty Health & life Sciences, Oxford Brookes University, UK | 272.08 |
| 4 | Integrated technologies for economically sustainable bio-based Energy | • Centre for Tropical Crops and Biocommodities, Queensland University of Technology, Australia<br>• The Centre for Energy, The University of Western Australia, Australia<br>• Department of Chemical Engineering, Curtin University, Australia | 444.00 |
| | | **National** | |
| 5 | Green enzymatic fat splitting | Acme Synthetic Chemicals, | 362.66 |

| | | | |
|---|---|---|---|
| | technology for production of fatty acids and acyl glycerols | Mumbai | (Industry Contribution) 850.60 (DST Contribution) |
| 6 | Pilot scale translational facility for value added chemicals from biomass | Privi Biotechnologies (P) Ltd, Mumbai | 395.00 (Industry Contribution), 390.00 (BIRAC, DBT Contribution to company as loan), 50.00 (BIRAC, DBT Contribution to ICT as grant) |
| 7 | Lignocellulosic ethanol pilot plant to integrated continuous pilot plant | • India Glycols Limited, Noida, UP | 862.50 (Industry Contribution), 862.50 (BIRAC, DBT contribution to company as loan) |

**Table 4: Some Prominent Patents from the Centre for Energy Biosciences**

| S. No. | Title | Patent No. | Status |
|---|---|---|---|
| 1 | Enzymatic process for fat and oil hydrolysis | SG11201404463P | Patent granted; Pilot plant being constructed for demonstration with DST support Total project cost (₹) = 850.60 L+362.50L = 1213.10L |
| 2 | Method for production of fermentable sugars from biomass | •US8709763 (USDIV-I); 2009<br>• US8338139; 2009<br>•US8673596 (USDIV-II); 2009<br>• BD1005172; 2009<br>• PK141809; 2009<br>•ZA2011/09250; 2012<br>•AU2010252547; 2015 | Patent granted; Pilot plant being constructed for demonstration with BIRAC, DBT support Total project cost (₹) = 862.50L+862.50L = 1725.00L |

| | | | |
|---|---|---|---|
| 3 | Process for fractionation of biomass | •JP2013-513816;2015 •ZA2013/00133; 2010 | Patent granted; Pilot plant being constructed for demonstration with BIRAC, DBT support Total project cost (₹) = 862.50L+862.50L = 1725.00L |
| 4 | Enzymatic production Of monoacylglycerol from oil | 1583/MUM/ 2014 | Patent filed; Pilot plant being constructed for demonstration with DST support Total project cost (₹) = 850.60 L+362.50L = 1213.10L |
| 5 | A process for fractionation of oligosaccharides from cereal Bran | 155/MUM/ 2014; PCT/IB2015/ 000030 | Patent filed; Pilot plant being constructed for demonstration with BIRAC, DBT support (₹) 395.00 (Industry Contribution), (₹) 390.00 (BIRAC, DBT contribution to company as loan) (₹) 50.00 |

**Table 5: Industry Consultancy and Income Generated in the year 2014-2015**

| S. No. | Name of the Company | Period | Amount (₹) in Lakhs |
|---|---|---|---|
| 1 | M/s. Warden International (Agencies) Pvt. Ltd, Mumbai | 3 months | 9.00 |
| 2 | M/s. Kanoria Chemicals & Industries Ltd, Kolkata | 1 year | 25.00 |
| 3 | M/s. Catapro Technologies, Nasik | 7 months | 8.00 |

2. **ICT-DAE Centre for Chemical Engineering Education and Research**:
   This Centre was established as a joint effort of ICT-Mumbai and the Department of Atomic Energy (DAE) for conducting Ph.D. programmes in Chemical Engineering to carry out R&D projects.This Centre is working in close association with the DAE research institutions such as BARC, Mumbai and IGCAR, Kalpakkam, Tamil Nadu.The research objective is focused on generation of nuclear power production, use of radioisotopes in industry, health and agriculture.

**Table 6: List of Important Sponsored Projects Related to the Centre for Chemical Engineering Education and Research**

| S. No. | Project title | Amount (₹) in Lakhs | Sponsoring agency |
|---|---|---|---|
| 1 | Design of solvent and extractant by molecular modelling for heavy metals | 84.40 | DAE |
| 2 | Experimental determination of $H_2$-$I_2$- HI-$H_2SO_4$ vapor-liquid equilibria | 48.40 | DAE |

| | | | |
|---|---|---|---|
| 3 | Studies on steam pyrolysis of a CHON amide as a waste solvent management method | 24.70 | IGCAR |
| 4 | Polysaccharide based nanocarriers for improved therapy of systemic fungal infections | 16.90 | DAE |
| 5 | Passive decay heat removal system of AHWR | 221.00 | DAE |
| 6 | Thermal hydraulic studies related to coolants for new generation reactors | 80.00 | DAE |
| 7 | Characterization of cavitation phenomena and its applications in solid liquid mass transfer operations | 88.90 | DAE |
| 8 | Design of sodium cold-trap | 23.80 | IGCAR |
| 9 | Preparation of mono disperse MOX | 23.80 | IGCAR |
| 10 | Role of cavitation and its prevention in sodium pump | 24.80 | IGCAR |
| 11 | Scale up of MOX precipitation | 21.50 | IGCAR |
| 12 | Characterization of the regeneration process for liquid sodium cold trap in secondary system | 38.00 | IGCAR |
| 13 | Transport of actinides and fission products across hollow fibre supported liquid membranes | 72.40 | DAE |
| 14 | Thermal mixer design | 24.20 | IGCAR |
| 15 | Flow distribution in inlet plenum of steam generators | 24.90 | IGCAR |
| 16 | Removal of dissolved TBP for aqueous stream | 24.50 | IGCAR |
| 17 | Self assembly of tethered nanoparticles :Macromolecule' for tailored nanomaterials | 95.00 | DAE |
| 18 | Knowledge based engineering : Improvements in reactor design, heavy water production efficiency, nuclear waste management and development of novel | 150.00 | DAE |
| 19 | Chemical engineering, education and research | 7500.00 | DAE |

3. **Centre for Green Technology:**

Synthetic chemicals are routinely used to make virtually every man-made product. However, when the production and use of chemicals are not managed responsibly it can also have enormous impact on human health and the environment. Alternative means of chemical production which have benign or reduced adverse impact are required and new robust technologies in this direction need to be developed. In recognition of this urgent need, Centre for Green Technology was established in order to promote research in green chemistry with ₹ 30 crores sanctioned by UGC. The Centre is jointly owned by ICT-Mumbai and University of Mumbai.

**National and International Accolades**

- The Melinda and Bill Gates Foundation, USA, has awarded four grants to ICT-Mumbai recently which speak volumes of ICT's standing internationally.
- During 2014-15, ICT-Mumbai with faculty strength of 82, published 382 research papers in international journals which is a record in India.
- There are around 340 UG scholarships which have been created through funds generated from endowments, philanthropists, donations, trusts etc.
- Many of the scientists actually earn their salaries through the consultation fees paid by the collaborating industry.

**Technology Enhancement in ICT-Mumbai**

ICT-Mumbai has established various dedicated units that promote technology development and commercialization. A couple of these units are as follows:

1. An entrepreneurship cell (E-Cell) was launched in April 2013 with the primary goal of accelerating the entrepreneurial culture of ICT-Mumbai.
2. The Technological Association (TA) is the student body of ICT-Mumbai that conducts various extra-curricular and co-curricular activities throughout each academic year. The in-house technical journal, Bombay Technologist is also run by the TA and actively promotes scientific writing among students.

The following Centres of Excellence are included in the future expansion plans of ICT-Mumbai:

1. Centre for Infectious Disease Control and Prevention
2. Centre for Process Intensification and Innovation
3. Centre for Product Engineering
4. Centre for Undergraduate Research In Engineering (CURIE)
5. Creation of Visiting Professorships endowments
6. Entrepreneurship resource centre
7. Group consultations: Adoption of sick industries.
8. Increasing international collaborations (Joint projects with leading institutes and Joint degrees , UG exchange, PG exchange)
9. Interactive student services portal
10. Technology Incubation Centre

11. Technology Transfer Cell

## Promotion of Research

- The culture of research among faculty and students is actively being promoted by facilitating participation in research projects and by providing resources and other facilities. Even UG students are engaged in active research in ICT-Mumbai. The institution facilitates its faculty by providing research funds as seed money. There are funds organized under Golden Jubilee Endowment through which seed money is provided to young faculty.
- ICT-Mumbai utilizes dedicated funds from agencies (BIRAC, RGSTC etc) for Tech Transfers.
- Teaching work load remission is provided to the faculty members in order to devote time to Research activities and for attending conferences etc. A 2 hour concession is given to Heads, Deans and other senior administrators (Controller of examination, Registrar, TEQIP Coordinator, and Course Coordinators).
- Faculties who did not have a Ph.D were encouraged to do Ph.D. Three faculty members took up the chance offered to them and completed their Ph. D during 2014-15. They have now started supervising Ph.D students.
- Sabbatical leave for higher research within the country and abroad can be availed and a good percentage of faculties have utilized this facility.
- New research areas such as computational chemistry, nanotechnology, material science, process control among many others has been initiated by young faculty, and is bound to bring laurels in future. All facilities and provisions such as duty leave and training expenses were made available for the same.
- Many endowment chairs have been created to invite eminent person from academic and industry. All efforts are made to appoint distinguished scientists and faculty through industry endowments. List of some industry endowments is given below:
    1. R.T. Mody Professor of Chemical Technology
    2. Sir Dorabji Tata Reader in Pharmaceutical Chemistry
    3. Darbari Seth Professor of Inorganic Chemical Technology
    4. Bharat Petroleum Distinguished Professor of Chemical Engineering
    5. V.V. Mariwala Chair in Chemical Engineering
    6. J.G. Kane Chair of Oil Technology

7. M. M. Sharma Distinguished Professor of Chemical Engineering
8. R. A. Mashelkar Chair of Chemical Engineering
9. Gunavati Kapoor Chair in Pharmaceutical Technology
10. Dr. B. P. Godrej Distinguished Professor of Green Chemistry and Sustainability Engineering
11. Pidilite Industries Ltd, Visiting fellow in Dyestuff Science & Technology
12. Marico Industries Visiting Fellowship
13. ICT - Lupin Visiting Fellowship for Bioprocess Technology
14. CIPLA Distinguished Visiting Fellowship in Pharmaceutical Sciences

    *For details please see NAAC Self Study Report, ICT-Mumbai,2015 (http://www.ictmumbai.edu.in/uploaded_files/NAAC-Self_Study_Report_2016.pdf)*

- The institute receives only salary grants from the state government and the government does not provide any other type of block grant to the institute. As such, institute does not earmark any budget head as a separate research fund in its annual budget. However, institute is supported by central government institutes such as UGC through its Career Advancement Scheme (CAS) programme, DST, CSIR, AICTE and Government and Industrial projects for the research work carried out in the institute.
- The instruments/equipments of ICT-Mumbai are available to research scholars 24X7, for performing their research work.

**Mode of Publicizing the Consultancy Expertise of the University:**

- The consultancy expertise available is publicized by the Institution through the Annual Reports and prospectus and through several conferences and workshops showcasing the capability of individual faculty member.
- Details of all faculty, their expertise and current consultancies, the projects under supervision as well other relevant details are published in the annual reports which are circulated to industries and also uploaded on the website. Industries approach the faculty directly or through the officials in the VC’s office for appointing faculty as consultants.
- As long as the terms and conditions of consultancy are in line with the institute’s policy, all faculty members are permitted to take consultancy without compromising on their academic work.

**Areas of Consultancy:** The areas of consultancy provided by ICT-Mumbai may be broadly classified into Pharmaceuticals (drug formulation, purification, delivery systems etc) Food industry (process, additives, formulation etc) Cosmeticeuticals, Nutraceuticals, Microbial biotransformation and Bio-based chemicals, Organic chemical synthesis and Natural product purification.

**Outcomes of Research in ICT-Mumbai**

1. **Publications**: Details of the publications by the faculty from 2011-15 are provided below:
   - Number of papers (national / international)published in peer reviewed journals - 2806
   - Chapters in Books – 29
   - Books with ISBN with details of publishers - 8
   - Books edited - 25
   - Monographs - 6
   - Number of publications listed in International Database (For e.g. Web of Science, Scopus, Humanities International Complete and EBSCO host) - 2037
   - Citation Index – 26,498
   - H-index – 63
2. **Patenting and Licensing**: ICT-Mumbai has filed/acquired 310 patents in last 10 years of which 189 are during the last 5 years. Two patents have been licensed during the year 2012-13. Trend in patenting in ICT-Mumbai in last 3 years is illustrated in figure 1.

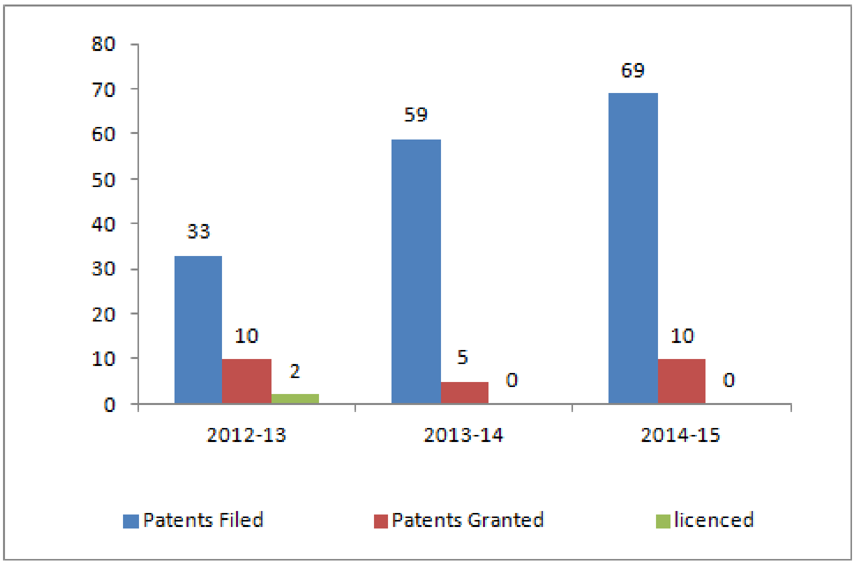



**Figure 1: Patents Filed, Granted and Licensed in ICT-Mumbai from 2012 Onwards**

***Source***: *NAAC A Self Study Report, ICT-Mumbai, 2015*

3. **Industry Sponsored Projects**: Around 232 industry/corporate houses sponsored projects are undertaken by ICT-Mumbai worth ₹ 84.7 crores. The list of industrial projects along with the funds involved is given below.

**Table 7: Prominent Industry/Corporate Houses Sponsoring Research Projects at ICT-Mumbai**

| Industry/Corporate Houses | Principle Investigator | Amount (₹) |
|---|---|---|
| Abbott Healthcare Pvt. Ltd | Prof. P.V. Devrajan | 603800.00 |
| Asian Paints Ltd | Prof . R.N. Jagtap | * |
| BASF Ltd | Prof. R.V. Adivarekar | * |
| Bill Gates Foundation. | Prof. B.N. Thorat | * |
| Bio-Rad Lab | Prof. A.M. Lali | 198987.00 |
| BIRAC | Dr P.R. Namade | 54656.00 |
| Cadbury India | Prof. Rekha S. Singhal | * |
| DSM India | P.R Gogate/V.K. Rathod | 34500.00 |
| General Mills-III | Prof. A.M. Lali | * |
| Glenmark Pharma Ltd | Dr. S.S. Sathaye | * |
| Godrej Agrovet Ltd | Prof. A.M. Lali | 8595540.00 |
| Himedia Laboratories Pvt Ltd | Prof. U.S. Annapure | * |
| Hindustan Unilever Ltd | Prof. P.A. Mahanwar | 301962.00 |
| India Glycols Ltd | Prof. A.M. Lali | * |
| IPCA Lab Pvt Ltd | Prof. S.S. Bhagwat | * |
| Nicholas Piramal | Prof. K.G. Akamanchi | * |
| Pepsico | Prof. A.M. Lali | * |
| Pidilite | Prof. R.N. Jagtap | 50000.00 |
| Reliance Industries | Prof. G.D. Yadav | * |
| Tata Chemicals Ltd | Prof. U.S. Annapure | 126405.00 |
| Unilever India Pvt Ltd | Prof. A.W. Patwardhan | 161270.00 |

* Project amount not available

***Source:*** *NAAC Self Study Report, ICT-Mumbai, 2015*

4. **Mutual Benefits Accrued due to Consultancy:** The faculties of the institute get an understanding of the industry requirements and an opportunity to solve real life problems. Financial remuneration is another added advantage. Institutional resources in the form of equipments, endowments etc are generated through consultancy. Industry gets expert advice in the shortest possible time which saves their resources (time, energy, money). Figure 2 presents the worth of industrial consultancy carried out in ICT-Mumbai

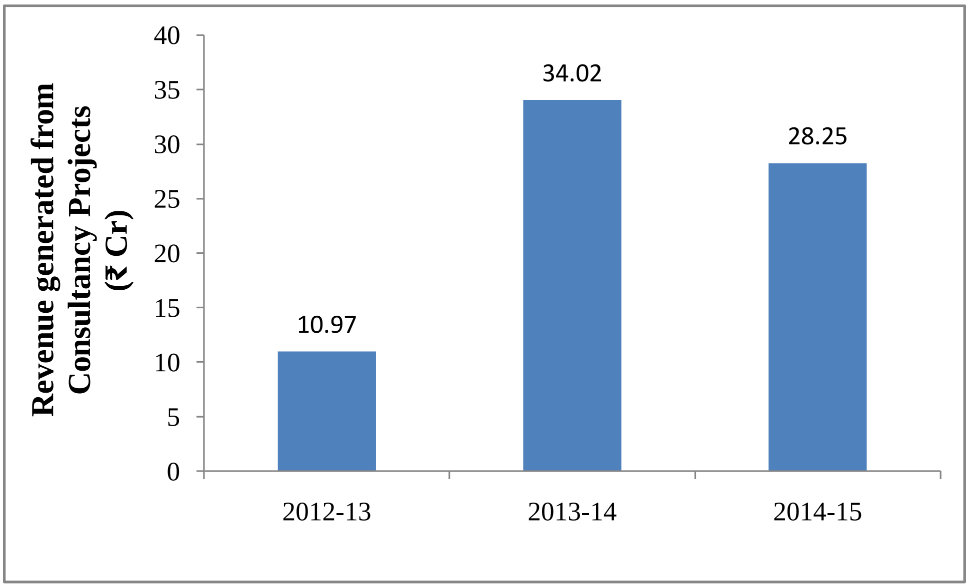



**Figure 2: Revenue Generated from Industrial Consultancy Projects**

***Source:*** *NAAC Self Study Report, ICT- Mumbai, 2015*

5. **Industrial Collaborations:** ICT-Mumbai has close working relations with both foreign and Indian institutes and industries. In order to facilitate faculty and student exchange, research programmes and joint projects and symposia a large number of MoUs has been signed. We have listed some important MoUs in the following table.

**Table 8: Important MoUs of ICT-Mumbai with National and International Industries**

| S. No. | National Industry/ Corporate Houses | Year of Collaboration |
|---|---|---|
| 1 | Bharat Petroleum Corp. Ltd (BPCL) | 2000, 2015 |
| 2 | Reliance Industries Ltd | 2007 |
| 3 | Hindustan Petroleum Corporation Ltd. | 2010 |
| 4 | General Mills Operations LLC | 2010 |
| 5 | Tata Chemicals Limited | 2010 |
| 6 | Biotech Consortium India Limited | 2010 |
| 7 | Bayer Crop Science Ltd | 2011 |
| 8 | Bio-Rad Laboratories India Pvt. Ltd | 2012 |
| 9 | GlaxoSmithKline Consumer HealthCare Ltd | 2012 |
| 10 | India Glycols Ltd | 2012 |
| 11 | Unilever Industries Pvt. Ltd | 2013 |
| 12 | Tata Chemical Ltd | 2013 |
| 13 | Kirloskar Integrated Technologies Ltd | 2013 |
| 14 | L'oreal India Pvt. Ltd | 2013 |
| 15 | Glenmark Research Centre(Non Disclosure Agreement) | 2014 |
| 16 | Reliance Technology Group (Non Disclosure Agreement) | 2014 |

| | | |
|---|---|---|
| 17 | Agilent Technologies | 2014 |
| 18 | lndian Oil Corporation Ltd | 2015 |
| 19 | Asian Paints Ltd | 2015 |
| 20 | Godrej industries Ltd | 2015 |
| 21 | Siemens Ltd | 2015 |
| **International Industry/ corporate houses** | | |
| 22 | Microsoft Corporation | 2010 |
| 23 | Coca Cola Ltd | 2012, 2014 |
| 24 | Essilor International | 2014 |

***Source:*** *NAAC A Self Study Report 2015*

**6. Generation of Entrepreneurs:** The industry-institute-government relationship fostered by ICT-Mumbai has been exemplary and has been cited as a role model for other institutes. There are several first generation entrepreneurs (numbering over 500) who have done pioneering work in chemical and allied industries in and around Mumbai and other parts of India who are the alumni of the institute. Some distinguished Alumni of ICT-Mumbai who became successful entrepreneurs are mentioned below.

***List of notable entrepreneurs generated:***

1. Shri. Mukesh D. Ambani (CMD, Reliance industries Ltd)
2. Dr. Dinesh Patel (Chairman, Themis Pharmaceuticals)
3. Dr. K. Anji Reddy (Chairman, Dr Reddy's Laboratory Ltd)
4. Shri. Ashwin S. Dani (Vice Chairman and MD, Asian Paints Ltd)
5. Shri. C. J. Bhumkar (Chairman, Soujanya Chemicals)
6. Shri. Chandrakant V. Gogri (Chairman, Aarti Industries and Aarti Group of Companies)
7. Shri. D.M. Trivedi (Famous Textile Technologist l)
8. Shri. J.R. Vyas (CMD, Dishman Pharmaceuticals and Chemicals)
9. Shri. J.R.Shah (Former President, Plastindia Foundation; Chairman, Jayvee Organics and Polymers)
10. Shri. S.M. Mokashi (Managing Director, Xytel India)
11. Shri. U. Shekhar and Shri SudhirPatil (Galaxy Surfactants Ltd)
12. Shri. V.G. Rajadhyaksha (Chairman, Hindustan Lever Ltd)
13. Shri. Narendra Parekh (Chairman, Pidilite lndustries)
14. Shri. NarotamSekhsaria (Founder & Managing Director, Gujarat Ambuja Cement Ltd; Sekhsaria Chemicals)
15. Shri. Nikhil R. Meswani (Tech. Director, Reliance Industries Ltd)

**Some important points for promotion of Intellectual Property Rights (IPR) of ICT-Mumbai**

Research carried out at ICT-Mumbai caters to both academic need as well as industrial applications. Rules and regulation for carrying out consultancy research work with industry/corporate houses in terms of consultancy and sponsored projects and subsequently filing of intellectual property can be accessed from the document “NAAC Self Study Report, ICT-Mumbai, 2015”*(http://www.ictmumbai.edu.in/uploaded_files/NAAC-Self_Study_Report_2016.pdf)*

Some of the salient features adopted by ICT-Mumbai for promotion of IP are as follows:

1. In the case of patent filled by the faculty members, if there is no third party involved, the license fee should be shared between the institute and the faculty members in the proportion of 30% to the institute and 70% to the faculty members.
2. In the case of patent filled by the faculty members, if there is no third party involved, the Royalty shall be shared in the ratio of 1:4 i.e. 20% to the institute and 80% to the faculty member and the other inventors.
3. The institute shall not pay any annual renewal fee for the patent granted. It shall be the responsibility of the authors.

सत्यमेव जयते

Department of Science & Technology
Govt. of India

# DST-Centre for Policy Research at PU, Chd.

***(DST/PRC/CPR-03/2013)***

## <u>REPORT-3</u>

**(May, 2015-Aug., 2016)**

# Patents Ecosystem of India Based on WIPO & IPO Indicators

# Index

# 1. Introduction

The ingenuity of the mind used for the creation of a commercial entity or a societal use is considered as the intellectual property of the concerned person i.e. inventor. The inventor has a legal right over these properties or inventions, which are termed as Intellectual Property Rights (IPRs). The IP protection is critical to foster innovation. Currently, IPRs cover patents, copyrights, trademarks, industrial designs, geographical indicators (GI), layout designs, trade secrets and new plant varieties. Without protection of ideas, individuals as well as businesses would not reap the full benefits of their inventions and thus would focus less on R&D.

Patents occupy a prominent position as global indicators for ranking of world economies. In general, there is direct relation between the economy and the patent-regime of a nation. Top five nations (Finland, New Zealand, Luxembourg, Norway and Switzerland), based on IPRI indicators (IPR Index-2016), are amongst the top 20 global economies of the world (GCI Report-2015). Similarly, lowest ranked nations (Zimbabwe, Haiti, Bangladesh, Myanmar and Venezuela), based on IPRI indicators (IPR Index-2016), have global rankings in triple digits (GCI Report-2015). India's global ranking in these two indicators hover around fifties. India's dream of becoming a strong and developed nation cannot be fulfilled unless India improves its ranking in the domain of IPR. In order to achieve this, it is imperative that we understand the ecosystem of IPR, especially Patents, existing in India. Keeping this in mind, DST-Centre for Policy Research at Panjab University, Chandigarh undertook a responsibility to (a) compare the IPR regime of five Asian countries namely, India, China, Japan, S. Korea and Singapore based on World Intellectual Property Office (WIPO) Report-2015 and (b) analyze the Indian patents database, compiled by the Controller General of Patents, Designs and Trade Marks (CGPDTM), so as to understand the strengths and weaknesses of Indian patent regime.

# 2. World Intellectual Property Office (WIPO)

WIPO is a specialized agency under United Nations (UN) and was set up in 1967 (originally known as BIRPI- Bureaux for the Protection of Intellectual Property) with an objective to promote and protect IP throughout the world. Currently, WIPO comprises of 188 member states. Till date, WIPO has administered 26 international treaties for practicing IPRs all over the world. WIPO became a dedicated agency under UN in year 1974 with a mandate to promote innovations and provide impetus to technology transfer, for improving the socio-economic as well as cultural/artistic levels of the developing economies. WIPO is working in three distinct fields a) protecting IP; b) designing policies and c) development and global cooperation. (Table 1)

**Table 1: IPR Related Activity Domains of WIPO**

| S. No. | Area of Work | Brief Details |
|---|---|---|
| 1. | **IP Protection and Services** | ***International patent system via Patent Cooperation Treaty (PCT)***: assists in seeking patent protection simultaneously in many countries throughout the world by filling one international patent. 148 countries have signed PCT agreement.<br>***Madrid-The International Trademark System***: It is one stop solution for registering and managing trademarks worldwide. It comprise of 97 member states.<br>***Hague-The International Design System***: It is an international registration of industrial designs over 65 territories under one application.<br>***Lisbon-International Registration of Appellations of Origin***: Through single registration protection for an appellation of origin is provided. |
| 2. | **Designing Policies** | For designing IPR policy, WIPO has developed number of negotiating bodies which are as:<br>a) **Governing Bodies:** WIPO assemblies<br>b) **Permanent Committees**: Programme and Budget Committee, Committee on Development and IP, Intergovernmental Committee on IP and Genetic Resources, traditional knowledge and folklore (Inter Governmental Committee), Advisory Committee on Enforcement<br>c) **Standing Committees**: Standing Committee on the Laws of Patents (SCP), law of trademarks, industrial designs and geographical indications (Standing Committee on the Law and Trademarks), copyrights and related rights (Standing Committee on Copy Rights and Related Rights), WIPO standards (Committee on WIPO Standards)<br>These bodies are responsible for designing polices for IPR for its member states. |

| | | |
|---|---|---|
| 3. | **Development and Global Cooperation** | WIPO works in collaboration with the governments of member states along with its public and private sectors/organizations to sensitize them about the benefits accruing from generation of IPRs.<br>Some of the co-operations are mentioned below:<br>• Regional Bureaus for Africa; Arab countries; Asia and the Pacific; Latin America and the Caribbean<br>• Division for Least Developed Countries (LDCs)<br>• Department for Transition and Developed Countries<br>• South-South cooperation |

***Source:*** *www.wipo.int*

Based on the WIPO Report 2015, a comparative study of five Asian countries i.e. Singapore, Japan, S. Korea, China and India has been carried out (Table 2). China, Japan and S. Korea are performing exceedingly well in the parameters of IP Filing in the 'residents category' as well as 'residents & abroad category'. All the three nations are in top five economies of the world, with China occupying first ranking. India's global ranking is satisfactory as it has been ranked 11 and 14 in the categories of 'residents' and 'resident & abroad'. However, Singapore needs to improve its ranking in both the categories.

In the parameter of 'number of filing of patent applications', China is far ahead of other four countries with over 900, 000 patent applications filed in its patent office. This number is 24 fold more than the applications filed in IPO (42,854). Interestingly, the sum total of all the four nations (Japan, S. Korea, Singapore and India) makes up only two-third of the total patent applications filed by China.

**Table 2: Global Rankings of Asian Countries Based on WIPO Report 2015**

| S. No. | Indicators | | Global Rankings | | | | |
|---|---|---|---|---|---|---|---|
| | | | **Singapore** | **Japan** | **S. Korea** | **China** | **India** |
| 1. | **IP Filing Rankings* (resident & abroad)** | Patents | 26 | 3 | 4 | 1 | 14 |
| 2. | **IP Filing Rankings** (residents)** | Patents | 30 | 3 | 4 | 1 | 11 |
| 3. | **Number of Patent Applications by Office of the Country** | Total | 10,312 | 3,25,989 | 2,10,292 | 9,28,177 | 42,854 |
| | | Residents | 1,303 | 2,65,959 | 1,64,073 | 8,01,135 | 12,040 |
| | | Non-residents | 9,009 | 60,030 | 46,219 | 1,27,042 | 30,814 |

*** Out of 100 economies, **out of 80 economies**

***Source:*** *World Intellectual Property Indicators Published by World Intellectual Property Organization (WIPO) (www.wipo.int/ipstats, http://www.wipo.int)*

## 3. Patent Regime in India Based on IPO Indicators

In India, the main body looking after IPRs is the office of CGPDTM located in Mumbai. This office is a subordinate office of the Department of Industrial Policy & Promotion (DIPP), which comes under the Ministry of Commerce and Industry (Fig. 1).

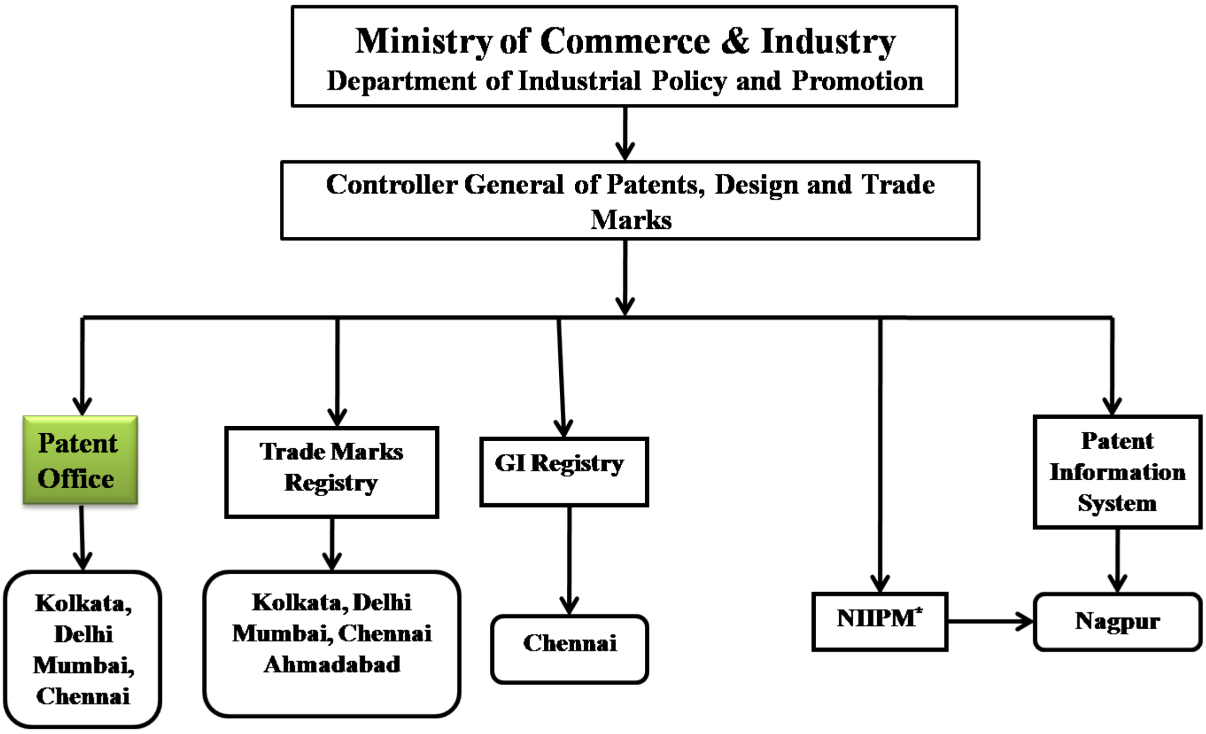



**Figure 1: Organizational Structure of Patent Regime in India**

**National Institute of Intellectual Property Management*

### Patent Applications

Table 3 throws a light on the trend of patents filed / granted in India in the last five years. A big jump in the number of patents filed (43,197) was observed in the time period 2011-12 over the preceding year i.e. 2010-11 (39,400). In the subsequent year (2012-13), a marginal increase of 477 patents filed was observed, taking the total tally to 43,674. However, in the following two years (2013-15), a slight decrease was observed in the number of patents filed. In the category of patents granted, 7,509 patents were granted in 2010-11, which is the highest score in the last five years. Following three years saw a significant decline of nearly

20%. However, last year (2014-15) figure showed a remarkable recovery as 5,978 patents was granted by the IPO. In the other two categories Total number of Patents examined, and Disposal of Request for Patent examination (granted, refused, abandoned), by enlarge an increasing trend was observed, suggesting improvement in the functioning of the IPO. Compared to 11,208 patents examined in 2010-11, more than double the number was examined in 2014-15.

**Table 3: Trend in Patent Applications**

| Year | 2010-11 | 2011-12 | 2012-13 | 2013-14 | 2014-15 |
|---|---|---|---|---|---|
| Filed | 39,400 | 43,197 | 43,674 | 42,951 | 42,763 |
| Examined | 11,208 | 11,031 | 12,268 | 18,615 | 22,631 |
| Granted | 7,509 | 4,381 | 4,126 | 4,227 | 5,978 |
| Disposal of request for examination (Granted + Refused + Abandoned) | 12,851 | 8,488 | 9,027 | 11,411 | 14,316 |

***Source***: *IPO Annual Report 2014-15*

**Applications Filed by Indian Applicants**

Figures 2 & 3 give the number of patents filed and granted in India in various fields of industrial sector. Mechanical sector leads the table with 10,031 filed-patents, amounting to 23% of the total filed-patents. Second ranking is held by Chemical (6,454), followed by Computers/Electronics (4,285) & Electrical (4,031), drugs (2,640) and Biotechnology (1,035) sectors.

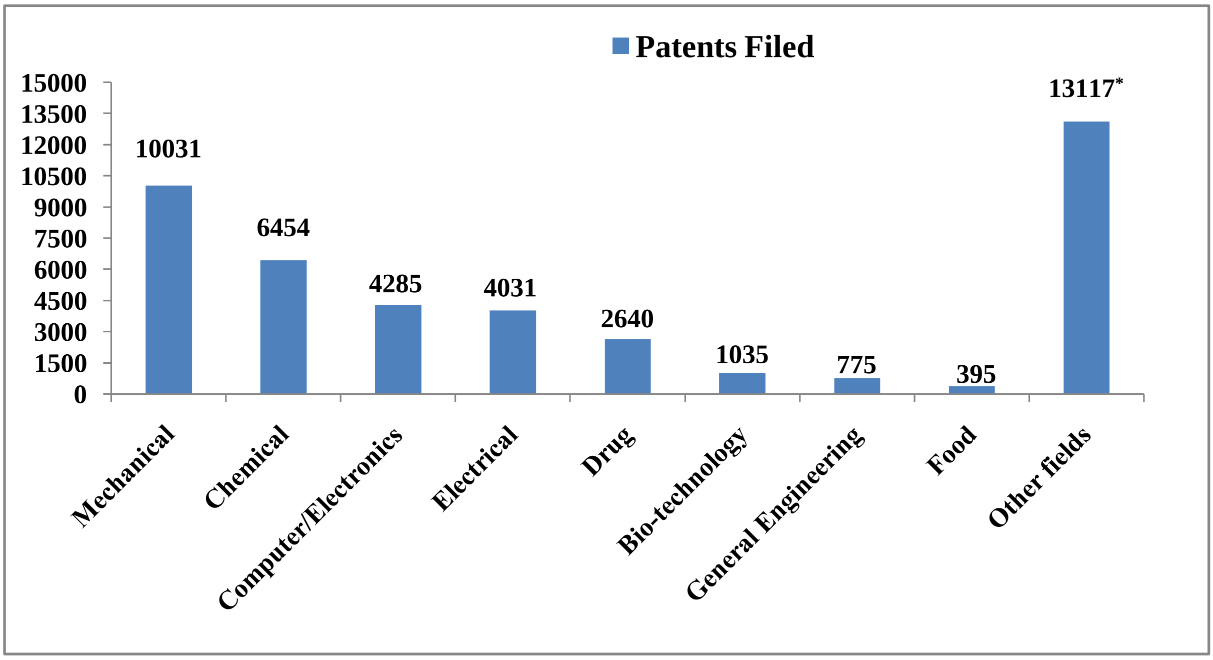


**Figure 2: Numbers of Patent Applications Filed in 2014-15 under Major Fields of Inventions**
***Source***: *IPO Annual Report 2014-15*

** Others – Bio-Medical, Bio-Chemistry, Communication, Physics, Civil, Textile, Metallurgy/Material Science, Agriculture Engineering, Polymer Science/Technology, Micro-Biology, Agrochemical, Traditional Knowledge BIO/CHEM/MECH*

In the patent-granted category, top six rankings of industrial sectors are the same as for patent-filed category. However, there is change in the sequence of ranking. Chemical sector (1,533) has replaced Mechanical sector (1,047) as number one ranked industrial sector followed by Computer/Electronic (835), Drugs (389), Electrical (376) and Biotechnology (262) sectors.

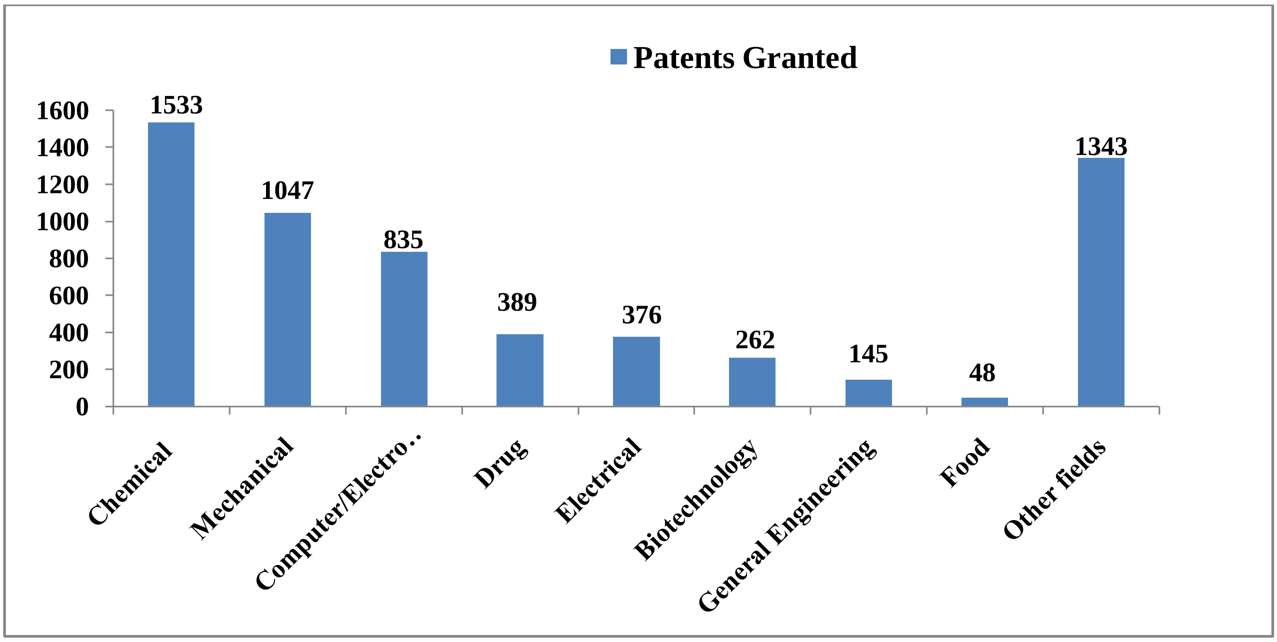



**Figure 3: Numbers of Patents Granted in 2014-15 under Major Fields of Inventions**

***Source***: *IPO Annual Report 2014-15*
** Others – Bio-Medical, Bio-Chemistry, Communication, Physics, Civil, Textile, Metallurgy/Material Science, Agriculture Engineering, Polymer Science/Technology, Micro-Biology, Agrochemical*

Analyzing the data on the basis of state-wise categorization of ordinary patents-filed (Fig. 4), Maharashtra (3,193) occupies first position followed by Karnataka (2,102), Tamil Nadu (1,412) and Delhi (1,099). In fact, out of 29 states, and 7 union territories, *(data for Lakshadweep is not available)* these four states account for 65% of the total ordinary patents filed with IPO. As per IPO data, out of the total of 42,763 patents filed, only 12,071 patent applications (ordinary, convention and PCT) were filed by Indians, and 31,692 were filed by foreign applicants. In other words, 72% applications were filed by foreigner applicants and only 28% were filed by Indian applicants.

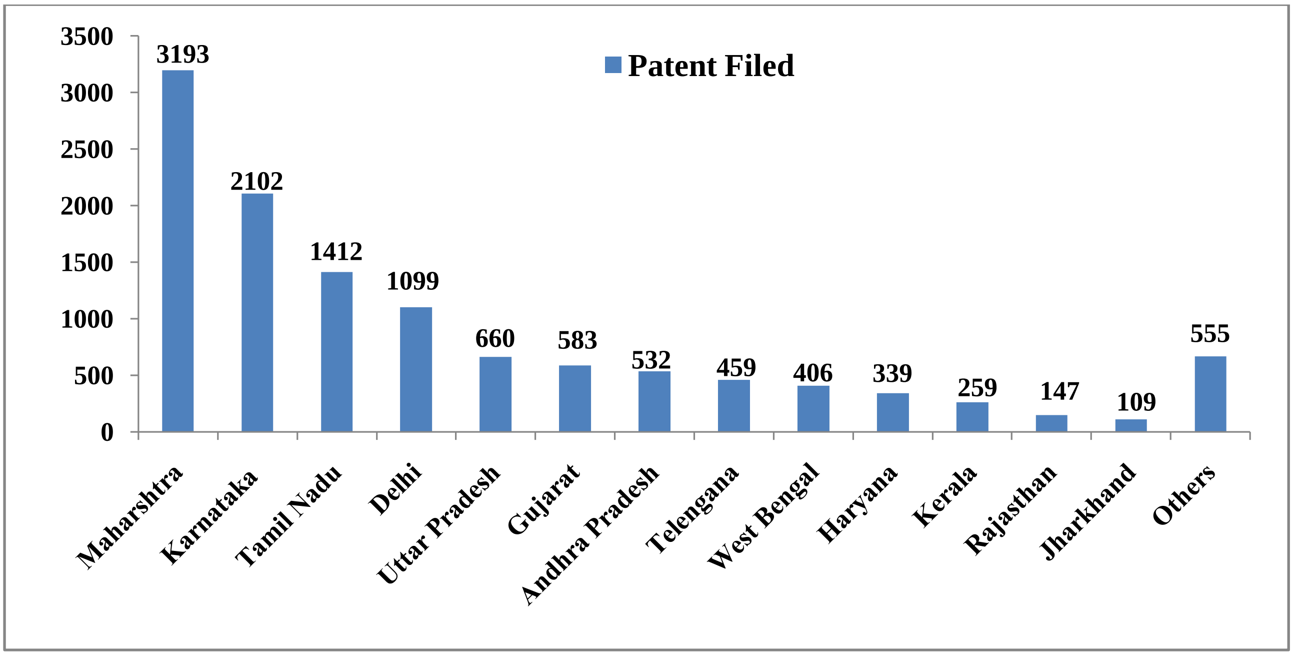



**Figure 4: Patents Filed (Ordinary) in the Year 2014-15 (>100 applications Filed)**
***Source***: *IPO Annual Report 2014-15*

**Table 4: Other (of Fig. 4) Comprises of Below States (<100 applications Filed)**

| S. No. | State/Union Territory | Ordinary (2013-14) | S. No. | State/Union Territory | Ordinary (2013-14) |
|---|---|---|---|---|---|
| 1. | Madhya Pradesh | **98** | 12. | Pondicherry | **16** |
| 2. | Punjab | **97** | 13. | Tripura | **8** |
| 3. | Orissa | **88** | 14. | Manipur | **5** |
| 4. | Uttaranchal | **61** | 15. | Dadra & Nagar Haveli | **2** |
| 5. | Assam | **46** | 16. | Arunachal Pradesh | **1** |
| 6. | Bihar | **31** | 17. | Sikkim | **1** |
| 7. | Chhattisgarh | **28** | 18. | Meghalaya | **0** |
| 8. | Chandigarh | **24** | 19. | Mizoram | **0** |
| 9. | Jammu & Kashmir | **17** | 20. | Nagaland | **0** |
| 10. | Himachal Pradesh | **16** | 21. | Andaman & Nicobar | **0** |
| 11. | Goa | **16** | 22. | Daman & Diu | **0** |

***Source***: *IPO Annual Report 2014-15*

In the domain of scientific and R&D organizations (Table 5), first ten organizations filed 870 patents in 2014-15, with CSIR organization filing maximum number of patents (315), followed by DRDO (98) and ICAR (68). Out of top ten organizations, seven belong to public sector. Three private sector companies namely, GHR Labs and Research Centre, Nagpur (31), GSP Crop Science Pvt. Ltd., Maharashtra (23) and Hetero Research Foundation, Hyderabad (22) occupy fourth, sixth and seventh rankings respectively.

**Table 5: Top 10 Indian Applicants for Patents from Scientific and Research & Development Organizations**

| S. No. | Name of Scientific and Research & Development Organization | Applications Filed |
|---|---|---|
| 1. | Council of Scientific & Industrial Research (CSIR), New Delhi | 315 |
| 2. | Director General, Defence Research & Development Organisation (DRDO), New Delhi | 98 |
| 3. | Indian Council of Agricultural Research (ICAR), New Delhi | 68 |
| 4. | GHR Labs and Research Centre, Nagpur | 31 |
| 5. | Department of Biotechnology (DBT), New Delhi | 23 |
| 6. | GSP Crop Science Pvt. Ltd. Ahmedabad | 23 |
| 7. | Hetero Research Foundation, Hyderabad, | 22 |
| 8. | Rotary Wing Research & Design Centre Hindustan Aeronautics Ltd., Bengaluru | 22 |
| 9. | Centre for Development of Advanced Computing (C-DAC), Pune | 20 |
| 10. | Department of Electronics and Information Technology (DEITY), New Delhi | 18 |

***Source**: IPO Annual Report 2014-15*

Table 6 lists the top ten Higher Education Institutes (HEIs) of India in the area of patent filing for the year 2014-15. IITs continue to occupy the first position. Surprisingly, Janardan Rai Nagar Rajasthan Vidyapeeth (Deemed) University, a new entrant has relegated IISc-Bangalore to third spot even though it showed an increase of nearly 43% over the preceding year i.e. 2013-14. Amity University has slipped to $4^{th}$ position with a decline in filing as compared to 2013-14 time period. In an interesting observation, eight out of top ten patent filing institutes belong to private sector. Only two institutes i.e. IITs and IISc-Bangalore belong to public sector. However, these two public institutes comprise of 61.48 % of the total patents filed by top HEIs mentioned in table 6.

**Table 6: Top 10 Indian Applicants for Patents from Institutes and Universities**

| S. No. | Name of Institute/University | Applications Filed |
|---|---|---|
| 1. | Indian Institute of Technology (Collective) | 337 |
| 2. | Janardan Rai Nagar Rajasthan Vidyapeeth (Deemed) University, Udaipur | 53 |
| 3. | Indian Institute of Science, Bangalore | 46 |
| 4. | Amity University, Noida | 43 |
| 5. | Sandip Foundations: Sandip Institute of Technology & Research Centre, Mumbai | 33 |
| 6. | Hindustan Institute of Technology & Science, Chennai | 31 |
| 7. | SAL Institute of Technology & Engineering Research, Ahmedabad | 22 |
| 8. | Sandip Foundations: Sandip Institute of Engineering and Management, Mumbai | 21 |
| 9. | Siddaganga Institute of Technology an Institution of Sree Siddaganga Education Society, Tomakuru, Karnataka | 19 |
| 10. | Karpagam University, Coimbatore. | 18 |

***Source**: IPO Annual Report 2014-15*

Amongst the top 5 Indian Patentees (Table 7), four belong to public sector i.e. CSIR (66). BHEL (56), IITs (30) and Tata Motors Limited (26). They occupy first, second, fourth and fifth rankings. Third position is occupied by a private company i.e. Samsung R&D Institute India Bangalore Private Limited, Bangalore.

**Table 7: Top 5 Indian Patentees**

| S. No. | Name of Organization | Patents Granted |
|---|---|---|
| 1. | Council of Scientific & Industrial Research, New Delhi | 66 |
| 2. | Bharat Heavy Electricals Limited, New Delhi | 56 |
| 3. | Samsung R&D Institute India Bangalore Private Limited, Bengaluru | 56 |
| 4. | Indian Institute of Technology (Collective) | 30 |
| 5. | Tata Motors Limited, Mumbai | 26 |

***Source**: IPO Annual Report 2014-15*

As far as top 5 foreign resident patentees are concerned (Table 8), Gm Global Technology Operations INC, a US company providing services for engineering and construction industries, is ranked at the top with 267 patents (granted). Second rank is held by Qualcomm Incorporated (205), an American based Semiconductor and Telecommunications equipment company. Third place is secured by Telefonaktiebolaget Lm Ericsson (Publ) (94 granted patents), a Sweden based company which provides software, equipments and services for communication technology. Fourth position (87 granted patents) is occupied by a consumer electronics company, known as LG Electronics, which is a S. Korean company. Fifth place is secured by Netherland based company known as Koninklijke Philips Electronics N. V., which focuses in light, health care and electronics.

**Table 8: Top 5 Foreign Resident Patentees**

| S. No. | Name of Applicant | Patents Granted |
|---|---|---|
| 1. | Gm Global Technology Operations Inc, U.S.A | 267 |
| 2. | Qualcomm Incorporated, U.S.A | 205 |
| 3. | Telefonaktiebolaget Lm Ericsson (Publ), Sweden | 94 |
| 4. | LG Electronics, S. Korea | 87 |
| 5. | Koninklijke Philips Electronics N. V., Netherlands. | 61 |

***Source**: IPO Annual Report 2014-15*

In the field of Information Technology (Table 9), Samsung R&D Institute India-Bangalore Private Limited (233) occupied the first place in the year 2014-15 which is a mobile telecommunication company, while, next four positions are occupied by public sector organizations i.e. Tata Consultancy Services Limited (147), a consulting and business solutions software company; Wipro limited (117), an information technology services provider; Hindustan Aeronautics Limited (57) and lastly, IITs (Collective) with 50 applications filed in the year 2014-15.

**Table 9: Top 5 Indian Applicants for Patents in the Field of Information Technology**

| S. No. | Name of Company | Applications Filed |
|---|---|---|
| 1. | Samsung R&D Institute India-Bangalore Private Limited, Bengaluru | 233 |
| 2. | Tata Consultancy Services Limited, Mumbai | 147 |
| 3. | Wipro Limited, Bengaluru | 117 |
| 4. | Hindustan Aeronautics Limited, Bengaluru | 57 |
| 5. | Indian Institute of Technology (Collective) | 50 |

***Source**: IPO Annual Report 2014-15*

**Patent Cooperation Treaty (PCT): National Phase Applications**

The majority of foreign patent applications filed in India were through the PCT national phase route. The number of such applications filed during 2014-15 was 26,057, which show 3.77% decrease in comparison with the previous year (2012-13) figure of 27,078 applications. The top five countries filing patents, through PCT national phase route are USA

(8,237), Japan (4,388), Germany (2,581), Netherlands (1,267) and Switzerland (1,252). Many other countries including France (1,236), United Kingdom (973), China (874), Sweden (835), and others are mentioned in figure 5.

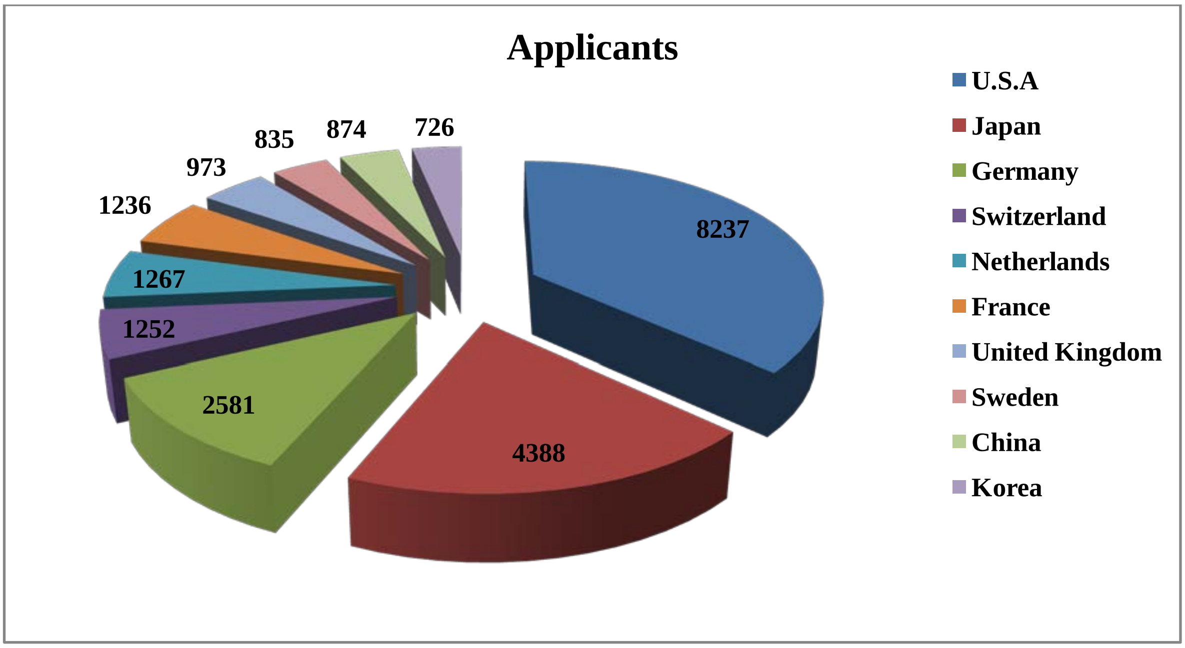



**Figure: 5 Top Ten Applicants for PCT National Phase (Country-Wise)**
***Source***: *IPO Annual Report 2014-15*

**Top 10 Foreign Resident Applicants**

The following table (Table 10) provides a list of top 10 foreign resident applicants who filed patent applications during 2014-15. It is observed that Qualcomm Incorporated a wireless technology producer continued to top the list with 1,214 applications. It was followed by a consumer electronics company, Koninklijke Philips N.V. (805), a network and telecom company, Telefonaktiebolaget LM Ericsson (449) and Samsung Electronics Co. Ltd. (379) are at 2nd, 3rd and 4th position respectively. Fifth position is secured by a chemical producer company BASF SE which is a Germany based company. Honda Motor Co. Ltd. is at 6$^{th}$ position with 280 applications filed, Siemens Aktiengesells Schaft a power generation technology company (277), General Electric Company (276) which is a consumer electronics and software company, Steel product producer company JFE Steel Corporation (230) and Sony Corporation (218) a consumer electronics company are at 7$^{th}$ , 8$^{th}$ , 9$^{th}$ and 10$^{th}$ positions respectively.

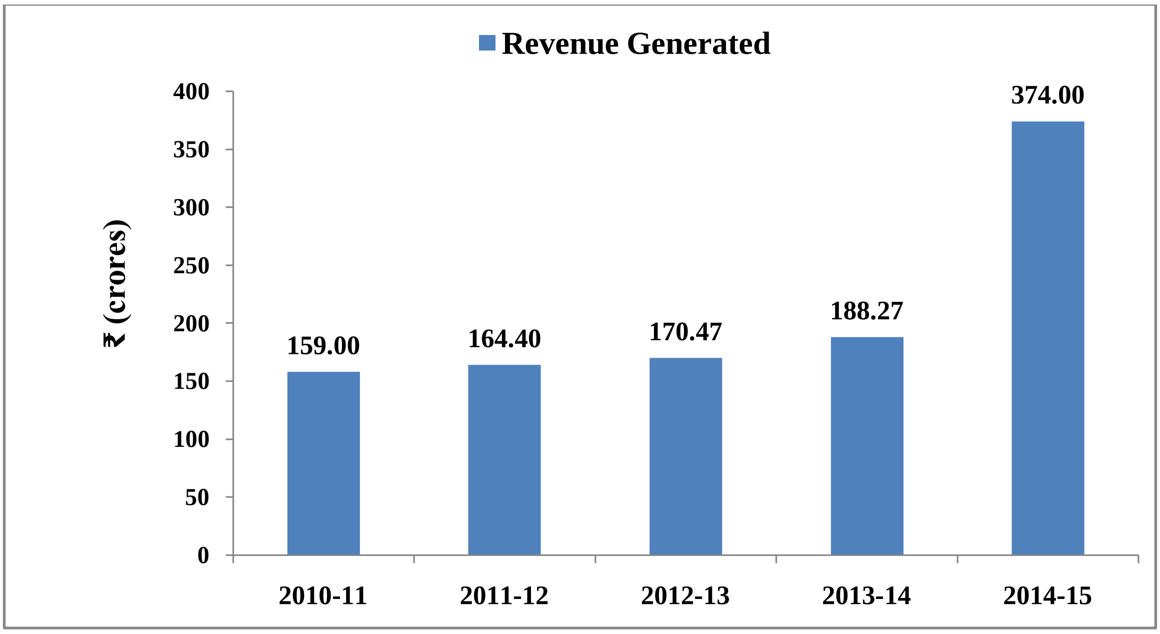
**Table 10: Top 10 Foreign Resident Applicants**

| S. No. | Name of Organisation | Number of Applications |
|---|---|---|
| 1. | Qualcomm Incorporated, USA | 1,214 |
| 2. | Koninklijke Philips N.V., Amsterdam | 805 |
| 3. | Telefonaktiebolaget Lm Ericsson (Publ), Sweden | 449 |
| 4. | Samsung Electronics Co. Ltd, S. Korea | 379 |
| 5. | BASF SE, Germany | 297 |
| 6. | Honda Motor Co. Ltd. Japan | 280 |
| 7. | Siemens Aktiengesells Schaft, Germany | 277 |
| 8. | General Electric Company, USA | 276 |
| 9. | JFE Steel Corporation, Japan | 230 |
| 10. | Sony Corporation, Japan | 218 |

***Source***: *IPO Annual Report 2014-15*

**Revenue Generated**

During the time period 2010-14, the revenues generated by the patent office, as fee for patent-application processing, ranged between ₹ 159 -180 crores. Surprisingly, last year's (2014-15) earnings jumped to ₹ 374 crores (Fig. 6.6) which were 98.93% more than the amount (₹ 188 crores) accrued in the previous year (2013-14). The trend of revenue-generated and revenue-expenditure are shown in the form of bar diagrams in figures 6. & 7 respectively.

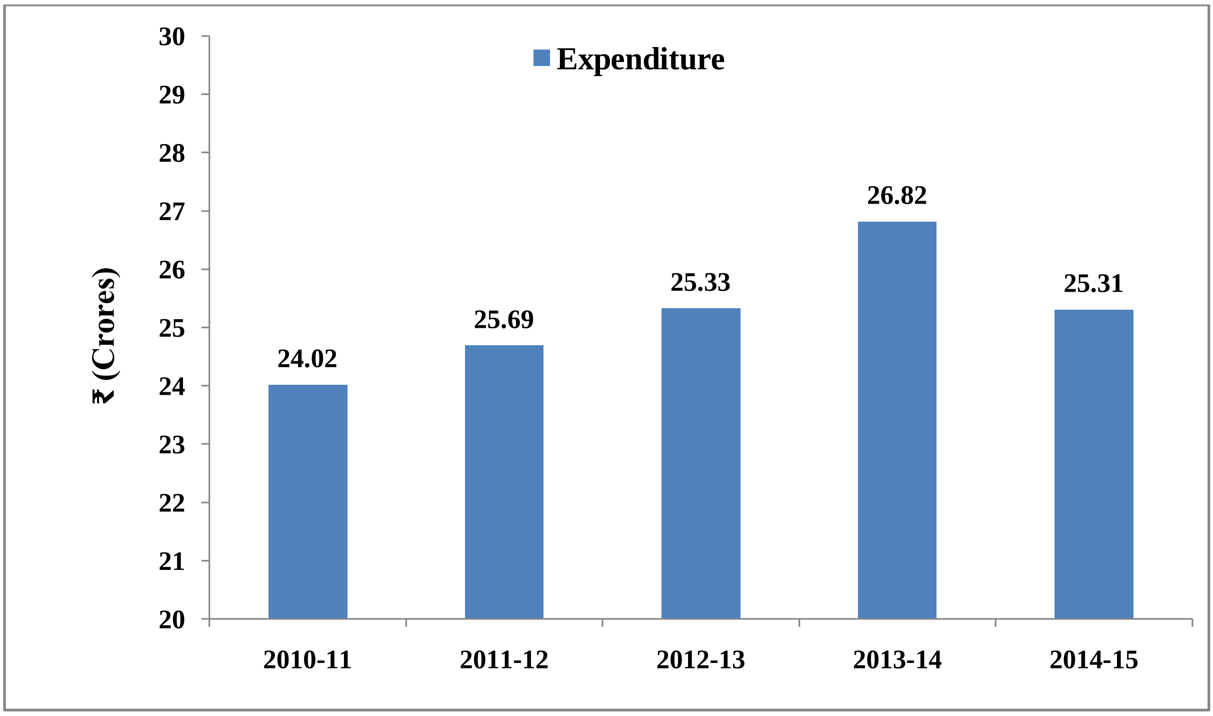



***Source:*** *IPO Annual Reports*

**Figure 6: Revenue Generated by Indian Patent Office**

**Revenue Expended**

During the time period 2010-15, the non-plan expenditure with regard to IP administration hovered around ₹ 25 ± 1.5 crores (Fig. 7). Maximum expenditure (₹ 26.82 crores) was incurred in 2013-14. Despite of peer expenditure, IP office accrued gross profit of 93% in the year 2014-15, whereas, it was 85% in the year 2013-14 and 84% in the year 2012-13.




***Source:*** *IPO Annual Reports*

**Figure 7: Expenditure on Patents by Indian Patent Office**

## 4. Draft of National IPR Policy, 2016

A draft of National Intellectual Property Rights policy has been issued by DIPP on 12th May 2016, which comprises of seven objectives as mentioned below.

1. **IPR Awareness: Outreach and Promotion**-To create public awareness about the economic, social and cultural benefits of IPRs among all sections of society.
2. **Generation of IPRs** - To stimulate the generation of IPRs.
3. **Legal and Legislative Framework**-To have strong and effective IPR laws which balance the interests of rights owners with larger public interest.
4. **Administration and Management** - To modernize and strengthen service oriented IPR administration.
5. **Commercialization of IPR** - Get value for IPRs through commercialization.

6. **Enforcement and Adjudication**-To strengthen the enforcement and adjudicatory mechanisms for combating IPR infringements.
7. **Human Capital Development**-To strengthen and expand human resources, institutions and capacities for teaching, training, research and skill building in IPRs.

Out of these seven objectives 2 and 5 have direct relevance to R&D. The details of these two objectives are mentioned below:

**Objective 2: Generation of IPR -** In India, the number of patents filing has increased in the last few years, but the percentage of filing by Indians is relatively low. India has a huge talent pool of scientific and technological talent spread over R&D institutions, enterprises, universities and technical institutes. There is a need to tap this productive knowledge resource and stimulate the creation of IP assets. The steps to be taken to attain this objective are outlined below:

**2.1.** Use the campaign "Creative India; Innovative India” to propagate the value of creativity and innovation, and the resultant benefit to the public; to create a mindset and culture that encourages knowledge generation and its application through IP.

**2.2.** Carry out a comprehensive IP audit or base line survey in various sectors in cooperation with stakeholders to assess and evaluate areas of strength and potential, prioritize target groups of inventors and creators, develop specific programs to address their needs, provide resources to enable them to create IP assets and utilize them for their own and social benefit.

**2.3.** Undertake studies to assess the contribution of IP content in different industries on the economy, employment, exports and technology transfer.

**2.4.** Focus on improving IPR output of National Research Laboratories, Universities, Technology Institutions and other researchers by encouraging and facilitating the acquisition of Intellectual Property Rights by them.

**2.5.** Encourage researchers in public funded academic and R&D institutions in IPR creation by linking it with research funding & career progression.

**2.6.** Encourage researchers in public funded academic and R&D institutions by having uniform guidelines for division of royalties between the organizations and individual researchers and innovators.

**2.7.** Include IP creation as a key performance metric for public funded R&D entities as well as Technology Institutions, and gradually extend such evaluation from Tier-1 to Tier-2

Institutions.

**2.8.** Provide guidance to researchers and innovators about national priority areas to focus on, for instance in energy and food security, healthcare and agriculture, as well as specific sectors such as biotechnology, data analytics, nanotechnology, new materials and ICT.

**2.9.** Encourage public funded R&D institutes and industry to develop affordable drugs relating to neglected diseases.

**2.10.** Encourage R&D including open source based research such as Open Source Drug Discovery (OSDD) by the Council of Scientific and Industrial Research (CSIR) for new inventions for prevention, diagnosis and treatment of diseases, especially those that are life threatening and those that have high incidence in India.

**2.11.** Establish and strengthen IP facilitation centers as nodal points especially in industrial and innovation university clusters.

**2.12.** Create an industry-academia interface for encouraging cross-fertilization of ideas and IPR-driven research and innovation in jointly identified areas.

**2.13.** Stimulate large corporations, both Indian and foreign, that have R&D operations, to create, protect and utilize IPRs in India.

**2.14.** Improve awareness of the value of copyright for creators, the importance of their economic and moral rights.

**2.15.** Introduce support systems for MSMEs, start-ups and grass root innovators to reduce transaction costs linked to IP creation for the entire value chain from IPR generation to commercialization, including schemes to facilitate domestic IPR filings.

**2.16.** Consider incentives to promote R&D, including the following steps:

**2.16.1.** Promote R&D through tax benefits available under various laws, through simplification of procedures for availing direct and indirect tax benefits.

> 2.16.2. Consider financial support for a limited period on sale and export of products based on IPRs generated from public funded research.
>
> 2.16.3. Creation of an effective and simple loan guarantee scheme in order to encourage start-ups and cover the risk of genuine failures in commercialization based on IPRs as mortgage-able assets.

**2.17.** Promote ‘infusion of funds to public R&D units’ as a part of Corporate Social Responsibility to foster a culture of open innovation.

**2.18.** Provide special incentives for creation of IPRs in green technologies and manufacture of energy efficient equipment.

**2.19.** The ambit of Traditional Knowledge Digital Library (TKDL) should also be expanded to include other fields besides Ayurveda, Yoga, Unani and Siddha.

**2.20.** Public research institutions should be allowed access to TKDL for further R&D, while the possibility of using TKDL for further R&D by private sector may also be explored, provided necessary safeguards are in place to prevent misappropriation.

**2.21.** Document oral traditional knowledge, taking care that the integrity of the said knowledge is preserved and traditional ways of life of communities are not compromised.

**2.22.** Introduce IPRs as part of academic curriculum in educational institutions, especially universities, law and technical institutions.

**2.23.** Increase awareness of international mechanisms and treaties (e.g. PCT, Madrid, Hague) to encourage creation and protection of IPRs by Indian individuals and entities in global markets.

**2.24.** Encourage and incentivize IP generation and utilization among students at all levels, use awareness programs and educational materials to inculcate an appreciation for the value of IP.

**2.25.** Encourage innovations in the agriculture and pisciculture sector through application of IP for higher sustainable agricultural production.

**2.26.** Encourage the registration of Geographical Indications (GIs) through support institutions; assist GI producers to define and maintain acceptable quality standards, and providing better marketability.

**2.27.** Encourage creation of design related IP rights by identifying, nurturing and promoting the aspects of innovation protectable under the design law and educating designers to utilize and benefit from their designs; involve the NIDs, NIFTs and others institutions in sensitization campaigns.

**2.28.** IPR generation for ICT technologies, including those relating to cyber security for India, will be encouraged.

**2.29.** Take steps to increase domestic filings of patent applications.

**2.30.** Promote India's rich heritage of traditional knowledge with the effective involvement and participation of the holders of such knowledge. Traditional knowledge holders will be provided necessary support and incentives for furthering the knowledge systems that they have nurtured from the dawn of our civilization.

**Objective 5: Commercialization of IPR -** The economic rewards and value for the owners of IP rights comes only from the commercialization of their IPRs. A planned effort should be made for capitalizing the existing IP assets in the country. Entrepreneurship should be encouraged so that the financial value of IPRs may be comprehended. Existing mechanisms including accelerators and incubators set up to promote entrepreneurship should be enlarged with IP-oriented services. Financing is a major barrier for entrepreneurs and therefore it is necessary to connect IP creators and investors. Another barrier faced is valuation of IP and assessment of the potential of the IPRs for the marketing purpose. There is a critical need to take stock of existing IP funding by different government departments and bodies like BIRAC, TIFAC and NRDC and take measures to centralize the same, scaling up successful models while avoiding duplication of efforts. Public – funded research laboratories, academia and other institutions should stimulate commercialization of their research outcomes. They ought to be suitably state-supported in the development and distribution of their IPRs. While certain bigger organizations have the intent and capabilities to commercialize their technologies/ IPRs, several others do not. Hence, it becomes imperative to establish facilitative mechanisms that can address such limitations, especially in terms of academic institutions, individual innovators and MSMEs. Another effective ways of achieving this would be by synergizing the activities of IP facilitation centres with the industrial clusters. Efforts should be made for the creation of a public platform to function as a common database of IPRs which can help creators and innovators connect to buyers, potential users and funding institutions. It would also be helpful in scouting the technology landscape to identify white spaces and thereby help promotion of innovative activities in uncovered areas. Significant potential for innovation exists in new and emerging technologies like nano-technology, agri-biotech, life sciences, biotechnology, green technologies, space technologies, telecommunications, new materials etc. The steps to be taken towards attaining this objective are outlined below:

**5.1.** Cell for IPR Promotion and Management (CIPAM) shall also undertake the following tasks:

5.1.1. Provide a platform for IPR owners and users of IPRs by acting as a facilitator for creators and innovators to be connected with potential users, buyers and funding agencies.

5.1.2. Undertake a study to examine the feasibility of an IPR Exchange.

5.1.3. Establish links among different organizations for exchange of information and ideas as also to develop promotional/educational products and services.

5.1.4. Facilitate access to databases on Indian IP and global databases of creators/ innovators, market analysts, funding agencies, IP intermediaries.

5.1.5. Study and facilitate implementation of best practices for promotion and commercialization of IP within the country and outside.

5.1.6. Promote public sector initiatives for IPR commercialization.

**5.2.** Promote licensing and technology transfer for IPRs; devising suitable contractual and licensing guidelines to enable commercialization of IPRs; promote patent pooling and cross licensing to create IPR based products and services.

**5.3.** Provide support for MSMEs, Individual Inventors and Innovators from the informal sectors with enablers like facilitation centers for single window services to help them commercialize their IPRs.

**5.4.** Incentivize Indian inventors, MSMEs, start-ups to acquire and commercialize IPRs in other countries also.

**5.5.** Examine availability of Standard Essential Patents (SEPs) on fair, reasonable and non-discriminatory (FRAND) terms.

**5.6.** Identify opportunities for marketing Indian IPR-based products, especially GIs, and services to a global audience.

**5.7.** Promote collaborative IP generation and commercialization efforts between R&D institutions, industry, academia and funding agencies.

**5.8.** Ensure enhanced access to affordable medicines and other healthcare solutions by (a) encouraging cross-sector partnerships between public sector, private sector, universities and NGOs; (b) promoting novel licensing models, and (c) developing novel technology platforms.

**5.9.** Streamline regulatory processes to ensure timely approval for manufacturing and marketing of drugs while maintaining safety and efficacy standards.

**5.10.** Make efforts to reduce dependency on active pharmaceutical ingredients (API) imports, including incentivizing manufacture of APIs in India and revitalizing public sector undertakings in health care sector.

**5.11.** Support the financial aspects of IPR commercialization by:

5.11.1. Enabling valuation of IP rights as intangible assets by application of appropriate methodologies and guidelines; facilitating securitization of IP rights and their use as collateral by creation of enabling legislative, administrative and market framework.

5.11.2. Facilitating investments in IP driven industries and services through the proposed IP Exchange for bringing investors/ funding agencies and IP owners/users together.

5.11.3. Providing financial support to the less empowered groups of IP owners or creators like farmers, weavers, artisans, craftsmen, artists etc. through financial institutions like rural banks or cooperative banks offering IP friendly loans.

5.11.4. Providing financial support for development and commercialization of IP assets through links with financial institutions including banks, venture capital funds, angel funds, crowd funding mechanisms.

5.11.5. Utilizing Technology Acquisition and Development Fund under the Manufacturing Policy for licensing or procuring patented technologies.

5.11.6. Taking stock of all IP funding by the Government and suggesting measures to consolidate the same to the extent possible; scaling up the funding as needed and avoiding duplication; enhancing the visibility of IP and innovation related funds so that utilization is increased; performance based evaluation for continued funding.

**5.12.** Promote use of Free and Open Source Software along with adoption of open standards; possibility of creating Indian standard operating environments will be examined.

**5.13.** Promote going-to-market activities by:

5.13.1. Creating mechanisms to help MSMEs and research institutions to validate pilots and scale up through market testing.

5.13.2. Providing seed funding for marketing activities such as participating in trade fairs, industry standards bodies and other forums.

5.13.3. Providing guidance and support to IPR owners about commercial opportunities of e-commerce through Internet and mobile platforms.

5.13.4. Encouraging enterprises to create brand equity from their IP rights, such as trademarks and GIs.

## 5. Summary

- This report gives a vision of patents status of India for which data has been taken from World Intellectual Property Organization (WIPO) Report-2015, and Indian Patent Office (IPO) Annual Report 2014-15.
- As per WIPO Report-2015, the global ranking of India is 11 and 14 in the indicators of IPR filing (residents) and IPR filing (residents and abroad) respectively. China, Japan and S. Korea have been ranked ahead of India and are amongst the top five

nations in these indicators. During the time period 2014-15, the total number of patent-applications received by IPO was 42,854 filed (residents + abroad), whereas China, Japan and S. Korea received 9, 28,177, 3, 25,989 and 2, 10,292 applications respectively.

- As per IPO Report 2014-15, the number of total patent applications (resident + abroad) filed with IPO ranged from 39,400 to 43,197 during the time period 2010-15. For the same period, the number of patents granted ranged from 4,126 to 7,509.
- As per latest report (2014-15), IPO received 42,763 patent applications and granted 5,978 patents.
- Categorizing the filed-patents based on the field of invention, Mechanical (10,031) tops the ranking, followed by Chemical (6,454), Computer/Electronics (4,285) and Electrical (4,031). However, in the category of patents-granted, the top ranking sequence is as follows: Chemical (1,533), Mechanical (1,047), Computer/Electronics (835) and Drugs (389). This data is for the time period 2014-15.
- State-wise categorization of patents-filed indicates that Maharashtra (3,193) leads the pack, followed by (Karnataka (2,102), Tamil Nadu (1,412), Delhi (1,099) and Uttar Pradesh (660). Top four states (Maharashtra, Karnataka, Tamil Nadu and Delhi) account for 65% of the total ordinary-patents filed in 2014-15. No patent was filed by Meghalaya, Mizoram, Nagaland, Andaman & Nicobar, and Daman & Diu.
- IITs (337) are top Indian applicants from *institutes/universities* in the parameter of number of patents filed during 2014-15. Amongst the top ten rankings, two belong to public sector and eight belong to private sector. JRNR Vidyapeeth (Deemed university) Udaipur tops the ranking (2) in the private sector.
- Amongst the top ten rankings, CSIR (315) tops the list in the category of *scientific and research organizations* in the parameter of number of patents filed during 2014-15. Amongst the top ten rankings, seven belong to public sector and three to private sector. GHR Labs and Research Centre, Nagpur tops the ranking (4) in the private sector.
- Amongst the top five Indian Patentees, four belong to the public sector i.e. CSIR (66). BHEL (56), IITs (30) and Tata Motors Limited (26). They occupy first, second, fourth and fifth rankings. Third position is occupied by a Bangalore based private company i.e. Samsung R&D Institute India Bangalore Pvt. Ltd., Bangalore.
- Amongst the top five Foreign Resident Patentees, two are US companies i.e. Gm Global Technology Operations (267 patents granted) and Qualcomm Incorporated

(205 patents granted). Other three Foreign Resident patentees are companies from Sweden, S. Korea and Netherlands.

- In 2014-15, 26,057 patents were filed in India PCT national phase. USA is at the top followed by Japan and Germany. These countries filed 8,237, 4,388 and 2,581 patents respectively. Amongst the companies, Qualcomm Incorporated (USA) filed 1,214 patents followed by Koninklijke Philips N V., Netherlands (805) and Telefonaktiebolaget Lm Ericsson (Publ), Sweden (449).
- In 2015, IPO generated revenue of ₹ 374 crores which was ₹ 186.73 crores more revenue as compared to previous year.
- A portion of the draft of the National IPR Policy-2016, dealing with education and R&D has been included in the report.

## 6. Conclusions

The patent data discussed in the text clearly indicates the poor status of patent regime in India *vis a vis* other Asian countries like China, Japan, and S. Korea. India lags behind these countries in the parameter of filed-patents under ‘Residents’ category, thus indicating the poor level of R&D being carried out in the research labs (of India). Going deeper into the root cause of this, one finds that India’s ranking in the indicator of ‘Research-Publications’ is quite impressive. It has been globally ranked 5$^{th}$ by SJR International Science Ranking (2015). However, the ranking takes a nose dive (50) in the indicator, Intellectual Property Rights. The last two statements indicate that science in India is publication-centric. A strong intervention is required to convert research into innovative products leading to a patent. The scientists need to be made aware of the benefits of patents. The government policies on IP should lay more emphasis on awareness and introduction of IP related courses in Higher Education Institutes and National Research Laboratories. Also, the universities and research laboratories should have dedicated ‘Patent Cells’ which should be well conversant with patent laws, patent searching and patent filing processes. TIFAC, an organization under DST, has established Patent Information Cells (PICs) in many states of India. These PICs have set up nodal centres at a few places, primarily in the universities for spreading awareness about IP. It is suggested that more nodal centres be set up in public as well as private universities. The science departments of universities may be mandated to introduce IPR courses, such as (a) ‘Certificate Course in IPR’, for under-graduates; (b) ‘Diploma Course in IPR’ for post-graduates; and (c) ‘Advanced Course in IPR’ for Ph.D. research scholars. It is also suggested that a *prior-art search* of the patents should be carried out before the start of Ph.D. research work, especially in the area of applied sciences. This effort will certainly help the scholar to understand whether his/her research work would lead to some novelty or would just be a repetition of research already taken place. Many a times, it has been observed that the outcome of a Ph.D. thesis has no novelty, as claimed by the scholar, because the information already exists. Such scenario results only in low or zero impact publication along with drain of the public money.

The majority of the patents (filed/granted) in India belong to the engineering sector. It is not surprising as India's premier higher education institute i.e. IITs is engineering-centric, have vibrant industry-academia centres and carry out R&D in collaboration with the industries. In other words, the ecosystem for translating research into technologies and patents is prevalent. Such an ecosystem needs to be created for other disciplines like pharma, agriculture, food and biotechnology. Dedicated institutes should be created in these domains, or the existing ones should be strengthened for R&D ecosystem for translational research. For example, ICAR has hundreds of agriculture universities/research centres spread all over India. A national policy may be drafted to strengthen them with Technology Business Incubators and Centres of Excellence (R&D) in partnership with industries. Similarly there is no dearth of pharma educational institutes, which can be strengthened for R&D, on the lines mentioned above. Also, top 'University-Industry linkage Pharma Institutes' like, University Institute of Pharmaceutical Sciences at Panjab University, Chandigarh; Bombay College of Pharmacy, Mumbai, and Manipal College of Pharmaceutical Sciences of Manipal University, Manipal can act as models for other pharma institutes/colleges. In addition, many R&D units of pharma industries have been accredited by DSIR and thus avail huge incentives from the government. Unfortunately, the number of patents generated by pharma industry is very low. For example, 2,640 patents were filed with IPO in 2014-15, under the field of Drugs. It accounts for only 5% (approx.) of the total patents filed in this period. There is a general feeling that most of the R&D units in the industrials sector are falling short of expectations. It is suggested that an independent body may be constituted to look into the performance of R&D units, especially DSIR- accredited labs. Good performers may be incentivized and bad ones penalized. This move will certainly elevate the level of novel research, which is a basic requirement for patent generation.

सत्यमेव जयते
Department of Science & Technology
Govt. of India

# DST-Centre for Policy Research at PU, Chd.

***(DST/PRC/CPR-03/2013)***

## <u>REPORT-4</u>

**(May, 2015-Aug., 2016)**

# *Case Studies on Feedback from Select Scientists engaged in Industry-Academia Research Projects*

# CONTENTS

## List of Abbreviations

| | |
|---|---|
| AICTE | All India Council for Technical Education |
| AIIMS | All India Institute of Medical Sciences |
| BARC | Bhabha Atomic Research Centre |
| BRNS | Board of Research in Nuclear Sciences |
| CDSCO | Central Drugs Standard Control Organization |
| CE | European Community |
| CII | Confederation of Indian Industry |
| CMC | Christian Medical College |
| CRO | Contract Research Organizations |
| CSIR | Council of Scientific & Industrial Research |
| DAE | Department of Atomic Energy |
| DBT | Department of Biotechnology |
| DCGI | Drug Controller General of India |
| DSIR | Department of Scientific and Industrial Research |
| DST | Department of Science and Technology |
| e.g. | Example |
| etc. | Et cetra |
| GLP | Good Laboratory Practices |
| GMP | Good Manufacturing Practices |
| GOI | Government of India |
| HEI | Higher Education Institute |
| I-A | Industry-Academia |
| IAEA | International Atomic Energy Agency |
| i.e. | That is |
| ICMR | Indian Council for Medical Research |
| ICT | Institute of Chemical Technology |
| IIT | Indian Institute of Technology |
| IP | Intellectual Property |
| IPR | Intellectual Property Right |
| INR | Indian Rupees |
| i.v. | Intra venous |
| JRF | Junior Research Fellows |
| KEM | King Edward Memorial |
| MHRD | Ministry of Human Resource Development |
| MOU | Memorandum of Understanding |
| MSMEs | Ministry of Small and Medium Enterprises |
| NAAC | National Assessment and Accreditation Council |
| NDDS | Novel Drug Delivery System |
| NRDC | The Natural Resources Defense Council |
| OPPI | Organization of Pharmaceutical Producers of India |
| PATSER | Program Aimed at Technology Self-reliance |
| PCT | Patent Cooperation Treaty |
| PGIMER | Post Graduate Institute of Medical Education and Research |
| PPP | Public Private Partnership |
| Pvt. Ltd. | Private Limited |
| R&D | Research and Development |
| S&T | Science and Technology |
| SGPGIMS | Sanjay Gandhi Post Graduate Institute of Medical Sciences |

| | |
|---|---|
| SOPs | Standard Operating Procedures |
| SMEs | Small Medium Enterprise |
| SRF | Senior Research Fellow |
| STI | Science Technology Innovation |
| TDB | Technology Development Board |
| TIFAC | Technology Information, Forecasting and Assessment Council |
| TU | Technical University |
| UGC | University Grants Commission |
| UNESCO | The United Nations Educational, Scientific and Cultural Organization |
| USA | United States of America |
| VASVIK | Vividhlaxci Audyogik Samshodhan Vikas Kendra |

## Introduction

In 21st century, innovations are the key drivers of nation’s economic growth and prosperity. These innovations are the outcome of high through put research activities carried out by various research and development (R&D) components persisting in public and private sectors. World’s most developed and emerging economies like USA, Korea, China, Russia etc. invests majorly into innovation development as a percentage of total R&D expenditure. R&D investments in innovations are reported to be highest in China (83%), followed by Israel (82%), the United States (63%), the Republic of Korea (62%), the Russian Federation (62%) and Japan (60%) (UNESCO Institute for Statistics, 2014). In these high income countries R&D activities are mainly undertaken by private sector and public: private investment in R&D works at 1: 2 ratio. However, in India, only 1/3rd of R&D investments are contributed by the private sector and rest comes from the public sector. Investments in R&D and its related activities lay mainly on government and higher education institutes, and private sector plays marginal role in R&D expenditure.

Since independence, four national scientific policies have been formulated. First one (in 1958) emphasized on the mass education though establishment of schools, colleges and universities, followed by setting up of National Research laboratories and IITs. The policy also addressed the country’s need in science, agriculture, industry and defence. Second policy, in 1983, termed as Technology Policy Resolution laid emphasis on attaining technological competence and self-reliance. 20 years later, in 2003, Government of India issued third science policy, termed as S&T Policy, to bring science and technology together and emphasized the need for investment into R&D to address national problems. The latest science policy came out in 2013 as Science, Technology and Innovation (STI) policy. This policy aims to develop synergies between science, technology & innovation, spreading scientific temper, and enhancing skills amongst all sections of society. To attain these goals, Government has increased its funding in research projects, set up Innovation Centres and S&T Parks, and incentivizing industrial sector to invest in R&D of universities and research laboratories of public sector. Unfortunately, despite these initiatives of Government of India, large presence of scientific pool, hundreds of Government funded research laboratories, enormous deposits of natural resources, immense biodiversity, our country is still tagged as third world country. We are faring poorly in the global indicators of economic and scientific progress.

India has realized the wide gaps existing in learning, research, innovation and skills development persisting in its higher education system where corrective actions are required. Poor linkages between academic and industrial sector is one of the major road blocks for improving R&D activities in India (Progress Harmony Development Chambers, India, 2015). It is clearly highlighted that India with global rank 50 lags far behind in university-industry collaborations in comparison to the most developed economies of the world for e.g. Finland, USA and Switzerland being top 3 rankers in university-industry collaborations where I-A collaborations has generated number of innovative technologies contributing to the nation's economic growth (Global Competitiveness Report, 2015-16).

One of the reasons for lack of synergy between industrial and academic sector is attributed to quality of research, which is skewed towards basic and fundamental research, and lack of application oriented research. In addition, industry feels that maximum graduates are not industry-ready, in terms of soft skills. On the other hand, academia feels that industry is reluctant to invest in research but wants quick solutions to their problems. There is a need for effective intervention to bring both these sectors closer by understanding their needs and expectations. Keeping this in mind, Department of Science and Technology (DST), Government of India desired that our Centre should carry out 5-6 case studies on successful I-A projects to understand the I-A ecosystem existing in Indian Universities and other Higher Education Institutes (HEI) of India.

DST-CPR initiated the task by reviewing number of I-A collaborative projects carried out in different universities and other HEIs of India. Our Centre contacted scientists working in public universities, private universities, technical institutes like Institute of Chemical Technology (ICT) and Indian Institute of Technology (IIT), medical research institute such as All India Institute of Medical Sciences (AIIMS) and industry representatives to understand the mechanics and challenges involved in delivering I-A collaborative research work. Our Centre prepared a detailed I-A Proforma (Annexure 1) to be filled in by scientists having practical experience of handling I-A collaborative projects. The Proforma also sought suggestions and hindrances faced by the scientists while pursuing I-A collaborative research projects. In total 18 select scientist from all over India were requested to fill I-A proforma for I-A case study. Out of these 8 scientists filled the I-A proforma (Section A, Table 1).Four eminent scientists could not send the filled proforma, but Prof. Tewari met them personally and noted down their suggestions for improving I-A interactions.

These scientists are:

- Prof. G. D. Yadav, Vice Chancellor, ICT, Mumbai.
- Prof. A. Jhunjhunwala, Chairman, IITM's Rural Technology and Business Incubator (RTBI), IIT, Madras.
- Prof. T. Pradeep, Head, DST-Unit of Nanoscience, IIT, Madras.
- Prof. Balram Bhargava, Exec. Director, Stanford-India Biodesign, AIIMS, New Delhi.

Prof. G.D. Yadav emphasized (a) the need for incentivizing university faculty indulging in I-A activities and (b) effective short term industry-projects for under- and post-graduate students of applied sciences.

Prof. A. Jhunjhunwala suggested that government should promote entrepreneurship programme in HEI, universities, IITs, research centres. He was also of the opinion that Small Medium Enterprises (SMEs) and Ministry of Small and Medium Enterprises (MSMEs) should be encouraged by the government to indulge in R&D activities, as large companies are good at scaling up products and are not interested in serious R&D.

Prof. T. Pradeep called for upgrading research eco-system in HEIs, especially the instrumentation facilities.

Prof. Bhargava stated that India has huge potential for innovative research in the field of Bio-Medical Engineering. In short span, the collaboration of AIIMS doctors with Engineering faculty of IIT has resulted in many successful start-ups and entrepreneurs coming out of Stanford Biodesign Centre. He recommended for setting up similar Centres in research oriented hospitals like PGIMER, Chandigarh, Medical Colleges in Delhi, Lukhnow, Chandigarh etc.

Only one scientist i.e. Prof. Vijay Chaudhary (University of Delhi, New Delhi) did not provide the necessary information.

The Report has been divided into 5 sections:

**Section A:** List of select scientist who have carried out successful I-A collaborative research projects in India.

**Section B**: Brief profile details of the scientists included in present case study.

**Section C:** Details of I-A collaborative projects carried out by select scientists.

**Section D**: Feedback from scientists for strengthening I-A collaborations in India.

**Section E**: Recommendations of the report.

## Section A

**List of select academicians and industrialists who carried out I-A collaborative projects.**

**Table 1: Selects scientists on whom present case study is carried out**

| S.No | Academician | Industry counterpart |
|---|---|---|
| 1 | Prof. V.B. Patravale<br>Institute of Chemical Technology (ICT), Mumbai | Shri. Dhirajlal Kothadia<br>Sahajanand Medical Technologies Pvt. Ltd., Surat, Gujarat |
| 2 | Prof. O.P. Katare<br>Panjab University, Chandigarh | IPCA Labs Pvt. Ltd., Mumbai |
| 3 | Prof. Neelima Kshirsagar<br>Seth GS Medical College and KEM Hospital, Mumbai | Dr. J.N. Verma<br>Founder and Managing Director<br>Lifecare Innovations Pvt. Ltd., Gurgaon |
| 4 | Prof. Shantanu Roy<br>IIT-Delhi, New Delhi | Thermax Pvt. Ltd., , Pune |
| 5 | Dr. Sunil Jha<br>IIT-Delhi, New Delhi | BSES Yamuna Power Ltd., New Delhi |
| 6 | Prof. R.K. Saxena<br>University of Delhi, New Delhi | Tata Chemical Ltd. Pune, Maharashtra |
| 7 | Prof. Dinesh Goyal<br>Thapar University, Patiala | Goetze India Pvt. Ltd., Patiala |
| 8 | Prof. K. Sankaran<br>Anna University, Chennai | TMI Systems, Bangalore |

## Section B

### Brief Profile details of the scientists included in present case study

Successful I-A interface is characterized by collaborative and interactive programmes between industrial sector and academic institutions. Intensification of interdependence between academia and industry is the need of hour in order to fulfil innovation and sustenance demands of the country. There is a need of paradigm shift in the approach and attitude of industrial sector and academic sector for achieving mutual constructing objectives i.e. to promote technological innovations/ products leading to economic development of nation. Despite various Government initiatives, there is ambiguity whether I-A interaction is partial in nature or there is considerable relationship. In order to understand the extent of I-A interaction, present study was carried out.

To begin with, our centre tends to take inputs/ feedbacks from scientists working in universities both public and private university, technical institutes like IITs and Institute of Chemical Technology (ICT) and industry representative who are pursuing research in different sectors such as pharma, engineering and biotech sector. Keeping this in mind, in present study two scientists namely Prof. V.B. Patravale working in ICT, Mumbai and Prof. O.P. Katare from Panjab University, Chandigarh and one industrialist Dr. J.K. Verma co-founder of Lifecare Innovations carrying out research in field of pharma sector, whereas on other hand, 2 scientist Prof. Shantanu Roy and Prof. Sunil Jha were selected working in premier institute of national Importance IIT-Delhi carrying out research in field of engineering sciences. Other promising field in which India's present research is rapidly progressing is biotechnology. Hence, 3 scientist namely Prof R. K saxena from University of Delhi, New Delhi; Prof. Dinesh Goyal from Thapar University, Patiala; and Prof. K. Sankaran from Anna University, Chennai engaged in field of applied microbiology and biochemistry were considered for reviewing there I-A collaborative experience.

In this section we tend to present brief details of select scientists in terms of their publications, patent profile, technologies developed and transferred and awards and accreditations that they have received for their industry oriented research.

**Scientist from Pharma Sector:**

1. ***Prof. V. B. Patravale (Pharmaceutical Sciences)***

   Prof. V.B. Patravale is a professor in the Department of Pharmaceuticals Sciences and Technology at ICT, Mumbai, which has been rated as top industry-academia linked institute of India (AICTE CII, 2014). She is credited with 72 research publications and till date has been granted 4 national patents and has filed 16 national and 6 international patents. Prof. Patravale is actively engaged in industrial collaboration, till now she has handled 19 I-A collaborative projects, 10 technologies transferred and almost 30 industrial products have been developed by her. Moreover she has provided number of consultancy services to the industrial units such as Cadila Pharma, Sahajannand Medical Technologies, Kamani Oils, Yuva cosmetics and Charbhuja Trading and Agency. She has been accredited with various industry related awards on her name. She is the recipient of prestigious OPPI Woman Scientist Award 2015 from the organization of Pharmaceutical products of India. In the same year she received Vividhlaxci Audyogik Samshodhan Vikas Kendra (VASVIK) award from its Apex committee. In the year 2013, Smt. Chandaben Mohanbhai Patel Industrial Research Awards for Women Scientist was awarded to Prof. Patravale. She is the grant awardee for Bill and Melinda Gates Foundation for developing “Nanovaccine for Brucellosis using Green Technology”. Prof. Patravale has strongly contributed to the innovations of industry importance in field of pharma sector and has been closely associated with pharmaceutical industrial segment of India.

2. ***Prof. O.P. Katare (Liposomal technology and drug development)***

   Prof. O.P Katare is a professor in University Institute of Pharmaceutical Sciences, Panjab University, Chandigarh. He is working in field of liposome technology and developing novel drug delivery systems including nanoparticles for tropical pharmaceutical products. He is credited with 112 publications and has been granted 3 national and 4 international patents and has filed 15 patents (9 national and 6 international). He has carried out more than 10 I-A research projects, transferred 3 technologies to industrial sector and developed 3 industrial products. Prof. Katare has been acknowledged for his innovative and industry linked research by DBT by awarding him Technology National Award 2007 conferred by President of India Dr. A.P.J Abdul Kalam. He has also received prestigious OPPI Scientist Industry Awards 2011 by GlaxoSmithKline in order to honor his innovations in pharmaceutical sector. He received best patent award from Indian Association of Biomedical Scientists for the development of psorisome. On the international front, he has been a founder member and expert on the scientific board of International Phospholipd Research Centre at Heidelberg, Germany. He has been actively associated with industry oriented research and has successfully transferred his technology to industry.

3. ***Dr. J.K Verma (Drug development)***

   Dr. J.K Verma is a co-founder and managing director of Lifecare Innovations Pvt. Ltd. located in Gurgaon excelled in his research in field of drug development with focus on controlled release of pharmaceuticals viz liposomal drugs and nano drugs. He is credited with 22 research publications and has been granted with 1 national and 6 international patents and has filed 3 national and 17 international patents. He has been actively involved with academia and till date has carried out 15 I-A collaborative research work. He has commercialized 6 technologies translated from academia and has developed 8 products in total. He has been honored for his industrial research and active involvement with academic sector by the Government of India. He has received numerous awards and honor and some of them are as innovation in medical sciences and technology from Indian Council of Medical Research (ICMR, 2015); Vigyn Ratna Award (2012, 2007); National Award from Department of Scientific and Industrial Research (DSIR, 2006), Department of Biotechnology (DBT, 2004, 2006), Technology Development Board (TDB, 2008) etc. Dr. Verma is amongst those industrialists who have shown trust on academia of the country and has immensely benefitted from I-A collaborations.

**Scientist from engineering sector**

1. ***Prof. Shantanu Roy (Computational fluid dynamics)***

   Prof. Roy is a professor in Department of Chemical Engineering of IIT-Delhi. He is pursuing his research in field of multiphase reactors, chemical reaction engineering and modeling, and computational fluid mechanics. He is credited with more than 70 publications and has been granted 3 international patents and has filled one international patent. He has been actively involved in more than 20 I-A research projects. He provides consultancy services to various industries and is member of scientific advisory committee of Ministry of Petroleum and Natural Gas. He also services as expert of several DST-TIFAC committees for technology projection. He has been awarded with DuPont Young Faculty Award 2004 by DuPont Chemical Company, USA for pursuing industry oriented research.

2. ***Dr. Sunil Jha (automation in manufacturing process)***

   Dr. Jha is associate professor in Department of Mechanical Engineering in IIT Delhi. He is working in field of manufacturing processes, mechanatronics and automation. He is credited with 20 publications and has filled 4 national patents. He has handled 7 I-A collaborative research products and has contributed to transfer of 3 technologies and development of 4 industrial products. He is also actively involved with number of industries for providing consultancy services in domain of product designing.

**Scientist from biotechnology sector**

1. ***Prof. R.K. Saxena (Applied Microbiology)***

   Prof. Saxena is a professor in University of Delhi in the Department of Microbiology. His major area of research work is industrial microbiology. He has published over 175 research publications and has been granted 2 national patents and has filed 12 national and one international patent. He has handled 3 major and 1 minor I-A research projects. Till date Prof. Saxena has contributed to the development of 8 industrial products which are under industrial negotiation for commercialization. Prof. Saxena has been awarded with young Indian Next practices award (2011) by Department of Science and Technology (DST) and Indian innovation initiative (2011) by CII. Prof. Saxena is also coordinator of Innovation, Incubation and Technology Development Cell of University of Delhi and is strongly contributing to the strengthening I-A collaborations in the University.

2. ***Prof. Dinesh Goyal (Applied Microbiology)***

   Prof. Goyal is working in Department of Biotechnology at Thapar University as professor. He is working in the field of applied microbiology and biotechnology. He is credited with 80 publications and one national patent. He has been actively engaged in 4 I-A research projectsand has transferred 3 technologies to industry and has developed 5 industrial products. He is actively involved in providing consultancy services to various industries. He has also heading Science Technology Entrepreneurship Park of Thapar University to promote technology development, attracting industries and promotion of entrepreneurship culture in the University.

3. ***Prof. K. Sankaran (Biochemistry)***

   Prof. Sankaran is working as professor in Centre for Biotechnology, Anna University, Chennai. He is credited with 40 research publications and has been granted 1 international patent and has filed 9 national and 2 international patents and. He has transferred 2 technologies to the industry and has developed 2 industrial products. He has been actively involved with consultancy services to Shree Kamdhenu Electronics Pvt. Ltd. and has been associated with field validation services along with Trivitron Healthcare for uropathogenic antibiogram device. He has been involved with number of I-A collaborative projects and is delivering them successfully under required time frame and industrial requirements.

Brief profiles and achievements of academicians (7) and industrialist (1) are presented in Table 2:

**Table 2: Brief profile of Select scientists who successfully delivered I-A collaborative research projects**

| S.No | Name | Broad Area of Research | Res. Papers | Patents | | I-A projects | Tech. transfer | Industrial products developed | Consultancy and Industry related awards |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Filed | Granted | | | | |
| 1 | Prof. V.B. Patravale | Pharmaceutical Sciences and Technology | 72 | 22 | 4 | 19 | 10 | 30 | **Consultancy**: Cadila Pharma, Sahajananad Medical Tecghnologies, Kamani Oils, Yuva cosmetics, Charbhuja trading and agency<br>**Award**: OPPI Women Scientist Award 2015, Smt. Chandaben Mohanbhai Patel industrial Research Award for Women Scientist 2013 |
| 2 | Prof. O.P. Katare | Liposome Technology and Drug Delivery | 112 | 15 | 7 | >10 | 3 | 3 | **Award**: DBT Technology National Award 2007, OPPI Scientist Industry Award 2011, Best Patent Award by Indian Association of Biomedical Scientists (IABMS, Chennai) |
| 3 | Dr. J. N. Verma | Drug Development | 22 | 20 | 7 | 15 | 6 | 8 | **Award**: Haryana Vigyan Ratna Award 2012, Vishnu Kamal Award 2009, National award- Technology Development Board 2008, Vigyan Ratna Award 2007, Scientist of the year 2003 |
| 4 | Prof. R.K. Saxena | Industrial Microbiology | 175 | 13 | 2 | 4 | - | 8 | **Award:** Young Indian Next Practices Award in i3 national fair 2011, Indian Innovation Initiative award 2011 |
| 5 | Prof. Dinesh Goyal | Applied Microbiology and Biotechnology | 80 | 1 | 1 | 4 | 3 | 5 | - |
| 6 | Prof. K. Sankaran | Biochemistry | 40 | 11 | 1 | - | 2 | 2 | **Consultancy**: Shree Kamdhenu Electronics Pvt. Ltd and Trivitron Healthcare, Chennai |
| 7 | Prof. Shantanu Roy | Computational Fluid Mechanics | >70 | 1 | 3 | >20 | - | - | **Consultancy:** Scientific Advisory Committee of Min. Of Petroleum and Natural gas, DST-TIFAC Committee expert member<br>**Award**: DuPont Young Faculty Award 2004 |
| 8 | Dr. Sunil Jha | Manufacturing Processes, Automation | 20 | 4 | - | 7 | 3 | 4 | - |

## Section C

## Details of I-A collaborative Projects carried out by Select scientists

### 1. Prof. V.B. Patravale, ICT, Mumbai

| | |
|---|---|
| Title | Development of Novel Drug Eluting Coronary Stents |
| Duration | 2006-15 (9 years) |
| Finances | Industry, ICT and Government financed in 3 stages of product development: INR 17,00,000 (1$^{st}$) + 2,69,376 (2$^{nd}$) + 7,21,355 (3$^{rd}$) |
| Manpower | 3 JRF and 1 Res. Assistant |
| Responsibilities | *Academia*: Concept development, product development and optimization, *in vitro* characterization, *ex vivo* studies.<br>*Industry*: Concept development, patent filing, scale-up, preclinical and clinical studies, product approval from authorities, marketing etc.<br>*Other Organization*: Prime Minister Fellowship Scheme (Government of India) for awarding JRF |
| Approach for initiating collaborative work | Industry approached Prof. Patravale for consultancy. After joining as a consultant, the work was then taken ahead as additional collaborative projects. |
| Stage at which Industry involved | Industry was involved at every stage of the project |
| IP Status | - |
| Institute Gain | • 25% of the project cost was received by institute as institutional share<br>• 33% of the consultancy cost was received by institute as institutional share<br>• Empowering image of institute in Industrial sector as promising academic collaborator |
| Scientist Gain | • Inventorship in the patents filed from the research work.<br>• Financial support to conduct research<br>• Publications<br>• Recognition in industrial arena<br>• Achieving scientific excellence |
| Industry Gain | • Research support and expertise to develop and optimize the product<br>• Cost effective product development<br>• Fulfillment of Social responsibility |
| Market Impact | • Global market entry (over 40 countries) with the superior coronary stents and 1$^{st}$ in India to receive European Conformity (CE) mark<br>• The regulatory authorities (India) not only approved the products but also increased the shelf life from initial 1 year to 2.5 years for SupraFLEX® in year 2015 |

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| | • More than 3.5 lakh stents implanted till date<br>• Revenue of ~INR 50 Cr was generated in year 2013-14<br>• Better market opportunity for products under development |
| Societal Impact | Superior product with respect to biocompatibility and restenosis rate was available for patients. Cost effective treatment modality with high efficacy for patients (almost 25% cost reduction than the competitor product) |
| Profit Sharing | Profits not shared with collaborator/ Institute |
| Outcome | Currently, 4 coronary stents are being marketed in India (First to receive CE mark) and abroad under the trade names Infinnium™, Supralimus™, Supralimuscore™, Everoflex™ (More than 3.5 lakh stents have been implanted). Other stents under development: S-Link, Supraflex etc. |

**2. Prof. O.P. Katare**

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| Title | Development and Scale-up of Some Novel Liposomal Products |
| Duration | There are different modules viz. Life long, time bound and case bound (continuing from 2004) |
| Finances | INR 5, 10, 000 (Industry and Panjab University) |
| Manpower | 4 JRF |
| Responsibilities | *Academia*: Concept formation, hypothesis testing, generation of scientific lab-scale data and scientific evidences, varied techniques for analysis, pre-formulation, formulation development, characterization and standardization, stability issues and assessment, package development, Product technology information.<br>*Industry*: Scale-up and tech-transfer issues, development of Standard Operating Procedures (SOPs) (Joint efforts), filling all the gaps to fulfil the regulatory requirements, funding supports for materials and outsourcing, fellowship for scholars and support for lab assistance and patent filing.<br>*Other organization*: Funds support from agencies like UGC, AICTE, DBT and DST for infrastructure and high cost instruments. |
| Approach for initiating collaborative work | Industry approached only in all cases. (In case of vice versa, it was failure) |
| Stage at which Industry involved | Right in the beginning at the conceptual level |
| IP Status | University shared with innovator the royalty amount, i.e. 2% of ex-factory price which was then distributed 50:50 between the university and investigators. |
| Institute Gain | • Based on the achievements, the institute & the university fetched so many high-funding projects likes DST-INSPIRE, DST-Policy Research Centre, UGC-NanoSci projects (worth crores of rupees). |

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| | • It helped University in ranking by different agencies like NAAC, THE etc.<br>• Generating finances through Centre for Industry Institute Partnership. |
| Scientist Gain | • The enhancement in the employability of the scholars. They were quickly absorbed in the high growth or top performing Pharma industries like Sun, Lupin, IPCA and others.<br>• Image or brand building at individual level and organizational levels both the investigators and university gained lots of advantages in this regard.<br>• Financial support for procurement of materials and outsourcing that saves lots of time.<br>• Generated I.P.R. with the support of Industries which is often ignored in the conventional lines of practice at the University level. |
| Industry Gain | They got novel pharmaceutical products with an edge over other products hence, the market advantages. The brand value in such cases becomes very high. |
| Market Impact | Products have been appreciated by the doctors and gradually catching up in the market. |
| Societal Impact | Helped suffering society |
| Profit Sharing | University shared with innovator the royalty amount, i.e. 2% of ex-factory price which was then distributed 50:50 between the university and investigators. |
| Outcome | Liposome and nano-tech based novel pharm. products for dermatological disorders like Psoriasis, Eczema and Fungal infection stability solutions |

**3. Dr. J. K. Verma**

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| Title | Scale Up Process Development for Production of Liposomal Amphotericin B, Awareness Program and Clinical Performance Trials |
| Duration | 16 months |
| Finances | Lifecare Innovations Pvt. Ltd., INR 99.76 lakhs (66.61%)<br>DSIR under PATSER INR 50.00 lakhs (33.39%) |
| Manpower | - |
| Responsibilities | *Academia*: Development of lab scale technology (*prior to this project*).<br>*Industry*: Innovations and developments to make the product – Liposomal Amphotericin B patient worthy and commercializable; with cold-chain compatible packing to maintain uninterrupted cold-chain from production to patients' bed-side.<br>*Other organization* (if any, like DST/DBT etc.): DSIR funded to the industry for this project for 16 months; DBT funded academic |

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| | institutions before this project |
| Approach for initiating collaborative work | In 1990s, Dr. J.N.Verma was the only known liposome technologist in Indian industry credited with discovery, development and commercialization of Asia's 1$^{st}$ liposomal product – a Liposome Agglutination Test for immunodiagnosis of Syphilis. Various Government agencies viz. DBT, NRDC and DSIR identified Dr.Verma and committed support for creating the company Lifecare Innovation to absorb DBT technology, carry out translational research and commercialization of life-saving drug for treatment of life-threatening fungal and leishmanial infections. |
| Stage at which Industry involved | Dr. J.N. Verma being a liposome technologist was in touch with Dr. B.K. Bachhawat and Dr. Neelima Kshirsagar since 1991 and was regularly interacting with their research groups.<br>Dr. Verma played pivotal role in establishing liposome technology in the industry in India and was involved in the project at different levels before the completion of clinical trials. |
| IP Status | IP was assigned to the industry and the institution was paid royalty. |
| Institute Gain | The institutions KEM Hospital Mumbai, DBT and DSIR received Royalties and DSIR's investment as Programme aimed at Technology Self Reliance (PATSER) grant along with interest was returned by Lifecare Innovations. |
| Scientist Gain | Scientists were benefitted by unprecedented recognition. In addition to other honors and awards Dr. Kshirsagar was conferred with B.C. Roy Award. |
| Industry Gain | Dr. Verma though in the industry as founder and managing director is involved in the project as a scientist. Without Dr. Verma's pioneering initiatives as a liposome technologist, and determined pursuit in a country that was not the most conducive for technopreneurship, this project would have been buried as project report in the archives of DBT as no company wanted to invest in this project perceived to be very risky.<br>Industry got an opportunity to establish commercial production of Novel Drug Delivery Systems (NDDS) based controlled release drugs viz. liposomal and nano-drugs.<br>Today Lifecare Innovations has forged several collaborations both within and outside India and has become inspiring example of technology led enterprise engaged in discovery and development of novel drugs. |
| Market Impact | Amphotericin B due to its overwhelming toxicity particularly nephrotoxicity is referred to as *Ampho-the-terrible*. With not even single other broad-spectrum anti-fungal drug discovered, Amphotericin B despite nephrotoxicity to 2/3$^{rd}$ of the patients administered with the drug, Amphotericin B continued to be the only hope for invasive and |

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| | systemic fungal infections. FUNGISOME™ – *Ampho-the-terrific* safer than any other anti-fungal drug in the world has rekindled hope that liposomes can help mitigate dose limiting toxicities. Consequent to FUNGISOME™, number of companies are now engaged in developing liposomal formulations of Amphotericin B and other drugs. New business of several hundred crores of liposomal drugs has developed in India alone. Following success of FUNGISOME™, Lifecare Innovations has developed and commercialized five lipid and liposomal formulations for treatment of fungal and leishmanial infections and psoriasis |
| Societal Impact | Prior to FUNGISOME™, Liposomal Amphotericin B was unaffordable by most Indians. Imported Liposomal Amphotericin B was mostly prescribed in defence hospitals. Now because of success of this project and consequent availability of FUNGISOME™, number of lives is saved every day. Two examples are cited below to highlight impact of this liposomal drug. |
| Profit Sharing | Institution was paid royalty |
| Outcome | FUNGISOME™ – the only indigenous and superior to imported Liposomal Amphotericin B (i.v.) was innovated, commercialized and made available throughout India and became preferred Liposomal Amphotericin B i.v. of most of the premier hospitals in India including – AIIMS New Delhi, PGIMER Chandigarh, Sanjay Gandhi Post Graduate Institute of Medical Sciences (SGPGIMS) Lucknow, Christian Medical College (CMC) Vellore, Tata Memorial Hospital, Mumbai, Medanta - the Medicity Gurgaon, Apollo group of Hospitals, R&D and other Defense Hospitals. The daily dose cost, success rate and nephrotoxicity of FUNGISOME™ were INR 5900, whereas of the imported AmBisome were INR 60,000. Prior to FUNGISOME, only 1% of the patients needing Amphotericin B could afford its nephrosafe Liposomal formulation whereas within 3 years of FUNGISOME launch, FUNGISOME alone catered to estimated 16% of the patients needing Amphotericin B i.v. Today FUNGISOME is emerging as drug of choice in several countries. It has been launched in Latin America under the brand name AmBullet®. |

**4. Prod. R.K. Saxena**

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| Title | Enzymatic Synthesis of Xylitol from Hemicellulose from Tata Chemicals Limited (TCL). |
| Duration | 2 years |
| Finances | 100% financial support by the industry |
| Manpower | 2 JRF |
| Responsibilities | *Academia*: Sole responsibility of the academia<br>*Industry*: Filing of the patents and subsequent commercialization |

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| | *Other organization* (if any, like DST/ DBT etc.): Nil |
| Approach for initiating collaborative work | Industry approached |
| Stage at which Industry involved | Right from the beginning |
| IP Status | Joint patents |
| Institute Gain | Infrastructural support and industrial relation (university-industry interaction) |
| Scientist Gain | A new dimension of industrial requirement were explored and investigated |
| Industry Gain | Industrial processes of bio molecules required by the industry were developed. |
| Market Impact | Details are with the industry |
| Societal Impact | Industry provided jobs, based on the work carried out by us |
| Profit Sharing | - |
| Outcome | The 2 products i.e. xylitol and propanedial were developed at the pilot plant<br>2 students working for these projects and were awarded Ph.D. degree of the university.<br>13 research paper were published |

**5. Prof. Dinesh Goyal**

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| Title | Utilization of waste biomass for removal of heavy metals from industrial effluents |
| Duration | 2005-2008 (3 years) |
| Finances | CSIR, New Delhi: 20 lakhs |
| Manpower | 2 JRF |
| Responsibilities | *Academia*: Project co-ordination & management with participating agencies and data generation Laboratory work and basic data generation<br>*Industry*: logistic support at the Unit, sample analysis, pilot scale trial<br>*Other organization* (if any, like DST/ DBT etc.): CSIR-Project monitoring |
| Approach for initiating collaborative work | Scientist approached the industry |
| Stage at which Industry involved | Towards the completion for pilot scale trials |
| IP Status | IP shared amongst the collaborators/institute/industry: Equally between TU and CSIR |
| Institute Gain | All deliverables were met. 2 Ph.D and 10 M.Sc were awarded, 12 publications in good journals. |

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| Scientist Gain | One patent granted No. 244750: A process for chromium VI removal from industrial effluents by waste biomass Date of publication 24.12.2010; Journal No. 52/2010; Inventor: Ahluwalia AS and Goyal Dinesh |
| Industry Gain | The industry made trial and used it for environmental clearance and maintenance in removing chromium from waste water. |
| Market Impact | Not ascertained |
| Societal Impact | Not ascertained |
| Profit Sharing | Never estimated |
| Outcome | In this process bio sorbent is manufactured from microbial waste biomass, originating as waste by-product from pharmaceutical industries, such as microbial waste biomass comprising of fungus *Penicillium* sp./*Pischia* sp./ *Rhizopus* sp./ *Aspergillus* sp., used in fermentative production of antibiotics. |

**6. Prof. K. Sankaran**

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|---|---|
| Title | Instrumentation for Long Term Monitoring of Neuromuscular and Cardiovascular Status for Diagnosis, Therapy and Rehabilitation |
| Duration | 3 years |
| Finances | Total project Amount =INR 41,33,000<br>Source of finances: DST, New Delhi |
| Manpower | 2 SRF |
| Responsibilities | *Academia*: Technology development<br>*Industry*: Field validation and commercialization<br>*Other organization* (if any, like DST/DBT etc.): DST for funding |
| Approach for initiating collaborative work | The scientist approached the industry |
| Stage at which Industry involved | During validation stage |
| IP Status | IP shared amongst the collaborators/institute/industry: 50:50 |
| Institute Gain | The institute gets the share as stipulated by the sub-committee from the one-time technology transfer fee and royalty. |
| Scientist Gain | Inventor reward was given to the scientist from the one-time technology transfer fee collected from the industry and also the scientist will be given his share from the revenue generated in the form of royalty on selling of every unit. |
| Industry Gain | NA |
| Market Impact | Unknown, as the product has not hit the market yet. |
| Societal Impact | Unknown, as the product has not hit the market yet. |
| Profit Sharing | - |

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| Outcome | Multi-channel synchronous wireless data acquisition; bladder pressure monitoring and extension for cystometrogram system. Standards compliance testing and certification of the product. The project was successfully technology transferred. |

**7. Prof. Shantanu Roy**

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| Title | Flow Studies, Mixing Pattern and Modeling of Rotary Bioreactor |
| Duration | 2 years |
| Finances | Industry ~ 60 lakhs; Ministry of Human Resource Development (MHRD; 25 lakhs); DST (37 lakhs); Board of Research in Nuclear Sciences (BRNS ; 20 lakhs); IIT (~ 30 lakhs). |
| Manpower | 1 SRF, 1 project assistant |
| Responsibilities | *Academia*: Conduct of in-house (in IIT) experiments, experiments in industry, establishing the experimental protocol and conduct of experiments, collection and analysis of data, modelling of flow phenomena.<br>*Industry*: Design of experimental unit, fabrication and installation. Providing logistical and manpower support for scientists from IIT and BARC.<br>*Other organization* (if any, like DST/DBT etc.): BRNS, DAE supported part of the developmental effort in IIT in general (not specific to the current project). |
| Approach for initiating collaborative work | Industry approached scientist. |
| Stage at which Industry involved | From beginning |
| IP Status | IP was not shared amongst the collaborators/institute/industry. The IP was mostly in form of knowhow. The specific details of the technology were not disclosed but the use of the experimental technique in this setting, which was a novel and significant accomplishment, has been published. |
| Institute Gain | • Technical success<br>• Training of students in a particular technology that has been developed in-house |
| Scientist Gain | This is now considered as a case study of industrial radio tracing by the International Atomic Energy Agency (IAEA), of which the PI is a technical expert. |
| Industry Gain | Product/technology is successfully commercialized and utilized by industry |
| Market Impact | It is substantial business of the “Water and Waste Solutions” division |

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| | of Thermax. The product is sold under the commercial name "BioCask". The I-A project in question provided a crucial step in commercialization of this technology. |
| Societal Impact | The product/technology that has been developed is an important technology for end-to-end wastewater and sludge treatment solution. It is commercially viable and used in various urban and rural centres. |
| Profit Sharing | No profit sharing |
| Outcome | The technology for flow imaging developed at IIT Delhi was never used in the industry directly. It was a challenge to do so, and this is the first ever (anywhere in the world) successful demonstration and use of this technique in the industry. The suspected problems were fully addressed and specific recommendations were made. Some minor design changes and major operational changes were made. Good efficiency was ensured and product/technology is a success in the market. |

**8. Prof. Sunil Jha**

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|---|---|
| Title | Solar Power Operated Water Pump |
| Duration | 3 Months |
| Finances | Industry: INR 6.50 Lakhs |
| Manpower | Nil |
| Responsibilities | *Academia*: To design efficient Solar operated irrigation pumping system.<br>*Industry*: To provide specifications of the requirement. |
| Approach for initiating collaborative work | Industry approached |
| Stage at which Industry involved | Since beginning of the project |
| IP Status | IP shared amongst the collaborators/institute/industry by 50-50 %. |
| Institute Gain | Technology knowhow |
| Scientist Gain | Get to know about the state of art of technologies in solar water pumping. |
| Industry Gain | Get commercial product developed in very short time. |
| Market Impact | BSES Yamuna Power Ltd. successfully commercialized and installed more than 60 such pumps in Delhi. |
| Societal Impact | Improved the water supply by reducing power dependency and cost. |
| Profit Sharing | No profit sharing with institute. |
| Outcome | Technology for solar water pumping for farmers, schools, hospitals etc and installation of solar pumps at respective sites |

**Section D: Feedback from scientists for strengthening I-A collaborations in India.**

| S.No | Name | Feedback | |
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| 1 | Prof. V.B. Patravale | Hindrances | Lack of infrastructure and facilities at institute end required extensive outsourcing in formative years. However the infrastructure was build up as per requirements in later years with the support of government and private industrial grants. |
| | | Suggestions | • Rules and regulations for collaborative projects/ consultancy and technology transfer should be properly defined (As this rules are properly and clearly defined at Institute of Chemical Technology, the execution of collaborative project and technology transfer was extremely swift and convenient)<br>• Patent cell within the institute can help the researchers scan micro patents at faster pace rather than being dependent.<br>• Patent royalty clause should be inbuilt and a specific percentage defined by the institution.<br>• Confidentiality agreement and MoU should be critically drafted safeguarding the interest of both the sides.<br>• Follow up mechanism for milestone payments should be automatically built in the system. No reminders from collaborators to central accounts should be necessary.<br>• No maintenance grant comes from Government/Institute which at times is necessary for smooth functioning of the project. |
| 2 | Prof. R.K. Saxena | Hindrances | NIL |
| | | Suggestions | • For applied research of national importance being carried out in public funded institutes, the industry should be involved from the very beginning of the research project. Government should give additional incentives to industries working on research projects of national importance.<br>• Each research institute should have a dedicated Industry-Academia Centre to look after I-A linkages, IPR management, Entrepreneurship, Technology Development and Technology Transfer.<br>• Government should encourage setting up research facilities and scale up facilities on the campus under PPP mode.<br>• Technology developed by scientist/teacher and transferred to an industry should be given academic wait age and incentives to the scientist/teacher. |
| 3 | Prof. Shantanu | Hindrances | Nothing in particular. Very good cooperation from industry, who very well championed the cause of incorporating high-end research into crucial parts of their technology. |

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| | Roy | Suggestions | • Major public sectors in India have a mandate for research and development, and part of that is joint development with academia. However what plagues success in many cases is that the middle-level management in such major public sectors, who have a direct knowledge of technical challenges and problems (where academia can help), have hardly any decision-making powers. Most of the R&D decisions are taken by top management, and many of the professional occupying such positions either do not have experience of R&D, or are too busy and disinterested in R&D, let alone interactions with academia.<br>• They would be present for industry-academia programmes and photo-ops, but since they have very little direct experience or requirement of research-based solutions, the whole effort ends up being cash sink with little positive results. There is need to have the people who are actually working on research to also be decision makers in terms of budgets, spending and setting directions for R&D.<br>• Also many public sectors have to abide by archaic laws of using “proven and demonstrated technologies” when they are in the process of design and commercializing a plant. Since new technologies would never by demonstrated, by definition, hence the incentive to go for new technologies developed under I/A interactions is small. Thus, an eco-system in which new technologies developed indigenously is encouraged, is required. This will have obvious conflicts with risk assessment that companies will make, and this has to be addressed.<br>• In private sectors in India, the problem is two-fold. There are several companies who “feel the need” for research based solutions, but are too small to afford major projects. They understand the challenges very well, are doing very good work on their own, but they are not part of an “eco-system” in which they can freely interact with academia. Maybe Government needs to create an environment, in terms of funding but also in terms of “access”, to support such companies to interact freely with academia.<br>• For large private sector companies in India, the challenges to develop and commercialize technology indigenously are too many. So most of them decide to “buy-out” technology from known vendors (usually themselves major multinational companies), with the incentive towards indigenous development is low.<br>• One other aspect is that major technology vendors provide guarantees on technology, when deployed. For a private (or even public sector) company that is a major requirement. Even if we do have new technologies and patents coming out of I/A relationships within the country, usually lack of an eco-system which ensures guarantees and troubleshooting support is a deterrent for going in for new technologies. Thus, it is important that some sort of undertaking on guarantee of |

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| | | | technologies and troubleshooting support, should be provided. |
| 4 | Dr. Sunil Jha | Hindrances | Problem in getting good manpower for short term projects. |
| | | Suggestions | • A dedicated team in Industry should be identified at the commencement of the project that will interact on regular basis with the Institute.<br>• Project Investigators at Institutes should be very clear about the deliverables of the project and work with clear focus in that direction.<br>• Institute should provide sufficient support to the PI for execution of the project in terms of space and other infrastructure. Because of space required for execution of the industrial consulting projects, institutes normally discourage projects which require space.<br>• There should be regular meets in institutes with different sectors of industry where industry can share their problems. Institute should maintain a website where industries can post their problems and the same information should be visible to all faculty members. |
| 5 | Prof. Dinesh Goyal | Hindrances | • Industry is not willing to spend even a single penny in exploratory research. If scientist has anything which is certified and proven technology or concept then only they will come forward that too if it leads to huge profits and money making. The industrial R&D is not at all strong in our country and they do not want to invest in that.<br>• While conducting trials at industry, there was least interest of industry people and it was only through personal contacts and our interest in doing something meaningful from academic point of view, we could attempt successfully. After completion of work reports were given to them and recommendations were explained, they never turned back to us for any further assistance.<br>• Fruits of science reach to society with a great difficulty and sometimes the new concept and new technology die off in between. People even after realizing its potential benefits are not able to accept, propagate and commercialize. Govt. support is necessary in this regard and all different wings of central and state govt. must come together to realize and implement immediately anything that relates to environment friendly green technologies, best practices in agriculture, environment protection etc.<br>• Indian industry has less faith in Indian scientific community.<br>• We nurture innovations, but it is half way and do not go further, or cannot go further, or there is no mechanism whereby it can be taken further towards its successful implementation and realization by the society. Scientists, researchers leave in between because of several reasons. |

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| | | Suggestions | • Industry must actively work with researchers in working out new concepts and finally cost benefits analysis so that product or process is acceptable by the industry.<br>• Provide incentives to the working teams for successful implementation.<br>• The findings generally remain in thesis/dissertation for years and we keep reinventing the wheels. iv. More collaboration between Industry and academia is necessary.<br>• Industry to realize that they can get enormous benefits from this in modifying their processes in a cost effective manner, using academia which is actually a center for knowledge creation.<br>• This knowledge can be protected as well as utilized by them for greater returns. v. Industry-Academia and Govt., to facilitate this and making aware of available technologies which can be commercialized or results of R&D are accepted by the end users.<br>• Patenting is very slow process in India, by the time patent is awarded everything vanishes.<br>• Fast patenting and its commercialization or adoption by the industry is very much required. Due to this reason publishing the work in Science Citation Index Impact factor journals only remains as an alternative. |
| 6 | Prof. O.P. Katare | Hindrances | • University Infrastructure: a) Lack of sufficient space and laboratory facilities b) Equipments, maintenance<br>• Retention of technology-trained scholars: This means that to carry on the efforts to the level of translation (Scale-up etc.), it needs well-equipped persons. But, there is no provision to retain them for such industrial projects. The work undoubtedly carried out by the scholar will leave after the Ph.D. work and the final work well then be left incomplete.<br>• Beurocratic hindrances in utilizing private funds: There are lots of objections to clear the bills, by audit department with the prevailing attitude. |
| | | Suggestions | • Centre for Industry Institute Partnership should be given complete autonomy, especially in utilizing personal funds.<br>• University should look to address the specific or individualized challenges which may be different project to project.<br>• The researchers should be given incentives.<br>• To retain post-Ph.D. scholars, there should be provision to provide the support without delay.<br>• Also, in order to attract industry, the provision of Service tax (which is getting on funding organization) be erased. |
| 7 | Dr. J. N. | Hindrances | • Non-availability of affordable land in and around Delhi. No start-up or entrepreneur led enterprise |

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| | Verma | | can afford any land. After 15 years also, we do not have land because of affordability. Make in India is reduced to only a slogan as no one in the country knows “make where in India”.<br>• Adequate financial support. If the financial support is not complete, the innovators are forced to depend on financers. Often these financers become impediments for the fruition of the project.<br>• Regulatory Agencies, particularly Drugs Controller General (India) [DCGI] / Central Drugs Standard Control Organization (CDSCO) do not work in time-bound manner, have no experience in dealing with new drugs, have no motivation to support innovation, have no appreciation of eroding patent life because of delays caused by them. Unless there are punitive actions and accountability against DCGI/CDSCO officials and State Drugs Controller Indian healthcare industry cannot progress. R&D alone cannot address unmet medical needs of the country and humanity. There should be time-bound procedures for all licenses and permissions and delays should not be allowed to be caused on frivolous grounds. Non-response should also not be allowed.<br>• Bureaucratic Harassment: we faced serious problems with excise department as despite clearly classified as Excise free, they charged excise on our first batch of product for which we had to stop salaries. Though we won the case, but wrongly charged excise duty was never returned. On subsequent batches they stopped only when we said that we will stop manufacturing and hold a press conference making Excise Department responsible for the deaths for the want of our life-saving drug.<br>• Bureaucratic Harassment: Pollution Control Board harassment and delays are very common.<br>• Power tariff and uninterrupted power supply to ensure Good Manufacturing Practices (GMP) Manufacturing and seamless Cold Chain. Special status shall be given to healthcare industry to provide uninterrupted power and incentivized tariff.<br>• The Government should promise and implement “Minimum Purchase” products manufactured through the support of Government Grant if they have been tested and their safety and efficacy is established through clinical trials. Though there is an order of MSME to procure minimum 25% from MSME in govt. procurement, hospitals in the country do not follow it and in fact several Hospitals have enforced in their “Terms and Conditions for tenders and rate contracts” a prohibitive minimum turnover clause to prevent participation of start-ups in tenders.<br>• If a superior product has been developed and commercialized in India, inferior imports shall be banned. Our product is known world over to be most safe and most effective of all Liposomal Amphotericin B in the world, but continue to allow inferior imports of very high value drug.<br>• If a product has been developed and manufactured with government support in India, that product |

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| | | | should be compulsorily purchased in all Govt. programs. This is not being followed. Government of India or the state Government never purchased even one vial of Fungisome for Kala-Azar control programs. |
| | | Suggestions | • Indian pharmaceutical industry is "Generics and Similar Centric". Because of the huge investments involved in development, clinical trials and international norms of GMP compliance, complexed by 15-20 years of development time, return on investments and reinvestable returns are not possible. To promote the drugs discovery and development, National Pharmaceutical Pricing Authority should be abolished. Similarly, Department of Pharmaceuticals has no role is either promotion of research or industry and thus should be abolished.<br>• Because of the long durations involved in pre-clinical regulatory toxicity and phase I to phase III clinical trials, most of the IP life of 20 years is eroded and leaves no commercial viability to get returns on investment, there should be a minimum of 15 years of post-commercialization patent life. In the absence of this provision, industry is not interested to develop products in collaboration with academic institutions.<br>• When the technology originates in the academic institution, there is pressure of publication from both students and faculty as the publications are parameter for their performance evaluation. There is little realization that the World has transitioned from "*publish or perish*" to "*publish and perish*". In such technologies industry cannot invest. Thus a system needs to evolve for granting higher credits for patents in comparison to publication. For example 1 patent filed in India should be credited as 1 publication; Patent Co-operation Treaty (PCT) filed should be equivalent to 2 publications; an Indian patent granted should be equal to 2 publications and a high value foreign patent granted should be equivalent to 2-4 publication. This is just an indication. The system should be evolved with critical evaluation of the formula.<br>• Young scientists shall be encouraged for entrepreneurship to take up commercialization of their work and continue collaboration with their alma mater. This will also maximize translation of research into commerce. These young scientists shall be supported with a corruption free support system as part of institution's entrepreneur cell.<br>• R&D funding to the MSMEs shall be provided as risk sharing grant such as PATSER. Under PATSER scheme, no money was returnable by the company in the event of failure. However, on successful commercialization, 1.3 times the grant amount was returnable over five years, starting one year after commercialization.<br>• Masters Degree program in relevant field shall have courses on documentation of R&D data, |

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| | | | intellectual property, regulatory affairs, entrepreneurship, and business management.<br>• There should be Government funded Contract Research Organizations (CROs) in Institution-Industry collaboration clusters possibly linked to entrepreneurship cells of the institution.<br>• Collaborations with Hospitals and Doctors is a unique requirement of healthcare industry. Medical Doctors in the country mostly respond with "so what do I get out of this collaboration". R&D contributions must be a part of performance appraisal of Doctors in both teaching and non-teaching hospitals.<br>• For sanction of R&D grant to an academic, norms shall be laid down to assess applicability/ commercialization of their earlier funded work as qualifying criterion to optimize usefulness of Government's R&D spending. |

## Section E

## Hindrances and Recommendations

### *Hindrances:*

1. **Limited research infrastructural set up**: e.g. research space, facilities like GMP, Animal laboratory, Tissue culture laboratory, Scale-up facilities, Commercialization of lab. Research. Lack of maintenance grant for existing instruments.
2. **Lack of industry funding**: Lack of funding from industry for basic and applied research. Industry becomes interested only when final product/technology is ready.
3. **Lack of skilled manpower**: Getting good manpower for short term projects is very difficult.
4. **Lack of 'complete set up' for taking laboratory research to commercialization stage.** i.e. assistance needed for IPR, interaction with industry, Royalty clause, Steps involved in scale-up and Taking product to market/society.
5. **Regulatory framework**: Regulatory bodies should act fast on technologies developed under I-A collaborative mode to avoid dead lock of technologies as industry gets put off by lengthy regulatory framework. Hence, slow regulatory framework for approving the valuable product act as barrier for commercializing the technology leading to descent in I-A interface in country.
6. **Beurocratic hindrances**: For utilization of private funds, university administration and Audit Branch raise lot of objections, which sometimes are trivial in nature.
7. **Government policies**: Government policy regarding minimum purchase of superior product developed in the country is not followed properly. It discourages the industry counterparts who face the music of losses from the product developed.

### *Recommendations:*

1. **Creation of a dedicated I-A cell**: Each university doing research should have a dedicated I-A Cell. Its responsibilities include- proper rules and regulations for collaborative research via creation of dedicated I-A cell addressing following issues. This responsibility should be taken by **dedicated I-A cell** in the academic institute to deal with all the issues pertaining to the I-A collaborations including creation of patent cell that will be in charge of patent filling and protecting IP.
    a) Framing of proper rules and regulations for collaborative I-A research e.g. IP share, Profit share, Time and finance involvement at each stage, Confidentiality agreement and MOU critically designed
    b) Assist researchers in Patent search, IPR issues, Technology development/transfer and Finding suitable industry for tie ups with scientists
    c) Holding I-A Meets on regular basis
    d) Look out for I-A programmes from funding agencies
2. **Maintenance grant**: Government should set aside special instrument maintenance grant and grants for maintaining research facilities like GLP, Tissue culture facility, Laboratory animal facility etc.

3. **Facilities under PPP mode**: Government should encourage setting up research facilities and scale up facilities on the campus under PPP mode such as creation of centre for excellence in collaboration with industrial sector to promote dedicated advanced research in particular field.
4. **I-A website**: Institute should have a I-A website mentioning the applied research, patents, technologies developed/transferred, consultancy work taken up by scientist. Website should also have a portal where Industries can post their problems and the same information should be visible to all faculty members.
5. **Dedicated Managing Body**: Top management of universities should be run by scientists having ample experience in the area of R&D.
6. **Extended patent protection**: In India time taken from filing a patent to commercialization of technology is too long. In biology related I-A project (e.g. Pre-Clinical Regulatory Toxicity and Phase I to Phase III Clinical Trials) most of the IP life of 20 years is eroded and leaves no commercial viability to get returns on investment. Rules/regulations should be amended so that there is minimum of 15 years of post-commercialization patent life. In the absence of this provision, industry is not interested to develop products in collaboration with academic institutions.
7. **Retention of expertise**: To retain post-Ph.D. research scholars, there should be a provision to the support without delay.
8. **Minimum purchase scheme**: The Government should promise and implement "Minimum Purchase" products manufactured through the support of Government grant. Though there is an order of MSME to procure minimum 25% from MSME in Government procurement, this practice is not being followed.
9. **Promotion of self-product**: If a superior product has been developed and commercialized in India, inferior imports shall be banned.
10. **Credits for patenting the research**: When the technology originates in the academic institution, there is pressure of publication from both students and faculty as the publications are parameter for their performance evaluation. There is little realization that the World has transitioned from "*publish or perish*" to "*publish and perish*". In such technologies industry cannot invest. Thus a system needs to evolve for granting higher credits for patents in comparison to publication. For e.g. 1 patent filed in India should be credited as 1 publication; PCT filed should be equivalent to 2 publications; an Indian patent granted should be equal to 2 publications and a high value foreign patent granted should be equivalent to 2-4 publication. This is just an indication. The system should be evolved with critical evaluation of the formula.
11. **Promoting entrepreneurship**: Young scientists shall be encouraged for entrepreneurship to take up commercialization of their work and continue collaboration with their alma mater. This will also maximize translation of research into commerce. These young scientists shall be supported with a corruption free support system as part of institution's entrepreneur cell.
12. **Accessibility to risk sharing grant**: R&D funding to the MSMEs shall be provided as risk sharing grant such as PATSER. Under PATSER scheme, no money was returnable by the company in the event of failure. However, on successful

commercialization, 1.3 times the grant amount was returnable over five years, starting one year after commercialization.

13. **Commencing dedicated courses**: Masters Degree program in relevant field shall have courses on Documentation of R&D data, Intellectual Property, Regulatory Affairs, Entrepreneurship, and Business Management.
14. **Creation of interlinked CROs**: There should be Government funded CROs in Institution-Industry collaboration clusters possibly linked to entrepreneurship cells of the institution.
15. **Assessment of R&D funding**: For sanction of R&D grant to academic, norms shall be laid down to assess applicability/commercialization of their earlier funded work as qualifying criterion to optimize usefulness of Government's R&D spending.

**Annexure 1**

I-A Proforma prepared for carrying out case study on select scientists having I-A collaborations

# DST- Centre for Policy Research at Panjab University, Chandigarh

## Questionnaire for Industry-Academia (I-A) Case Studies

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**Section A -** ***(Personal Information)***

1. Name:
2. Date of Birth:
3. Present Position:
4. Complete Postal Address:
5. Mobile/Landline #:
6. Email:
7. Highest Academic Qualification:
8. Broad Area of Research:
9. Research papers (Nos. only):
10. Patents (Filed): National- ; International-

    Granted (Granted): National- ; International-
11. No. of Industry-Academia (I-A) research projects handled:
12. No. of Technologies transferred:
13. No. of Industrial product(s) developed:
14. Any other industry related activity (consultancy etc.):
15. Industry Related awards/ honours:

## <u>**Section B-** ***(Project Related Information)***</u>

1. Title of I-ACollaborative Research:
2. Name and Address of Collaborative Industry:
3. Name & Address of other Collaborators (if any):
4. Genesis of the Project:
5. Duration of the Project:
6. Amount and source of finances of the project. *(Pl provide percentage of cost sharing):*
7. Manpower (*JRF/SRF/Res. Assistant/Project Assistant*) hired for the project.
8. Distribution of Responsibilities:

    (i) Academia:

    (ii) Industry:

    (iii) Other organization (if any, like DST/DBT etc.):
9. Deliverables:
10. Outcome of the project:
11. Whether scientist (s) approached the industry or vice versa:
12. At what stage was industry involved in the project:
13. How was the scientist(s) benefitted by this collaborative project:
14. How was the institute (s) benefitted by this collaborative project:
15. How was the industry benefitted by this collaborative project:
16. What is the market impact of the outcome of this project:
17. What is the societal-impact of the outcome of this project:
18. Whether any incentive to the scientist(s) was provided by the institute:
19. How was the Intellectual Property (IP) shared amongst the collaborators/institute/industry:
20. How were the profits shared by the collaborators/institute/industry:

## Section C -*(Feedback & Suggestions)*

1. Please list the hindrances faced during the conduct of I-A research collaboration:
2. Kindly provide suggestions that will make I-A interactions more simple and fruitful:

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सत्यमेव जयते

Department of Science & Technology
Govt. of India

# DST-Centre for Policy Research at PU, Chd.

***(DST/PRC/CPR-03/2013)***

## <u>REPORT-5</u>

**(May, 2015-Aug., 2016)**

# *Industry-Academia R&D Regimes in Indian Institutes of Technology*

# INDEX

# 1. Introduction

The Industry-Academia (I-A) synergy is an indicative of the scientific innovation index of a nation. Developed countries like USA, UK, Germany, Japan and S. Korea enjoy a golden hand-shake between the academic and industrial sectors. The healthy collaboration of industry with academia is responsible for increased number of scientific innovations in these countries. India ranks third, next to USA and China, in terms of size and diversity of higher education system. However, it has not been able to accomplish the desired technological advancement (Nandi R, 2014). One the major reasons for this is attributed to the lack of, or absence of, ecosystem needed for transforming university-research into patents/technologies/processes. Out of more than 700 Higher Education Institutes (HEIs) in India, only a handful of academic institutes e.g. IITs, ICT-Mumbai and IISc-Bangalore are known for generation of patents and technologies. These institutes are also in the forefront of engaging industrial sector in its R&D programmes. In fact, IITs at Chennai, Kanpur, Mumbai, Khargapur and Delhi are considered to be the flag-bearers of I-A R&D in India. Each IIT has a dedicated academic programme (Table 1) comprising of undergraduate, post graduate and Ph.D. programmes which primarily caters to engineering domain, though biology related courses, such as biotechnology, are making inroads in these institutes. The IITs have contributed to the nation's growth and are accepted world over as the notable institutes in the domain of teaching and R&D. Table 2 lists the achievements of first generation of IITs in the different parameters of science & technology. The IITs possess almost all determinants of good I-A interface, such as I-A Cells, Intellectual Property Rights (IPR) Cell, Tech-Transfer Cell, Entrepreneurship Cell, Technology Business Incubators and so on. This chapter aims to portray the I-A regime of all the IITs existing in India.

**Table 1: Academic Programmes of First Generation IITs i.e. Established Before 2000**

| Attributes | IIT Kharagpur | IIT Bombay | IIT Madras | IIT Kanpur | IIT Delhi | IIT Guwahati |
|---|---|---|---|---|---|---|
| ***Year of Establishment*** | 1950 | 1958 | 1959 | 1959 | 1961 | 1994 |
| ***Campus Area (acres)*** | 2100 | 530 | 617.8 | 1055 | 325 | 700 |
| **Academics** | | | | | | |
| ***Departments*** | 19 | 15 | 16 | 20 | 13 | 12 |
| ***Centres*** | - | 14* | 16 | 27 | - | 08 |
| ***UG Students*** | 2818 | 7400 | 10,000 | 2255 | 3590 | 2570 |
| ***PG Students*** | 7612 | | | 1476 | 4239 | 1069 |
| ***PhDs (enrolled)*** | 616 | 2600 | 2120 | - | - | 1544 |
| ***Faculty Members*** | 600 | 700 | 614 | 309 | 459 | 372 |

**(9 centres+4 interdisciplinary programmes +1 school of management)*

**Source:** *IIT Kharagpur, IIT Bombay, IIT-K, IIT-M, IIT Delhi, IIT-K, IIT Guwahati Annual Reports (2010-2015); http://www.iitkgp.ac.in/; http://www.iitb.ac.in/, https://www.IIT-M.ac.in/, http://www.iitd.ac.in/, http://www.iitk.ac.in/, http://www.iitr.ac.in/*

**Table 1: Academic Programmes of Second Generation IITs i.e. Established After 2000**

| Attributes | IIT Roorkee | IIT Bhubaneswar | IIT Hyderabad | IIT Gandhinagar | IIT Patna | IIT Jodhpur | IIT Ropar | IIT Indore | IIT Mandi | IIT BHU |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Year of Establishment*** | 2001 | 2008 | 2008 | 2008 | 2008 | 2008 | 2009 | 2009 | 2009 | 2012 |
| ***Campus Area (acres)*** | 356 | 936 | 567 | 450 | 501 | 900 | 525 | 510 | 520 | 400 |
| **Academics** | | | | | | | | | | |
| ***Departments*** | 21 | 7 (schools) | 14 | 13 | 8 | 8 | 7 | 11 | 4 (school) | 13 |
| ***Centres*** | 12[a] | 3 | - | - | 3 | 2 | - | - | - | 3 |
| ***UG Students*** | 4472 | 164 | 900 | 123 | 599 | NA | NA | 294 | 400 | NA |
| ***PG Students*** | 2093 | 71(76*) | 450 | 36 | 131 | NA | NA | 242 | | 414 |
| ***Ph.Ds (enrolled)*** | 1471 | 48 | 500 | 2 *(degrees awarded)* | 185 | NA | NA | 264 | 100 | 210 |
| **Faculty Members** | 369 | 125 | 145 | 150 | 66 | 53 | 70 | 70 | 100 | 265 |

******Joint Msc-PhD integrated*; [a] 1 academic centre, 3 centres of excellence, 5 academic service centres and 3 supporting units.

***Source:*** *www.iitr.ac.in, www.iitbbs.ac.in/, www.iith.ac.in/, www.iitgn.ac.in/, www.iitj.ac.in, www.iitp.ac.in/, www.iitrpr.ac.in/, www.iiti.ac.in/, http://www.iitmandi.ac.in/, www.iitbhu.ac.in/*

**Table 2: Science and Technology Indicators of First Generation IITs**

| IP Attributes | IIT Kharagpur | IIT Bombay | IIT Madras | IIT Kanpur | IIT Delhi | IIT Guwahati |
|---|---|---|---|---|---|---|
| ***Publications (2014-15)*** | 2162 | ~1500 | 1194 | 1298 (2014) | 1300 | 1250 |
| ***Patents (2010-15)*** | | | | | | |
| ***Filed*** | 231 | 569 | 239 | 204 | 146 | 37 |
| ***Granted*** | 13 | >61 | 25 | 9 | 25 | 6 |
| ***Technology available*** | 214 | 409 | 358 | 6 | 50 | 05 |
| ***Technology Licensed (till date)*** | 24 | >140 | 60 | 60 | 15 | 06 |
| ***Revenue generated from tech transfers (Crores ₹; upto 2015)*** | 186.80 | 209 | 461 | 2.38 | 135.83 | 1 |
| ***Incubating Companies*** | 172 | 71 | 95 | 52 | 44 | 13 |
| ***Start-ups (till date)*** | 104 | >26 | 89 | 26 | 16 | 10 |
| ***Industrial Collaborations (MoUs; 2010-15)*** | 72 | 225 | ~176 | 124 | 8 | 09 |
| ***Corporate Clients*** | ~400 | ~400 | 227 | ~124 | 48 | 50 |
| ***Sponsored projects (Crores ₹; 2010-15)*** | 577.45 (2011-2016) | 1149.95 | 491.11 | 401.23 | 328 (2010-2014) | 220.53 |
| ***Revenue generated Consultancies (Crores ₹; 2010-15)*** | 69.75 (2011-2016) | 143.5 | 251.11 | 52.25 | 138 (2010-2014) | 16.37 |

***Source:*** *IIT Bombay, R&D highlights 2016, Annual Reports (IIT-K) 2010-2015; Annual Reports (IIT-M) 2010-2015, Annual Reports (IIT Bombay) 2010-2015, Questionnaire filled by IITs for DST-CPR at PU, Chd., http://www.iitk.ac.in/, http://www.iitr.ac.in/, http://www.iitb.ac.in/, https://www.IIT-M.ac.in/, http://www.iitd.ac.in/, http://www.iitkgp.ac.in/, http://www.iitg.ac.in/, External Peer Review committee Report (IIT Delhi -2015), External Peer Review committee Report (IIT Kharagpur -2015).*

## 2. Industry – Academia R&D Activities of IITs

### I. Indian Institute of Technology, Kharagpur (IIT-KGP)

***(http://www.iitkgp.ac.in/)***

**Introduction:** IIT-KGP was the first IIT to be established in 1950 in Kharagpur, West Bengal. The institute published close to 2100 research articles in the academic year 2014-15. In the last five years, the institute has filed over 230 patents, out of which 15 patents have been granted. 214 technologies are available to be commercialised and ~25 have been licensed, generating a revenue close to ₹186 crores. The institute has 72 industrial collaborations (2010-15), ~ 400 corporate clients, 172 incubatees and 104 start-ups till date. In the last five years (2011-16), IIT-KGP has earned close to ₹ 76 crores from consultancy projects and ₹ 577 crores from sponsored projects.

### *Industry Related Programmes*

a) **Sponsored Research & Industrial Consultancy (SRIC)** (http://www.ttg-sric.iitkgp.ernet.in/sric/): To monitor the high volumes of sponsored research and consultancy projects, SRIC was initiated in 1982. The centre has well built infrastructure and the capacity to handle approx. 700 R&D projects at a time. Under the aegis of SRIC, the institute has set up an IPR and Industrial Relations Cell to look after the interests of faculty, funding agencies and industry partners. Currently, SRIC cell has 773 on-going research projects. In the last five years, the total funds received by IIT-KGP were over ₹ 630 crores through more than 1500 research and consultancy projects.

b) **Technology Transfer Group** (http://www.ttg-sric.iitkgp.ernet.in/ttg/research.php): This is an initiative of the students under the aegis of SRIC. The main objective of this group is to act as a link between the academia and the industry to facilitate the transfer of technologies (industry-ready) developed at IIT-KGP and to market the intelligentsia of the institute as a research consultant. The services offered by this group includes:
    - *Consultancy*: Industry or any external agency can approach the institute for problem solving.
    - *Technology Assessment*: Helps in assessment of existing processes/ technologies to reach upon possible areas for improvement.

- *Research Lab Services*: The *state of art* laboratories with avant-grade instruments and skilful research staff cater for technology evaluation, lab based testing and analysis, and research collaborations.
- *Expert Access*: The large pool of highly accomplished scientists and researchers can be contacted for consultancy on key technical areas.
- *Know-how Transfer*: This group is responsible for research reports/ publications, procedures, protocols, formula, designs/ drawings and any other information with regard to a particular technology, product and process.
- *Product Design*: This service brings together various partners for idea generation, concept development, testing, and implementation thereby converting the ideas into final commercial entity.

The Technology Transfer group has also initiated **IndAc**, a confluence of industry and academia. It provides platform to the industry to present their needs and to the academia for showcasing itself as a research consultant.

c) **The Science and Technology Entrepreneur's Park-Technology Business Incubator (STEP-TBI) (**http://www.step-iit.org/): STEP at IIT-KGP was established in 1986 with financial support from DST, IDBI, IFCI and ICICI. STEP has created conducive surroundings to nurture and guide entrepreneurial efforts. It has led to number of technology transfers and successfully converted research outcomes to commercially viable entities. STEP works in unanimity with the other programmes like Technology Business Incubation (TBI) and Technology Incubation and Entrepreneurship Training Society (TIETS). It acts as a pipeline amid the institute and the world outside to enable facilitation of transfer of technology along with conversion of research outcomes of entrepreneurs into commercially viable entities.

STEP-TBI gets funding support through various schemes of GoI such as Promoting Innovations in Individuals Start-ups and MSME (PRISM), Technology Incubation and Development of Entrepreneurs (TIDE) scheme and Technology Development Board (TDB).

- **Technology Incubation and Entrepreneurship Training Society (TIETS)** (http://www.step-iit.org/about_tiets.html): This society was created in the year

2006 and seeded the efforts to create infrastructure to trigger the generation of entrepreneurship, idea generation, incubation and integration amongst students and alumni. TIETS has created an avenue for incubates where they get fund support, mentoring and prototype branding. It works in close association with STEP.

- **Entrepreneurship Cell (E-Cell**) (http://www.ecell-iitkgp.org/index.php): This non-profit organization, run by the students, is dedicated to the cause of boosting entrepreneurship among students. The Cell acts as a forum to provide opportunity for students entrepreneurs to trial their idea with the help of TIET and STEP. It has also led to the design of courses and training programmes for IIT stakeholders and public in general. E-Cell organizes various patent workshops, case study workshops and knowledge camps to promote entrepreneurship among students. It has successfully linked investors with the entrepreneurs.

**d) Technopreneur Promotion Programme (TePP) Outreach cum Cluster Innovation Centre (TOCIC) (**http://www.step-iit.org/TePP.html): With the initiatives of DST and DSIR, TOCIC was started in 2014 for promoting independent innovators and transforming them into entrepreneurs by facilitating them with government grants, mentoring and technical guidance through academic and industry experts.

**e) Telecom Centre of Excellence (TCOE)-Vodafone IIT Centre of Excellence in Telecommunications (VICET) at IIT-KGP:** Established under PPP mode in 2007, VICET is one of the successful examples of government Dept. of Telecommunication), academia (IIT-KGP) and industry (Vodafone) Ltd.). The main research of VICET is “Next Generation Networks and Technology”.

| **Examples of a few technologies developed, patents and MoUs signed by IIT-KGP in 2015-16** | |
|---|---|
| **S. No.** | **Technologies Developed** |
| 1. | Venucane: An electronic travel aid for visually impaired and blind people |

| | | |
|---|---|---|
| 2. | Ultrafiltration membrane for cold sterilization of bottle gourd juice (*Lagenaria siceraria*) for extended shelf life and method thereof | |
| 3. | Ultra-sensitive simultaneous electrochemical determination of arsenic, mercury and copper | |
| 4. | Surveillance using partial gait sequences of a human being | |
| 5. | Purification of lactic acid and its polymerisation to polylactic acid with improved property | |
| 6. | Non-invasive blood glucose measuring system | |
| **S. No.** | **Patents** | **Application Number** |
| 1. | A low complexity generalized frequency divion multiplexing transceiver | 1018/KOL/2015 |
| 2. | A micro-reactor based energy efficient process for cellulosic ethanol production | 961/KOL/2015 |
| 3. | Stable hybrid polymer adapted for superhydrophobicity and process for manufacture thereof | 758/KOL/2015 |
| 4. | Reconstituted rice grains and its process of manufacture | 699/KOL/2015 |
| 5. | A precoded generalized frequency division multiplexing system to combat inter symbol interference and reduce peak to average power ratio | 453/KOL/2015 |
| 6. | An adverse environmental effect resistant seamless wireless sensor network system. | 425/KOL/2015 |
| **S. No.** | **MoU with Industry** | **Signed with** |
| 1. | MoU with Hindustan Aeronautics Limited (HAL), Bangalore. | Hindustan Aeronautics Limited (HAL) |
| 2. | MoU with SAP Lab India Doctoral Fellowships | SAP Lab India |

***Source:*** *https://www.iitsystem.ac.in/*

## II. Indian Institute of Technology, Bombay (IIT-B)

***(http://www.iitb.ac.in/)***

**Introduction**: IIT-B was the second of its kind and established in the year 1958 in the western part of the country. This was the first institute to be established with the aid of foreign funds provided by UNESCO.

Since its inception, institute has received huge amount of R&D funds from both national and international organizations and industrial segment. Government funding accounts for ~70% where as industry funding accounts for ~21% (IIT-B, Industry Interaction Flyer 2016). The financial insight to the R&D funding of IIT-B in last five years is depicted in figure 1

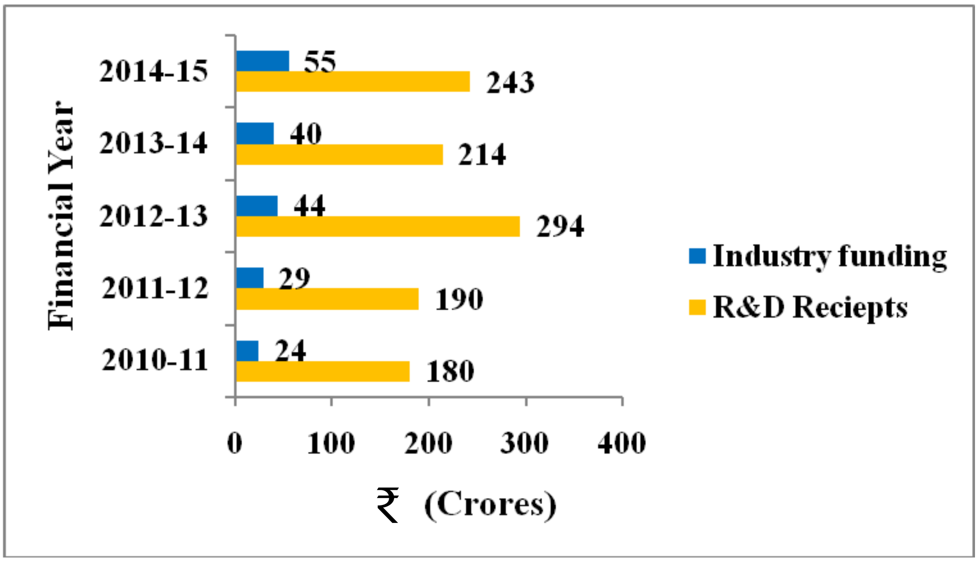



**Figure 1: R&D Funding in IIT-B (2010-15)**

***Source:*** *IIT-B Annual Report 2014-15*

To set a benchmark in research directed towards industrial growth, IIT-B has established various centres. IIT-B has over 1500 publications in the academic year 2014-15. In the last five years, the institute has filed ~570 patents of which nearly 60 patents have been granted. An astounding increase in the number of patent filings was witnessed e.g. in 2010, 46 Indian patents were filed from IIT-B. The number rose to 102 in year 2015. IIT-B is credited with National Intellectual Property Award (2015) and Thomas Reuters India Innovation Award (2014) due to its enhanced role in country's R&D development.

IIT-B is actively involved in translating its research into commerce through licensing and start-ups. The institute has about 400 technologies that are ready for transfer/licensing and approx. 140 technologies have been licensed till date, which have generated total worth close to ₹ 210 crores. To bolster I-A interactions, it has signed 225 MoUs with various industrial organizations. It has approx. 400 corporate clients, 71 incubatees and > 25 start-ups till date. IIT-B, in the last five years, has drawn ~ ₹ 140 crores and ~ ₹ 1150 crores from consultancy and sponsored projects respectively.

## *Industry Related Programmes*

a) **Industrial Research and Consultancy Centre (IRCC)** (http://www.ircc.iitb.ac.in/IRCC-Webpage/rnd/index.jsp): The centre set up in 1975, facilitates and co-ordinates all R&D activities of the institute. The centre aids in generating and protecting the IP of the institute, and their deployment for economic development through commercialisation. It is involved in facilitating short term projects to solve industrial problems as a consultancy projects (~2690 consultancy projects in past 5 years worth ₹ 144.5 crores) or industrially/government sponsored fully fledged long term technology development projects (~1198 sponsored projects in past 5 years worth ₹ 1149.95 crores) (Fig. 2). All the research funding and interaction of the institute with the industries/ private sector are managed under the umbrella of IRCC.

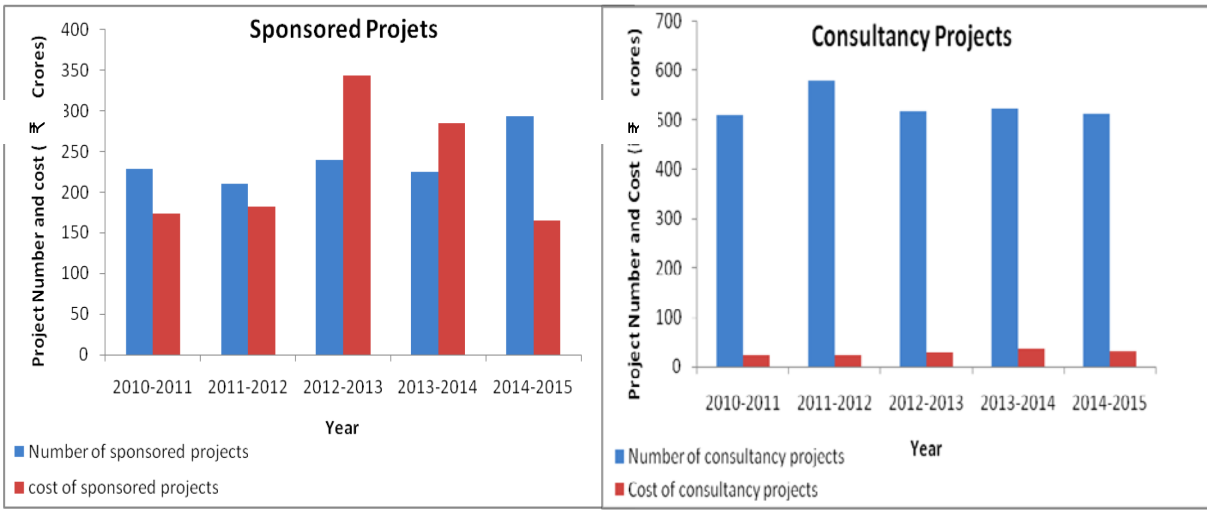



**Figure 2: Number of Sponsored and Consultancy Projects and the Revenue Generated Through Them**

***Source:*** *IIT-B Annual Report 2014-15*

Under the aegis of ‘Industry Partnership Scheme’ industry sponsored labs have been set up where industry and IIT-B faculty can jointly undertake project work.  Select major industry-sponsored laboratories set up in recent years include:

- Xilinx FPGA Laboratory
- The Tata Infotech Laboratory

- Intel Microelectronics Laboratory
- Laboratory for Intelligent Internet Research
- Tata Consultancy Services Laboratory for VLSI Design and Device Characterisation
- Texas Instruments Digital Signal Processing (TI-DSP) Laboratory
- Wadhwani Electronics Laboratory
- Cummins Engine Research Laboratory
- Applied Materials Nano Manufacturing Laboratory
- VLSI Design Consortium

In addition, various consortia groups of IIT-B-government-industry, under PPP mode have been established. These consortia are as following:

- Centre of Excellence in Telecom
- Healthcare Research Consortium
- Industry Affiliates Program at the National Centre for Photovoltaic Research and Education (NCPRE)
- National Centre for Aerospace Innovation and Research
- National Solar Thermal Power Research Testing and Simulation Facility

The relations of IIT-B with the industry are such that the industry may also sponsor a student in the field of their interest and some of the industries that have sponsored students of IIT-B are Konecranes, Areva, TCS, Infosys and Intel. Along with this, around 20 Chair Professorships have been established at IIT-B by both the alumni and the industries e.g. TATA Chair, Praj Industries Chair, Forbes Marshall Chair and Bajaj Group Chair in order to promote I-A collaborations and industry participation in academics.

IIT-B has upheld the social responsibility very well by contributing to both urban and rural community by means of technology based solutions under the Centre for Technology Alternatives in rural areas. IIT-B has led to the development of various technological advancements especially for rural areas like development of dry sanitation system, dhoop stick making machine, bore recharge system, water storage system of natural fibres, low cost check dams and herbal oil extraction unit. IIT-B also designed the symbol of Indian Rupee (₹) which is now the official Indian currency symbol used globally (IIT-B, R&D Highlights 2016).

In the year 2014, under IRCC, a **Research Park** was established in IIT-B with financial support from the MHRD. Research Park provides an ecosystem where academia and industry/ research fraternity can work in close collaboration on research problems, product innovation and technology challenges. IRCC has also released revised Intellectual Property (IP) policy of IIT-B and takes care of licensing of IP developed by IIT-B.

b) **Society for Innovation and Entrepreneurship (SINE)** (http://sineiitb.org/sine/home**):** SINE was established in 2004 with the support from IIT-B alumni. SINE is a platform for promotion of entrepreneurship and administers business incubator that supports technology based entrepreneurship. It maintains a support system for knowledge based start-ups founded by IIT community thereby leading to creation of wealth and social upliftment. Till date it has incubated 64 companies, 38 companies have graduated and 19 incubatees are residents of SINE. It has generated more than 1500 jobs (IIT-B, R&D Highlights 2016). SINE also manages a TBI at IIT-B.

c) **The Desai Sethi Centre for Entrepreneurship (DSCE)** (http://www.iitb.ac.in/dsce/en/about): It was established in 2013 in collaboration with Desai Sethi foundation. It aims in spurring entrepreneurship in the campus by introducing various entrepreneurship academic programmes. It has initiated 'Proof of Concept Centre' (PoCC) to support students to convert their ideas into tangible products through performance management, validation facilities and rapid prototyping. It also supports budding entrepreneurs through micro-grants and mentoring.

d) **The Entrepreneurship Cell (E-Cell)** (http://www.ecell.in/2015/): It is non-profit organization of students initiative in which regular workshops, innovative games, speaker sessions, competition for aspiring entrepreneurs, provides financial resources such as seed funding, networking and consultancy for budding student entrepreneurs. It has led to various initiatives that support the upcoming student start-ups. These initiative are as:

    - Freelancers and Co-founder Platform (FCoF)

- E-summit
- Eureka road to enterprise
- National Entrepreneurship Challenge (NEC) in association with Lenovo
- Entrepreneurship and Business (ENB) Club
- Start-up Services Platform (SSP)

The vision behind these initiatives was to build a strong and flexible ecosystem in the organization for allowing the expansion of knowledge according to the changes in the socio-economic needs of the society.

e) **Tata Teleservices IITB Centre of Excellence in Telecommunications (TICET):** This centre was established under the PPP mode in 2007 vide signing of an MoU between DoT, GoI, IIT-B and Tata Teleservices Ltd. The main focus area of the TCOE at IIT-B is “Rural Telecom Technology”. The TCOE has been set up with an aim to create novel services/ applications, develop global level manufacturing capability, generation of intellectual property, entrepreneurship and will meet the challenges that have been faced by the telecom industry in India.

IIT-B in its quest for dispersing knowledge and to deliver this knowledge to the society, engages in several activities to interact with local and global organizations. Its major activities include:

- **Continuing Education Programme (CEP):** Short, intensive courses for working professionals in industry or government, for enhancing expertise in their respective fields. In house courses are also conducted for special training of a particular group according to the needs of a particular industry.
- **Quality Improvement Programme (QIP):** This programme was launched by the GoI in 1970, to upgrade the faculty of other institutions. QIP enables them to obtain Master’s and Doctoral degrees.
- **Centre for Distance Engineering Education Programme (CDEEP):** CDEEP intends to provide distance education through different media such as video recordings of classroom lectures, web-based courses, live interaction and so on. The prowess of IIT-B’s faculty is freely available for learners everywhere. The courses that the institute offers through their

distance education programme are the same as the ones taken by the students of IIT-B.

IIT-B, since its initiation, has reaped huge benefits from its locale, which is one of the largest industry-intensive area's in India. The R&D activities of the institution have been largely governed and promoted by its geographical location.

| Examples of a few technologies developed and patents by IIT-B in 2014-15 | | |
|---|---|---|
| **S. No.** | **Technologies Developed** | |
| 1. | Supercritical fluid extraction system design for extraction of food flavours, additives and medical components | |
| 2. | Palletized tea storage methodology employing controlled atmosphere | |
| 3. | Vermiculture technology for solid and liquid waste management | |
| 4. | Graphs theoretic algorithms for automatic index determination of differential algebraic equations | |
| 5. | Design analysis and simulation of batch distillation and pressure swing adsorption units. | |
| **S. No.** | **Patents** | **Application Number** |
| 1. | A method and a system for producing thermolabile nanoparticles with controlled properties and nanoparticles matrices made thereby | 2213/MUM/2011 |
| 2. | A solar cell having three dimensional junctions and a method of forming the same | 3467/MUM/2010 |
| 3. | Electrodiagnostic equipment | Patent application no. 14/MUM/2001<br>Patent grant no. 206022 |
| 4. | A diagnostic method for determining deformations in a transformer or reactor winding | Indian patent application no. 1893/MUM/2007<br>US patent Grant no. 8,278,939 |

***Source:*** *IIT-B Annual Report 2014-15*

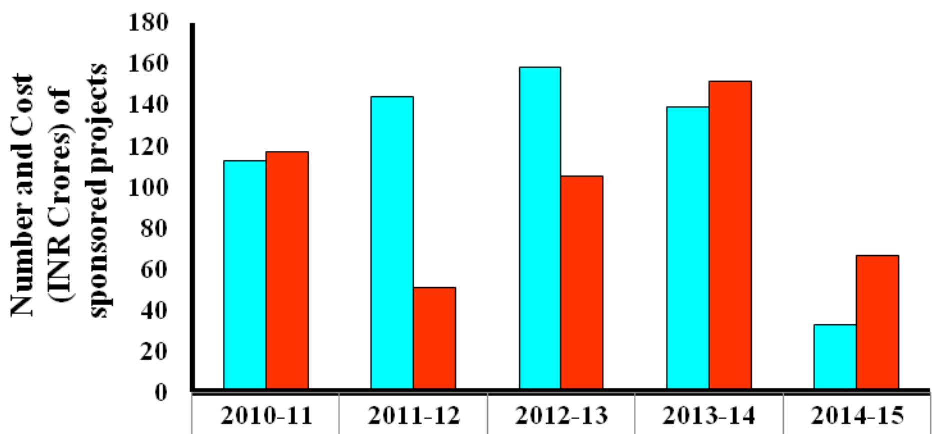
## III. Indian Institute of Technology, Madras (IIT-M)

***(https://www.iitm.ac.in/)***

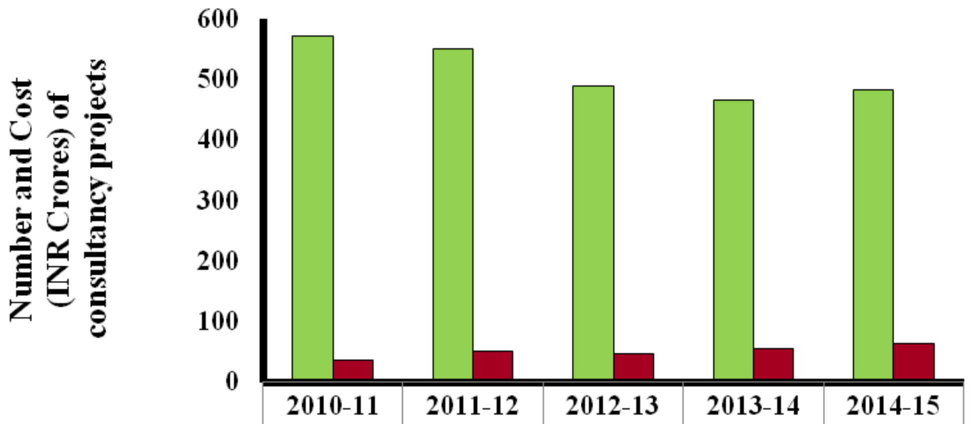
**Introduction**: IIT-M was established in 1959 with partial assistance from West Germany, which provided for services of experts, foremen, training facility and the supply of equipment for setting up 20 laboratories and a central workshop at IIT-M. Amongst all IITs, IIT-M leads in the industrial collaborations and functioning in industry-funded projects. IIT-M published over 1100 research articles during 2014-15. Out of 239 patents filed in the academic years 2010-15, 25 have been granted. The institute has approx. 350 technologies ready to be licensed and 60 have been licensed till date, which have generated a worth of ₹ 461 crores. Further, the institute is emerging as one of the most vibrant start-up hub of the country. Till date, a total of 89 start-up companies have been incubated in IIT-M and 95 are present incubatees. The institute has signed MoUs with close to 175 industries and has 227 corporate clients. In the last five years (2010-15), IIT-M has undertaken sponsored projects worth ₹ 491 crores and has generated ₹ 251 crores from consultancy projects.

### *Industry Related Programmes*

a) **The Centre for Industrial Consultancy and Sponsored Research (IC&SR**) (https://www.IIT-M.ac.in/icsr): Established in 1973, this centre aims to promote interaction between the industry and the institute facilitating sponsored and consultancy projects. It holds the responsibility for industrial collaboration in terms of research and consultancy, technology licensing and intellectual property related issues. Today, the centre for IC&SR stands as an independent section of the institute. It has initiated the industrial association scheme to attract industrial sectors and at present hosts 227 industries under this scheme. IC&SR facilitated the emergence of number of centres for excellence in the institute and also taken up sponsored and consultancy projects worth crores of rupees as depicted in figure 3.




| | 2010-11 | 2011-12 | 2012-13 | 2013-14 | 2014-15 |
|---|---|---|---|---|---|
| No. of sponsored projects | 113 | 144 | 158 | 139 | 33 |
| Cost of sponsored projects (INR Crores) | 117.1 | 50.77 | 105.2 | 151.47 | 66.57 |




| | 2010-11 | 2011-12 | 2012-13 | 2013-14 | 2014-15 |
|---|---|---|---|---|---|
| No. of consultancy projects | 570 | 549 | 487 | 464 | 482 |
| Cost of consultancy projects (INR Crores) | 36.3 | 50.77 | 45.88 | 54.01 | 64.15 |

**Figure 3: Number and Cost of Sponsored and Consultancies Projects Carried Out in IIT-M**

***Source:*** *IIT-M Annual Report 2014-15*

**b) IIT-M Research Park** (http://respark.IIT-M.ac.in/about_us.php): The Research Park at IIT-M is one of the most accomplished set up in the country. It is an independent company promoted by IIT-M and its alumni registered under Section 25 (now Section 8 of Companies Act 2013) of Companies Act 1956 and is India’s first university driven research park. It facilitates promotion of R&D in partnership with industry, generation of new ventures and promoting rural economic development. IIT-M Research Park assists newly formed companies with a research focus to set up base in IIT-M Research Park and provides expertise of IIT-M to develop knowledge and innovation ecosystem. It contains more than 30 corporate clients from various different segments as depicted in figure 4. The golden triad of industry, faculty and students working together has generated many successful innovations.

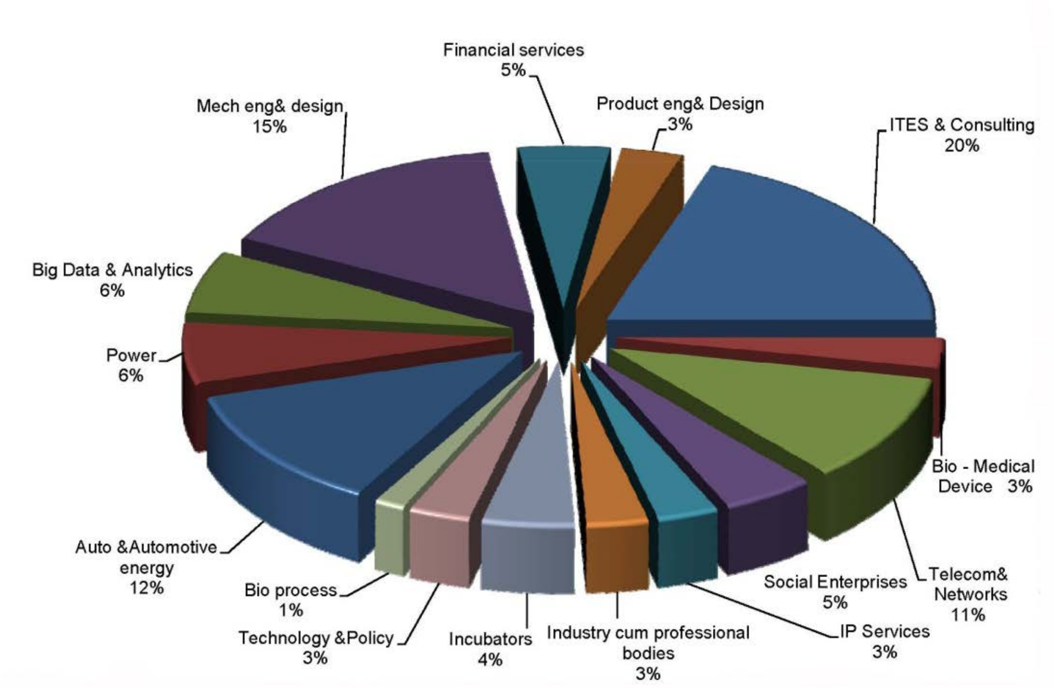



**Figure 4: Industrial Sectors in Collaboration with IIT-M in IIT-M Research Park**

***Source:*** *http://respark.IIT-M.ac.in/about_us.php*

c) **IIT-M Incubation Cell** (http://www.incubation.IIT-M.ac.in/): It aims to synergize and coordinate innovation, entrepreneurship and facilitating industrial interactions. It is working in the field of industrial solutions, rural technologies and social impact. It supports creation of ecosystem for R&D development including staff, students, alumni, faculty, industry and R&D partners in creation of successful ventures. It has also been registered under Section 8 of the Companies Act 2013 and recognized as a TBI by NSTEDB. In totality, 94 incubatees have been incubated in the IIT-M incubation cell and more than 50 companies converted to successful ventures. IIT-M incubation cell taps vast faculty and alumni network to provide mentoring support associated with IIT-M entrepreneurship forum specifically designed to help entrepreneurs to move in direction from business idea to actual start up.

The IIT-M incubation cell has also launched the **Entrepreneur-in-Residence programme** where current incubatees can avail unique opportunity to interact one-on-one with accomplished entrepreneurs. It has further nurtured several incubators which were established for specific sectors like:

- **The Rural Technology Business Incubator (RTBI)** (http://www.rtbi.in/) was set up in 2006 in association with World Bank's Infodev project and DST. Major focus area of RTBI is rural and social development. It has incubated over 41 companies and has graduated 14 successful start-ups which work for solving some of the rural India challenges such as water, food, power and education.
- **Bio-incubator** (http://www.bioincubator-IIT-M.in/) was established by BIRAC under Bio Incubator Support Scheme (BISS) and aims to foster Indian biotech entrepreneurship and innovation enhancing R&D capabilities of SMEs, MSMEs and start-ups. It offers space, high-end equipments, research facilities, scale-up facilities, technical support and financial assistance to researchers with nascent ideas to transform into commercialized process/product. It contains 24 corporate clients and has incubated 11 companies.
- **The Cell for Technology Innovation, Development and Entrepreneurship Support (C-TIDES)** (http://www.c-tides.IIT-M.ac.in/), started in 1998, also named as Entrepreneurship Cell, is a core for student entrepreneurship activities in IIT-M to promote student led entrepreneurship and pre-incubation support.

IIT-M has recently adopted business incubation policy to set guidelines for coordination of growing entrepreneurial culture in IIT-M. IIT-M incubation cell specifically holds responsibility of implementing the policy effectively.

d) **Reliance IITM Centre of Excellence (RITCOE):** RITCOE was founded in 2007, when an MoU was signed between DoT, GoI, IIT-M and Reliance Communications Ltd. This centre, which focuses on "Telecom Infrastructure and Energy" was established with an aim to position India as a global telecom manufacturing hub and along with other CoE aims to cope up with the problems that the telecom industry faces.

e) **The Centre for Innovation (CFI)** (http://cfi.IIT-M.ac.in/main/): CFI was founded with funds donated by the alumni of the 1981 batch and is a student lead body. The CFI provides for infrastructural support, and guidance nurture innovation in engineering.

f) The **Centre for Social Innovation and Entrepreneurship (CSIE)** (http://csie.IIT-M.ac.in/): Founded in 2010 this centre works towards developing the social enterprise in India by focusing on teaching and research in the said domain.

g) **IIT-M Entrepreneurship Forum**: The IIT-M Alumni Association initiated this forum to bring about awareness and promotion of entrepreneurial activeness amongst the other IIT members. This forum intends to contribute by providing the students with a culture/apprenticeship in start-ups and tutorship.

IIT-M, in its future activities, is planning a large project on contemporary manufacturing, focusing on virtual technologies and sustainability. Over the next decade, the success of these projects could become important for laying the foundation for a competitive technology industry.

| **Examples of a few technologies developed and patent by IIT-M in 2015-16** | | |
|---|---|---|
| **S. No.** | **Technologies Developed** | |
| 1. | A steering/seat assembly for monitoring and alerting a driver based on his/her fatigue and/or behavior | |
| 2. | Boss mool lab | |
| **S. No.** | **Patent** | **Application Number** |
| 1. | A method of measuring the air-fuel ratio of a spark ignition engine | 3194/CHE/2008 |

***Source:*** *https://www.iitsystem.ac.in/*

## IV. Indian Institute of Technology, Kanpur (IIT-K)

***(http://www.iitk.ac.in/)***

**Introduction**: IIT-K was established by GoI in the year 1959 under "The Kanpur Indo-American Programme". The institute received technical assistance from a group of top nine institutes of USA. IIT-K has emerged as an institute that has excelled in education and research activities in tune with the needs of the society. IIT-K has close to 1300 research publications in the year 2014-15. In the last five years, 204 patents were filed from the institute out of which 9 patents have been granted. IIT-K presently has 6 technologies ready to be transferred and the institute has already licensed 60 technologies, resulting in earnings of ₹ 2.38 crores. With 52 incubatees and 26 start-ups till date the institute has been promoting innovation and entrepreneurship actively. IIT-K has generated ₹ 52.25 crores and ₹ 401 crores from consultancies and sponsored projects respectively. It has close to 124 corporate clients and has signed MoUs with approx. 120 industrial organizations.

### *Industry Related Programmes*

a) **SIDBI Innovation and Incubation Centre (SIIC)** (http://www.iitk.ac.in/siic/d/about-siic): Set up at IIT-K in collaboration with Small Industries Development Bank of India (SIDBI), SIIC, fosters innovative research and activeness in entrepreneurship, in technology related fields/areas. It was established in 2000 with the perception of being able to transform the knowledge of the institute into wealth. The centre has a twofold vision; the vision statements are:

- To create a generation of zealous entrepreneurs.
- To convert novel research into valuable intellectual property.

For IIT-K, SIIC acts as a single platform for agendas in regard to innovative research, development and commercialization of technology, incubation, entrepreneurship etc. The profile of incubating and graduated companies is presented in figure 5 and 6.

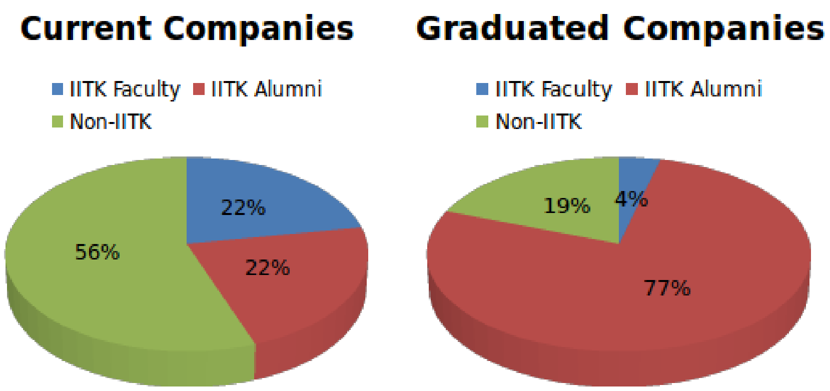



**Figure 5: Pie Chart of IIT-K for Current Incubates and Graduated Companies**

***Source:*** *http://www.iitk.ac.in/*

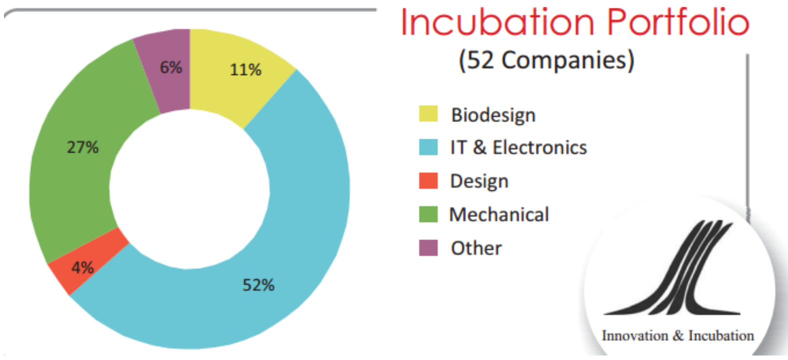



**Figure 6: Sector Wise Incubation Portfolio of IIT-K**

***Source:*** *http://www.iitk.ac.in/*

So far, SIIC has successfully:

- Incubated and mentored ~52 companies.
- Disbursed seed funds of ₹ 50 crores.
- Collaborated with organizations like NEN, SUM, IIMA.
- Commercialized 56 patents (worth ₹ 2.38 crores).
- Sponsored projects (2010-2015) = 619
- Consultancy projects (2010-2015) = 451

**Major Activities of SIIC Include -**

**i. Incubation**: A whole spectrum of incubation related facilities and other services are provided by SIIC to the eventual entrepreneurs and also help the entrepreneurs realize the conversion of their novel ideas into commercially viable results. The incubatees at SIIC explore different domains such as, scientific know-how, engineering and other integrative areas. The centre has gained a decent visibility and developed a fine interface through events like the entrepreneurial talk series, conferences, workshops and seminars that it has been hosting/organizing. Today, SIIC is one of the most prestigious incubators in India and it has grown tremendously since its initiation in 2003. From one incubation centre, representing IIT-M, SIIC has evolved to being seven centres representing various arms of government. It acts as a:

- SIDBI Innovation and Incubation Centre (for SIDBI)
- Technology Business Incubator (for DST)
- MSME Incubator (for MSME)
- Technology Incubation & Development of Entrepreneurs (for MIT)

- Technology Entrepreneurship Promotion (for DSIR)
- Bio-Incubator (for DBT)
- MoLE Incubator

**ii. Patenting**: The IIT-K faculty members and disciples take professional aid from SIIC, for filing of IP (patents, copyrights etc.). Thus, the centre also acts as Technology Transfer Office (TTO) of the institute. So far, the centre has been responsible for filing more than 264 patents for the IIT-M faculty and students. In collaboration with a commercial partner; to meet the needs of the industry, this centre facilitates up-gradation/modification of the technology developed at the institute, so that the technology is ready for the market. The faculty member related to development of the technology acts as a mentor for the same. Marketing of the product and customer support are the responsibilities taken up by the commercial partner. SIIC also has strategic alliances with organizations like National Entrepreneur Network (NEN), Singapore Management University (SMU), IIM Ahmedabad and others. SIIC, in collaboration with these organizations, regularly holds workshops and trainings to promote entrepreneurship.

**b) Knowledge Incubation for Technical Education Quality Improvement Programme (TEQIP)** (http://www.iitk.ac.in/tkic/teqip.html): The centre acts as a nodal archive for all the emerging academic knowledge, along with being a platform for teacher training activities and knowledge up-gradation of the students.

The objectives of TEQIP are:

- Strengthening institutions to produce high quality engineers for better employability
- Scaling-up postgraduate education and demand-driven R&D and innovation
- Establishing 'Centres of Excellence' for focused applicable research
- Training of faculty for effective teaching
- Enhancing institutional and system management effectiveness

**c) TePP Outreach cum Cluster Innovation Centre (TOCIC)** (http://www.iitk.ac.in/siic/d/article/siic-becomes-tepp-outreach-centre): As a new initiative during 1998-99, the Ministry of Science and Technology, GoI, launched a novel programme known as "Technopreneur Promotion Programme" (TePP) jointly operated by DSIR and TIFAC of the DST to highlight and bring out the boundless amounts of novel and innovative ideas of the nationals of the country. TePP is an initiative to bolster innovators and transform them into technology-based entrepreneurs (Technopreneurs).

The objectives of the TePP are:

- Promote and support untapped creativity of individual innovators.
- Assist the individual innovators to become technology based entrepreneurs.
- Assist the technopreneur in networking and forging linkages with other constituents of the innovation chain for commercialization of their developments

**d) National Centre for Flexible Electronics (FlexE):** This centre was set up in the year 2014, with the grant from DeitY, under the ESDM scheme of Electronics Policy 2012 of GoI. The FlexE Centre provides a platform for meaningful interactions amongst the industry and the academia. The main objectives of the centre include:

- *Research & Development*: Scientific investigations and studies in the field of flexible electronics.
- *Manufacturing*: Developing partnership with the industry to conduct research with a view of taking it to the manufacturing level.
- *Ecosystems*: Facilitating formation of a conducive ecosystem for both the industry and the academia by addressing aspects such as materials, machinery, links with reputed national and international centres.
- *Entrepreneurship*: Scope for incubating small scale industries in the field of flexible electronics.
- *International Partnerships*: Develop strategic partnerships to aid accelerated product development cycle.
- *Human Resources*: Development of human resources for the relevant expertise.

e) **BSNL IITK Telecom Centre of Excellence (BITCOE):** Another CoE, under the PPP mode was established at IIT-K. An MoU signed between the DoT, GoI, IIT-K and Bharat Sanchar Nigam Ltd. founded this centre. The setting up of TCOE is a big initiative wherein the govt., academia and industry are working collaboratively and the biggest telco's of India have joined hands as principal sponsors. The main focus area of this centre is 'Multimedia & Telecom, Cognitive Radio & Computational Mathematics'.

| **Examples of a few technologies developed, patents filed and MoUs signed by IIT-K in 2014-15** | | |
|---|---|---|
| **S. No.** | **Technologies Developed** | |
| 1. | Design and fabrication of autonomous flapping wing unmanned air vehicle for surveillance and aerial photography | |
| 2. | Development of autonomous rotary unmanned aerial vehicle (RUAV) in 10 kg weight | |
| 3. | Opto fluidic optical lens and lens filter system | |
| 4. | Comprehensive air sampling device | |
| 5. | Water purification filter | |
| 6. | Laser-facilitated synthesis of metal | |
| **S. No.** | **Patents** | **Application Number** |
| 1. | An instrument for tonic note selection & voice range determination for Indian music singer | 1272/DEL/2014 |
| 2. | Remote monitoring and control for power system network using mobile SCADA application | 1322/DEL/2014 |
| 3. | Coiled carbon nanomaterial coated carbon fiber reinforced high perfomance polymer nanocomposites for structural applications and method of manufacturing the same | 1331/DEL/2014 |
| 4. | Compact air cooler using nano-structured surfaces | 3246/DEL/2014 |
| **S. No.** | **MoUs with Industry** | **Signed with** |
| 1. | To design and develop computer programming course | IREO Private Limited, New Delhi |
| 2. | Experimental evaluation of textile reinforcement for seismic strengthening of masonry infills. | Saint Gobain Research India, Chennai |

| | | |
|---|---|---|
| 3. | Development of high strength highly ductile low carbon alloy multiphase steels for structural applications. | Tata Steels Ltd., Mumbai |
| 4. | Conducting the CODE competition. | Hindustan Unilever Limited, Mumbai |

***Source:*** *https://www.iitsystem.ac.in/*

## V. Indian Institute of Technology, Delhi (IIT-D)

***(http://www.iitd.ac.in/)***

**Introduction**: IIT-D was established in 1959 by GoI in collaboration with the British Government. Strong industrial links have been maintained by the faculty of the institute by means of consultancy assignments. These assignments include various aspects like process and product development, troubleshooting, parameter checks etc. In addition to these activities, the faculty members of the institute also hold short-term training programmes that are company specific. To achieve enhanced industrial participation in the engineering education, the institute has taken an initiative to start with a masters degree programme which will be sponsored by the industry. It has dedicated centres to provide specific administrative and directorial aid for industry sponsored and consultancy projects and related R&D activities and has earned huge revenues of approx ₹ 0.36 crores from I-A interface. In the year 2014-15, there were 1300 research publications from the institute. From the year 2010 to 2015, the institute filed 146 patents, of which 25 were granted. Till date 15 technologies have been licensed by the institute generating worth amounting nearly to ₹ 135 crores and 50 are ready to be transferred/ licensed. The institute earned ₹ 328 crores and ₹ 138 crores from sponsored projects and consultancy projects respectively (2010-14), generated 16 start-ups and has 44 incubatees presently. In the last five years, IIT-D has signed eight MoUs with industries.

### *Industry Related Programmes*

a) **The Industrial Research and Development (IRD)** (http://ird.iitd.ac.in/content/about-ird): The IRD unit is responsible to provide administrative backing and management for the varied types of projects that are undertaken by the faculty of IIT-D. Through IRD, IIT-D has laid strong emphasis on sponsored research and industrial interactions (Fig. 7). It has contributed to solving industrial problems relevant to the need of the country. IRD has initiated various industry sponsored master degree programmes to enhance industrial participation in R&D and engineering education. Main area for which IRD is working:

- Sponsored research projects (high impact projects)
- Consultancy jobs
- Professional development fund
- Intellectual property rights
- Sponsored fellowships
- Industry sponsored M. Tech programmes

| Financial Year | Sponsored Research Projects | |
|---|---|---|
| | Numbers | Sanctioned Value (Rs. Lacs) |
| 2010-11 | 130 | 12107 |
| 2011-12 | 123 | 5712 |
| 2012-13 | 142 | 8863 |
| 2013-14 | 150 | 6865 |
| 2014-15 | 164 | 15377 |

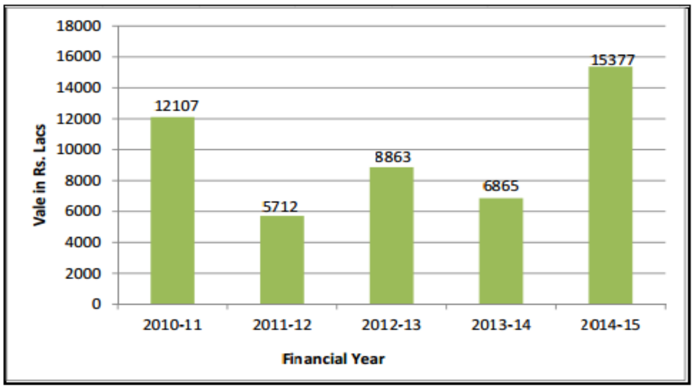



**Figure 7: Sponsored Research Projects Undertaken Under IRD (2010-15)**

***Source:*** *http://ird.iitd.ac.in/IRD/Highlights.pdf*

b) **Foundation for Innovation and Technology Transfer (FITT)** (http://www.fitt-iitd.org/): FITT was established in 1992 as a registered society. It is one of the most successful industrial interface organizations in the country. It aims to foster, encourage and build-up commercialization of R&D in IIT-D for mutual memberships. It has grown as self sustaining centre having numerous financial reserves in form of ₹ 0.36 crores in year 2015. FITT itself consists of number of services that are involved in innovation, technology and product development in collaboration with number of industries and generation of entrepreneurs and start-ups. Services offered by FITT are as following:

- Information support service to industry and R&D organisations

- Transfer of technology relating to proven R&D outputs
- Research partnership with industry for technology development and its commercial applications
- Innovative problem solving consultancy with industry clients.
- Industrial access to the array of specialised equipment and central facilities HRD programmes
- Corporate membership of FITT
- Facilitate funding for development of innovative ideas of commercial implications

With strong support from the government, FITT has established **Incubation Centres** such as **TBI, Biotech Incubation Facility, Science and Technology Parks.** FITT has been a huge success in terms of I-A collaborative project which has generated ₹ 52 crores of assets since last 5 years. There are more than 64 corporate clients who avail corporate membership of FITT and draw mutual benefits from the services that FITT offers and in return contributed to ~ ₹ 17 lakhs of FITT earnings. Further, >46 companies are presently incubated in FITT that has potential to become successful ventures.

FITT works towards bringing the research outputs of the scientific community to the market by way of patenting their innovative research and preparing a business model for their applied research.

c) **Airtel IIT Delhi Centre of Excellence in Telecommunications (AICET):** Collaboration between DoT, GoI, IIT-D and Bharti Airtel Ltd. (tri-partite MoU), lead to the establishment of AICET at IIT-D. This centre mainly focuses on 'Telecom technology and management' and is a part of the Bharti School of Telecommunication Technology and Management, which was set up at IIT-D in 2000. It aims to generate technology that is at par with the world standards thereby evolving India into a global leader in the area of telecom.

| **Examples of a few technologies developed by IIT-D in 2015-16** | |
|---|---|
| **S. No.** | **Technologies Developed** |
| 1. | Dual functionalized redox sensitive biodegradable polymeric nanosystems for targeted drug delivery in cancer therapy |

| | |
|---|---|
| 2. | Piezo-based foot pressure sensor |
| 3. | Nanopatterned cadmium selenide langmuir-blodgett platform for leukemia detection |
| 4. | Smart and innovative textile materials (SMITA) |
| 5. | Limb immobilization device (LID) |

***Source:*** *https://www.iitsystem.ac.in/*

## VI. Indian Institute of Technology, Guwahati (IIT-G)

***(http://www.iitg.ac.in/)***

**Introduction:** IIT-G was established on September 1st 1994 and its academic programme commenced in 1995. IIT-G is the sixth member in the IIT fraternity and within a brief span of time it has evolved and built up a world class infrastructure for advanced scientific R&D activities. Research is an integral part of the academic activities at IIT-G. The sponsored research has helped to bridge the gap between the academia and industry, added to the infrastructure of the institute and acted as training ground for young researchers. The R&D Office is the wing of the institute which facilitates, channelizes, records, and regulates all the funded research projects and consultancy works. During the academic year 2014-15, the institute published 1250 research publications and total R&D funding received during the same time period was ₹ 73.95 crores. IIT-G has filed 37 patents (2010-15), of which six were granted. A revenue of ₹ 1 crore has been generated from the six technologies that have been transferred till date and five technologies are available with the institute for transfer. With over 50 corporate clients and close to 10 industrial collaborations, IIT-G has earned ₹ 220 crores from various sponsored projects and ~ ₹ 16 crores from consultancy projects. 10 start-ups have evolved from the institute and there are 13 incubating companies presently.

### *Industry Related Programmes*

a) **IITG-Technology Incubation Centre (IITG-TIC):** In order to strengthen technology commercialization and entrepreneurship, IIT-G has established IITG-TIC (http://www.iitg.ac.in/tic/home.html) as a society under the Registration of Societies Act XXI of 1860. Its main objective is to back the entrepreneurial efforts amongst the faculty and alumni of the IIT-G. IITG-TIC provides a platform to explore and implement the innovative ideas into a commercially viable product through technology start-up companies. This centre facilitates interdisciplinary research with special emphasis on development and innovation of high-growth knowledge-based-business and nurtures the indigenous products with innovative hardware/embedded designs. The centre offers technical support, business mentoring and soft loan facility. IITG-TIC also possesses one of the **Business Incubators** approved and recognized by the Ministry of MSME. The TDB, GoI, has also approved grant assistance to IITG-TIC to support start-ups units.

b) **The Rural Technology Action Group, North-East (RuTAG-NE):** The RuTAG-NE (http://www.iitg.ernet.in/mech/Rutag-pal/about1.htm) was established in 2006. The main objective of this centre is to modify and enhance the systems/technologies that have been developed and are functioning, to a better level of functioning, by means of S&T. For example: the process of production of Eri Silk, traditionally is very laborious and lengthy, for which, RuTAG-NE has developed a machine that has the ability to complete a day's work in an hour. This centre has also successfully established a pilot plant for the production of Muga Silk. RuTAG-NE is responsible for developing quite a few accessory machines such as Hank to Bobbin Winding Machine and Sectional Warping Machine etc. The cost of these machines is lower as compared to their cost in the market. RuTAG-NE has also been training group of women from an NGO for the production of cost effective necessities.

In the academic year 2014-15, a technology '*Grating array based zonal wavefront sensor board setup*' was developed at the institute.

## VII. Indian Institute of Technology, Roorkee (IIT-R)

***(http://www.iitr.ac.in/)***

**Introduction**: The College at Roorkee was established in 1847 AD and was the first engineering college in the British Empire. It attained the status of a University under the Act No. IX of 1948 of the United Province (Uttar Pradesh). In 1949, Pt. Nehru elevated the status to the First Engineering University of Independent India, through a Charter. The Roorkee University was declared as an institute of national importance, with the passing of a bill in the parliament, on September 21st 2001 and was then renamed to Indian Institute of Technology

Roorkee (IIT-R). In the year 2014-15, IIT-R has 1209 publications to its credit and generated a revenue of ₹ 38.05 crores through industrial consultancy in the same year.

## *Industry Related Programmes*

a) **Sponsored Research and Industrial Consultancy (SRIC)** (http://www.iitr.ac.in/research/pages/SRIC.html**):** IIT-R recognizes the importance of the teamwork of education with research and industrial consultancies. Under the Dean, an office of SRIC operates, that caters towards providing organizational and accounting support to the members of the faculty that are performing sponsored research and industrial consultancy work. The centre also offers backing/support by working in closely with the private sector and government organizations and facilitating IP protocols.

Some examples of industrial consultancy are:

- Development of industrial projects/systems/processes
- Development of laboratories
- Testing of industrial products/samples
- Development and application of information technology
- Pre-feasibility and feasibility studies

b) **The Entrepreneurship Development Cell (EDC)** (http://edciitr.com/): The EDC of IIT-R, was set up to encourage entrepreneurial activities among the scholars of IIT-R and to foster the spirit of creativeness and innovation. Initiatives taken by EDC, cell are:

- Endeavour entrepreneurship
- E-Club to overcome problems of students
- Start-up internship programme to lessen the gap amongst the students and the start-up ecosystem
- An online database of start-ups (startups.edciitr.com) of students and alumni of IIT-R
- PrernaYatra which is an entrepreneurial journey organized by EDC IIT-R.
- Incubate which is a B-Plan competition organized by TIDES Centre

c) **Intellectual Property Right Cell (**http://www.iitr.ac.in/ipr/index.html**):** IIT-R has also created a cell to generate alertness and administer guidance to staff, students and outside agencies. This IPR cell contributes by equipping every one of the practices and the rules of institute regarding IPR and the obligations to be followed in course with the IPR policy of the institute. DST started a programme known as "Technopreneur Promotion Programme" (TePP) in 1998-1999 to promote and support the creative intellect of innovators of the country and to assist technopreneur in developing linkages with organizations. Outreach centres of TePP, known as TePP Outreach Centre (TUC), have been opened in different parts of the country and also at IIT-R.

d) **RailTel IITR Centre of Excellence in Telecom (RICET):** This CoE was established by DoT in association with RailTel and IIT-R to work in the area of 'ICT and Broadband Applications'. The main objectives of this centre include developing applications that are specific to the needs of India and therefore will add value to the economic and social activities of the citizens. These CoE also aim to generate market ready workforce and continuously upgrade the technical know-how in their domains.

e) **Continuing Education Centre:** The Centre conducts 60 to 70 short term training programmes for personals of the industrial sector and govt./semi govt. organizations and public undertakings, research institutions and industries.

<table>
<tr><th colspan="3">Examples of a technology developed and patent by IIT-R in 2015-16</th></tr>
<tr><th>S. No.</th><th colspan="2">Technology Developed</th></tr>
<tr><td>1.</td><td colspan="2">ED cell/ CD cell with membrane for zero discharge of waste water</td></tr>
<tr><th>S. No.</th><th>Patent</th><th>Application Number</th></tr>
<tr><td>1.</td><td>A novel fractionating hydrolysis process for production of fermentable sugars from lignocellulosic biomass of kans grass (Saccharum spontaneum)</td><td>201611005358<br>Dt 16.2.2016</td></tr>
</table>

***Source:*** *https://www.iitsystem.ac.in/*

## VIII. Indian Institute of Technology, Bhubaneswar (IIT-BBS)

***(http://www.iitbbs.ac.in/)***

**Introduction**: IIT-BBS was established in 2008 from the campus of its mentor institute IIT-KGP and in 2009 it commenced its operation from the city of Bhubaneswar. The institute has been undertaking a number of research projects from funding organizations like DST, CSIR, DRDO, NIC and ISRO and consultancies to industries. Till now the institute has published ~ 1000 research publications and has filed 12 patents. Industries like M/s MGM Minerals Group have helped the institute develop, by establishing "MGM Chair Professor" in the School of Minerals, Metallurgical and Materials Engineering with an endowment of ₹ 300 lakhs.

### *Industry Related Programmes*

a) **Sponsored Research and Industrial Consultancy (SRIC) Cell** (http://www.iitbbs.ac.in/sric-application/)**:** SRIC coordinates all sponsored research and consultancy projects. MoUs have been signed with various industrial collaborators such as the MGM Minerals Group to work in areas of common interest. A large number of research projects along with industrial consultancy projects are carried out independently in each school though IIT-BBS does not have any dedicated cell for I-A activities. From 2010-2015 IIT-BBS has carried out 170 sponsored projects, mainly government funded and 41 industrial consultancy projects.

Since 2010, industry has actively collaborated with the institute by means of consultancy and has contributed to more than ₹ 48 crores of revenue (Fig. 8).

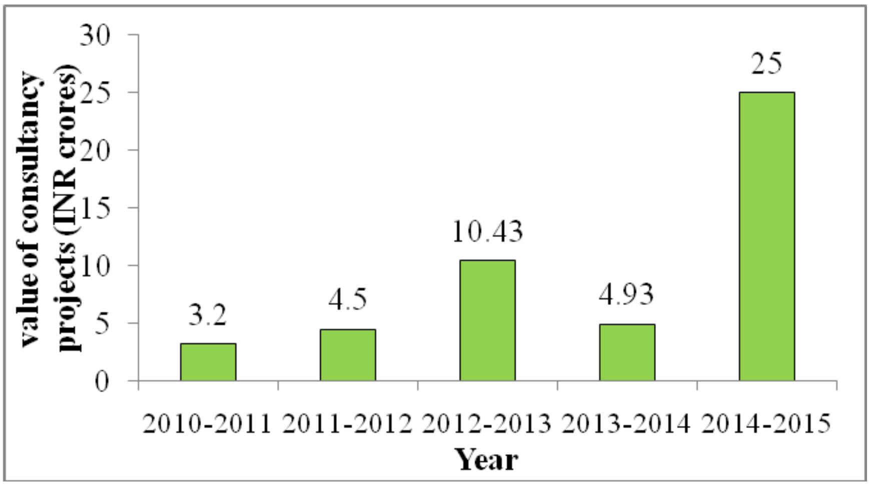



**Figure 8: Value of Consultancy Projects Undertaken by IIT-BBS**
***Source:*** *IIT-BBS Annual Report 2014-15*

| Examples of a few technologies developed and MoU signed by IIT-BBS in 2015-16 | | |
|---|---|---|
| **S. No.** | **Technologies Developed** | |
| 1. | Verification of virtual live migration between data centres in cloud | |
| 2. | Fuel for all: Optimization of indian LPG cylinder distribution system | |
| 3. | A thousand eyes: Ensuring a safer world through a vehicle mounted surveillance system | |
| 4. | Development of structural lightweight concrete using sintered flash aggregate | |
| 5. | Development of an integrated zero energy modular system for the treatment of rural domestic wastewater: emphasis on nutrient removal | |
| **S. No.** | **MoU with Industry** | **Signed with** |
| 1. | Advanced research laboratory on big data analytics | Affine Analytics Private Ltd. |

***Source:*** *https://www.iitsystem.ac.in/*

## IX. Indian Institute of Technology, Hyderabad (IIT-H)

***(http://www.iith.ac.in/)***

**Introduction**: IIT-H was found in 2008 at a makeshift campus in ordinance factory in Medak district and in 2009 shifted to its main campus in Kandi. IIT-M acted as mentor institute for IIT-H by supporting it at various levels. IIT-H today boasts of around 1850 students, 145 faculty members and 14 academic departments covering areas of engineering, sciences, liberal arts and design. The scientific staff and the disciples of the institute are at the forefront of academic innovations and innovative research. IIT-H has had approx. 930 publications, 15 patents filed and close to 230 sponsored research and consultancy projects (Annual Report 2014-15). IIT-H has tie-ups with industrial giants who provide the students scholarships and research internships.

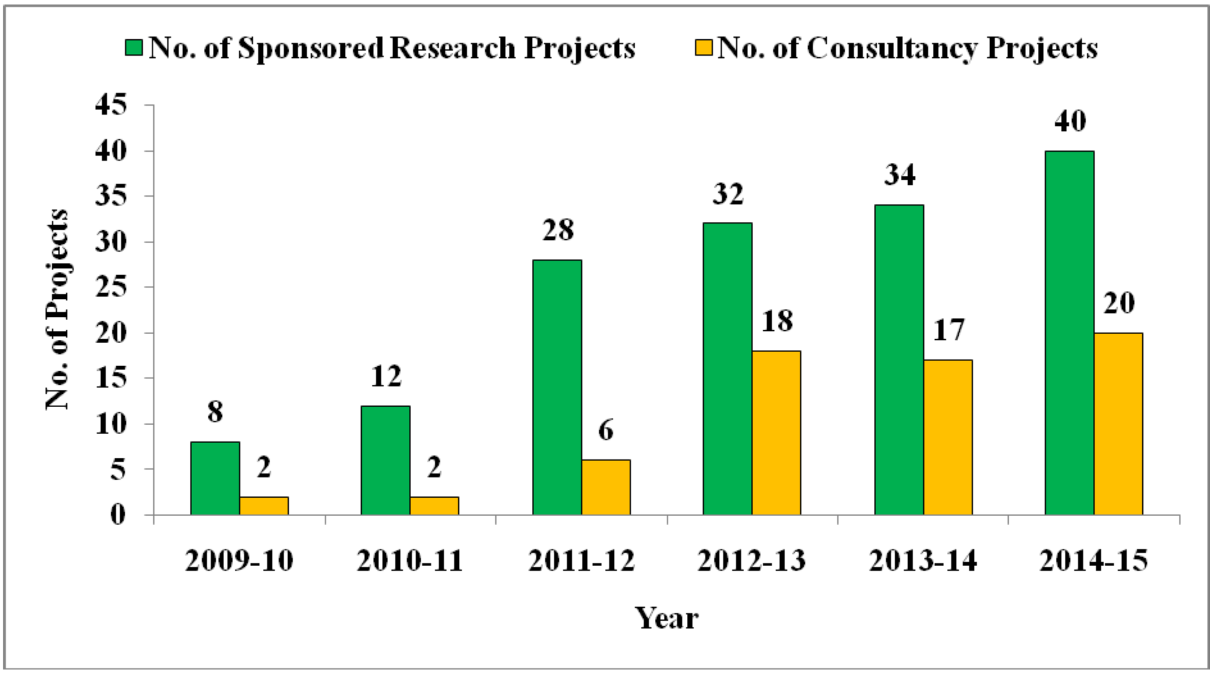



**Figure 9 (A): Number of Sponsored Research and Consultancy Projects Undertaken by IIT-H**

***Source:*** *IIT-H Annual report 2014-15*

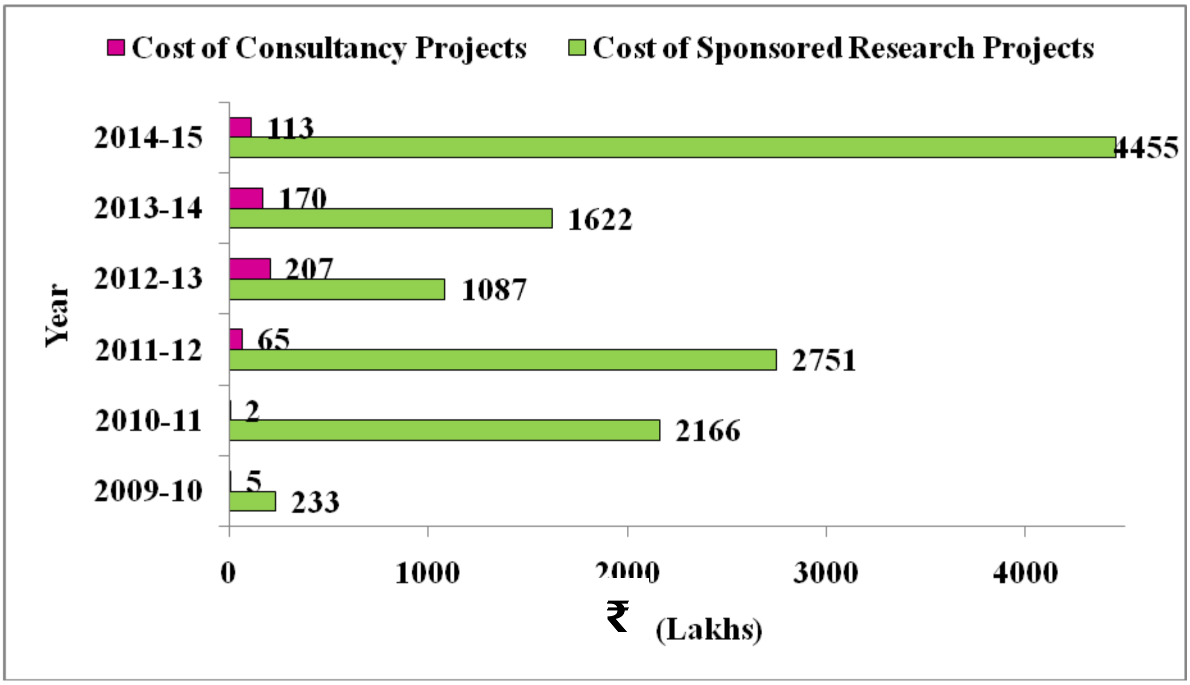



**Figure 9 (B): Cost (₹ Lakhs) of Sponsored Research and Consultancy Projects Undertaken by IIT-H**

***Source:*** *IIT-H Annual report 2014-15*

IIT-H has established collaboration with various industries located in and around Hyderabad. Mainly the institute offer consultancy to the industries. IIT-H has undertaken more than 45 industry consultancy projects. Figure 9 (A & B) shows the trend in sponsored and consultancy projects undertaken by IIT-H, 2010 onwards. Over 100 sponsored projects from national funding agencies and private companies have been undertaken by the institute. IIT-H is in association with ~100 companies and is on the way to establish strong I-A interface in coming years.

Recently, the institute launched its **Technology Business Incubator** to promote entrepreneurial culture. The incubator has incubated 4 companies. In IIT-H, **TEQIP** has also been set up to aid transformation in technical education system with support from World Bank. IIT-H is associated with **Unnat Bharat Abhiyan** and working for rural development by producing technologies for accelerating growth in rural areas.

## *Industry Related Programmes*

a) **Center for Healthcare Entrepreneurship:** This center was inaugurated in the year 2015 and is sponsored by two entrepreneurs (IIT Bombay alumini) from the Silicon Valley. This center aims towards innovative, affordable healthcare solutions for addressing the needs of India’s population, particularly the underserved. The centre identifies and groom innovators, mentor them to the level of production, scale up and eventually societal adoption of the technology/ product and its impact.

b) **Entrepreneurship Cell (E-Cell):** The E-Cell at IIT-H is a student run body that aims to foster entrepreneurial temper amongst the students of the institute. The cell supports the innovative streak in the students by providing them with resources, networking, guidance and motivation. Various events hosted by the cell include idea to business workshops, lecture series (by entrepreneurs from all over the country) and prototyping events.

| **Examples of a few technologies developed and patents by IIT-H in 2015-16** | | |
|---|---|---|
| **S. No.** | **Technologies developed** | |
| 1. | Earthquake disaster management system | |
| 2. | Snake robot for search and rescue missions | |
| **S. No.** | **Patents** | **Application Number** |
| 1. | Silver nanoparticle array sandwiched multilayer thin film amorphous silicon photovoltaic device | |

| | | |
|---|---|---|
| 2. | An apparatus for measuring transverse pullout resistance of a reinforcing element and method thereof | CHE/2015 |
| 3. | Lateral reinforcement system and method for concrete structures | 3001/CHE/2015 |

***Source:*** *https://www.iitsystem.ac.in/*

## X. Indian Institute of Technology, Gandhinagar (IIT-GN)

***(http://www.iitgn.ac.in/)***

**Introduction**: IIT-GN was founded in 2008 and is located in Ahmedabad (Gujarat). The institute is strongly working to attract industries for carrying out research and consultancy projects. For industrial outreach it has started industry open house and industry partnership retreat where more than 50 industries from all over India. The institute has explored the areas where industries can partner with the institute and has partnered with >25 industrialists for carrying out research in various domains. These events showcase expertise, infrastructure capabilities of institute that can be availed by industrial sector. Till now, the institute has undertaken 54 sponsored research projects and 23 consultancy projects from government and industrial collaborators. Till date it has filled 8 patents and ~1266 publications.

### *Industry Related Programmes*

a) **Incubation Centre (IIC):** It has been established to promote innovation and entrepreneurship. In 2012, the institute received TIDE grant from MeitY to enable creation of incubator. IIC is well connected with ecosystem partners and incubators in Ahmedabad. It contains one non-resident and 2 resident incubatees. The institute has launched a deferred placement policy in 2014 for enabling students to opt out of placement and pursue their entrepreneurship dreams.

b) **Innovation and Entrepreneurship Centre (IIEC)** and **Technology Business Incubator** (under aegis of DST) were established to support incubation and technology commercialization is under progress. IIT-GN has also launched **Women in Start-ups (WINS)** an initiative for fostering techno-entrepreneurship skills among women.

c) The institute has community outreach programme namely **Nurture and Empower Entrepreneurial Ventures (NEEV)** to promote growth of entrepreneurship through training, mentoring and networking opportunities.

| **Examples of a few technologies developed and MoUs signed by IIT-GN in 2015-16** | | |
|---|---|---|
| **S. No.** | **Technologies developed** | **Year** |
| 1. | Smart eye | 2015-16 |
| 2. | One touch doctor | 2015-16 |
| **S. No.** | **MoUs with the Industries** | **Signed with** |
| 1. | To encourage collaborative research with leading industries around the globe for providing technological innovation | KHS Machinery Private Limited, Ahmedabad |
| 2. | Analog lab setup | M/s EdGate Technologies Pvt. Limited, University Program partner of Texas Instruments, India |
| 3. | To organize a program for academic cooperation in areas of mutual interest | Xylem Water Solutions India Private Limited, Vadodara, Gujarat |
| 4. | To promote collaboration between industry and academia for joint research and development of bio-medical information processing/instruments, healthcare/lifestyle products and security systems. | Pracsol Health India Private Limited (PHIPL) |
| 5. | Analog teaching lab setup | Cranes Software International Limited |
| 6. | For intensifying academic cooperation | Tata Consultancy Services Limited |

***Source:*** *https://www.iitsystem.ac.in/*

## XI. Indian Institute of Technology, Patna (IIT-P)

***(http://www.iitp.ac.in/)***

**Introduction**: IIT-P was established on August 06, 2008. Initially the institute was under the mentorship of IIT-G. The institute has now carved a niche in the domains of education, inquests and research. It has ten academic departments with student strength of 670 in the undergraduate courses, 160 in postgraduate courses and 250 in the doctoral program. The institute has been growing steadily with the increase in number of faculty members to 101 and a non teaching staff of 70 members. In the year 2014-15, the institute published nearly 75 research publications.

## *Industry Related Programmes*

**a)** **Sponsored Research and Industrial Relations Unit (SRIRU)** (http://www.iitp.ac.in/index.php/research/r-and-home.html): IIT-P considers the need to facilitate R&D efforts in a disciplined manner to ensure a strong base and growth in research by generating resources, effective collaborations and links with the private sector. SRIRU, established in 2009, is a special unit set up to act as an a unit to coalesce the funding agencies and IIT-P for handling the industrially sponsored research and consultancy works. SRIRU handles the directorial and logistics aspects related to recruitments, accounts, audits, liaisons with sponsors, and prepare the status reports.

**b)** IIT-P has also set up an **Incubation Centre (IC)** in the area of Electronic System Design & Manufacturing with focus on Medical Electronics. This is funded by MeitY & Bihar State Government. IC focuses on developing products for commercial exploitation via the route of physical infrastructure, technical expertise and networking support to new enterprises with innovative technologies.

**c)** **Entrepreneurship Club** (http://www.iitp.ac.in/ecelliitp/)**:** This club is established by the students of IIT-P with the goal of forming a common point for the aspiring entrepreneurs at the institute. The students aim to foster an environment that would empower aspiring students by coordinating with successful entrepreneurs who have undertaken this path. Various lectures and workshops on business topics are held, successful entrepreneurs and industry leaders are invited for business talks and speeches. This plan has been devised by the students to promote entrepreneurship within the IIT-P community.

**d)** IIT-P has also taken initiative in curriculum development for the industry. The institute offers post graduate courses for industry personnel.

| Examples of a few patents and MoUs signed by IIT-P in 2015-16 | | |
|---|---|---|
| **S. No.** | **Patents** | **Application Number** |
| 1. | Automatic booklet scanning machine (ABSM) | Indian Patent Application No. 1082/KOL/2015 |
| 2. | New design application - Handle operated garbage & soil Collector | Indian Design Application No :272013/D/NF/SKM |
| **S. No.** | **MoUs with the Industries** | **Signed with** |
| 1. | Centre of excellence of natural language processing | Reed Elsevier India Private Limited |
| 2. | Research on NLP and machine learning | Process Nine Technologies Pvt. Ltd, Gurgaon |
| 3. | EzDI research lab of health informatics | Mediascribes Solutions (India) Pvt. Ltd. |

***Source:*** *https://www.iitsystem.ac.in/*

## XII. Indian Institute of Technology, Jodhpur (IIT-J)

***(http://www.iitj.ac.in/)***

**Introduction:** The MHRD announced the establishment of eight new IITs in the country on March 28th 2008. IIT-J (formerly known as IIT Rajasthan), was one of them. The institute has collaborations with Microsoft R&D, IBM, and TCS. Representatives from top industries pay regular visits to the department for delivering seminars, conducting workshops.

### *Industry Related Programmes*

**a)** IIT-J has a well placed **Office of R&D,** which is responsible for organizational and directorial support for sponsored research projects, industrial consultancies and other R&D activities of IIT-J. It facilitates and promotes collaborations between the industry and academia, and the liaisons between the institute and various funding agencies. This office also carries the responsibility of facilitating documentation of the intellectual property of the institute and filing of patents. The office runs the interface for:

- Management of projects (sponsored, consultancy & other research projects).
- Management of office – Publishing of R&D newsletters, research magazine of the institute, developing a database of R&D contacts in industry, academia and other organizations (national and international).

- It also manages the MoUs, IPRs and other corporate communications of the institute.
- Industry liaisons are also held with the Office of R&D. All the interactions with the industry, industrial R&D, consultancy, extension services, technology transfers, industry internship for faculty mainly are looked after by the Office of R&D.

b) **Entrepreneurship Cell** (http://iitjecell.in/index.html): IIT-J has started an entrepreneurship cell to develop the entrepreneurial mindset in aspiring entrepreneurs. Organizing the start-up visits and conducting case studies on successful start-ups are main events organized by this cell.

c) **Blended Technical Education Program:** IIT-J is initiating to collaborate with industries towards enhancing the learning experience of students and faculty members. The thought behind the Blended Technical Education Program was to inspire the students to help solve the obstacles of the Indian industry. The aegis of the program desired to have industry captains lay a framework by giving a real life picture of sectoral technologies, needs of the industry, challenges and research opportunities. The program encompasses other programs such as:

- **Vanguard Lectures**-The Vanguard Lecture Series form an integral part of Blended B. Tech. Program. These lecture series enable the students to get a know-how of the industrial ecosystem and deeper insights in the technological areas, by listening to talks given by distinguished experts from the industry and academia. The first phase of the program began in July 2014, and since then it has witnessed two successful series of vanguard lectures delivered by the domain experts from industry and academia.
- **Industry Immersion Program (IIP)**-The Institute has signed MoUs with leading Indian industries to strengthen its undergraduate technical education. Currently, five industry partners have joined the IIP, namely: (1) Mahindra & Mahindra Limited, Mumbai; (2) Larsen & Toubro Limited, Mumbai; (3) Tata Motors Limited, Mumbai; (4) TVS Motor Company Limited, Chennai; and (5) Tata Power Limited, Mumbai. The IIP is an impressive module that focuses on learning by doing, working on live assignments under the mentorship of

industry professionals, engaging in industry linked projects (starting in fourth semester of B. Tech). This program will also help the faculty members by broadening their horizon and giving them the ability to look beyond the institute for developing relations with the industry. A precedent of the same is an MoU signed between the institute and TVS Motor Company, Chennai. It is aimed at expanding I-A collaboration by giving the faculty and students of the institute an experience of the industry experience and in turn, the professionals of TVS can get academic experience.

| **Example of a technology developed and a patent by IIT-J in 2015-16** | | |
|---|---|---|
| **S. No.** | **Technology Developed** | |
| 1. | Open volumetric air receiver (OVAR) | |
| **S. No.** | **Patent** | **Application Number** |
| 1. | A black chromium coating bath | 1433/DEL/2013 |

***Source:*** *https://www.iitsystem.ac.in/*

## XIII. Indian Institute of Technology, Ropar (IIT-RPR)

***(http://www.iitrpr.ac.in/)***

**Introduction:** IIT-RPR was established in 2008 by the MHRD under the mentorship of IIT Delhi. The institute of national importance is located at Rupnagar in the state of Punjab. The institute in its endeavour to live up to the status and brand name created by its predecessors is keen to establish a robust academic environment along with facilitating cutting edge R&D. The faculty at IIT-RPR is encouraged to initiate research work and are also provided with facilities/initial grants to sustain research work. The institute pushed the faculty to perform collaborative research with other research labs and also with the industry. The institute has a number of consultancy projects to its credit. IIT-RPR is soon going to establish a Central Research Facility to amplify its research activities. The institute has set up dedicated cells to strengthen and reinforce the spirit of innovation and entrepreneurship amongst its faculty and students.

### *Industry Related Programmes*

a) **Prototype Development and Innovation Fund (Entrepreneurship Cell):** This initiative was set up in collaboration with the Punjab Technical University, to foster innovation within various domains of knowledge and technology development. It aims to work towards finding innovative solutions for industrial and societal concerns that are critical to the world. This fund was established to address the gap between research laboratories and the market. It funds projects that are commercially viable and have the potential to serve the technological needs of the nation.

b) **Intellectual Property Rights (IPR) Cell:** The Patent Information Centre (PIC) of the Punjab State Council for Science & Technology has set up an IPR Cell at IIT-RPR to provide IPRs protection information and patenting facilities to the institutes faculty and students. The cell is responsible for all activities related to patenting and technology transfers to the industry.

c) **Technology Business Incubator (TBI):** The institute has received a grant of ₹ 500 lakhs to set up a TBI in Punjab. This grant shall be devoted towards the central government's "Start-Up India Programme". The incubator will foster innovation and entrepreneurship ecosystem. TBI will provide various facilities like mentoring, physical office space, library and equipments among other things. Key focus will also be on providing networking and marketing support to all incubatees in order to enable and prepare them to raise capital through angel funding. The TBI, with specialized *state of art* facility will focus on providing the incubatees unlimited access to the skilled resources in the field of S&T, in order to help them grow. The main objectives of this incubator are:

   - To promote new technology/knowledge/innovation based startups.
   - To build a vibrant startup ecosystem, by establishing a network between academia, financial institutions, industries and other institutions.
   - To provide cost effective, value added services to startups like mentoring, legal, financial, technical, intellectual property related services.
   - To provide a platform for speedy commercialization of technologies developed by the host institution or by any academic/technical/R&D institution or by an individual.
   - To create jobs, wealth and business in alignment with national priorities.

d) IIT-RPR has a **Centre for Innovation & Business Incubation (CIBI),** which provides incubation services for start-ups with a technology and knowledge base. Established in 2013, this center focuses on accelerating innovation, business incubation and growth of entrepreneurship at IIT-RPR. The objective of CIBI is to facilitate the 'conversion of research activity into entrepreneurial ventures'. It has received financial assistance from various sources along with from DST, GoI. The institute is supporting four start-ups, at the moment.

## XIV. Indian Institute of Technology, Indore (IIT-I)

***(http://www.iiti.ac.in/)***

**Introduction:** The institution was set up in 2009**.** IIT-I through its endeavours has attained international importance and recognition. The institute has been a participant in several projects of international repute and also is in partnership with different research organizations. IIT-I has gained recognition due to its collaborative research efforts with agencies from many foreign countries like USA, France, S. Korea, Japan, Germany, Portugal etc. The institute has generated a net worth close to ₹ 22 crores through approximately 82 sponsored projects.

### *Industry Related Programmes*

a) **Innovation and Entrepreneurship Development Centre (IEDC):** This centre was funded by DST, with a purpose to foster an environment of innovation and entrepreneurship. This centre has supported the on campus student activities by setting up **Student Entrepreneurship Support Cell (SESC).** SESC has been proactively generating awareness amongst the pupils through the means of events and workshops and bolstering them for entrepreneurial efforts. In a time span of six months, since the initiation of this cell it conducted nearly 50 events and also bagged the 2$^{nd}$ position at National Entrepreneurship Challenge organized by IIT Bombay in Feb, 2014 and Best Debutant Award in E-Week in March 2014, organized by National Entrepreneurship Network. IIT-I students are charged and are in the process of initiating their entrepreneurial ventures thereby applying their innovative ideas into practical applications.

**b)** To develop linkages with the private sector and to cater to their needs of enhancing their academic qualifications, IIT-I has initiated **Continuing Education Programmes (CEPs)** and 'Short Courses' for working professionals in industry, institutions and other organizations across India. These courses enable them to update their knowledge and skills, and also to train them in *state of art* facilities.

| **Examples of a few patents and MoU signed by IIT-I in 2015-16** | | |
|---|---|---|
| **S. No.** | **Patents** | **Application No.** |
| 1. | Method device and apparatus for managing phone/device Profile based on an event | 3415/MUM/2015 |
| **S. No.** | **MoUs with the Industries** | **Signed with** |
| 1. | Technical mentoring of the students at IIT Indore | IBM India Private Limited |
| 2. | Training programs for the life sciences student community | Wipro GE Healthcare Pvt. Ltd., Bangalore |

***Source:*** *https://www.iitsystem.ac.in/*

## XV. Indian Institute of Technology, Mandi (IIT-MN)

***(http://www.iitmandi.ac.in/)***

**Introduction:** IIT-MN is an autonomous premier engineering institute located in Himachal Pradesh, which was established in 2012, in association with IIT Roorkee.

The institute encourages linkages with the industry and the students are required to undergo industrial training. The **Career and Placement Cell** at the institute facilitates the internship of the students at various reputed industries.

| **Example of a technology developed and MoU signed by IIT-Mandi in 2015-16** | | |
|---|---|---|
| **S. No.** | **Technology Developed** | |
| 1. | Interactive landslide simulator for risk communication against landslides (http://pratik.acslab.org/) | |
| **S. No.** | **MoU with the Industries** | **Signed with** |
| 1. | TCS research scholar program | Tata Consultancy Services Limited |

***Source:*** *https://www.iitsystem.ac.in/*

# XVI. Indian Institute of Technology, BHU [IIT(BHU)]

***(http://www.iitbhu.ac.in/)***

**Introduction**: The Institute of Technology, Banaras Hindu University (IT-BHU), was converted into Indian Institute of Technology (Banaras Hindu University), Varanasi by the Government of India, New Delhi on 29th June, 2012. The institute gives due importance to links with the industry and it is mandatory for students to undergo industrial internship which is facilitated by the **Training and Placement Cell.** The campus placements of the students in various industries are also looked after by the cell. Soft skill development programmes to make the students industry ready are undertaken by the cell**.** To inculcate the spirit of innovation and creation of entrepreneurs the institute has set up a dedicated cell.

## *Industry Related Programmes*

a) **Malaviya Centre for Innovation, Incubation and Entrepreneurship (MCIIE):** All the industrial and societal activities of IIT(BHU) are being coordinated by MCIIE. This centre is also registered as a separate society. This centre was set up with a dedication to promote innovation and entrepreneurship. The centre aids the guidance of knowledge driven enterprises and facilitates the commercialization of a product. This centre fosters the establishment of newer firms that create jobs, commercialize novel technologies thereby strengthening the national economy.

| **Examples of a few technologies developed and patents by IIT(BHU) in 2015-16** | | |
|---|---|---|
| **S. No.** | **Technologies Developed** | |
| 1. | Synthesis of water based adhesives (http://www.shrimalibond.com) | |
| 2. | Extraction of silica from rice husk ash (http://www.bridgedots.com/) | |
| 3. | Reverse osmosis based potable water system with improved yield (http://www.aquvio.com/) | |
| **S. No.** | **Patents** | **Application Number** |
| 1. | Application of grafted amylopectin for waste water treatment | 60/Cal/2001 |
| 2. | An innovative polyherbal bioabsorbable dermal patch for wound healing | 2087/DEL/2015 |
| 3. | A novel polyherbal formulation for growing adolescent girl and process for its preparation | 736/DEL/2015 |
| 4. | A novel polyherbal formulation for reduction in obesity and process for its preparation | 735/DEL/2015 |

| | | |
|---|---|---|
| 5. | An improved caving longwall method for winning of coal from thick seam in single life under massive and hard roof conditions in underground mines | 212/DEL/2002 |
| 6. | Device for sealing inside an upward drilled borehole for high pressure water injection in underground mines | 855/DEL/2001 |

***Source:*** *https://www.iitsystem.ac.in/*

## 3. Summary

- IITs not only impart top class teaching but also carry out globally competitive R&D in the domains of engineering and biotechnology. Industry-Academia (I-A) engagements are the highlight of all IITs.
- Each new IIT is being mentored by one of the first generation IITs e.g. IIT-H and IIT-RPR are being mentored by IIT-M and IIT-D respectively.
- IIT-KGP leads all IITs in the parameter of *publications* (2162) in the time period 2014-15. IIT-B (~1500), IIT-D (1300) and IIT-K (1298) occupy second, third and fourth position respectively. IIT-KGP also leads in the number of Incubating Companies (172), followed by IIT-M (95) and IIT-B (71).
- IIT-B leads in the following parameters: *Patents filed* (569) and *granted* (>61) in the period 2010-15), *Technologies available* (409) and *licensed* till date (>140), and *industrial collaborations* (225) in the time period 2010-15.
- First generation IITs have been generating large amount of revenues through their linkages with the industrial sector by means of sponsored projects and consultancy projects. IIT-M ranks number one amongst all IITs in, *Revenue generated through tech transfers* (₹ 461 crores) till 2015 and *Consultancies* (₹ 251 crores).
- A vibrant *I-A interface* is present in IITs e.g. *SRIC* at IIT-KGP, IIT-R, IIT BBS, *IRCC* at IIT-B, *IC&SR* at IIT-M, *SIIC* at IIT-K, *IRD* at IIT-D and *SRIRU* at IIT-P. This interface manages the industrial relations of the institute and monitors the R&D activities being performed at respective IITs.
- To protect and promote the intellectual property (IP) of the institute, nearly all IITs have set up dedicated *IPR Management Cells.*
- To encourage the spirit of entrepreneurship and start-ups, most IITs, such as IIT-KGP, IIT-B, IIT-M, IIT-R, IIT-H, IIT-GN, IIT-P, IIT-J, IIT-I, IIT(BHU) have established *Entrepreneurship Cells.* .

- A few IITs, namely IIT-KGP, IIT-D, IIT-M, IIT-G, IIT-H, IIT-GN and IIT-RPR. have established *Technology Business Incubators* (TBIs) to nurture technology and knowledge based enterprises and assist them during their start up period, which is close to three years. TBIs offer space, services, technical assistance, legal assistance, networking support, access to infrastructure and equipment, financial support, as well as assistance in the development of business plans.
- A few IITs like IIT-KGP, IIT-M, IIT-B have come up with *Research Parks* which aim to create an environment for innovation and entrepreneurship.
- The IITs have also been working towards dispersing knowledge to the society outside. Barring a few, IITs have *Continuing Education Programme (CEP)* for the industry personals. IIT-D also offers a special *Professional Candidate Registration (PCR) Programme,* and IIT-RPR offers *Part-time Ph.D. for industry personals*.

## 4. Conclusions

The ever thriving economy of India demands committed technical resources (manpower) and technology creators. This requires an environment conducive for fostering innovative intellect that is driven by the knowledge base. The IITs not only impart top class teaching but are also equally effective in converting their academic wealth into commercial success by means of patents, technology transfers etc. The presence of all components needed for translational research namely, I-A Cell, IP Cell, Entrepreneurship Cell, Centres of Excellence (R&D) is responsible for the success stories of technologies, products, patents and start-ups in the first generation IITs. Second generation IITs are in the process of developing infrastructure needed for translational research. Once it is in place, these IITs will also be a force to be reckoned with in the domains of publications, patents and technologies.

In India, majority of 700 universities and > 300 national research laboratories are devoid of value chain needed for converting scientific knowledge into innovative product. The establishment of such value chain in these institutes will certainly help in boosting the number of patents and technologies. Also, on the lines of having one older IIT mentoring a new IIT, universities having potential for generating IP can also be allocated one mentoring IIT.

## 5. References


- Annual reports of IIT Kharagpur, IIT Bombay, IIT Madras, IIT Kanpur, IIT Delhi, IIT Guwahati, IIT Roorkee, IIT Bhubaneswar, IIT Hyderabad, IIT Gandhinagar, IIT Patna, IIT Jodhpur, IIT Ropar, IIT Indore, IIT Mandi, IIT(BHU).
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- http://www.iiti.ac.in/
- http://www.iitj.ac.in/
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## *Addendum*

## Impacting Research Innovation and Technology (IMPRINT) India Initiative for IITs (www.imprint-india.org)

In order to attain economic prosperity and upliftment, emphasis of R&D needs to be directed on societal and economical challenges of the country. To address these challenges, in 2015 MHRD came out with an innovative programme i.e. IMPRINT* India Initiative. This programme will cater to the challenges in science and engineering sector to enable, empower and embolden the nation for inclusive growth and societal development. The programme will be carried out by the scientific fraternity of sixteen IITs and IISc, Bangalore. Director of IIT Kanpur, Prof. Indranil Manna is heading IMPRINT India Initiative. IMPRINT has signed MoUs with 25 ministries to support them to carry forward research work carried out in IITs.

MHRD has identified 10 domains of societal importance, and the responsibility of accomplishing the objectives of these domains is vested upon five institutes as mentioned below.

| Institute | Domains# (10) |
|---|---|
| **IIT Kharagpur** | • Information and Communication Technology<br>• Health Care |
| **IIT Bombay** | • Nano-technology Hardware<br>• Energy |
| **IIT Kanpur** | • Water Resources and River systems<br>• Advanced Materials |
| **IIT Madras** | • Manufacturing<br>• Security and Defense |
| **IIT Roorkee** | • Sustainable Habitat |
| **IISc Bangalore** | • Environmental Science and Climate Change |

*#Each domain is categorized into themes, sub-themes, target and topics for promoting research and innovation.*

- IMPRINT is working with a task force to map the strength and weakness in Indian education system to champion the engineering targets.
- Under IMPRINT initiative, focus is on strengthening academia and industry linkages in order to create and sustain an inclusive scientific eco-system in society to develop novel goods and services to add both competitive and add value to serve the nation.

- Presently, IMPRINT is in its first phase which is focusing on creation of a policy document that will define the scope, mandate and strategy for pursuing engineering challenges in the country.
- Second phase of IMPRINT will focus on developing technological products/ processes through well developed innovation system for the societal need.

सत्यमेव जयते

Department of Science & Technology
Govt. of India

# DST-Centre for Policy Research at PU, Chd.

***(DST/PRC/CPR-03/2013)***

# <u>REPORT-6</u>

**(May, 2015-Aug., 2016)**

# *Industry-Academia Related Questionnaire Survey Report of IITs*

## INDEX

# 1. Introduction

The hand holding of industry with academia has gained momentum as the evolving system of collaborations amongst the two, provides benefits to both the entities and gives them the prowess to address the challenges at the global and national level. The Industry-Academia (I-A) collaborations have carved a successful niche in the R&D ecosystem of the developed economies and are contributing greatly to the knowledge economy of the nations. However, in developing countries, including India, I-A research collaborations are in the nascent stage. India's global ranking in the parameter of 'university-industry research linkage' is not impressive even though more than 700 universities (public and private) and nearly 1700 DSIR accredited labs exist in our nation. The time has come to bring them on a single platform so that they collectively work together and contribute significantly towards economic and societal progress.

In India, Indian Institutes of Technology (IITs) have been successfully carrying out I-A activities and can act as role models for other higher educational institutes, primarily universities.

Keeping this in mind, the Centre for Policy Research at Panjab University, Chandigarh established by Department of Science and Technology (DST), New Delhi, Govt. of India (GoI) has carried out a study on the existing I-A interface in IITs.

Present study focuses on existence of I-A cells in IITs, industrial research carried out in form of sponsored research and consultancy and promotion of entrepreneurship culture. Table 1 enlists the officials who provided the information sought in the questionnaire, of their respective institutes.

This report comprises of the following sections:

2 Methodology

3 Results & Discussion

4 Conclusions

**Table 1: List of Professors who Provided the Information Sought in the Questionnaire**

| S. No. | Institute | Name & Designation |
|---|---|---|
| 1. | **IIT Kharagpur** | Prof. Partha P. Chakrabarti<br>Director, IIT Kharagpur |
| 2. | **IIT Bombay** | Prof. K.P Kaliappan<br>Acting Dean (R&D), Office of the Dean (R&D) |
| 3. | **IIT Madras** | Prof. Krishnan Balasubramaninan,<br>Dean, Industrial Consultancy & Sponsored Research |
| 4. | **IIT Kanpur** | Prof. Siddhartha Panda<br>Associate Dean, Industrial Collaboration |
| 5. | **IIT Delhi** | Prof. Naresh Bhatnagar,<br>Associate Dean (R & D) |
| 6. | **IIT Guwahati** | Prof. D. Chakraborty<br>Dean (R&D) |
| 7. | **IIT Roorkee** | Prof. Deepak Khare<br>Head, Dept. of Water Resources Development & Management |
| 8. | **IIT Bhubaneswar** | Prof. Rabindra Kumar Panda<br>Dean (R&D) |
| 9. | **IIT Gandhinagar** | Prof. Surya P. Mehrotra<br>In-charge, R&D |
| 10. | **IIT Patna** | Prof. Pushpak Bhattacharyya<br>Director, IIT Patna |
| 11. | **IIT Jodhpur** | Prof. V. Narayanan<br>Coordinator (R&D) |
| 12. | **IIT Ropar** | Dr. Harpreet Singh<br>Assoc. Dean (Industrial Relations, International & Alumini Affairs) |
| 13. | **IIT Indore** | Dr. Santosh Kumar Vishvakarma,<br>Faculty In-charge, Placement |
| 14. | **IIT Mandi** | Prof. B.D. Chaudhary<br>Dean, Sponsored Research & Industrial Consultancy |
| 15. | **IIT(BHU), Varanasi** | Prof. P.K. Jain<br>Dean (R&D) |

Department of Science & Technology
Govt. of India

# DST- Centre for Policy Research

at

**PANJAB UNIVERSITY, CHANDIGARH-160 014 (INDIA)**

*(Estt. Under the Panjab University Act VII 1947 enacted by the Govt. of India)*

## ***SURVEY ON INDUSTRY-ACADEMIA LINKAGES*** ***(For Academia)***

*The information sought pertains to your Institute only. This survey consists of 17 objective type questions. For questions 2-9, pl. fill up the columns 'Yes/No/Other'. For questions 12-17, please underline / tick / bold the option(s) mentioned in the question.*

*The filled up Questionnaire can either be emailed at dstprc2014@pu.ac.in or a hard copy may be sent to* ***Prof. Rupinder Tewari,*** *Co-ordinator, DST – Centre for Policy Research, Deptt. of SAIF/CIL, CIL Building, Panjab University, Sector-14, Chandigarh-160014.*

<table>
<tr><td colspan="7">(i) Name of the Institute:<br>(ii) Complete address:</td></tr>
<tr><td>1.</td><td colspan="6">Interaction of the Institute with the Industries</td></tr>
<tr><td></td><td>Life Sciences (Please specify the field)</td><td>Engineering Sciences (Please specify the field)</td><td>Business Management</td><td>Legal Studies</td><td colspan="2">Other(s)</td></tr>
<tr><td>Industrial training</td><td></td><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>Campus recruitments</td><td></td><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>Research collaborations</td><td></td><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>Members of the governing body</td><td></td><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td colspan="4"></td><td>Yes</td><td>No</td><td>Other</td></tr>
</table>

| | | | | |
|---|---|---|---|---|
| 2. | Does the Institute have a dedicated “Industry - Academia Cell” or its equivalent? | | | |
| 3. | Is the Institute aware of the Industry oriented Govt. funded programs like DSIR, TDB, BIRAC, PM’s Fellowship Programme for Doctoral Research? | | | |
| | | **Yes** | **No** | **Other** |
| 4. | Does any Industry have a set up (research facility / laboratory) in the Institute? | | | |
| 5. | Is there any Industry sponsored research fellowship in the Institute? | | | |
| 6. | Do the students of the Institute visit industrial facilities on a regular basis? | | | |
| 7. | Are there any incentives for faculty members / researchers who have obtained patents/ transferred technology? | | | |
| 8. | Does the Institute provide leave to the faculty to take an assignment in the Industry? | | | |
| 9. | Does the Institute offer special courses/ modules for regular employees of the Industry? | | | |
| 10. | Does the Industry use infrastructure resources like instruments, library, legal services, any other (pl. mention) of the Institute? | | | |
| 11. | Does the Institute have an IPR Cell/ Entrepreneurship Cell/ Placement Cell/ Technology transfer Cell/ any other (pl. mention)? | | | |
| 12. | Does the Institute engage Industry personals for teaching programmes? If yes, are they engaged as:<br>(a) Invited speakers for a few lecture, (b) Guest faculty, (c) Adjunct faculty | | | |

| | |
|---|---|
| 13. | Please fill in the appropriate details relevant to the Institute (last five years):<br>(a) Number of Patents (i) Granted................ (ii) Filed.................<br>(b) Number of Technology transfers (i) Commercialized.................. (ii) Under process.................<br>(c) Number of MoU with the Industries (i) Signed................ (ii) Under process................ |
| 14. | Does the Institute hold workshops/ conferences/ seminars in association with the Industry (pl. mention)? |
| 15. | Factors hampering the growth of Industry-Academia linkages in the Institute are :<br>(a) Lack of common area of interest<br>(b) Lack of co-operation from the Industry<br>(c) Intellectual property rights (IPR) issues<br>(d) Not much weight-age given by Institute to develop industrial linkages<br>(e) Lack of incentives for Industry- driven research |
| 16. | Lack of sensitization of Intellectual Property Rights (IPR) in the Institute is because of:<br>(a) Compulsion of publication (as a part of doctoral programs) hampers going in for patents.<br>(b) Tedious protocols of IPR<br>(c) Lack of IPR related guidance and awareness<br>(d) Lack of a dedicated IPR cell in the Institute |

| | |
|---|---|
| 17. | The barriers preventing the successful technology transfers from the Institute to Industry are:<br>(a) Inadequate legal support services<br>(b) Inadequate technical facilities<br>(c) Any other |
| 18. | Please pen down any other suggestions you wish to share: |

Signature/ Seal: Dated:

**Name, Designation and Complete address:**

## 2. Methodology

a) **Setting:** This study was conducted at DST-Centre for Policy Research at Panjab University, India. The approval for conducting this study was obtained from DST, GoI, New Delhi, India.

b) **Study Design:** This study was based on a questionnaire, which was designed particularly for this study. The participating institutes included all the IITs established up till the year 2012 (excluding IITs at Tirupati & Palakkad).

The questionnaire contained 17 objective type questions with subparts, related to I-A interactions, start-ups, intellectual property, entrepreneurship, technology transfer, and patents. The reference year and instructions regarding filling questionnaire were mentioned on top of the questionnaire. The institutes were asked to answer these questions by either writing yes/no/other or by ticking ( ✓) the appropriate options.

This survey was carried out to check the status and strength of I-A interface in all IITs. By exploring the scenario of I-A interaction in IITs, we can analyse and understand the benefits of collaboration of industry and institutes and can formulate policy to promote I-A interactions in India.

c) **Data Collection:** The data was collected through a survey conducted using a questionnaire. A stipulated time period was given for filling up of the questionnaire. During analysis, the answers were represented by using numbers zero (0) and one (1). ‘1’ is for option marked and ‘0’ for those options that have not been marked.

d) **Statistical Analysis:** An excel sheet of all the questions was prepared and coded accordingly. For every question and its sub question, the total number of options ticked were counted and totalled following which the percentage was calculated.

e) **Graphical Representation:** Graphs were plotted/made in accordance with the percentage calculations.

## 3. Results & Discussion

The Questionnaire was sent to 16 IITs of which 15 responded with filled in questionnaires, corresponding to an overall response of 93.75%. Two IITs (IIT Tirupati and IIT Palakkad) were not sent the questionnaire because they were established the very same year that the survey was initiated.

Despite repeated reminders IIT Hyderabad failed to respond to the questionnaire.

***Question: 1***

a) ***Industrial Training Programme***

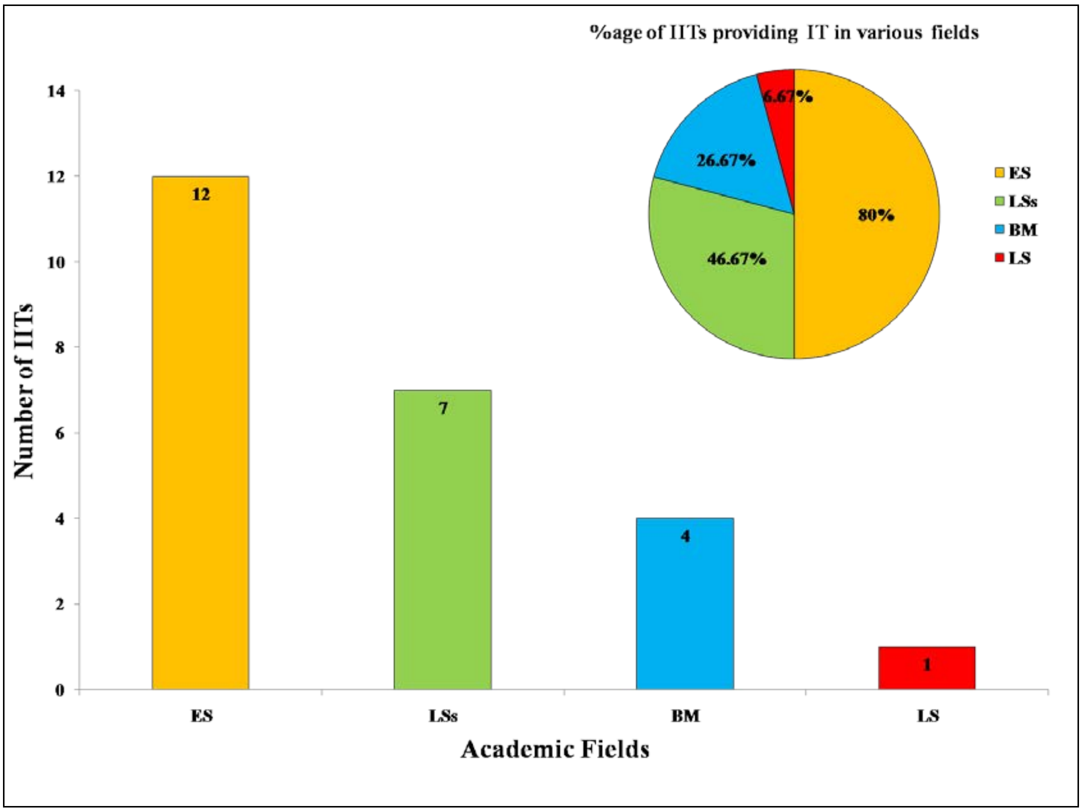


**Figure 1: Number and Percentage of IITs Providing Industrial Training in Different Fields**

* Abbreviations -- Life Sciences (LSs), Engineering Sciences (ES), Business Management (BM), Legal Studies (LS)

**Table 2: Fields in which Industrial Training is provided by IITs**

| S. No. | Name | Life Sciences | Engineering Sciences | Business Management | Legal Studies |
|---|---|---|---|---|---|
| 1. | **IIT Kharagpur** | ✓ | ✓ | ✓ | ✓ |
| 2. | **IIT Bombay** | ✓ | ✓ | ✓ | NA |
| 3. | **IIT Madras** | — | — | — | NA |
| 4. | **IIT Kanpur** | ✓ | ✓ | ✓ | NA |
| 5. | **IIT Delhi** | ✓ | ✓ | ✓ | NA |
| 6. | **IIT Guwahati** | ✓ | ✓ | NA | NA |
| 7. | **IIT Roorkee** | ✓ | ✓ | — | NA |
| 8. | **IIT Bhubaneswar** | NA | ✓ | — | NA |
| 9. | **IIT Gandhinagar** | — | — | — | NA |
| 10. | **IIT Patna** | — | ✓ | NA | NA |
| 11. | **IIT Jodhpur** | — | ✓ | NA | NA |
| 12. | **IIT Ropar** | — | ✓ | NA | NA |
| 13. | **IIT Indore** | — | — | NA | NA |
| 14. | **IIT Mandi** | — | ✓ | NA | NA |
| 15. | **IIT(BHU)** | ✓ | ✓ | NA | NA |

* NA – Not Applicable
* — – Industrial Training not provided

As depicted in the table 2 and figure 1, all IITs have ‘industrial training’ in their curricula which is undertaken in association with industries. Out of 15 IITs, the students of 12 IITs go for industrial training in the field of engineering sciences, which is justified by the fact that IITs are majorly institutes of higher technical education specialising in engineering. According to the information provided on the website of respective institutes, it was gathered that out of 15, 14 institutes have life science programs but industrial training is a part of the curriculum in only 7 of them. It was noted that business management is present as a course in 8 IITs and 4 participate in industrial training. A course on legal studies is present only in IIT Kharagpur, where industrial training in the said field is also undertaken (Annexure I).

***b) Campus Recruitments:***

Campus Recruitment is an important aspect of collaboration of the academic sector with the industries and hence can be referred as a parameter for gauging the readiness of the students for the industrial sector. Table 3 and figure 2 depict the status of the campus recruitment in different fields in the IITs. As all the IITs have expertise in engineering sciences, highest campus recruitment was observed in the same. Eight of the 14 IITs, which provide courses in life sciences, also engage in campus recruitment. In the field of business management (course provided by 8 institutes), 5 IITs are actively involved in campus recruitment. A course on legal studies is provided by IIT Kharagpur only, and they engage in campus recruitment for the same.

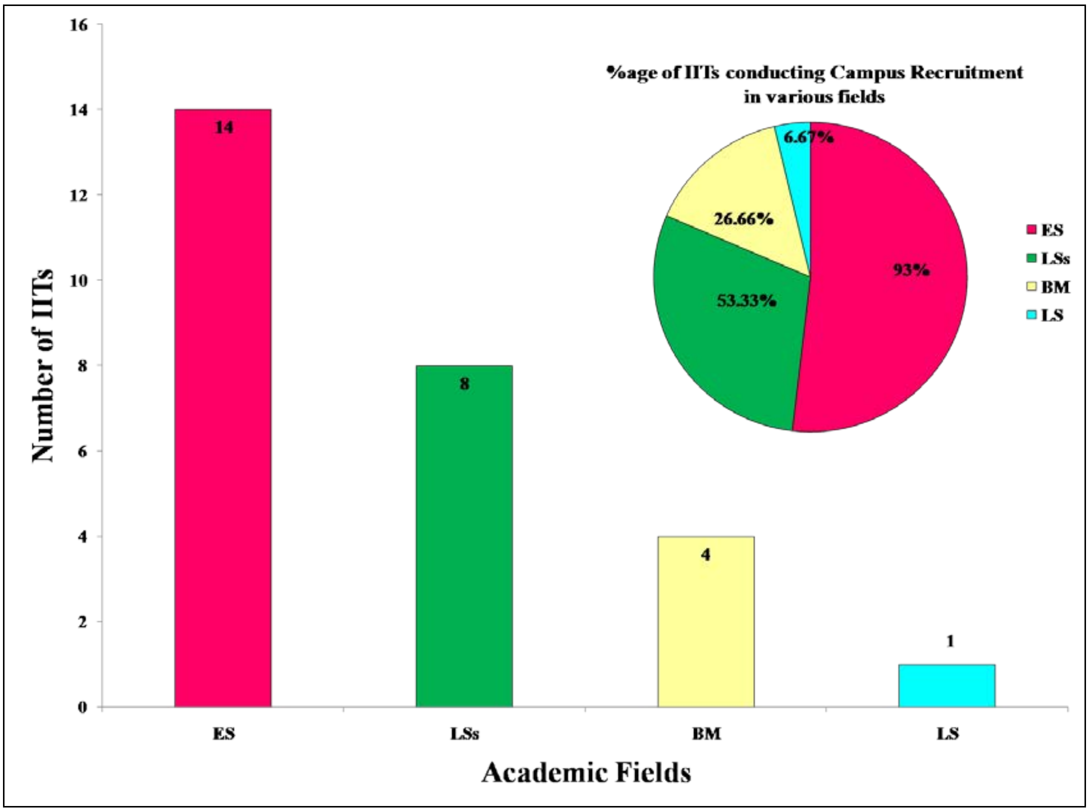


**Figure 2: Number and Percentage of IITs Providing Campus Recruitment in Different Fields**

* Abbreviations -- Life Sciences (LSs), Engineering Sciences (ES), Business Management (BM), Legal Studies (LS)

**Table 3: IITs Providing Campus Recruitment in Various Fields**

| S. No. | Name | Life Sciences | Engineering Sciences | Business Management | Legal Studies |
|---|---|---|---|---|---|
| 1. | **IIT Kharagpur** | ✓ | ✓ | ✓ | ✓ |
| 2. | **IIT Bombay** | ✓ | ✓ | ✓ | NA |
| 3. | **IIT Madras** | — | — | — | NA |
| 4. | **IIT Kanpur** | ✓ | ✓ | ✓ | NA |
| 5. | **IIT Delhi** | ✓ | ✓ | ✓ | NA |
| 6. | **IIT Guwahati** | ✓ | ✓ | NA | NA |
| 7. | **IIT Roorkee** | ✓ | ✓ | — | NA |
| 8. | **IIT Bhubaneswar** | NA | ✓ | — | NA |
| 9. | **IIT Gandhinagar** | — | ✓ | — | NA |
| 10. | **IIT Patna** | — | ✓ | NA | NA |
| 11. | **IIT Jodhpur** | ✓ | ✓ | NA | NA |
| 12. | **IIT Ropar** | — | ✓ | NA | NA |
| 13. | **IIT Indore** | — | ✓ | NA | NA |
| 14. | **IIT Mandi** | — | ✓ | NA | NA |
| 15. | **IIT(BHU)** | ✓ | ✓ | NA | NA |

* NA – Not Applicable
* — – Campus Recruitment not provided

### c) *Research Collaborations:*

To bring out the best in innovative research to the market, 'research collaborations' between industrial sector and academic sector are essential. As most of the IITs are majorly specialised in engineering sciences therefore maximum research collaborations have been witnessed in the said field followed by life sciences. Of the 8 institutes that provide business management courses, 5 of them are actively involved in research collaborations as well. Table 4 and figure 3 reflect the successful research collaborations of IITs in different domains.

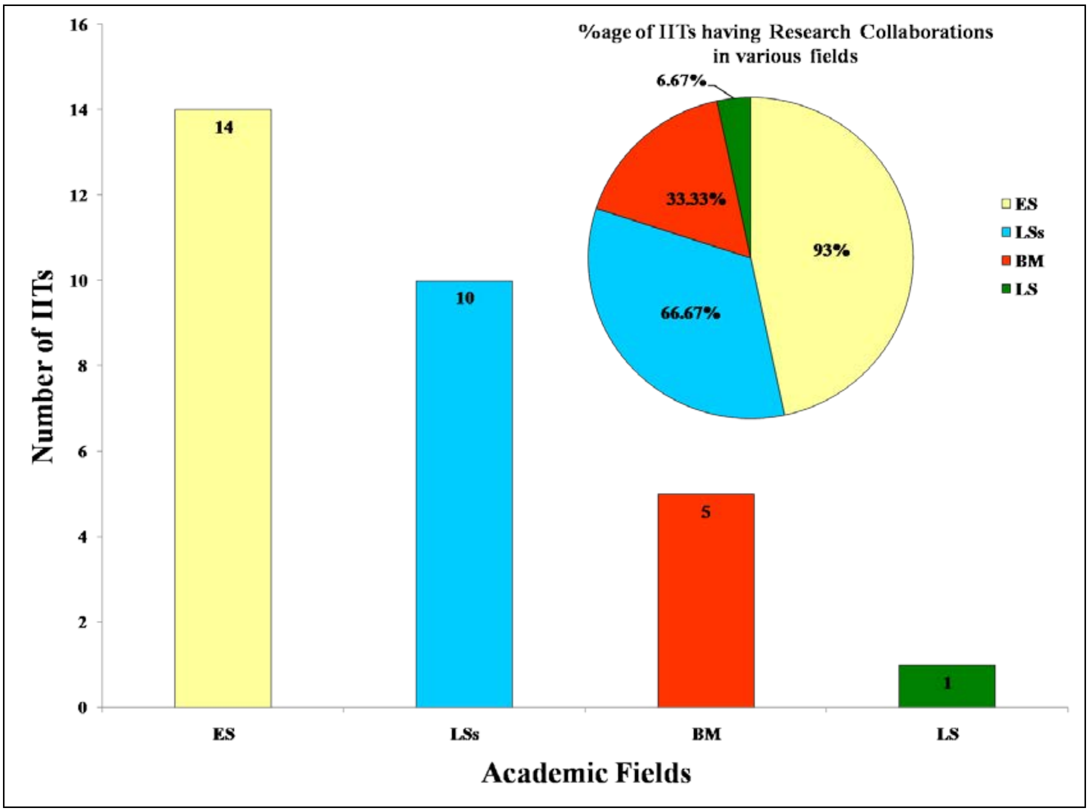


**Figure 3: Number and Percentage of IITs Having Research Collaborations in Different Fields**

* Abbreviations -- Life Sciences (LSs), Engineering Sciences (ES), Business Management (BM), Legal Studies (LS)

**Table 4: IITs Having Research Collaborations in Various Fields**

| S. No. | Name | Life Sciences | Engineering Sciences | Business Management | Legal Studies |
|---|---|---|---|---|---|
| 1. | **IIT Kharagpur** | ✓ | ✓ | ✓ | ✓ |
| 2. | **IIT Bombay** | ✓ | ✓ | ✓ | NA |
| 3. | **IIT Madras** | ✓ | ✓ | ✓ | NA |
| 4. | **IIT Kanpur** | ✓ | ✓ | ✓ | NA |
| 5. | **IIT Delhi** | ✓ | ✓ | ✓ | NA |
| 6. | **IIT Guwahati** | ✓ | ✓ | NA | NA |
| 7. | **IIT Roorkee** | ✓ | ✓ | — | NA |
| 8. | **IIT Bhubaneswar** | NA | ✓ | — | NA |
| 9. | **IIT Gandhinagar** | — | — | — | NA |

| | | | | | |
|---|---|---|---|---|---|
| 10. | **IIT Patna** | — | ✓ | NA | NA |
| 11. | **IIT Jodhpur** | ✓ | ✓ | NA | NA |
| 12. | **IIT Ropar** | — | ✓ | NA | NA |
| 13. | **IIT Indore** | ✓ | ✓ | NA | NA |
| 14. | **IIT Mandi** | — | ✓ | NA | NA |
| 15. | **IIT(BHU)** | ✓ | ✓ | NA | NA |

* NA – Not Applicable

* — – No Research Collaborations

### *d) Industry representation in the Governing Body:*

It is an understood fact that the involvement of industry personnel in designing the study and research modules of an academic institute will enhance the performance of the institute. This has been well implemented by a few IITs who have included industry representatives in the governing body of institute (Table 5).

**Table 5: IITs Having Industry Representation in the Governing Body**

| S. No. | Name | Life Sciences | Engineering Sciences | Business Management | Legal Studies |
|---|---|---|---|---|---|
| 1. | **IIT Kharagpur** | — | — | — | — |
| 2. | **IIT Bombay** | — | ✓ | ✓ | NA |
| 3. | **IIT Madras** | — | — | — | NA |
| 4. | **IIT Kanpur** | — | — | — | NA |
| 5. | **IIT Delhi** | — | ✓ | ✓ | NA |
| 6. | **IIT Guwahati** | — | ✓ | NA | NA |
| 7. | **IIT Roorkee** | ✓ | ✓ | — | NA |
| 8. | **IIT Bhubaneswar** | NA | — | — | NA |
| 9. | **IIT Gandhinagar** | — | — | — | NA |
| 10. | **IIT Patna** | — | ✓ | NA | NA |
| 11. | **IIT Jodhpur** | — | ✓ | NA | NA |
| 12. | **IIT Ropar** | — | ✓ | NA | NA |

| | | | | | |
|---|---|---|---|---|---|
| 13. | **IIT Indore** | — | — | NA | NA |
| 14. | **IIT Mandi** | — | — | NA | NA |
| 15. | **IIT(BHU)** | ✓ | ✓ | NA | NA |

* NA – Not Applicable

* — – No industry representation

***Question: 2 – Presence of a dedicated "Industry-Academia Cell" or its equivalent?***

Apart from having industry oriented syllabi, presence of dedicated I-A Cells in IITs fosters conversion of academic knowledge into technologies. As mentioned in table 6, out of 15 IITs, 14 (93.3%) have a dedicated cell for I-A interface eg. Sponsored Research & Industrial Consultancy (SRIC) in IIT Kharagpur, Industrial Research & Consultancy Centre (IRCC) in IIT Bombay, Centre for Industrial Consultancy & Sponsored Research (IC&SR) in IIT Madras, Industrial Research & Development (IRD) & Foundation for Innovation and Technology Transfer (FITT) in IIT Delhi.

**Table 6: Presence of I-A Cell or its Equivalent in IITs**

| S. No. | Name | Name of the Cell |
|---|---|---|
| 1. | **IIT Kharagpur** | • Sponsored Research & Industrial Consultancy (SRIC) Cell<br>• Science & Technology Entrepreneur's Park-Technology Business Incubator (STEP-TBI),<br>• Technology Incubation & Entrepreneurship Training Society (TIETS)<br>• Technopreneur Promotion Programme (TePP) Outreach cum Cluster Innovation Centre (TOCIC)<br>• Research Park at Rajarhat |
| 2. | **IIT Bombay** | • Industrial Research & Consultancy Centre (IRCC)<br>• Society for Innovation and Entrepreneurship (SINE)<br>• The Desai Sethi Centre for Entrepreneurship (DSCE)<br>• The Entrepreneurship Cell (E-Cell) |
| 3. | **IIT Madras** | • Industrial Consultancy and Sponsored Research (IC&SR) Centre |

| | | |
|---|---|---|
| | | • IIT Madras (IITM) Research Park<br>• IITM Incubation cell<br>• The Cell for Technology Innovation, Development and Entrepreneurship Support (C-TIDES)<br>• The Rural Technology Business Incubator (RTBI)<br>• Bio-Incubator |
| 4. | **IIT Kanpur** | • SIDBI Innovation and Incubation Centre (SIIC)<br>• TePP Outreach cum Cluster Innovation Centre (TOCIC) |
| 5. | **IIT Delhi** | • The Industrial Research and Development (IRD)<br>• Foundation for Innovation and Technology Transfer (FITT) |
| 6. | **IIT Guwahati** | • IITG-Technology Incubation Centre (IITG-TIC)<br>• The Rural Technology Action Group (RuTAG), North-East |
| 7. | **IIT Roorkee** | • Sponsored Research and Industrial Consultancy (SRIC) Cell<br>• Technology Incubation and Entrepreneurship Development Society (TIEDS)<br>• Entrepreneurship Development Cell (EDC)<br>• Technopreneur Promotion Programme (TePP) Outreach Centre (ToCIC). |
| 8. | **IIT Gandhinagar** | • Incubation centre (IIC)<br>• Innovation and Entrepreneurship Centre (IIEC)<br>• Technology Business Incubator (DST-TBI) |
| 9. | **IIT Patna** | • Sponsored Research and Industrial Relations Unit (SRIRU)<br>• Entrepreneurship Club |
| 10. | **IIT Jodhpur** | • Entrepreneurship cell |
| 11. | **IIT Ropar** | • Prototype Development and Innovation Fund (Entrepreneurship Cell)<br>• Intellectual Property Rights (IPR) Cell<br>• Centre for Innovation and Business Incubation (CIBI)<br>• Technology Business Incubator (TBI) |
| 12. | **IIT Indore** | • Innovation and Entrepreneurship Development Centre (IEDC) |

| | | |
|---|---|---|
| 13. | **IIT(BHU)** | • Malaviya Centre for Innovation, Incubation and Entrepreneurship (MCIIE) |

***Question: 3 - Is the institute aware of the industry oriented Govt. funded programs like DSIR, TDB, BIRAC, PM's fellowship programme for doctoral research?***

Govt. funding plays a very crucial role in science based innovations and technologies that determine the global competitiveness of the nation. All the IITs are aware of govt. funded programmes which provide financial support for research and infrastructure development.

***Question: 4 – Industrial set up in the institute***

Nine IITs that have an industrial set up on the campus are at Kharagpur, Bombay, Madras, Kanpur, Delhi, Guwahati, Roorkee, Gandhinagar and Patna (Table 7). It can be assumed, that one of the main reasons for the industries being attracted to these IITs is that they are well established and have acquired experience and broad base of knowledge which is of immense value to the industry. Another reason for the same can be that these IITs are situated at locations which are industry dominant. Therefore, both the entities are easily accessible to each other, to address the needs of their respective domains.

**Table 7: Presence of Industrial Set Up in IITs**

| S. No. | Name | Name of the Set-up/ Laboratory |
|---|---|---|
| 1. | **IIT Kharagpur** | • Vodafone Essar-IIT Centre of Excellence in Telecommunications (VEICET)<br>• Steel Technology Centre<br>• General Motors-IIT Kharagpur Collaborative Research Laboratory on Electronics, Controls and Software |
| 2. | **IIT Bombay** | • Xilinx FPGA Laboratory<br>• The Tata Infotech Laboratory<br>• Intel Microelectronics Laboratory<br>• Laboratory for Intelligent Internet Research |

| | | |
|---|---|---|
| | | • Tata Consultancy Services Laboratory for VLSI Design and Device Characterization<br>• Texas Instruments Digital Signal Processing (TI-DSP) Laboratory<br>• Wadhwani Electronics Laboratory<br>• Cummins Engine Research Laboratory<br>• Applied Materials Nano manufacturing Laboratory<br>• Tata Teleservices-IITB Centre of Excellence in Telecommunications (TICET)<br>• VLSI Design Consortium |
| 3. | **IIT Madras** | • Autodesk, Microsoft and Intel have established Centres of Excellence and sponsored research laboratories in the campus.<br>• Reliance IITM Telecom Centre of Excellence (RITCOE) |
| 4. | **IIT Kanpur** | • BSNL-IITK Telecom Center of Excellence<br>• Samtel Center for Display Technologies (SCDT) |
| 5. | **IIT Delhi** | • Bharti School Of Telecommunication Technology And Management<br>• Airtel IIT Delhi Centre of Excellence in Telecommunications (AICET) |
| 6. | **IIT Guwahati** | • Society for Applied Microwave Electronic Engineering and Research-SAMEER |
| 7. | **IIT Roorkee** | • Intel set up a Planet Labs in E&C Dept.<br>• Cisco set up equipment for a Telephony and Security Lab<br>• RailTel IIT Roorkee Centre of Excellence in Telecom (RICET) |
| 8. | **IIT Gandhinagar** | • Grant from the Underwriters Laboratories Inc (UL) to develop safety initiatives at the Institute.<br>• Ricoh Company Ltd, aided the establishment of a Centre for Design and Innovation at the Institute.<br>• Analog Teaching Lab Setup by Cranes Software International Limited<br>• C2000 Micro Controller Lab Setup by Cranes Software International Limited |
| 9. | **IIT Patna** | • Elsevier Centre of Excellence for Natural Language Processing<br>• Sushrut-eZDI Research Lab |

***Question: 5 –Industry sponsored research fellowship in the institute***

The investment of private sector in R&D activities is a key parameter for commercialisation of technologies and for taking them from the bench to the market. It has been observed that the time for commercialising technologies is shorter in countries where private sector is actively engaged in R&D. One of the factors that reflect such engagements is 'industry sponsored research fellowships' in HEIs. As shown in table 8, industries have offered fellowships to almost all IITs (13) thereby promoting industrial research and active long term linkages of the two.

**Table 8: Industry Sponsored Fellowships in IITs**

| S. No. | Name | Industry Partner/ Name of the Fellowship |
|---|---|---|
| 1. | **IIT Kharagpur** | • TCS Research Scholarship Program<br>• Google India Fellowship<br>• Indian Oil Educational Scholarship<br>• Aditya Birla Scholarship<br>• Singapore Technologies Scholarship in Engineering |
| 2. | **IIT Bombay** | • OP Jindal Engineering and Management Scholarships<br>• TCS Research Scholarship Program<br>• Infosys Fellowship<br>• Intel India PhD Fellowship<br>• Crompton Greaves Research Fellowship Programme |
| 3. | **IIT Madras** | • Aditya Birla Scholarship<br>• TCS Research Scholarship Program<br>• OP Jindal Engineering and Management Scholarships<br>• Singapore Technologies Engineering Scholarship<br>• Nissan Scholarship |
| 4. | **IIT Kanpur** | • Aditya Birla Scholarship<br>• OP Jindal Engineering and Management Scholarships |
| 5. | **IIT Delhi** | • OP Jindal Engineering and Management Scholarships |
| 6. | **IIT Guwahati** | • ABB India Ltd. |
| 7. | **IIT Roorkee** | • OP Jindal Engineering and Management Scholarships |
| 8. | **IIT Bhubaneswar** | • WMG (Warwick Manufacturing Group, U.K.) |
| 9. | **IIT Gandhinagar** | • AIMIL LTD sponsors research at the institute |
| 10. | **IIT Patna** | • TCS Research Scholarship Program |

| | | |
|---|---|---|
| 11. | **IIT Indore** | • TCS Research Scholarship Program |
| 12. | **IIT Mandi** | • TCS Research Scholarship Program |
| 13. | **IIT(BHU)** | • TCS Scholarship Program<br>• OP Jindal Engineering and Management Scholarships |

***Question: 6 - Do the students of the institute visit industrial facilities on a regular basis?***

Industrial visits form an important part of the curricula and play an essential role in bridging the gap between classroom and the real world. Students learn about “real life” examples of application of science, engineering and business management.

Students from all the IITs involved in the study, visit industrial facilities on a regular basis to get an insight of the practicality and work ecosystem of the industries.

***Question: 7 - Incentives to faculty members / researchers who have obtained patents/ transferred technology?***

Providing impetus to the faculty members and researchers for generation of intellectual property (IP) (patents, technology transfer primarily) is of utmost significance to advocate research that can support economic prosperity of the nation. Eleven IITs i.e. 73% (Fig. 4) provide incentives to the faculty members and researchers to motivate them for undertaking research having societal impact.

The IITs that provide faculty with incentives are IIT Kharagpur, IIT Bombay, IIT Madras, IIT Kanpur, IIT Delhi, IIT Bhubaneswar, IIT Jodhpur, IIT Gandhinagar, IIT Indore, IIT Mandi and IIT(BHU).

IIT Guwahati, IIT Roorkee and IIT Patna do not have any provision for incentivising their faculty members/researchers who have obtained IP or commercialized technology.

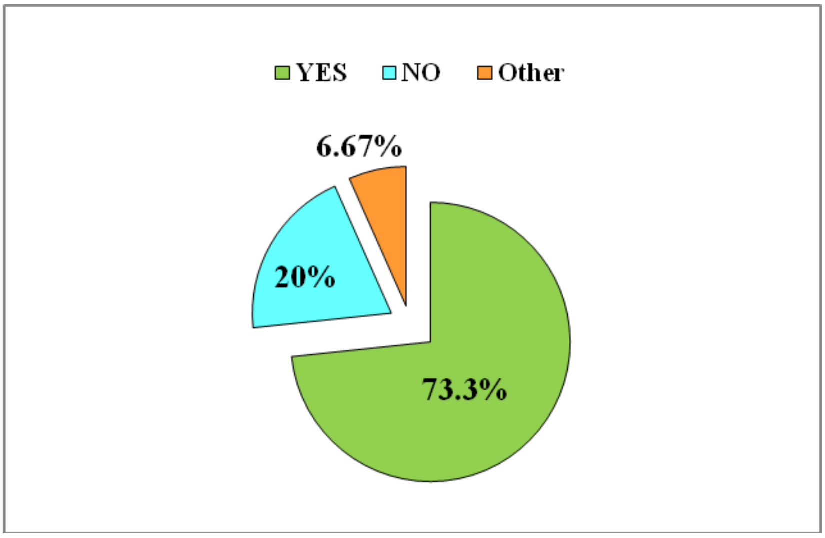


**Figure 4: Percentage of IITs Providing Incentives to Faculty/Researchers with Patents/Tech Transfers**

***Question: 8 – Provision of leave to the faculty to take an assignment in the industry?***

Paid leaves and sabbaticals are a way of giving time to the faculty and researchers for indulging in extra academic research collaborations. Fourteen IITs have this provision for their faculty members which gives them an opportunity to take assignments with the industry. IIT Gandhinagar does not give permission to its faculty to take any sabbatical for working with an industry.

***Question: 9 - Does the institute offer special courses/ modules for regular employees of the industry?***

In order to attract the industry towards the academic sector, academia can offer certain specific courses or modules for industry employees. These courses will help the industry employees to obtain certification for their professional growth. As observed in table 9 out of 15 IITs, 10 provide such special courses. For example FITT in IIT Delhi has initiated 'Professional Candidate Registration' (PCR) programme through which a number of courses in different fields are offered by the institute in accordance to suitable time slots, for commencing part time post-graduate/Ph.D. programme. There are certain online modules as well that can be taken up by industry personnel.

**Table 9: IITs Offering Special Courses for Industry Personnel**

| S. No. | Name | Name of the Courses |
|---|---|---|
| 1. | **IIT Kharagpur** | • Continuing Education Programme (CEP) |
| 2. | **IIT Bombay** | • Continuing Education Programme (CEP) |
| 3. | **IIT Madras** | • Continuing Education Programme (CEP) |
| 4. | **IIT Kanpur** | • Continuing Education Programme (CEP) |
| 5. | **IIT Delhi** | • Professional Candidate Registration (PCR) programme<br>• Continuing Education Programme (CEP) |
| 6. | **IIT Roorkee** | • Continuing Education Programme (CEP) |
| 7. | **IIT Bhubaneswar** | • Continuing Education Programme (CEP) |
| 8. | **IIT Gandhinagar** | • Continuing Education Programme (CEP) |
| 9. | **IIT Ropar** | • External Registration Program (Part-time Ph.D) for industry personnel |
| 10. | **IIT Indore** | • Continuing Education Programme (CEP) |
| 11. | **IIT(BHU)** | • Short term courses/ training programmes |

***Question: 10 - Does the industry use infrastructure resources like instruments, library, legal services, any other of the institute?***

A number of HEIs have a large pool of infrastructural resources and facilities that are of world class status. In order to establish effective I-A interface, both academia and industry should develop close collaboration with freedom of exchange of knowledge and resources such as instruments, library and other services. IITs are in the forefront of promoting industrial linkages. As depicted in Figure 5, 93.33% of the IITs (14) have set up a freedom of resource access for the industries that has lead to strong foundation for endowing I-A linkages. IIT Patna does not have any such provision of resource sharing.

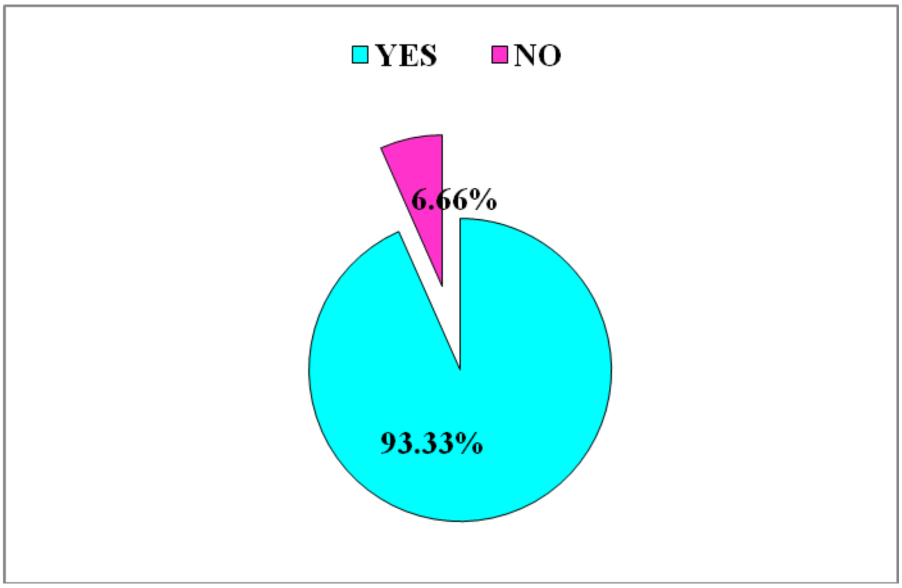


**Figure 5: Percentage of IITs Sharing Infrastructure with Industries**

***Question: 11 - Does the institute have an IPR Cell/Entrepreneurship Cell/Placement Cell/Technology Transfer Cell/any other?***

All IITs have a dedicated cell for IPR management/Entrepreneurship/Technology transfer. Presence of such cells aids in stimulating process of ideation to commercialization. These cells take responsibility for rendering all kinds of IPR assistance and inductive services like patenting and licensing. Expert mentorship for entrepreneurship and start-ups is also provided by these cells.

***Question: 12 - Does the institute engage industry personals for teaching programmes? If yes, are they engaged as: (a) Invited speakers for a few lecture, (b) Guest faculty, (c) Adjunct faculty***

In order to proliferate I-A linkages, not only industry oriented research should be undertaken by the academia, but they should also encourage industry participation via inviting speakers for special lectures or as a faculty (guest/adjunct), to bring forward industrial needs, practices and experiences amongst students.

Figure 6 and table 10 represent the number and percentage respectively, of IITs that engage industry personnel for different teaching programs. 14 IITs (93%), invite speakers from the industry to deliver special lectures in the field of their expertise. These kind of invited lectures are helpful for students to integrate the practical knowledge with theoretical aspects. Ten IITs

(67%) and eleven IITs (73%) have tied up with the industry experts to be the guest faculty and adjunct faculty at their institutes, respectively.

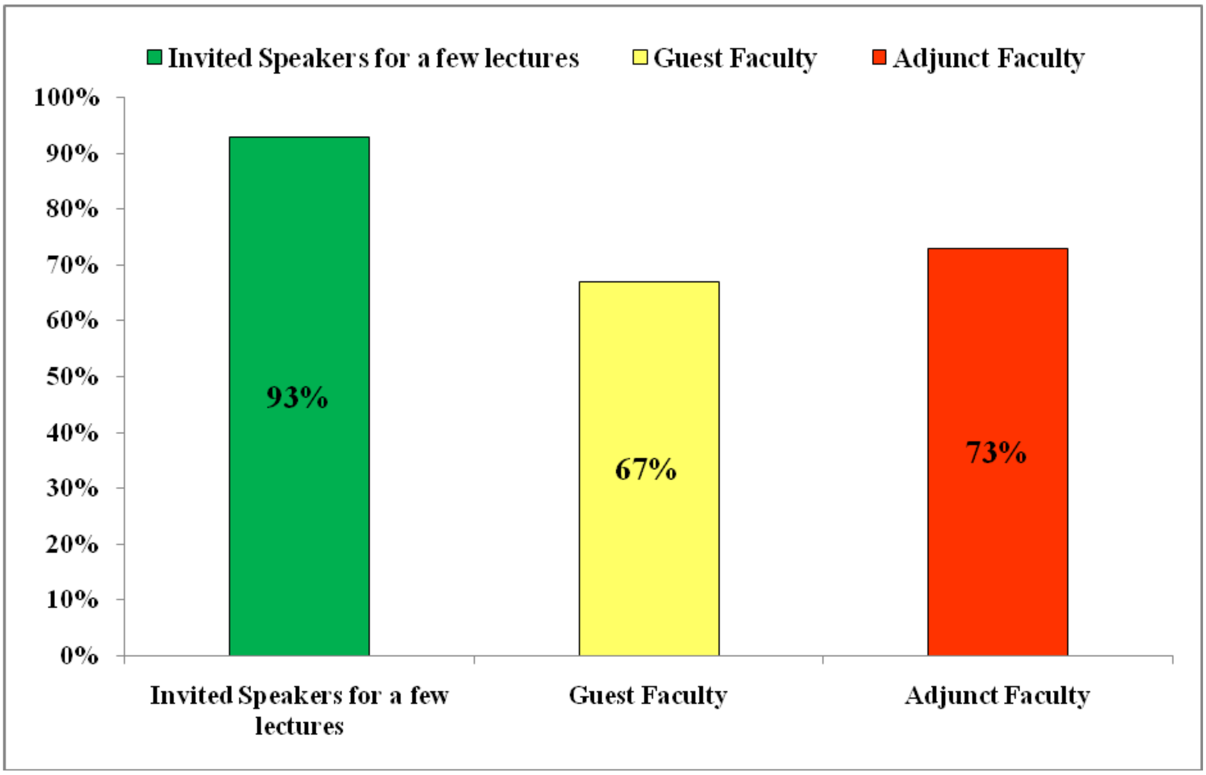


**Figure 6: Percentage of IITs Engaging Industry Experts in Teaching Programme**

**Table 10: IITs Involving Industry Personnel in Teaching Programs**

| S. No. | Name | Invite Speakers for Special Lectures | Guest Faculty | Adjunct Faculty |
|---|---|---|---|---|
| 1. | **IIT Kharagpur** | ✓ | ✓ | ✓ |
| 2. | **IIT Bombay** | ✓ | — | ✓ |
| 3. | **IIT Madras** | ✓ | ✓ | ✓ |
| 4. | **IIT Kanpur** | ✓ | ✓ | ✓ |
| 5. | **IIT Delhi** | ✓ | ✓ | ✓ |
| 6. | **IIT Guwahati** | ✓ | ✓ | — |
| 7. | **IIT Roorkee** | — | — | — |
| 8. | **IIT Bhubaneswar** | ✓ | ✓ | ✓ |
| 9. | **IIT Gandhinagar** | ✓ | ✓ | ✓ |

| | | | | |
|---|---|---|---|---|
| 10. | **IIT Patna** | ✓ | ✓ | ✓ |
| 11. | **IIT Jodhpur** | ✓ | ✓ | ✓ |
| 12. | **IIT Ropar** | ✓ | — | — |
| 13. | **IIT Indore** | ✓ | — | ✓ |
| 14. | **IIT Mandi** | ✓ | — | — |
| 15. | **IIT(BHU)** | ✓ | ✓ | ✓ |

*** —** – No industry personnel in teaching programmes

***Question: 13 – Statistics of Patents Filed, Patents Granted, Technology Transfer, and MoUs signed with the industries, of IITs.***

In today's era of knowledge economy an organization gains the trust and competence by means of its IP profile. The physical assets of an institution are of less worth and value as compared to the intangible capital (know-how, innovations, inventions etc.). IPRs are statutory rights that allow inventors to exploit their inventions for an exclusive time period. IPRs are not only devices/tools to protect ones innovation and creative ideas for generation of revenue but they are also the basis of strong alliances between different stakeholders for the benefit of society and technological development. IITs take special efforts to undertake innovative research leading to generation of IP.

Table 11 enlists the number of patents (filed and granted), technologies commercialized, technologies under process and MoUs with industries, of IITs in the last five years. Figure 7 (A & B) represents the patents filed and granted of first generation and second generation IITs respectively. Figure 8 represents the technologies commercialized and technology commercialization under process by first generation IITs. Second generation IITs are yet to open their account in the parameters of technology commercialization. Figure 9 (A & B) depicts the MoUs signed with the industries of the first and second generation IITs respectively.

IITs at Bombay, Kanpur, Madras and Delhi are performing exceptionally well in transferring technologies developed at the institute (73, 56, 17 and 15 respectively) to the market. These institutes have also generated remarkable number of IP in terms of patent (filed/granted) – IIT Bombay (439/61), IIT Kanpur (204/09), IIT Madras (311/24), IIT Delhi (146/25) and IIT Kharagpur (231/13), in the last five years (2010-15).

Amongst the second generation IITs of IIT(BHU), IIT Roorkee, IIT Ropar, IIT Bhubaneswar and IIT Patna have credited themselves with a satisfactory number of patent filings (> 10). IIT(BHU) and IIT Roorkee, have been granted 3 patents each.

Another parameter that reflects the successful I-A interface, is number of MoUs signed between industries and institutes. Maximum number of MoUs have been signed by IIT-Bombay (225) followed by IIT Madras (176), IIT Kanpur (124) and IIT Kharagpur (60). Amongst the newer IITs maximum number of MoUs have been signed by IIT Gandhinagar and IIT(BHU) (14 each) followed by IIT Jodhpur and IIT Bhubaneswar (6 each).

**Table 11: Patents, Technology Transfer and MoU Details 2010 Onwards**

| S. No. | Name | Patents | | Technology Transfers | | MoU with Industries | |
|---|---|---|---|---|---|---|---|
| | | Granted | Filed | Commercialized | Under Process | Signed | Under Process |
| 1. | **IIT Kharagpur** | 13 | 231 | 09 | 02 | 60 | 10 |
| 2. | **IIT Bombay** | 61 | 439 | 73 | 00 | 225 | 00 |
| 3. | **IIT Madras** | 24 | 311 | 17 | 05 | 176 | 00 |
| 4. | **IIT Kanpur** | 09 | 204 | 56 | 00 | 124 | 00 |
| 5. | **IIT Delhi** | 25 | 146 | 15 | 01 | 08 | 03 |
| 6. | **IIT Guwahati** | 06 | 61 | 04 | 01 | 14 | 00 |
| 7. | **IIT Roorkee** | 03 | 22 | 00 | 00 | 03 | 00 |
| 8. | **IIT Bhubaneswar** | 00 | 10 | 00 | 00 | 06 | 00 |
| 9. | **IIT Gandhinagar** | 00 | 04 | 00 | 00 | 14 | 00 |
| 10. | **IIT Patna** | 00 | 09 | 00 | 00 | 00 | 00 |
| 11. | **IIT Jodhpur** | 00 | 05 | 00 | 00 | 06 | 01 |
| 12. | **IIT Ropar** | 00 | >10 | 00 | 00 | 00 | 02 |
| 13. | **IIT Indore** | 00 | 07 | 00 | 00 | 02 | 00 |
| 14. | **IIT Mandi** | 00 | 01 | 00 | 00 | 03 | 00 |
| 15. | **IIT(BHU)** | 03 | 09 | 00 | 00 | 14 | 08 |
| | **Total** | **144** | **1469** | **174** | **09** | **655** | **24** |

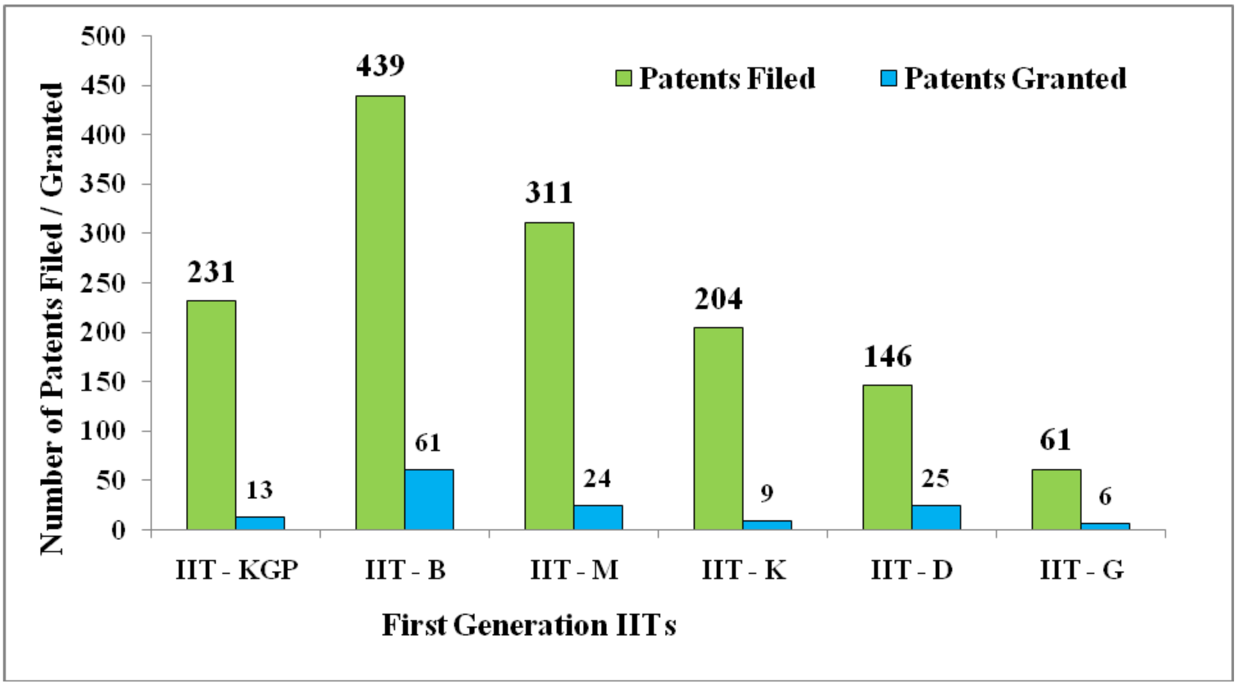


**Figure 7 (A): Patents Filed/Granted of First Generation IITs**

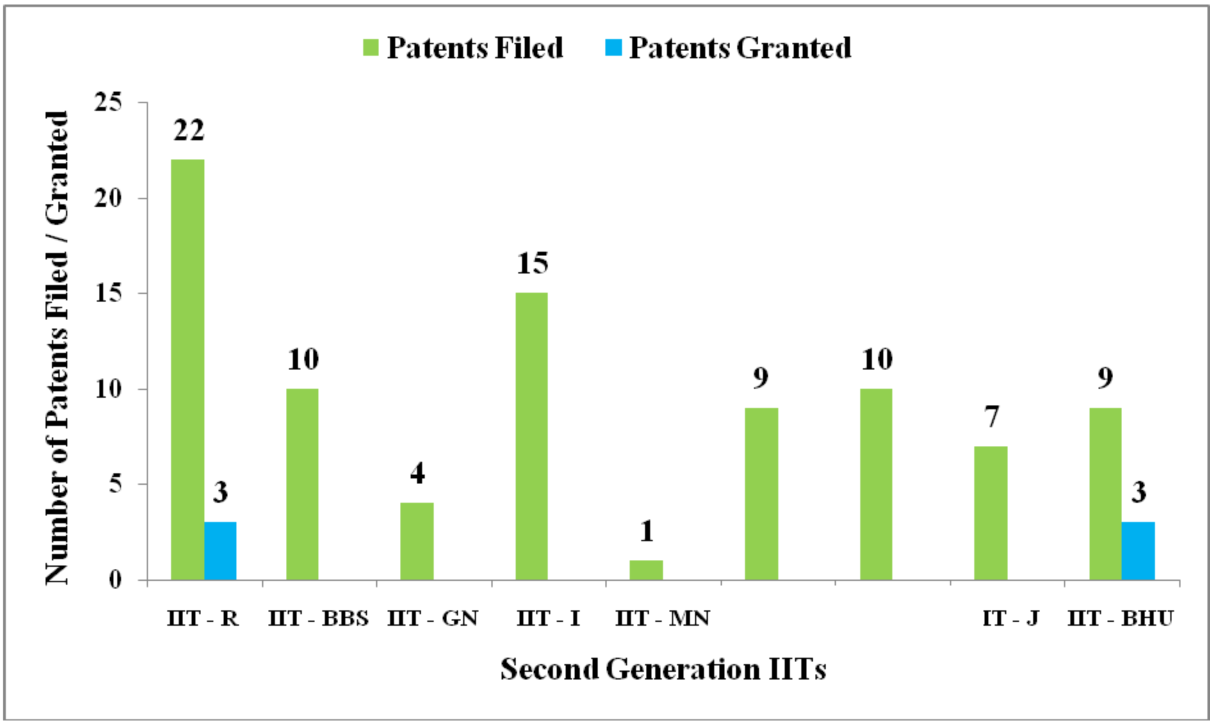


**Figure 7 (B): Patents Filed/Granted of Second Generation IITs**

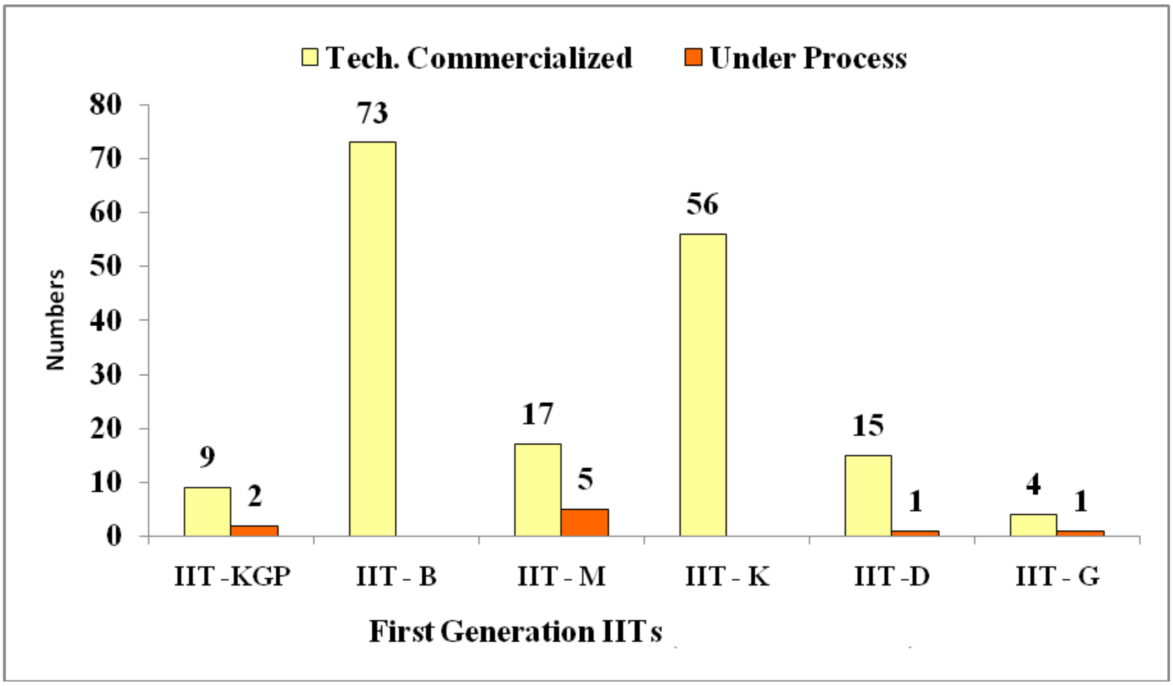


Figure 8: Technologies Commercialized/ Under Process of First Generation IITs

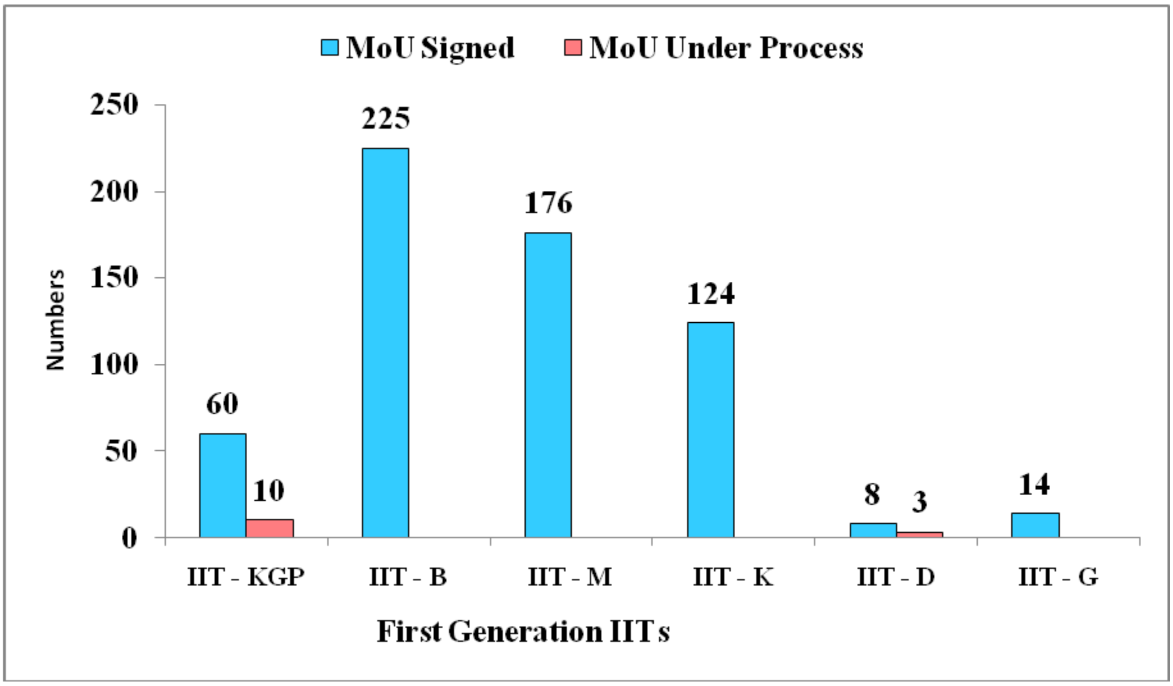


Figure 9 (A): Industry-Academia MoUs of IITs (first generation)

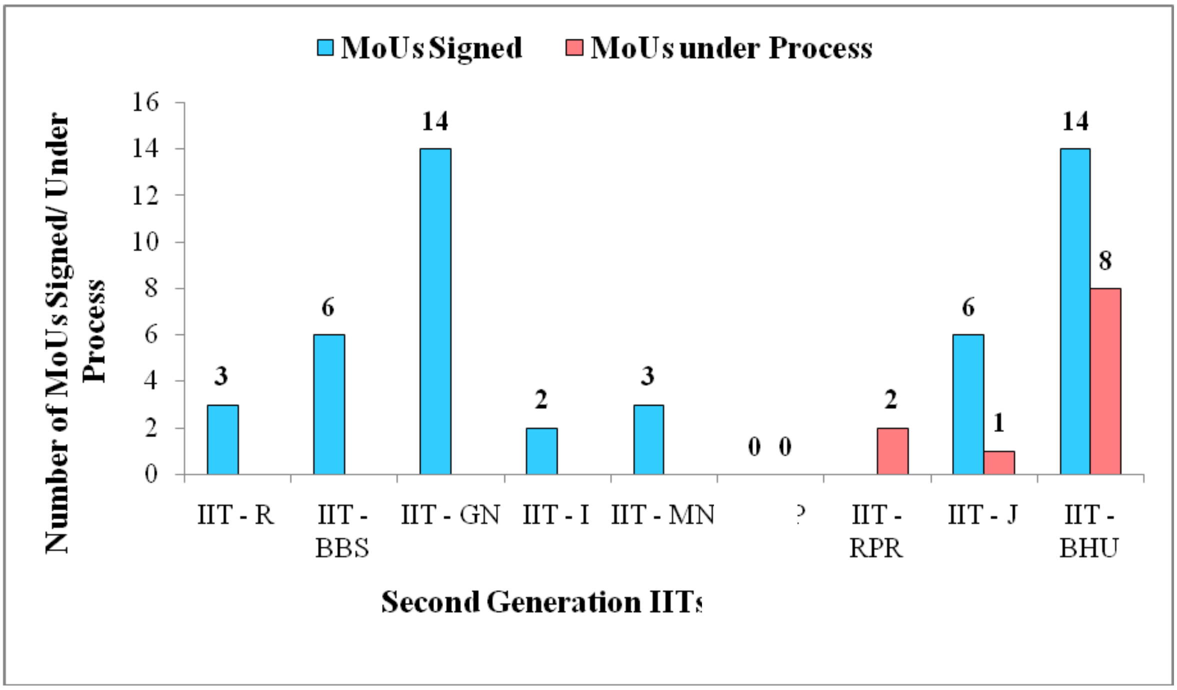


**Figure 9 (B): Industry-Academia MoUs of IITs (second generation)**

***Question: 14 –- Organisation of workshops/conferences/seminars in association with the industry?***

Workshops, seminars and conferences give an opportunity to the stakeholders of I-A linkages to interact with each other at one single platform. These modes of interaction apprise the entities of the latest developments in each other's fields and the scope for collaboration. Realising the importance of such events all IITs are actively engaged in organising workshops, conferences and seminars in association with the industry. The industry benefits largely from these events by means of gathering academic expertise for problem solving and betterment of existing technologies.

***Question: 15 - Factors hampering the growth of Industry-Academia linkages:***

a) ***Lack of common area of interest:*** 7 of the 15 IITs agree on this factor (46.7%).

b) ***Lack of co-operation from industry:*** 6 of the 15 IITs agree on this factor (40%).

c) ***Intellectual property rights issues:*** 5 of the 15 IITs agree on this factor (33.3%).

d) ***Not much weightage given by the institute to develop industrial linkages:*** 4 of the 15 IITs agree on this factor (26.7%).

e) ***Lack of incentives for industry driven research:*** 5 of the 15 IITs agree on this factor (33.3%).

*f)* ***Others:*** 2 (new generation) of the 15 IITs have stated additional factors (13.33%)

- Being new institutes, the priority was given to setting up of laboratories and other infrastructure required for UG/PG teaching.
- Faculty members not yet ready to handle industry relations.

It is observed that most of the IITs (46%) (IIT Indore, IIT Delhi, IIT Madras, IIT Mandi, IIT Bombay, IIT Gandhinagar and IIT Patna) believe lack of common area of interest to be a major factor that hampers growth of I-A linkages, which can be explained by the lack of awareness of research areas/interests of both the organisations (Fig. 10). Therefore, measures should be taken to overcome this barrier by creation of modes such as National Web Portal.

Some of the IITs (IIT Indore, IIT Mandi, IIT Gandhinagar, IIT Kanpur, IIT Kharagpur and IIT Patna) feel that the industry does not come forward for joining hands (40%) and a few of them (IIT Indore, IIT Madras, IIT Gandhinagar, IIT Kharagpur and IIT Patna) also agree that the complications related to IPR pose as a bottleneck (33.3%). The issues of lack of confidence in each other and time constraints add to these factors. The lack of incentivisation, as discussed above (Q. 7), by the institute is also a factor that hinders I-A interactions.

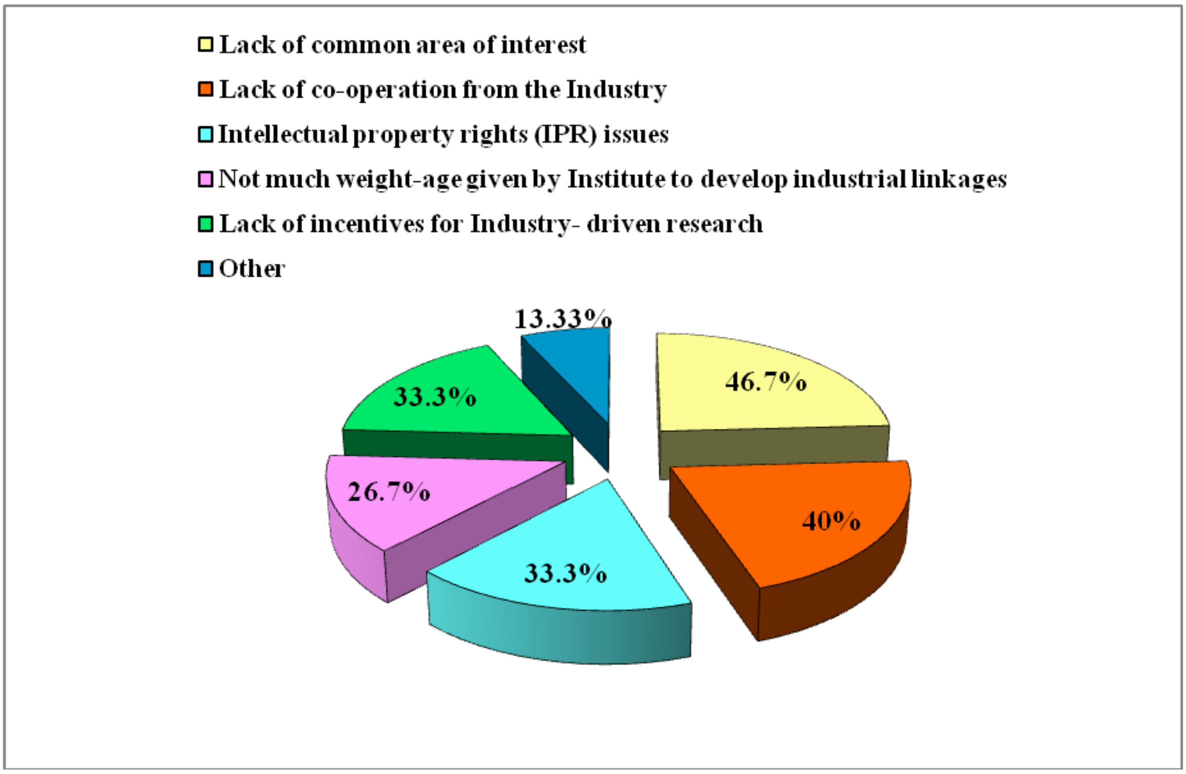


**Figure 10: Factors Hampering the Growth of I-A Linkages in Institute**

***Question: 16 – Lack of sensitization of Intellectual Property Rights (IPR) in the institute is because of:***

Figure 11 and table 12 represent the factors affecting generation of IP in IITs.

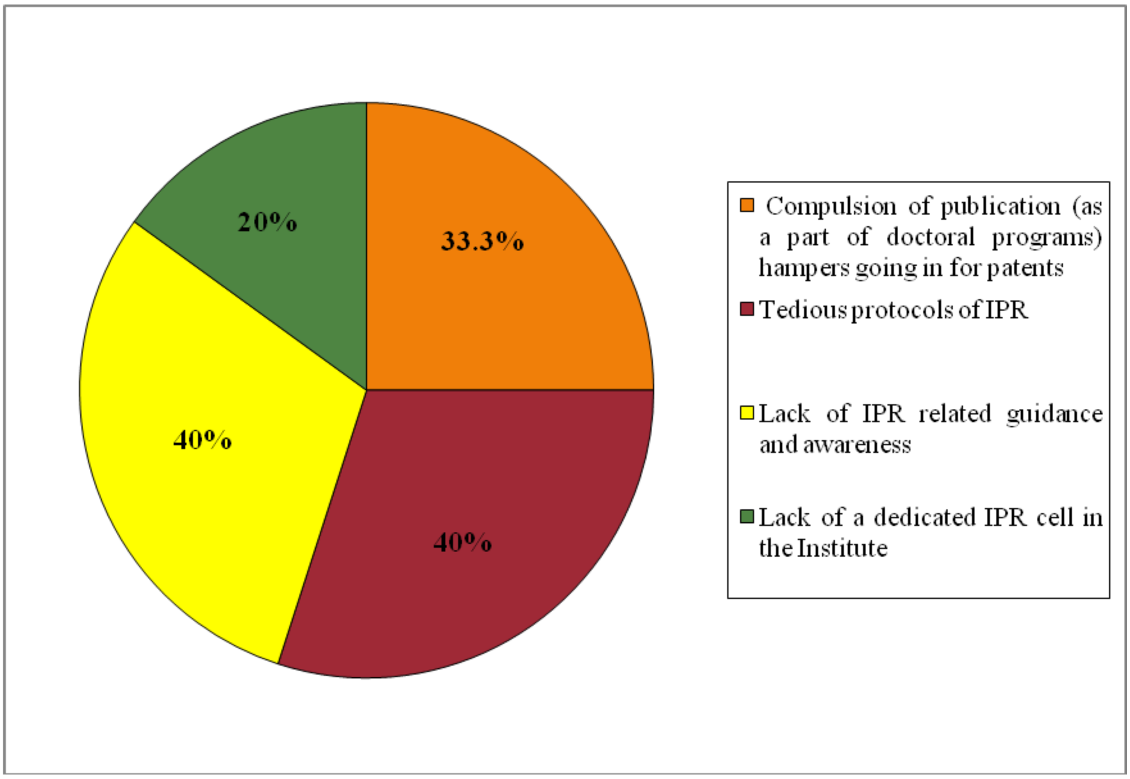


**Figure 11: Factors Responsible for Lack of Sensitization of IPR in IITs**

**Table 12: Factors Responsible for Lack of Sensitization of IPR in the Institutes**

| S. No. | Factor | Percentage | Responders |
|---|---|---|---|
| ***a)*** | ***Compulsion of publication (as a part of doctoral programme) hampers going in for patents*** | 33.3% | IIT Mandi, IIT Gandhinagar, IIT Kanpur, IIT Kharagpur and IIT Patna stated that the academic sector gives more weightage to the publications than to IP. |
| ***b)*** | ***Tedious protocols of IPR*** | 40.0% | 6 IITs [IIT Delhi, IIT Mandi, IIT Ropar, IIT Kharagpur, IIT Patna, IIT(BHU)] agree that filing of IP is a cumbersome process and also involves high finances and time, which is not affordable by every researcher. |
| ***c)*** | ***Lack of IPR related guidance and*** | 40.0% | 6 IITs (IIT Delhi, IIT Mandi, IIT |

| | | | |
|---|---|---|---|
| | ***awareness*** | | Ropar, IIT Jodhpur, IIT Patna, IIT-BHU) agree upon the unavailability of appropriate guidance at the right time. |
| ***d)*** | ***Lack of dedicated IPR Cell in the institute*** | 20.0% | IIT(BHU), IIT Mandi and IIT Patna. |

***Question: 17 - Barriers preventing the successful technology transfers from the institute to industry:***

The successful conversion of academic knowledge into technologies is imperative for achieving global competitiveness in the area of science & technology. Table 13 and figure 12 highlight the barriers faced by IITs in technology transfers.

**Table 13: Factors Responsible for Hindering Technology Transfer in Institutes**

| S. No. | Factor | Percentage | Responders |
|---|---|---|---|
| ***a)*** | ***Inadequate legal support services*** | 26.7% | Four IITs (IIT Mandi, IIT Ropar, IIT Kharagpur and IIT Patna) feel that the lack of legal support is a hampering factor. One of the reasons may be the fact that hiring external legal services require audit permissions and high financial resources. |
| ***b)*** | ***Inadequate technical facilities*** | 13.3% | Only 2 IITs [IIT(BHU) and IIT Roorkee] feel that unavailability of technical facilities hampers the testing of prototype of a new technology. The unavailability of technical facilities could be credited to lack of funds, lack of technical support and lack of maintenance. |

| | | | |
|---|---|---|---|
| *c)* | ***Others*** | 46.67% | 7 IITs (IIT Kanpur, IIT Jodhpur, IIT Gandhinagar, IIT Bombay, IIT Mandi, IIT Madras, IIT Delhi) have stated other factors that hamper technology transfers, such as<br>• Lack of govt. support and incentivisation of faculty<br>• Technology developed is not ready for industry<br>• Lack of training to assess the need and market for a technology<br>• Insignificant portfolio of patents in technology domain<br>• Insufficient engagements of faculty with the industry |

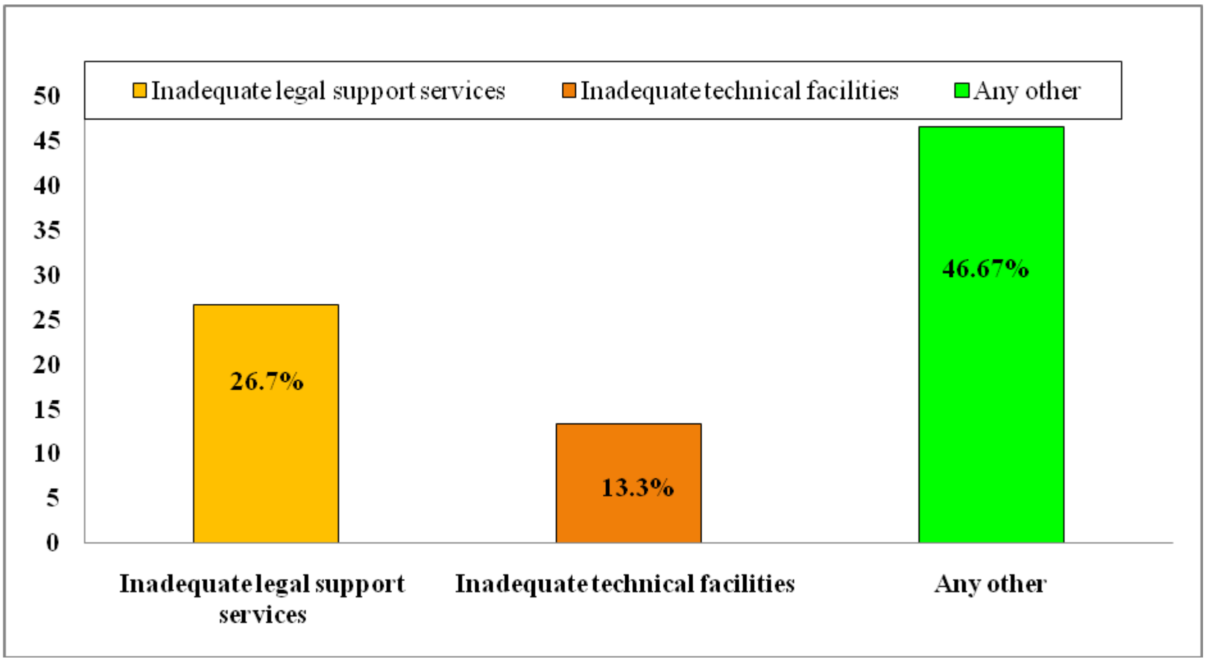


**Figure 12: Barriers Preventing Successful Technology Transfer from Institute**

## 4. Summary

The I-A Questionnaire was sent to 16 IITs. Two newly established IITs at Tirupati and Palakkad were not included in the study. IIT-Hyderabad did not respond to our questionnaire, despite repeated reminders. The salient points of the survey are:

- Majority of IITs have adequate presence of industrial sector in the form of members of governing/academic bodies, delivering guest lectures and holding joint workshops/seminars/conferences.
- Out of 15 IITs, 12 IITs provide industrial training to students in the fields of *Engineering*, 7 IITs in *Life Sciences* and 4 IITs in *Business Management*. Only IIT Kharagpur has a course in '*Legal Studies'* and imparts practical training as well.
- By and large all the IITs have dedicated I-A Cells, IPR Management Cells and Entrepreneurship Cells.
- Nine IITs have campus research centers set up by the industries. A few of them have been established under PPP mode e.g. Telecom Centers of Excellence.
- Majority of IITs (13) have industry sponsored '*Research Fellowships'* for the students.
- Eleven IITs have a provision for incentivizing faculty members/researchers who convert their innovations into patents/technologies. Three IITs namely, IIT Guwahati, IIT Patna and IIT Roorkee do not have such provision.
- Except IIT Gandhinagar, all IITs have a provision for sabbatical-leave for the faculty members willing to take up industrial assignments.
- Eleven IITs have a system of continuing education for the employees of the private sector. These IITs offer courses for the industrial sector that help employees achieve professional growth.
- All IITs are actively engaged in R&D. First generation IITs have excellent record in number of research publications, patents and tech transfers. In the period from 2010-2015, IIT Bombay is the frontrunner in the parameter of 'Patents Filed/Granted' (439 patents filed, 61 granted) followed by IIT Madras (311 patents filed, 24 granted). In the last five years, maximum numbers of technologies have been commercialized by IIT Bombay, followed by IIT Kanpur and IIT Madras. IIT Bombay is also at the forefront of signing MoUs with the industries (225 MoUs since 2010), followed by IIT Madras and IIT Kanpur.
- In the category of 'Factors hampering the growth of I-A linkages in IITs', seven IITs feel 'lack of common area of interest' and 'lack of cooperation from the industry' as the

major road blockers. Six IITs are of the view that the industry does not come forward for joining hands with academia for collaborative research. Five IITs believe 'lack of appropriate incentives for industry driven research' and 'the issue of IPR' as dampeners for effective I-A research collaborations. The issues of 'lack of confidence in each other' and 'time constraints' add to these factors.

- With regard to the lack of sensitization of IPR in the institute, 6 IITs feel that (a) tedious protocols of IPR and (b) lack of IPR related guidance constrain the faculty members to go in for technology oriented research work. Four IITs believe that the compulsion of publication in doctoral programmes hampers them from going in for IP protection. Seven IITs believe that (a) lack of governmental support, (b) in appropriate incentivisation to the faculty, (c) inadequate legal services, and (d) inadequate technical facilities also pose as bottlenecks for effective tech transfers and IP generation.

## 5. Conclusions

The industry and academia are two vital sectors for nation building, but have different goals and priorities. Earlier, both sectors were developing independent of each other. However, with changed scenario of the global economy, the hand shake of academia with industry has become an important component for the generation of innovations, for boosting the economy of the nations. Developed countries have already created bridges between academia and industry, whereas developing countries, including India, have just begun to make inroads.

In India, IITs are the flag bearers of industry-academia (I-A) relationship in the areas of academics as well as research. The governing bodies as well as academic bodies of IITs have industry personals on board. The industry visits by students is a serious business. Industry happily delivers guest lectures. Some of them have been accredited as adjunct-faculty. The creation of Industry Chairs and industry sponsored research-project/scholarships/fellowships in IITs is a reflection of the faith of industrial sector in IITs. Centres of Excellence (CoE) in IITs are a shining example of triple helix model for R&D under PPP mode, where intelligentsia in collaboration with industry works on the futuristic innovations for commercial gains or societal value. The funds for the development of infrastructure of are primarily provided by the government through funding agencies. These factors along with the presence of I-A Cell, Patent Cell, Entrepreneurship Cell has helped IITs to produce significant number of publications, patents and technologies. In addition, IITs are helping the industrial sector by running dedicated courses for its employees, which help them in gaining promotions.

Universities and national research labs in India have intelligentsia in abundance and are also equipped with reasonable number of equipments, courtesy UGC-SAP, DST-PURSE and TEQIP programmes. Once the missing links for translational research are provided to them, industry would be happy to tie up with scientists from academia and research labs. The extension of I-A linkages to academia and research labs will take to the tally of technologies and patents to a higher pedestal, thereby improving the S&T quotient of the nation.

Though the level of I-A interactions in IITs is quite satisfactory, but there is a room for improvement. Many of IIT scientists feel lack of (a) common area of interest, (b) cooperation from the industry, (c) incentives for industry driven research and (d) IPR knowledge are some of the important factors hampering the growth of I-A collaborative R&D. The first two factors can be addressed by having regular meetings of specific industry associations with the IIT professors. For the last two factors, IITs excelling in the areas of incentivisation of faculty and IPR Cell can act as mentors for other IITs to overcome these deficits.

1. *Enhancing industrial tie ups for imparting industrial training via industry visits and involving more and more of industry representatives in teaching programme.*
2. *Initiation of industrially designed courses catering to the industrial needs and expectations.*
3. *Induction of special courses for industry personals to pursue education along with their job commitments to increase their knowledge pool.*

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## ***Annexure I***

### Academic fields offered at different IITs

| Name | Life Sciences | Engineering Sciences | Business Management | Legal Studies |
|---|---|---|---|---|
| **IIT Kharagpur** | ✓ | ✓ | ✓ | ✓ |
| **IIT Bombay** | ✓ | ✓ | ✓ | — |
| **IIT Madras** | ✓ | ✓ | ✓ | — |
| **IIT Kanpur** | ✓ | ✓ | ✓ | — |
| **IIT Delhi** | ✓ | ✓ | ✓ | — |
| **IIT Guwahati** | ✓ | ✓ | — | — |
| **IIT Roorkee** | ✓ | ✓ | ✓ | — |
| **IIT Bhubaneswar** | --- | ✓ | ✓ | — |
| **IIT Gandhinagar** | ✓ | ✓ | ✓ | — |
| **IIT Patna** | ✓ | ✓ | --- | — |
| **IIT Jodhpur** | ✓ | ✓ | --- | — |
| **IIT Ropar** | ✓ | ✓ | — | — |
| **IIT Indore** | ✓ | ✓ | — | — |
| **IIT Mandi** | ✓ | ✓ | — | — |
| **IIT(BHU), Varanasi** | ✓ | ✓ | — | — |
| **Total** | **14** | **15** | **8** | **1** |

***Source:*** *http://www.iitkgp.ac.in/, http://www.iitb.ac.in/, https://www.iitm.ac.in/, http://www.iitk.ac.in/, http://www.iitd.ac.in/, http://www.iitg.ac.in/, http://www.iitr.ac.in/, http://www.iitbbs.ac.in/, http://www.iitgn.ac.in/, http://www.iiti.ac.in/, http://www.iitmandi.ac.in/, http://www.iitp.ac.in/, http://www.iitrpr.ac.in/, http://www.iitj.ac.in/, http://www.iitbhu.ac.in/*

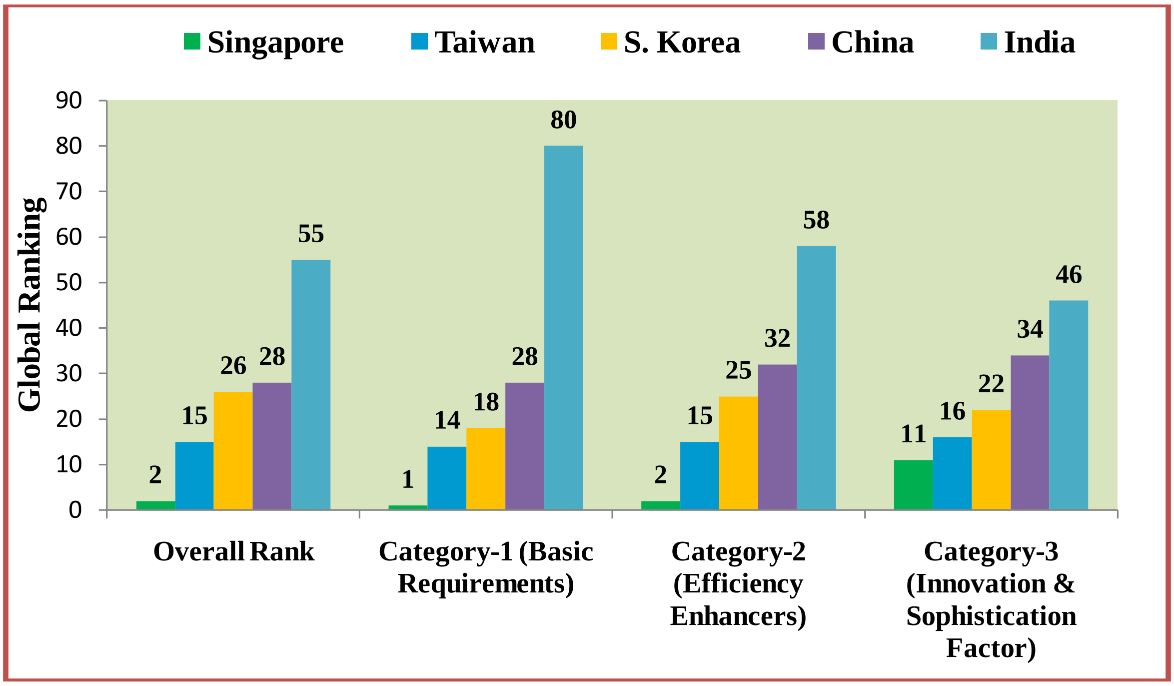
सत्यमेव जयते
Department of Science & Technology
Govt. of India

# DST-Centre for Policy Research at PU, Chd.

*(DST/PRC/CPR-03/2013)*

## <u>REPORT-7</u>

# *Comparative Study of Asian Economies: Lessons for India*



# Index

# 1. Introduction

In the 21st century, Asia is perceived to be the most dynamic part of the global economy. In this report, a comparative study has been carried out on five Asian countries (Singapore, Taiwan, South Korea, China and India) based on The Global Competitiveness Index (GCI) Report 2015-16, published by The World Economic Forum (WEF). These nations were struggling economies at the time of their Independence which was around in the middle of 20th century. However, since then Singapore has made stupendous progress and is amongst the top five successful economies of the world. Taiwan, S. Korea and China have also made significant strides and are globally ranked 15, 26 and 28 respectively. India opened its market to the world in the last decade of 20th century. Singapore, Taiwan and S. Korea are considered as 'Innovation driven economies', China as 'Efficiency driven economy' and India as 'Factor driven economy'. India has all the basic ingredients to be counted among major global economic players. However, for migration to 'Efficiency/Innovation driven economy' India needs to seriously address many pillars/indicators belonging to the categories of "Basic Requirements" and "Efficiency Enhancers".

These Asian countries are progressing at a fast pace and becoming significant part of the global economy. Countries like, Singapore, Taiwan and S. Korea, despite being small in size and population have made remarkable progress in various economic parameters and have leap-frogged into the category of 'Innovation driven economy', which was earlier dominated by western countries such as USA, UK, Germany, Canada and France. Singapore has been recognised as world's leading international financial centre, Taiwan has become largest importer and exporter of merchandise and S. Korea has earned the reputation of leading manufacturers of information technology equipments. It is perceived by think tanks of the world that in the near future, two other Asian countries, India and China, will be the leading economies of the world as they have all the ingredients needed for becoming economically stable nations, e.g. plenty of natural resources, huge land and coastal areas, abundant scientists and universities, many advanced research laboratories/institutions and young workforce. China has reformed its economic policies and is quite serious in its implementation as well. India's economic policies and mode of governance have also been reformulated, but implementation of the policies needs a fresh impetus.

The comparison carried out in this report is based on various domains such as health, education, science and technology (S&T), infrastructure, marketing capability/capacity, legal framework etc. The report also lists out parameters in which India has to work very hard, if it desires to be counted as a developed nation. Table 1 lists general information about Singapore, Taiwan, S. Korea, China and India. Except Singapore, other three countries became independent nations around the middle of the 20$^{th}$ century (there is no official independence day of Taiwan). Singapore tasted independence a bit later, in 1965. India and China possess large land mass and are densely populated as compared to Singapore, Taiwan and S. Korea. All the five nations have different modes of governance and type of economies.

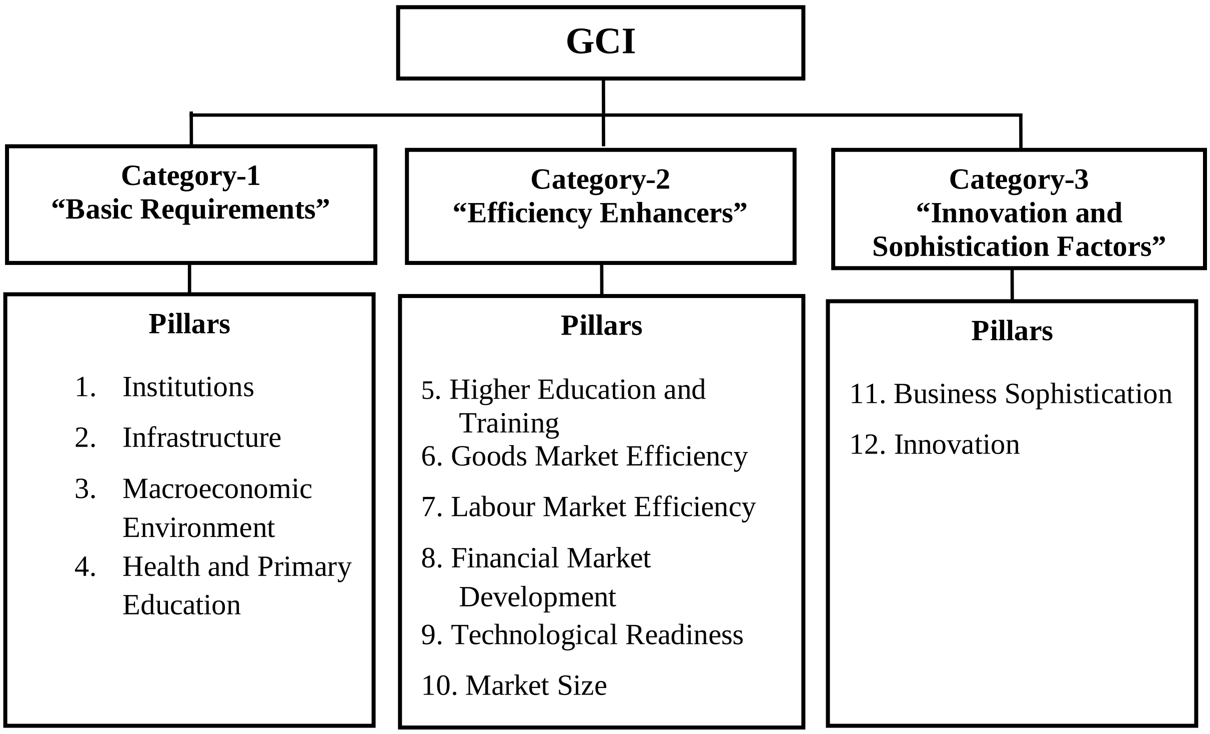
**Table 1: General information about select Asian countries**

| Attributes | Singapore | Taiwan | S. Korea | China | India |
|---|---|---|---|---|---|
| Independence | August 9, 1965 | No official day | August 15, 1948 | October 1, 1949 | August 15, 1947 |
| Population[a] (billions) | 0.057 | 0.02343[b] | 0.504 | 1.364 | 1.295 |
| Land Area[a] (square kilometers) | 707 | 36,193[c] | 97,466 | 9,388,211 | 2,973,190 |
| Mode of Government | Parliamentary Republic | Multi-Party Democracy[c] (Semi-Presidential) | Presidential | Autocratic Socialist | Federal Republic |
| Mode of Economy | Free Market | Capitalist Economy | Market Economy | Socialist Market | Mixed Economy |

***Source:*** *a-World Bank-2014 (www.worldbank.org),*
*b-Trading Economy (http://www.tradingeconomics.com/taiwan/indicators), c- http://www.taiwan.gov.tw*

## 2. Structure of GCI and comparison of five Asian economies

GCI compares the economic competitiveness of nations (140 nations in 2015-16 edition) based on the statistical data collected from internationally recognized agencies, like International Monitory Fund (IMF), World Health Organization (WHO), and United States-India Educational Foundation Education (USIEF) etc. GCI data is divided into three broad categories ("Basic Requirements", "Efficiency Enhancers" and "Innovations and Sophistication Factors") comprising of 12 pillars (P) (Fig.1) which encompass 114 indicators (I) (mentioned in the text). The classification of world economies which is based on the stage of development is given in Table 2. The stage of development [Stage 1 (Factor driven), Stage 2 (Efficiency driven) and Stage 3 (Innovation driven)] of a country is being proxied by its GDP per capita (US$). GCI takes stages of development into account by considering higher relative weights to those pillars that are more relevant for an economy given its particular stage of development. Any country which falls between two of the stages are considered in transition stage.




***Source:*** *The Global Competitiveness Index (GCI) Report 2015-16*

**Fig. 1: Classification of Global Competitiveness Index**

**Table 2: Classification of world economies based on the stages of development**

| Categories of GCI | Stages of development | | |
|---|---|---|---|
| | **Stage 1 (Factor driven)** | **Stage 2 (Efficiency driven)** | **Stage 3 (Innovation driven)** |
| **GDP per capita (US$) thresholds** | <2,000 | 3,000-8,999 | >17,000 |
| **Weightage (%) for each category of GCI** <br> *i. Basic Requirements* | 60 | 40 | 20 |
| *ii. Efficiency Enhancers* | 35 | 50 | 50 |
| *iii. Innovation and Sophistication Factors* | 5 | 10 | 30 |
| **Numbers of nations in each stage** | 35 Economies including India | 31 Economies including China | 38 Economies including Singapore, Taiwan, S. Korea |

***Source:*** *The Global Competitiveness Index (GCI) Report 2015-16*

As per GCI ranking of 140 nations, Singapore (2), Taiwan (15), S. Korea (26) are in 'Innovation driven stage', China (28) is in 'Efficiency driven stage' and India (55) is in 'Factor driven stage'. India has to cover a lot of ground for marching into Efficiency/Innovation driven stage. It needs to have a serious look at its economic policies as well as their implementation approaches. Similarly, China has to do introspection and make changes in policies and governance for advancing to innovative stage. The comparative graphical depiction of all 5 countries based on three categories ("Basis Requirements", "Efficiency Enhancers" and "Innovation & Sophistication Factor") is given below in Fig. 2. The area in which more emphasis is needed by these countries is discussed in the following text and tables.

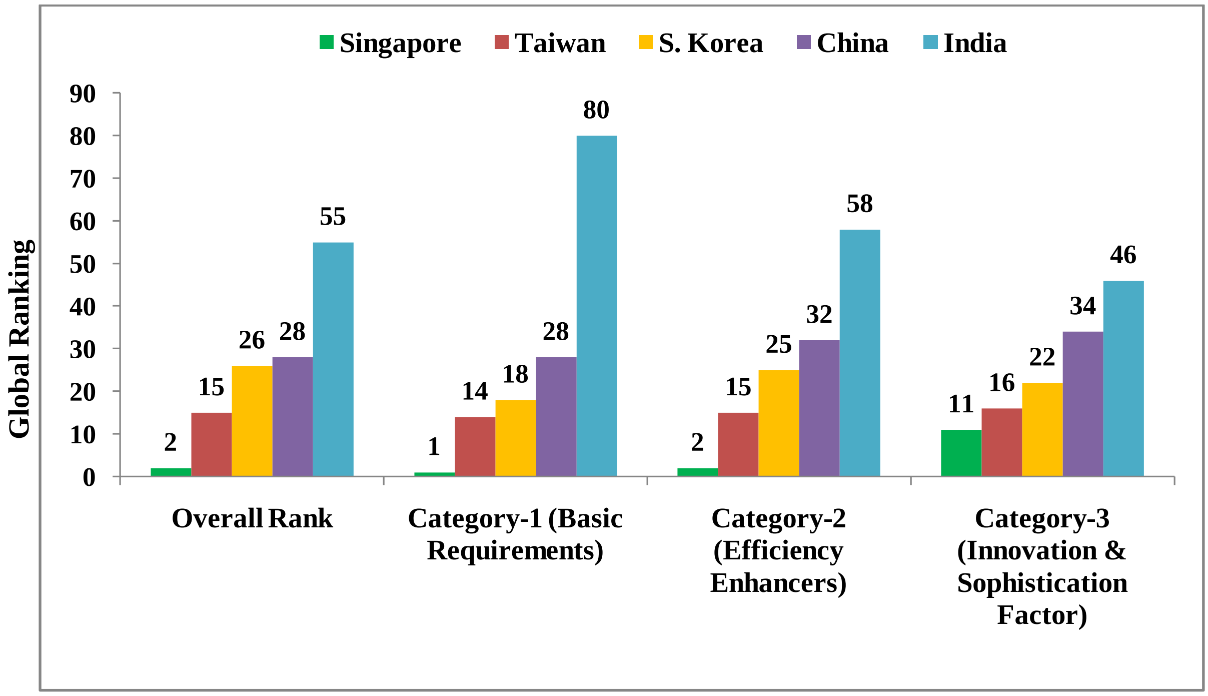



**Fig. 2: Global rankings of the nations based on three categories of GCI**

### Category-1 (Basic Requirements)

“Basic Requirements” category provides information about the basic foundation of a nation and comprises of four pillars (P) i.e. P-1: ‘Institutions’, P-2: ‘Infrastructure’, P-3: ‘Macroeconomic Environment’ and P-4: ‘Health and Primary Education’. The graphical representation of the global ranking of the five countries based on the pillars (P1-P4) of this category is shown in Fig 3.

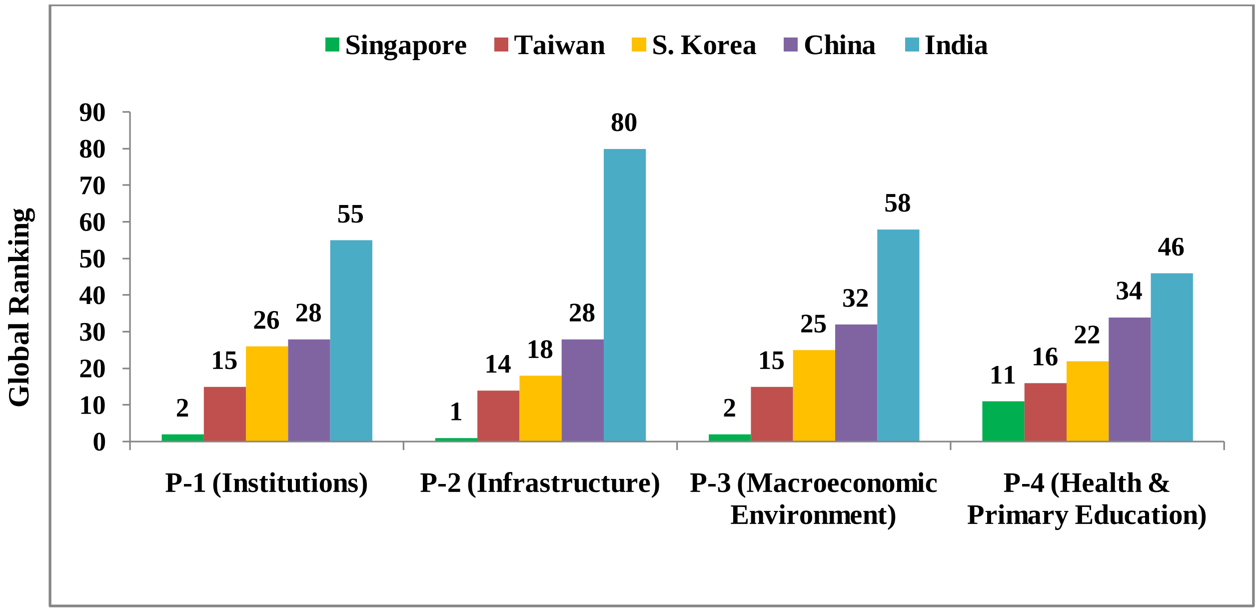



**Fig. 3: Global rankings of the nations based on the pillars of the category-1 (Basic Requirements)**

***P-1 (Institutions):*** This pillar comprises of the administrative and legal structure within which individuals, firms, and governments function and interact to generate wealth. The role of institutions extends beyond the legal framework. The attitudes of the government regarding market freedom and the overall functional efficiency are also very important. The institutional quality is a strong determinant of competitiveness and growth (Acemoglu *et al.*, 2001; Sala-i-Martín & Subramanian, 2003). Firms are unwilling to invest in a country or region, if their rights are not protected (de Soto, 2000).

**Table 3: Global rankings of the nations based on the indicators of P-1 (Institutions)**

| **Indicators** | | **Global Rankings** | | | | |
|---|---|---|---|---|---|---|
| **Number** | **Name** | **Singapore (2)[a]** | **Taiwan (27)[a]** | **S. Korea (69)[a]** | **China (51)[a]** | **India (60)[a]** |
| I-1.01 | *Property Rights* | 4 | 19 | 45 | 63 | 103 |
| I-1.02 | *Intellectual Property Protection* | 4 | 27 | 52 | 50 | 50 |
| I-1.03 | *Diversion of Public funds* | 4 | 34 | 66 | 28 | 40 |
| I-1.04 | *Public Trust in Politicians* | 1 | 32 | 94 | 67 | 31 |
| I-1.05 | *Irregular Payments & Bribes* | 3 | 29 | 46 | 67 | 63 |
| I-1.06 | *Judicial Independence* | 23 | 47 | 69 | 29 | 64 |
| I-1.07 | *Favouritism in Decision of Govt. Officials* | 2 | 24 | 80 | 24 | 32 |
| I-1.08 | *Wastefulness of Govt. Spending* | 3 | 45 | 70 | 26 | 51 |
| I-1.09 | *Burden of Govt. Regulation* | 1 | 20 | 97 | 50 | 27 |
| I-1.10 | *Efficiency of Legal Framework in Settling Disputes* | 1 | 56 | 57 | 66 | 42 |
| I-1.11 | *Efficiency of Legal Framework in Challenging Reg.* | 10 | 63 | 74 | 36 | 39 |
| I-1.12 | *Transparency of Govt. Policy Making* | 1 | 15 | 123 | 86 | 58 |
| I-1.13 | *Business Costs of Terrorism* | 41 | 33 | 93 | 60 | 126 |
| I-1.14 | *Business Costs of Crime & Violence* | 7 | 16 | 68 | 76 | 98 |
| I-1.15 | *Organized Crime* | 5 | 32 | 83 | 51 | 119 |
| I-1.16 | *Reliability of Police Services* | 8 | 37 | 47 | 60 | 86 |
| I-1.17 | *Ethical Behaviour of Firms* | 4 | 31 | 95 | 61 | 44 |
| I-1.18 | *Strength of Auditing & Reporting Standards* | 7 | 19 | 72 | 80 | 95 |
| I-1.19 | *Efficacy of Corporate Boards* | 6 | 35 | 120 | 105 | 96 |
| I-1.20 | *Protection of Minority Shareholders Interests* | 6 | 16 | 95 | 71 | 69 |
| I-1.21 | *Strength of Investor Protection* | 3 | 30 | 21 | 110 | 6 |

*a – Overall Global Rank*

In this pillar Singapore has been ranked as number 2 and Taiwan is at 27th position, whereas, China, S. Korea and India have been placed at number 51, 69 and 60 respectively (Table 3). In fact, Singapore has single digit ranking (1-9) in eighteen indicators. Except India, which is at number 6 in indicator I-1.21 (*Strength of Investor Protection*) , remaining others are not even ranked amongst the top ten economies in any of the indicator. Taiwan has secured top 20 positions in 6 indicators pertaining to *Property Rights* (I-1.01), *Burden of Govt. Regulation* (I-1.09), *Transparency of Govt. Policy Making* (I-1.12), *Business Costs of Crime & Violence* (I-1.14), *Strength of Auditing and Reporting Standards* (I-1.18) and *Protection of minority Shareholders Interests* (I-1.20) out of 21 indicators. China has a global ranking in twenties in four indicators pertaining to *Favouritism in Decision of Govt. Official (*I-1.07), *Wasteful Expenditure* (I-1.08), *Diversion of Public Funds* (I-1.03) and *Judicial Independence* (I-1.07) and Taiwan in three indicators which are *Intellectual Property Protection (*I-1.02), *Irregular Payments and Bribes* (I-1.05) and *Favouritism in Decision of Govt. Official* (I-1.07). In comparison, S. Korea and India have been ranked in twenties in only one parameter. India is ranked at 27 in *Burden of Government Regulation* (I-1.09) and S. Korea has secured 21st position in *Strength of Investor Protection* (I-1.21). In five indicators (I-1.01, I-1.02, I-1.05, I-1.10, and I-1.12-20), China, India and S. Korea do not figure in top 40 nations, thereby suggesting a need for vast improvement in these parameters. In addition, China has to address the issues of *Public Trust in Politicians* (I-1.04), *Burden of Government Regulation* (I-1.09) and *Strength of Investor Protection* (I-1.21), as its global rankings in these indicators are 67, 50, 110 respectively. Similarly, poor global rankings of S. Korea, ranging from 69-97 in five indicators i.e. *Public Trust in Politicians* (I-1.04), *Judicial Independence* (I-1.06), *Favouritism in Decision of Govt. Officials* (I-1.07), *Wastefulness of Govt. Spending* (I-1.08), and *Burden of Govt. Regulation* I-1.09) requires serious thinking and impetus for improvement by the government. India has to lay more emphasis on *Wastefulness of Government Spending* (I-1.08) as it has been ranked at 51st position. Singapore has only one parameter (I-1.13) related to *Business Cost of Terrorism to* improve upon, where it's ranking is 41st.

***P-2 (Infrastructure):*** Under this pillar the quality and extensiveness of 'Infrastructure' in a country is assessed. Among the important infrastructures, a wide network of effective modes of transportation, uninterrupted electricity supply and a robust and extensive telecommunications network are considered essential for economic growth. Infrastructures which can be either physical or digital, has indirect impact on the productivity by enabling and improving access to basic services such as sanitation, education and healthcare, thus contributing towards a workforce which is healthier and better skilled (Calderon & Serven, 2014). The global rankings of the five nations in this pillar (Table 4) indicate that Singapore (2), Taiwan (12) and S. Korea (13) are doing very well, whereas China (39) and India (81) have lot of room for improvement. Singapore has excellent infrastructure in terms of road, rail, airport and seaport as it has been globally ranked amongst the top eight global economies. In fact, it is top ranked in the *Quality of Air Transport Infrastructure* (I-2.05) and second to Netherland in *Quality of Port Infrastructure* (I-2.04). Based on the indicators I-2.08 and I-2.09, it seems Singaporeans rely more on mobile telephones rather than on fixed telephones. S. Korea's and Taiwan's performance is praiseworthy in this (I-2.09) pillar. The overall rank of Taiwan and S. Korea in this pillar is almost same and Taiwan has secured top 10 positions in 2 indicators i.e. *Quality of Roads* (I-2.02) and *Fixed-Telephone lines/100 populations* (I-2.09). In fact in the indicator *Fixed-Telephone lines/100 populations,* Taiwan is on 2nd position following Hong Kong SAR (1 rank) and performing far better than Singapore (29). S. Korea has been globally ranked in the range of 10-38 barring *Mobile Telephone Subscription* (I-2.08) as it relies more on *Fixed Telephones* (I-2.09) and competing with Taiwan in this indicator, which is at 4 in this indicator (I-2.09). Though China's position is better than India's in all the nine indicators, but both lag behind Singapore, Taiwan and S. Korea in almost all the indicators. China and India have satisfactory *Railroad Infrastructure* (I-2.03) but need big improvements in *Quality of Roads* (I-2.02), *Quality of Air Transport Infrastructure* (I-2.05), *Quality of Port Infrastructure* (I-2.04), *Quality of Electric Supply* (I-2.07) and *Telephone Connectivity* (I-2.08 and I-2.09).

**Table 4: Global rankings of the nations based on the indicators of P-2 (Infrastructure)**

| Indicators | | Global Rankings | | | | |
|---|---|---|---|---|---|---|
| **Number** | **Names** | **Singapore (2)[a]** | **Taiwan (12)[a]** | **S. Korea (13)[a]** | **China (39)[a]** | **India (81)[a]** |
| I-2.01 | *Quality of Overall infrastructure* | 4 | 21 | 20 | 51 | 74 |
| I-2.02 | *Quality of Roads* | 3 | 10 | 17 | 42 | 61 |
| I-2.03 | *Quality of Railroad Infrastructure* | 8 | 11 | 10 | 16 | 29 |
| I-2.04 | *Quality of Port Infrastructure* | 2 | 19 | 27 | 50 | 60 |
| I-2.05 | *Quality of Air Transport Infrastructure* | 1 | 26 | 28 | 51 | 71 |
| I-2.06 | *Available Airline Seat km/week, millions* | 20 | 26 | 19 | 2 | 11 |
| I-2.07 | *Quality of Electricity Supply* | 3 | 28 | 38 | 53 | 98 |
| I-2.08 | *Mobile Telephone* | 14 | 44 | 65 | 107 | 121 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | *Subscriptions/100 populations* | | | | | |
| I-2.09 | *Fixed – Telephone Lines/100 populations* | 29 | 2 | 4 | 63 | 116 |

*a – Overall Global Rank*

***P-3 (Macroeconomic Environment):*** **'**Macroeconomic Environment' is determined by the aggregated indicators such as GDP, unemployment rates, price indexes etc. This pillar evaluates the stability of the 'Macroeconomic Environment', which is of paramount importance for the smooth functioning of the nations. A nation cannot work properly if inflation goes out of the hand. The overall ranks of Singapore, Taiwan, S. Korea, China, and India are 12, 13, 5, 8 and 91 respectively (Table 5). These rankings clearly suggest that barring India, all the four nations are doing quite well in this pillar.

India fares very poorly in all but one indicator *Gross National Savings* (I-3.02) as its global ranking is in triple digits in three out of total five indicators. These indicators are I-3.01: *Government Budget Balance*, I-3.03: *Inflation, Annual % Change* and I-3.04: *General Government Debt*. In one indicator I-3.03 (*Inflation, Annual % Change)* four nations i.e. Singapore, Taiwan, S. Korea and China are at 1st position, whereas, India is at 105th position which is undoubtedly miserable. S. Korea, China and Taiwan can look upon Singapore for improvements in the indicator related to *Government Budget Balance* (I-3.01). Singapore's ranking in four indicators (I-3.01, I-3.02, I-3.03 and I-3.05) is remarkable, Taiwan and S. Korea is performing almost equally well in last 4 indicators.

**Table 5: Global rankings of the nations based on the indicators of P-3 (Macroeconomic Environment)**

| **Indicators** | | **Global Rankings** | | | | |
|---|---|---|---|---|---|---|
| **Number** | **Names** | **Singapore (12)[a]** | **Taiwan (13)[a]** | **S. Korea (5)[a]** | **China (8)[a]** | **India (91)[a]** |
| I-3.01 | *Government Budget Balance, % GDP* | 6 | 60 | 19 | 34 | 131 |
| I-3.02 | *Gross National Savings, %GDP* | 5 | 12 | 14 | 3 | 23 |
| I-3.03 | *Inflation, Annual % Change* | 1 | 1 | 1 | 1 | 105 |
| I-3.04 | *General Government Debt, % GDP* | 127 | 56 | 52 | 66 | 103 |
| I-3.05 | *Country Credit Rating, 0-100* | 7 | 21 | 20 | 26 | 50 |

*a – Overall Global Rank*

***P-4 (Health & Primary Education):*** Apart from health, this pillar also takes into consideration the scale and quality of the basic education received by the population. Basic education is increasingly important in today's scenario as it enhances the efficiency of each individual worker and also has an impact on the overall national productivity (Cole & Neumayer 2006). Lack of basic education constrains business development and further expansion. Singapore is ranked at number 2 after Finland (1$^{st}$ rank) in this pillar (Table 6). Taiwan, S. Korea, China and India have been ranked at 14$^{th}$, 23$^{rd}$, 44$^{th}$ and 84$^{th}$ respectively.

The extent of prevalence of two major diseases, malaria and tuberculosis as well as infant mortality are indicative of the level of hygienic conditions prevailing in a country. Poor hygienic conditions do have impact on the performance of public and private sectors. Amongst the five nations, India has the maximum *Prevalence of Malaria (I-4.01), Tuberculosis (I-4.03)*, *HIV (I-4.05)* and *Infant Mortality Deaths (I-4.07)* and thus ranks very poorly in the global rankings (Table 6). As shown in Table 6 Singapore and Taiwan are performing extra ordinarily well in first two indicators i.e. *Malaria Cases/ 1000000 Populations* (I-4.01) and *Business Impact of Malaria* (I-4.02) because both the countries have been declared Malaria free. China has better record than India but poor record *vis a vis* Singapore, Taiwan and S. Korea.  Even though, the causative agent of malaria, anopheles mosquito, thrives in temperate region, malaria cases are not seen in Singapore due to maintenance of hygiene throughout the nation.

Amongst the parameters of primary education (I-4.09), Singapore is listed amongst the top three nations. Finland and Belgium occupy first and second rankings respectively. India does not figure in the top 50 nations. Though Taiwan (16) and S. Korea (36) have a better ranking than China (55) and India (52) in the indicator of *Quality of Primary Education* (I-4.09), but China (20) has a better record than S. Korea (31) in the indicator, *Percentage of Primary Education Enrolment* (I-4.10) in which India is placed at 77$^{th}$ position.

**Table 6: Global rankings of the nations based on the indicators of P-4 (Health & Primary Education)**

| Indicators | | Global Rankings | | | | |
|---|---|---|---|---|---|---|
| **Number** | **Names** | **Singapore (2)[a]** | **Taiwan (14)[a]** | **S. Korea (23)[a]** | **China (44)[a]** | **India (84)[a]** |
| I-4.01 | *Malaria Cases/1000,000 populations* | M.F | M.F | 18 | 15 | 44 |
| I-4.02 | *Business Impact of Malaria* | N/Appl. | N/Appl. | 22 | 32 | 60 |
| I-4.03 | *Tuberculosis Cases/1000,000 populations* | 66 | 69 | 89 | 81 | 113 |

| | | | | | | |
|---|---|---|---|---|---|---|
| I-4.04 | *Business Impact of Tuberculosis* | 48 | 46 | 85 | 93 | 132 |
| I-4.05 | *HIV Prevalence, % Adult populations* | 1 | 1 | 1 | 1 | 63 |
| I-4.06 | *Business Impact of HIV/AIDS* | 39 | 25 | 79 | 86 | 130 |
| I-4.07 | *Infant Mortality, Deaths/1,000 Live Births* | 6 | 25 | 16 | 59 | 114 |
| I-4.08 | *Life Expectancy in Years* | 6 | 30 | 13 | 53 | 107 |
| I-4.09 | *Quality of Primary Education* | 3 | 16 | 36 | 55 | 52 |
| I-4.10 | *Primary Education Enrolment, net %* | 1 | 32 | 31 | 20 | 77 |

*a – Overall Global Rank*

**Category-2 (Efficiency Enhancers):** The factors that are responsible for enhancing the efficiency of human resource and economic operations are grouped under this category. Six pillars comprising this category are 'Higher Education and Training', 'Goods Market Efficiency', 'Labour Market Efficiency', 'Financial Market Development', 'Technological Readiness' and 'Market size'. Based on the overall ranking of this category, Singapore, Taiwan, S. Korea , China and India have been placed at number 2, 15, 25, 32 and 58 respectively (Fig. 2). First place is occupied by USA. The overall ranking of five nations under this category (P5-P10) is given in Fig. 4.

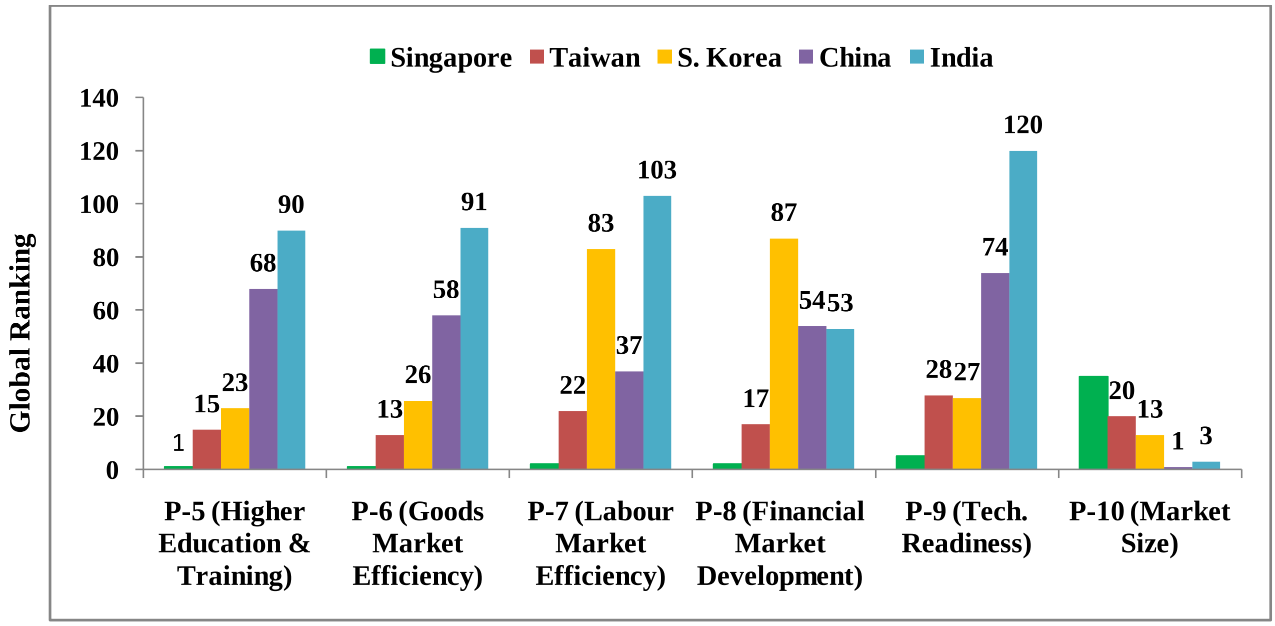



**Fig. 4: Global rankings of the nations based on the pillars of category-2 (Efficiency Enhancers)**

***P-5 (Higher Education and Training):*** This pillar focuses on secondary and tertiary enrolment rates as well as the quality of education as evaluated by business leaders. The extent of staff training is also considered because of the importance of vocational and continuous training for constant upgradation of workers' skills. Today's rapidly globalizing economy necessitates countries to nurture pools of highly educated workers, who are able to perform complicated tasks and rapidly adapt to their changing environment and the evolving needs of the economy (Acemoglu, 2009). Every indicator of this pillar is very important for economies to move up the value chain.

This pillar comprises of eight indicators (Table 7) and Singapore is positioned at number one in the overall rank. Except for *Secondary Education Enrolment* (I-5.01), Singapore is doing exceedingly well in other 7 indicators as its global ranking is in single digit. The education system of Singapore is very strong and coordination with education ministries is also very good. This effective coordination has resulted in the ranking of two of its universities i.e. National University of Singapore (26) and Nanyang Technological University (55) in top 100 universities worldwide (Times Higher Education Ranking, 2015). S. Korea has an excellent record in the indicator I-5.02 *(Tertiary Education Enrollment, gross %),* where it has been ranked at number 2. Only Greece is ahead of S. Korea in this indicator. In this indicator (*Tertiary Education Enrollment, gross %)* Taiwan (8) and Singapore (9) have secured top 10 positions, which is commendable. They also have satisfactory score related to the availability of access to internet services (I-5.06) in the schools. China and India are way behind many nations in this pillar as their global rankings range between (47-85) and (43-105) respectively in the indicators falling under this pillar.

**Table 7: Global rankings of the nations based on the indicators of P-5 (Higher Education & Training)**

| Indicators | | Global Rankings | | | | |
|---|---|---|---|---|---|---|
| **Number** | **Names** | **Singapore (1)[a]** | **Taiwan (15)[a]** | **S. Korea (23)[a]** | **China (68)[a]** | **India (90)[a]** |
| I-5.01 | *Secondary Education Enrolment, gross %* | 17 | 31 | 48 | 74 | 105 |
| I-5.02 | *Tertiary Education Enrolment, gross %* | 9 | 8 | 2 | 83 | 86 |
| I-5.03 | *Quality of Education System* | 3 | 46 | 66 | 56 | 43 |
| I-5.04 | *Quality of Math & Science Education* | 1 | 15 | 30 | 49 | 63 |
| I-5.05 | *Quality of Management Schools* | 4 | 33 | 59 | 85 | 55 |
| I-5.06 | *Internet Access in Schools* | 2 | 27 | 19 | 47 | 100 |
| I-5.07 | *Availability of Specialized training Services* | 8 | 23 | 48 | 63 | 68 |
| I-5.08 | *Extent of staff Training* | 4 | 27 | 36 | 50 | 48 |

*a – Overall Global Rank*

***P-6 (Goods Market Efficiency):*** Economies with efficient goods markets are well placed to provide the right mix of products and services according to their supply-and-demand environment (Aghion & Schankerman, 2004). Market competition (both domestic and foreign), customer orientation and buyer sophistication are taken into consideration in assessing goods market efficiency. The best environment for the exchange of goods requires minimal governmental intervention that impedes business activity. There are 16 indicators under this pillar (Table 8).

**Table 8: Global rankings of the nations based on the indicators of P-6 (Goods Market Efficiency)**

| **Indicators** | | **Global Rankings** | | | | |
|---|---|---|---|---|---|---|
| **Number** | **Names** | **Singapore (1)[a]** | **Taiwan (13)[a]** | **S. Korea (26)[a]** | **China (58)[a]** | **India (91)[a]** |
| I-6.01 | *Intensity of Local Competition* | 21 | 5 | 13 | 36 | 101 |
| I-6.02 | *Extent of Market Dominance* | 13 | 4 | 97 | 28 | 41 |
| I-6.03 | *Effectiveness of Anti-Monopoly Policy* | 5 | 23 | 33 | 36 | 41 |
| I-6.04 | *Effect of taxation on incentives to invest* | 5 | 26 | 78 | 50 | 38 |
| I-6.05 | *Total Tax Rate, % profits* | 10 | 58 | 48 | 128 | 123 |
| I-6.06 | *No. Procedure to Start a Business* | 9 | 9 | 9 | 123 | 129 |
| I-6.07 | *No. Days to Start a Business* | 4 | 53 | 10 | 117 | 110 |
| I-6.08 | *Agricultural Policy Costs* | 6 | 44 | 69 | 16 | 53 |
| I-6.09 | *Prevalence of Non-Tariff Barriers* | 1 | 17 | 97 | 78 | 82 |
| I-6.10 | *Trade Tariffs, %duty* | 2 | 68 | 85 | 117 | 124 |
| I-6.11 | *Prevalence of Foreign Ownership* | 4 | 49 | 92 | 74 | 96 |
| I-6.12 | *Business Impact of Rules on FDI* | 3 | 50 | 98 | 61 | 92 |
| I-6.13 | *Burden of Customs Procedures* | 2 | 12 | 43 | 56 | 54 |
| I-6.14 | *Imports as a %age of GDP* | 2 | 42 | 74 | 131 | 116 |
| I-6.15 | *Degree of Customer Orientation* | 9 | 5 | 25 | 68 | 97 |
| I-6.16 | *Buyers Sophistication* | 7 | 19 | 8 | 21 | 26 |

*a – Overall Global Rank*

Under this pillar, number one global ranking is again occupied by Singapore. Out of a total 16 indicators, it enjoys a ranking between 1-10 in 14 parameters. In the remaining two parameters of *Intensity of Local Competition* (I-6.01) and *Extent of Market Dominance* (I-6.02), it has been ranked at number 21 and 13 respectively. Taiwan has secured single digit positions in 4 indicators i.e. *Intensity of Local Competition (*I-6.01), *Extent of Market Dominance (*I-6.02), *Number of Procedures to Start a Business (*I-6.06) *and Degree of Customer Orientation* (I-6.15). Even it is doing much better than Singapore in these above mentioned indicators. S. Korea is ranked at 26 and matches Singapore and Taiwan in *Number of Procedure to start a Business* i.e. 9, (I-6.06). Even in *Number of Days to Start a Business* (I-6.07) and *Buyers Sophistication* (I-6.16), S. Korea is not far behind Singapore. In one indicator i.e. I-6.01 dealing with the extent of market competition of goods/services, Taiwan is ahead of S. Korea, Singapore, China and India. China and India have lot of catching up to do in this pillar as they are not even in the top 100 nations in 5 indicators i.e. *Taxation Rate* (I-6.05), *No. of Procedures to Start a Business* (I-6.06), N*umber of Days to Start a Business* (I-6.07), *Percentage duty on Trade Tariffs* (I-6.10) and *Imports as % of GDP* (I-6.14). The best ranking of these two countries is in twenties in the indicator *Buyers Sophistication* (I-6.16). In majority of the indicators belonging to the pillar 'Goods Market Efficiency' both these countries do not figure in the top 50 nations considered for the comparative data analysis for this report.

***P-7 (Labour Market Efficiency):*** The 'labour Market Efficiency' and flexibility are critical for ensuring that workers are employed in their most effective sector in the economy and incentivized to put in their best effort (Bassanini *et al.*, 2009). Efforts to promote meritocracy, gender equality and strong incentives for employees promote efficient labour markets. These factors have a positive effect on the overall performance of workers and the attractiveness of the country for global talent. Rigid labour markets are generally characterized by high unemployment rates. This pillar comprises of 10 indicators (Table 9).

**Table 9: Global rankings of the nations based on the indicators of P-7 (Labour Market Efficiency)**

| Indicators | | Global Rankings | | | | |
|---|---|---|---|---|---|---|
| **Number** | **Names** | **Singapore (2)[a]** | **Taiwan (22)[a]** | **S. Korea (83)[a]** | **China (37)[a]** | **India (103)[a]** |
| I-7.01 | *Cooperation in Labour-Employer Relations* | 3 | 19 | 132 | 62 | 86 |
| I-7.02 | *Flexibility Wage Determination* | 6 | 14 | 66 | 73 | 120 |
| I-7.03 | *Hiring & Firing practices* | 4 | 14 | 115 | 17 | 25 |
| I-7.04 | *Redundancy Costs, Weeks of Salary* | 5 | 102 | 117 | 117 | 70 |
| I-7.05 | *Effect of Taxation on Incentives to Work* | 3 | 21 | 99 | 58 | 36 |
| I-7.06 | *Pay & Productivity* | 3 | 9 | 24 | 20 | 47 |

| | | | | | | |
|---|---|---|---|---|---|---|
| I-7.07 | *Reliance on Professional Management* | 5 | 26 | 37 | 55 | 86 |
| I-7.08 | *Country Capacity to Retain Talent* | 6 | 39 | 25 | 30 | 40 |
| I-7.09 | *Country Capacity to Attract Talent* | 2 | 56 | 35 | 27 | 40 |
| I-7.10 | *Women in Labour Force, ratio to men* | 75 | 79 | 91 | 60 | 132 |

*a – Overall Global Rank*

Once again, Singapore is doing very well in this pillar, as only one country, Switzerland is ahead of Singapore in the overall global rank. In nine out of total ten indicators, Singapore's global ranking ranges between 2 - 6. Only the indicator I-7.10, dealing with extent of women doing labour work, its global ranking (75$^{th}$) is quite poor. In fact, the other four nations are also not doing well in this indicator as they have been ranked at 60 (China), 79 (Taiwan), 91 (S. Korea) and 132 (India). Taiwan has 22$^{nd}$ position in this pillar and figures in the top 20 nations in 4 indicators out of 10. Those are: *Cooperation in Labour-Employer Relations* (I-7.01), *Flexibility Wage Determination* (I-7.02), *Hiring & Firing Practices* (I-7.03) and *Pay & Productivity* (I-7.06). China has an overall ranking of 37, with best ranking of 17 in the indicator *Hiring and Firing Practices* (I-7.03). In other three indicators involving *Pay and Productivity* (I-7.06), *Capacity to Retain Talent* (I-7.08) and *Capacity to Attract Talent* (I-7.09), China's performance is not bad as its global rankings of these indicators range from 20-30. However, it has to address other indicators, especially I-7.04, which deals with the cost of the salary paid to a redundant employee. Its global ranking in this indicator is 117. Though S. Korea's overall ranking in this pillar is 83$^{rd}$, but its performance is satisfactory (global rankings 24-37), in four indicators (I-7.06, I-7.07, I-7.08 and I-7.09) dealing with ability to attract and retain talent, level of professional management and the relationship of employees salary vis a vis productivity of the company. India does not figure in top 100 nations in this pillar. Only in one indicator (I-7.03: *Hiring and Firing Practices*) its global rank is 25 is satisfactory. Its poorest performance is in the parameter dealing with the *Ratio of Men to Women in Labour Force* (I-7.10), where it has been ranked at number 132. If we consider the ranking range of all 5 nations, Singapore and Taiwan ranges in the same scale, 2-75, 2-79 respectively and S. Korea and India ranges in the same scale, 24-132, 25-132 respectively.

***P-8 (Financial Market Development):*** A sound and well-functioning financial sector allocates the natural resources or resources generated by a nation's citizens, as well as those entering the economy from abroad, to their most productive uses for economic activities

(Levine, 2005). Financial market development is determined by capital availability from sources such as loans, securities exchanges, venture capital, and other financial products for which the banking sector needs to be trustworthy and transparent. The global ranking range for India under this pillar is 13-100 (Table 10), whereas for Singapore, Taiwan, S. Korea and China, the range is between 3-17, 3-80, 47-119 and 16-80 respectively. In the indicator V*enture Capital Availability (I-8.05)* India is doing better than S. Korea (86) and China (16) with global rank 13 and competing with Taiwan (12). Singapore enjoys the 3rd position in this indicator. Taiwan has procured top 20 positions in 4 indicators out of 8 i.e. *Affordability of Financial Services* (I-8.02), *Financing through Local Equity Market* (I-8.03), *Venture Capital Availability* (I-8.05) and *Regulations of Securities Exchanges* (I-8.07).

**Table 10: Global rankings of the nations based on the indicators of P-8 (Financial Market Development)**

| **Indicators** | | **Global Rankings** | | | | |
|---|---|---|---|---|---|---|
| **Number** | **Names** | **Singapore (2)[a]** | **Taiwan (17)[a]** | **S. Korea (87)[a]** | **China (54)[a]** | **India (53)[a]** |
| I-8.01 | *Availability of Financial Services* | 8 | 24 | 99 | 61 | 81 |
| I-8.02 | *Affordability of Financial Services* | 7 | 11 | 89 | 48 | 71 |
| I-8.03 | *Financing through Local Equity Market* | 8 | 3 | 47 | 44 | 45 |
| I-8.04 | *Ease of Access to Loans* | 4 | 26 | 119 | 21 | 29 |
| I-8.05 | *Venture Capital Availability* | 3 | 12 | 86 | 16 | 13 |
| I-8.06 | *Soundness of Banks* | 5 | 25 | 113 | 78 | 100 |
| I-8.07 | *Regulation of Securities Exchanges* | 3 | 14 | 78 | 52 | 69 |
| I-8.08 | *Legal Rights Index, 0-12* | 17 | 80 | 63 | 80 | 44 |

*a – Overall Global Rank*

**P-9 (Technological Readiness):** The application of technology is increasingly essential for firms to compete and prosper in the globalized economy. The pillar of 'Technological Readiness' measures the efficiency with which existing technologies are adopted by an economy to enhance industrial productivity with particular emphasis on its capacity to fully leverage information and communication technologies (Comin & Hobijn 2004). This pillar comprises of 7 indicators (Table 11) which are reflective of the levels of science and technology of the nations.

**Table 11: Global rankings of the nations based on the indicators of P-9 (Technological Readiness)**

| Indicators | | Global Rankings | | | | |
|---|---|---|---|---|---|---|
| **Number** | **Names** | **Singapore (5)[a]** | **Taiwan (28)[a]** | **S. Korea (27)[a]** | **China (74)[a]** | **India (120)[a]** |
| I-9.01 | *Availability of Latest Technologies* | 13 | 36 | 31 | 95 | 108 |
| I-9.02 | *Firm-Level Technology Absorption* | 16 | 25 | 27 | 66 | 102 |
| I-9.03 | *FDI & Technology Transfer* | 2 | 37 | 67 | 69 | 95 |
| I-9.04 | *Individuals Using Internet* | 24 | 22 | 20 | 70 | 107 |
| I-9.05 | *Fixed Broadband Internet Subscriptions/100 populations* | 23 | 16 | 5 | 57 | 104 |
| I-9.06 | *Int'l Internet Bandwidth, kb/s per User* | 4 | 45 | 57 | 119 | 116 |
| I-9.07 | *Mobile-Broadband Subscriptions/100 populations* | 1 | 34 | 12 | 71 | 124 |

*a – Overall Global Rank*

The global rankings of Singapore (5), Taiwan (28), S. Korea (27), China (74) and India (120) clearly indicate that Singapore is far ahead of other four countries. Singapore is technology as well as internet savvy and Taiwan is a leading competitor in the world's ICT sector. According to the World Trade Organization, Taiwan was the 20$^{th}$ largest exporter and 19$^{th}$ largest importer of merchandise in 2014 (The official website of republic of China, 2016). Singapore not only encourages FDI (I-9.04), but also promotes the use of wireless connectivity (I-9.06 & 9.07). S. Korea figures in the top 20 global rankings in three indicators (I-9.04, I-9.05 and I-9.07) and can improve in two indicators namely, *FDI & Technology Transfer* (I-9.03) and *International Internet Bandwidth* (I-9.06). In the indicator, *Individuals Using Internet* (I-9.04) Singapore (24), Taiwan (22) and S. Korea (20) are competing with each other. China and India are yet to embrace technology and use of internet services on a large scale. Under this pillar the global rankings of China and India are 57-119 and 95-124 respectively. In fact, India's ranking is more than 100 in all the indicators except *FDI and Technology Transfer* (I-9.03) i.e. 95. The dismal scenario of India as well as China in this pillar calls for radical changes in the policy related to FDI, latest-technology usage and internet services.

***P-10 (Market Size):*** Traditionally, the markets available to firms have been constrained by national borders and the size of the market affects productivity since large markets allow firms to exploit economies of scale (Romer, 1996). However, in this era of globalization, international markets have emerged as a substitute for domestic markets, especially for small countries. Thus market size is inclusive of both domestic and foreign markets. There are 4 indicators under this pillar (Table 12).

**Table 12: Global rankings of the nations based on indicators of the P-10 (Market Size)**

| Indicators | | Global Rankings | | | | |
|---|---|---|---|---|---|---|
| **Number** | **Names** | **Singapore (35)[a]** | **Taiwan (20)[a]** | **S. Korea (13)[a]** | **China (1)[a]** | **India (3)[a]** |
| I-10.01 | *Domestic Market Size Index* | 43 | 24 | 13 | 2 | 3 |
| I-10.02 | *Foreign Market Size Index* | 9 | 13 | 8 | 1 | 3 |
| I-10.03 | *GDP (PPP$ billions)* | 39 | 20 | 13 | 1 | 3 |
| I-10.04 | *Exports as a %age of GDP* | 3 | 23 | 47 | 110 | 114 |

*a – Overall Global Rank*

This is the only pillar in which India and China have been ranked amongst top 5 nations. China tops the overall rankings, followed by USA and India. Top rankings of these nations in the first two indicators namely, *Domestic Market Size Index* (I-10.01) and *Foreign Market Size Index* (I-10.02) could be attributed to large size as well as large population of both these countries. However, India and China are performing poorly in the export sector as reflected by their rankings of 110 and 114 respectively, in the indicator I-10.04 (*Exports as a %age of GDP*) in which Singapore is at 3rd position and Taiwan is ranked at 23rd position. S. Korea's global ranking of 8-13 in the first three indicators (I-10.01–I-10.03) is suggestive of good performance in the domains of domestic market size, foreign market size and purchasing power parity (PPP). However, it can improve upon the indicator I-10.04 dealing with the exports of goods and services to the rest of the world. Singapore, not only encourages foreign investment but also exporting many of the products manufactured (I-10.04: *Exports as a %age of GDP*) and thus globally placed at 3rd position. Because of small size and population, Singapore finds difficult to increase the *Domestic Market Size Index* (I-10.01). The ranking range of Taiwan is 13-23 which is very consistent. Taiwan is leading Singapore in 2 indicators (Table 12) out of 4 i.e. *Domestic Market Size index* (I-10.02), which may be again attributed to population and size of both the countries and *GDP (PPP$ billions) (I-10.03).* Though, the population size of India and China is very big but the manpower is semi-skilled and poor in education. By working on these parameters, both nations can certainly improve upon exporting many goods and thus generating revenues for the respective countries.

**Category-3 (Innovation & Sophistication Factors):** This category is comprised of two pillars i.e., 'Business Sophistication' & 'Innovation'. The ranking in these pillars determine the level of sophistication in terms of business operations as well as application of technological innovation. The overall ranking of five nations under this category (P11 and P12) is given in Fig. 5. In both the pillars Singapore tops the global ranking amongst five nations, followed by Taiwan, S. Korea, China and India.

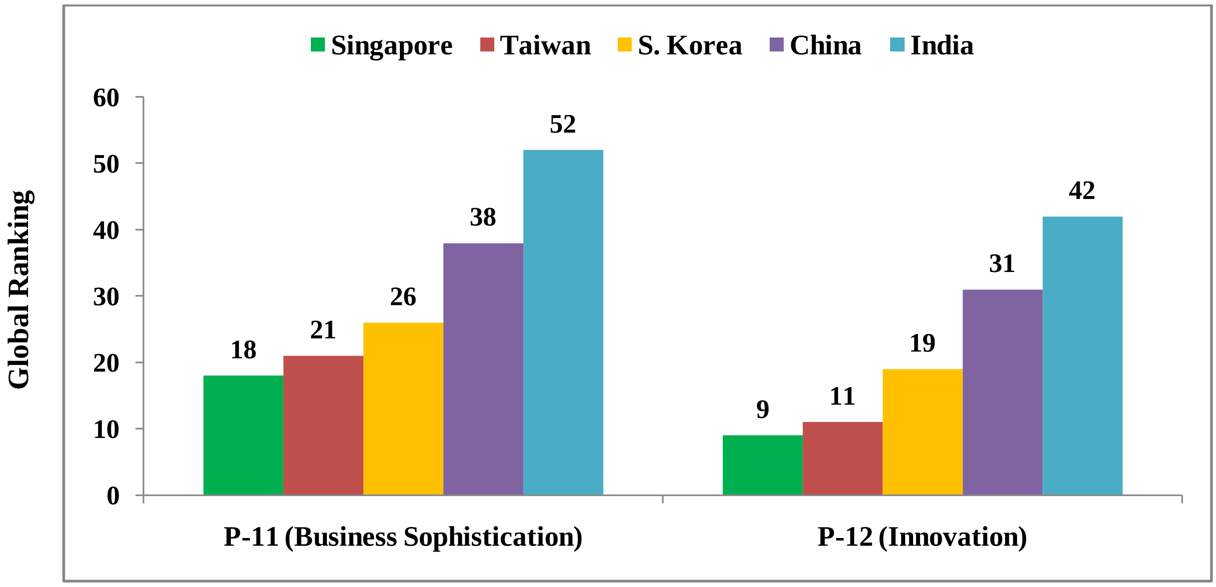



**Fig. 5: Global rankings of the nations based on the pillars of category-3 (Innovation & Sophistication Factors)**

***P-11 (Business Sophistication):*** It is a common knowledge that sophisticated business practices lead to higher efficiency in the production of goods and services. The qualities of a country's overall business networks and of individual firms' operations and strategies are two closely interlinked factors that determine business sophistication (WEF Report, 2015). The assessment of the sophistication factors such as branding, marketing, distribution, advanced production processes, and the production of unique and sophisticated products are grouped under this pillar. There are 9 indicators under this pillar (Table 13)

**Table 13: Global rankings of the nations based on the indicators of P-11 (Business Sophistication)**

| Indicators | | Global Rankings | | | | |
|---|---|---|---|---|---|---|
| Number | Names | Singapore (18)[a] | Taiwan (21)[a] | S. Korea (26)[a] | China (38)[a] | India (52)[a] |
| I-11.01 | *Local Supplier Quantity* | 71 | 13 | 23 | 15 | 54 |
| I-11.02 | *Local Supplier Quality* | 26 | 20 | 28 | 63 | 66 |
| I-11.03 | *State of Cluster Development* | 13 | 5 | 23 | 24 | 29 |

| | | | | | | |
|---|---|---|---|---|---|---|
| I-11.04 | *Nature of Competitive Advantage* | 15 | 22 | 20 | 48 | 47 |
| I-11.05 | *Value Chain Breadth* | 12 | 19 | 21 | 43 | 29 |
| I-11.06 | *Control of International Distribution* | 24 | 38 | 15 | 29 | 48 |
| I-11.07 | *Production Process Sophistication* | 14 | 21 | 23 | 49 | 61 |
| I-11.08 | *Extent of Marketing* | 18 | 22 | 33 | 64 | 82 |
| I-11.09 | *Willingness to Delegate Authority* | 21 | 31 | 62 | 48 | 56 |

*a – Overall Global Rank*

Amongst the five nations, Singapore is globally ranked at 18, followed by Taiwan (21), S. Korea (26), China (38) and India (52). Except for one indicator, *Local Supplier Quality* (I-11.01), Singapore is ranked between 12 - 26 in rest of the eight indicators. In five indicators (I-11.03, I-11.04, I-11.05, I-11.07 and I-11.08), it is ranked among the top 18 nations. The overall rank of Taiwan is 3 ranks less than Singapore in this pillar but Taiwan is ahead of Singapore in three indicators pertaining to *Local Supplier Quantity* (I-11.01), *Local Supplier Quality* (I-11.02), and *State of Cluster Development* (I-11.03). In the First indicator of this pillar (I-11.01) China (15) and Taiwan (13) is competing with each other as there is only 2 ranks' difference between them. S. Korea's performance is satisfactory as its rankings ranges between 15 - 33, for eight indicators. Only in one indicator i.e. *Willingness to Delegate Authority* (I-11.09), it is ranked at 62$^{nd}$ position. China has only three indicators, I-11.01 (*Local Supplier Quantity*), I-11.03 (*State of Cluster Development*) and I-11.06 (*Control of International Distribution*) in which it is ranked among the top 30 nations, whereas in other six indicators, it is placed in the global rankings between 43 - 64. India's overall ranking of 52$^{nd}$ indicates that it has to do a lot to catch up with Singapore, Taiwan, S. Korea and China. Its best ranking (29) is in the indicator, *Value Chain Length* (I-11.05) and worst (82$^{nd}$) in *Extent of Marketing* (I-11.08), which suggests that India has to quickly learn the nuances of marketing and administration if it dreams of becoming a significant player in the global economy.

***P-12 (Innovation):*** This pillar of competitiveness focuses on technological innovation. Technological breakthroughs or innovations have been at the very foundation of many dramatic productivity gains that our economies have historically experienced because in the long run, standards of living can be largely enhanced by technological innovations alone. The acceptability of new, unconventional and disruptive ideas has a great impact on creative innovations that break new frontiers in knowledge creation (Acemoglu *et al.*, 2014).

**Table 14: Global rankings of the nations based on the indicators of P-12 (Innovation)**

| Indicators | | Global Rankings | | | | |
|---|---|---|---|---|---|---|
| Number | Names | Singapore (9)[a] | Taiwan (11)[a] | S. Korea (19)[a] | China (31)[a] | India (42)[a] |
| I-12.01 | *Capacity for Innovation* | 19 | 21 | 24 | 49 | 50 |
| I-12.02 | *Quality of Scientific Research Institutions* | 12 | 26 | 27 | 42 | 45 |
| I-12.03 | *Company Spending on R&D* | 11 | 13 | 21 | 23 | 31 |
| I-12.04 | *University-Industry Collaboration in R&D* | 5 | 14 | 26 | 32 | 50 |
| I-12.05 | *Govt Procurement of Advanced Tech. Products* | 4 | 29 | 24 | 9 | 26 |
| I-12.06 | *Availability of Scientists & Engineers* | 11 | 28 | 40 | 36 | 49 |
| I-12.07 | *PCT Patents, Application/million populations* | 14 | n/a | 7 | 32 | 61 |

*a – Overall Global Rank*

This pillar comprises of seven indicators (Table 14). The pattern of comparative rankings of the five nations is the same as observed in the pillar-'Business Sophistication'. Singapore (9[th]) tops the list, followed by Taiwan (11[th]), S. Korea (19[th]), China (31[st]) and India (42[nd]). Interestingly, in this pillar, except Taiwan all other nations are performing better than the pillar 'Business Sophistication', as indicated by better ranking of each nation in the 'Innovation' pillar. Singapore has impressive showing in all the indicators as its global rankings are in top 20 nations of the world. Its single digit ranking of 5 in the indicator, *University-Industry Collaboration in R&D* (I-12.04) shows that it lays high emphasis on converting academic knowledge into patents and commercial products. The involvement of private sector investment in R&D is also praiseworthy as it has been globally ranked at position 11 in the indicator, *Company Spending on R&D* (I-12.03). These impressive rankings are the outcome of highly skilled scientists and availability of sophisticated instruments and other infrastructure (I-12.02 and I-12.06). Taiwan's over all rank is 11 in this pillar. The investment of private sector in R&D scenario is good as it is ranked at 13[th] position in the indicator in *Company Spending on R&D* (I-12.0-3). Taiwan figures in top 30 nations in all 6 indicators under this pillar (the data on patents (I-12.07) is not available for Taiwan in GCI because it is not signatory of Patent Corporation of Treaty (PCT)). S. Korea's ranking of 19 is satisfactory in this pillar. Except one indicator (I-12.06: *Availability of Scientists and Engineers*), it is doing reasonably well in other six indicators (Table 13). Its patent filing ratio is one of the best in the world (I-12.07: *PCT Patents, Application/million* *populations*). However, it can vastly improve its ranking if it lays more emphasis on the scientific infrastructure and producing more professional scientists and engineers. China is not far behind S. Korea in almost all the indicators of the pillar 'Innovation'. In fact, it is leading S. Korea in two indicators namely, (*Govt. Procurement of Advanced Technology Products* (I-12.05) and *Availability of Scientists and Engineers* (I-12.06). India lags behind in all the seven indicators. However, its performance is not as bad in this pillar as is in others. It has been ranked in the range of 26-61, in the pillar of 'Innovation'. India is bound to improve its ranking in this category because heavy investment in R&D and new initiatives of the government to boost Entrepreneurship, Start-ups, Technology Parks and providing relaxations to industries for investments in R&D in universities (Skill Development Policy, 2015).

## 3. Conclusion

The data presented in this report clearly spells out that Singapore is not only leading Taiwan, S. Korea, China and India in the domain of economic competitiveness, but also is one of the top economically stable countries. Out of 114 indicators of GCI, it is among the top five ranked nations in 54 indicators encompassing all the three categories ("Basic Requirements" –top 5 in 23 indicators, "Efficiency Enhancers" – top 5 in 29 indicators, "Innovation & Sophistication" – top 5 in 2 indicators). Singapore tops (Rank 1) in the global rankings in 11 indicators ("Basic Requirements" – rank 1 in 8 indicators, "Efficiency Enhancers" –rank 1 in 3 indicators).

Taiwan is perceived to be the only Asian country which can compete with Singapore in global rankings based on GCI-2015-16 report. It has secured top 5 positions in 11 indicators out of 114 and top 20 in 40 indicators. Taiwan occupies an important position in the global economy and many authoritative analyses done by World Trade Organization, Economist Intelligent Unit and World Economic Forum, rank Taiwan among the top nations year after year. The country is a leading player in the world's ICT sector and also a major supplier of goods across industrial fields. According to Taiwan's Govt. the information and communication technology industry contributes to around one-third of Taiwan's GDP (The official website of republic of China, 2016).

Taiwan, S. Korea and China have been ranked number one in the indicators of C*ontrol over Inflation (I-3.03)* and *HIV Prevalence, % adult populations (I-4.05).* S. Korea and China have reasonable overall GCI rankings in twenties. In addition, S. Korea ranks among the top five global economies in the areas of *Tertiary Education Enrolment* and *Internet Connectivity/100 Population*. China is ranked number 2 in *Market Size Index*. This fact along with huge population has made China an international hub of commercial activities. However, these 4 countries can look towards Singapore in which they are poorly ranked globally. For example, Taiwan can improve upon *Women in Labour Force, ratio to men, Legal Rights Index* and *Control of International Distribution.* S. Korea needs to modify its labour laws, governance of corporate boards, trade tariffs, foreign ownership of companies and easy access to secure loans. Similarly, China should have a serious relook into labour laws, establishment of a new businesses, corporate governance, adoption of latest technologies, promotion of internet connectivity etc.

India is way behind Singapore, Taiwan, S. Korea and China, in all the three categories of GCI. There is a huge gap between India and the four Asian countries in the category of "Basic Requirement". Singapore tops the list with 1st global rank, Taiwan is at 14th position, China and S. Korea are in top 30 economies and India is at 80th position. In the category of "Efficiency Enhancers", Singapore is at 2nd position, Taiwan is at 15th and S. Korea and China are in top 40 nations, whereas, India is at 58th position. In the third category "Innovation & Sophistication Factors" India again lags behind these nations, though the margin is not as huge as in other two categories.

Not only, GCI Report ranks India poorly, other global reports such as World Bank, Human Development Index and The World Fact Book have also rated these four countries ahead of India (Table 15). Because of poor hygienic conditions and limited medical facilities, the life expectancy of Indians is in mid 60s only, whereas other four countries have a much higher life span. Similarly, the literacy rate of India is in early seventies vis a vis mid nineties of other three nations. Majority of Indians still reside in villages. Only one third of its population lives in cities. On the other hand Singapore is 100% urbanite. Taiwan, China's and Singapore's urban population is around 78%, 54% and 82% respectively. By addressing these parameters, India will not only improve the quality of life, but this will also help in generating quality workforce, which in turn will boost the GDP of the nation.

**Table 15: Comparative data of global agencies of select Asian countries**

| Attributes | Singapore | Taiwan | S. Korea | China | India |
|---|---|---|---|---|---|
| Life Expectancy[a] (years) | 82.3 | 80 | 81.5 | 75.4 | 66.5 |
| Human Development Index (HDI)[b] | 0.912 | 0.882[e] | 0.898 | 0.727 | 0.609 |
| Literacy Rate Over 15 years[c] (%) | 96.8 | 98.5 | 97.9 | 96.4 | 71.2 |
| GDP[d] (Trillion US$) 2014 | 0.31 | 0.53[f] | 1.41 | 10.35 | 2.05 |
| GDP Growth[d] (annual %) | 2.9 | -0.68[f] | 3.3 | 7.3 | 7.3 |
| Urban Population[d], 2014 (% of total population) | 100 | 78.0[g] | 82 | 54 | 32 |

***Source:*** *a-The Global Competitiveness Index 2015-16, b - Human Development Index (HDI-2015), c-The World Fact Book 2015, d - World Bank -2011-15 (www.worldbank.org).*

*e-http://focustaiwan.tw/news/asoc/201409180039.aspx,*
*f-http://www.tradingeconomics.com/taiwan/gdp-growth-annual*
*g-https://en.wikipedia.org/wiki/Urbanization_by_country*
*United Nations does not recognize Taiwan as a sovereign state.*
*Taiwan is not listed as a separate country for world development indicators.*

Although India's global ranking is not impressive at the moment, but it has all the ingredients to become a potential force in global economy in times to come. It has huge natural reserves, large young semi-skilled population, large land and coastal areas. Govt. of India has started taking remedial steps by modifying its economic policies. The impact of such transformation is evidenced by the GDP growth rate of over 7.0%, which is considered one of the best by global standards. US, UK, Germany's growth rate ranges between 1.6 - 2.9 (GCI Report, 2015-16). The scientific excellence of India in the areas of Space Technology and Information Technology is acknowledged by the pundits of developed countries. A separate ministry for Entrepreneurship and Skill Development has been established and provided with large amounts of funds to create a skilled manpower for the industrials sectors and also to encourage young minds of India to convert their novel ideas into Start Up entities (Skill Development Policy 2015). Science Parks, Technology Incubators and Higher Education Institutes on the lines of world acknowledged Indian Institute of Technology (IIT) are being set up (Kumar & K. B, 2011). Infrastructure (roads, airports, educational institutes) is being promoted under public private partnership (ppp) mode (PPP India, 2005). Indian Government is also promoting FDI (India Budget, 2015). These commitments have started paying good dividends as indicated in improved rankings of global agencies like World Economic Forum and various bodies of UNO. The overall GCI rank of India in 2014 was 71 and in 2015, it has jumped to 55. Govt. of India is granting more powers to the states and embracing them as equal partners in India's growth targets. The improvement in Indian economy has been acknowledged by the International Monitory Fund (IMF). It has remarked that Indian economy is in the bright spot in the global landscape and will be one of the fastest growing and big emerging market economies of the world (IMF Report, 2016).

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***(DST/PRC/CPR-03/2013)***

# REPORT-8

## Foundation for Innovation and Technology Transfer (FITT): A Case Study on Industry–Academia Interface in India

**(May 2014- Aug. 2015)**

**Coordinator: Prof Rupinder Tewari**

## Introduction

In 21st century, Industry-Academia (I-A) collaborations have become a subject of great interest to academicians, industry leaders and policymakers, as it is now acknowledged that scientific innovations will be the key driver of the economy of the nations. For innovations of applied nature, strong research collaboration between industry and academia is imperative. In the developed countries, universities and private sector have effective and flourishing I-A bond and many successful I-A models exist. Whereas in the developing nations, the collaboration between the academia and the industry has not been harnessed to its full capacity.

India, a developing country and presumably one of the futuristic top global economy of the world, currently ranks 50th in university-industry collaboration (Global Competitiveness Report 2015-2016). It has a vast network of over 700 Higher Education Institutes (HEIs) comprising of universities, Indian Institute of Technologies (IITs) and National Institute of Technologies (NITs), Indian Institute of Managements (IIMs). It also has over 300 national research laboratories (Table 1). In 2014, Indian scientists published nearly 114,500 research papers/articles and were globally ranked amongst the top ten nations of the world (SCImago Journal, 2014). Unfortunately, the quality of publications is not impressive, as the H-index value of 320 relegated India to a global ranking of 20. The global ranking scenario looks more grim by considering another global indicator i.e. Intellectual Property Rights (IPR). India does not figure in the top 50 nations in IPR indicator (International Property Rights Index Report 2014). In comparison, Singapore, a small Asian country published 17,198 papers/articles and was globally ranked 32 (SCImago Journal, 2014; International Property Rights Index Report 2014). However, global ranking of 25 and 15 for H-Index value and IPRs clearly indicates that though Singapore not only publishes higher quality papers *vis a viz* India, but also converts its research outputs into innovative technologies/products at a high rate. A comparative analysis of India and Singapore on these indicators is illustrated in Figure 1. This data also implies that there is strong I-A interface in Singapore and India can learn a lot from its small Asian partner.

**Table 1: Higher Education Institutes/National Research Laboratories in India**

| S.No. | Higher Education Institutes/National Research Laboratories | Number |
|---|---|---|
| | **Universities** | |

| | | |
|---|---|---|
| 1. | Central Universities | 46 |
| 2. | State Universities | 342 |
| 3. | Deemed Universities | 125 |
| 4. | Private Universities | 228 |
| **Technical Institutes** | | |
| 5. | Indian Institute of Technology (IIT's) | 18 |
| 6. | National Institute of Technology (NIT's) | 31 |
| **National Research Laboratories** | | |
| 7. | Council of Scientific & Industrial Research (CSIR) Laboratories | 43 |
| 8. | Department of Science and Technology (DST) Laboratories | 25 |
| 9. | Department of Biotechnology (DBT) Laboratories | 10 |
| 10. | Indian Council of Medical Research (ICMR) Laboratories | 32 |
| 11. | Indian Council of Agricultural Research (ICAR) Laboratories | 100 |
| 12. | Defence Research and Development Organisation (DRDO) Laboratories | 48 |
| 13. | Department of Atomic Energy (DAE) Laboratories | 13 |
| 14. | Indian Space and Research Organisation (ISRO) Centres | 42 |

*Source:* *http://www.csirhrdg.res.in*, *http://www.ugc.ac.in*, *http://www.icmr.nic.in*, *http://www.icar.org.in*, *http://www.dst.gov.in*, *http://www.dbtindia.nic.in*, *http://www.drdo.gov.in*, *www.isro.gov.in*, *www.dae.nic.in*

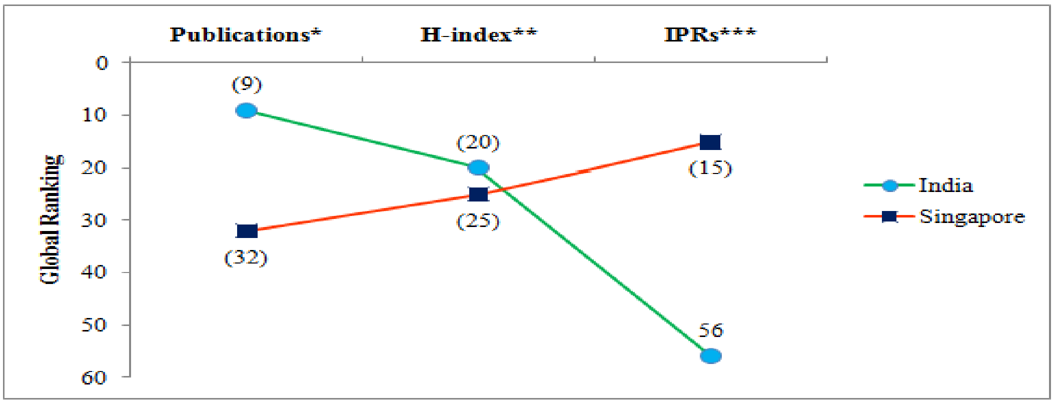


**Figure 1 Global ranking comparison of India and Singapore viz-a-viz scientific research output**

*Source: * Scopus 2013.*
*** H-index: based on the set of most cited papers and the number of citations that they have received in other publications, Scopus.*
**** International Property Rights Index Report 2014*

The present Indian government is fully aware of the importance of effective I-A interface. The Department of Science & Technology (DST), Government of India (GoI), New Delhi has set up a Policy Research Centre at Panjab University, Chandigarh, India. One of the mandate of this Centre is to prepare an effective country specific model of I-A interface for Indian universities (http://cpr.puchd.ac.in/). As IITs are the hub of I-A interactions, a case study was carried out on the I-A centre established in 1995 and termed as Foundation for Innovation and Technology Transfer (FITT). Since its inception it has brought about a sea change in the number of patents and technology transfers. It is not only self sufficient in finances but also enjoys a corporate membership of over 300 companies. The present article briefly describes the inception and governance of FITT (for details, please see the article of Sengupta, 2009) and mainly deals with the various programmes/activities being conducted by FITT. FITT can serve as an effective model for the promotion of I-A interactions for India and other developing countries.

## INCEPTION OF FITT

GoI established FITT in 1995 in the campus of IIT Delhi (IIT-D), a premier engineering institute of India by GoI as the first I-A interface (FITTAnnual Report 1994-95). The GoI at that time provided an amount of INR 1.6 crores as an aggregated fund to IIT-D for initiation and build up of FITT. The mission statement of FITT was formulated as '**To be an effective interface with the industry to foster, promote, and sustain commercialization of science and technology of the institute for mutual benefit**'. The centre was set up as an autonomous and self governing body, to act as a single window utility to the industrial sector with complete professionalism and function as a marketing arm for the IIT-D developed technologies (Sengupta, 2009). The broad organizational structure is composed of a) Governing Council and b) Research Council. The Governing council consists of representatives from industries, industrial associations and nominee from Ministry of Human Resources Development, selected nominated members from IIT-D senate and its board of governors. On the other hand, Research Council is composed of selected faculty members of IIT-D having experience in I-A collaborations. The management is vested with the Managing Director of the organization, guided by a Governing Council and a Research Council.

## A. PROGRAMS AND SERVICES AT FITT

Since the inception of FITT, a large number of programs and initiatives have been introduced in an effort to catapult the I-A linkages to the next level. The programs initiated by FITT can broadly be categorized as the following:

1. Incubation Centers
2. Research/Technology Development Projects
3. Knowledge Augmentation Courses
4. IPR Management Related Services and Programmes
5. Corporate Partnership for the Industrial Sector
6. Government Schemes
7. Memorandum of Understandings (MoUs) with Private Sector
8. FITT Awards and Recognitions

### 1. Incubation Centers

In an endeavor to promote entrepreneurship and start-up companies, FITT initiated the task of setting up incubators/science parks on IIT-D campus, thereby providing easy access to students/innovators. These incubation centers were set up with the aim of providing the entrepreneur with space for a prototype laboratory and other basic infrastructural and instrumentation facilities, without getting into the hassle of paper work. In addition, start-ups having credible business plan(s) with focused proprietary knowledge are promoted by FITT. It admits start-ups for an initial period of two years but an extension beyond the initial period is granted depending on the scope of the work. The incubator centre provides facilities such as product innovation, product development, software testing, pilot experimentation, simulation and prototyping, industrial training and technology related work which works in homology with the institute. Major activities of incubation centers are Technology Business Incubation Unit (TBIU), Bio-Incubator Facility, Science Parks and the units set up under Bio-Accelerator Programme.

Various incubation facilities provided by FITT are as under:

- **Technology Business Incubation Unit (TBIU)**

TBIU was started in 2000 under the aegis of Technology Institution Program (TIP), as a part of the Industrial Credit and Investment Corporation of India (ICICI)/World Bank Funded TIP at IIT-D (Bhattacharya, 2005).

The TBIU program at IIT-D is aimed at promoting entrepreneurship among students, faculty and scientists and creating successful technology business enterprises for the future.

Under this scheme, the start-ups/technology entrepreneurs are provided with an initial seed money and space for converting new ideas/concepts/service into a business opportunity that is commercially viable. This model has proven to be extremely helpful for the conversion of nascent technological ideas into commercial entities. TBIU, in its premises and in sync with the institute, permits activities such as innovative product development, software development and testing, simulation and prototyping, pilot scale experimentation, training and other works related to technology development. Thus, FITT not only provides modern infrastructure to the technoentrepreneurs but also provides for handholding, managerial and material support for establishing themselves. In return, minimal space utilisation charges and equity share of the company rests with FITT.

The day-to-day administration of the TBIU lies with FITT. However, the management of TBIU rests with the TBIU board and a standing/screening committee, comprising of senior faculty scientists and industry experts from all over India to screen and evaluate the incubation proposals for entrepreneurs/start-ups admission to the TBIU.

Some of the successful examples of the start-ups graduated from FITT:

- ***Ekam Eco Solutions Pvt. Ltd.***

  Ekam Eco Solutions Pvt. Ltd. (www.ekamecosolutions.com) was initiated in financial year 2013-14 with the aim of providing ecological solutions in the field of nutrient recovery, water conservation, sanitation and sustainable habitat (FITT Annual Report 2013-14). It works in the domains of sustainable livelihoods, sustainable sanitation and value-added bamboo products. Ekam has successfully commenced its objectives by addressing the gap in innovation and product development and is in the process of delivering out a number of innovative solutions, which could be implemented at rural and urban levels. Global Corporate Social Responsibility (CSR) Excellence and Leadership award 2015 was presented to Ekam in the category of Social Impact Awards at APB News (www.ekamecosolutions.com).

- ***Novo Informatics Pvt. Ltd.***

  Novo Informatics Pvt. Ltd. (http://novoinformatics.com) was founded at the TBIU in 2012 and has recently begun its commercialization and scale-up on independent grounds. It has developed software products like geno-analyzer, novo-proteomics, novo-genomics and disease specific database drawing a bridge between bio-informatics and experimentation. Presently, IIT-D is its research partner.

- ***Genesis Location Services Pvt. Ltd.***

  Genesis Location Services Pvt. Ltd. (http://genesis-locationservices.com) was established in 2014. This start-up has developed on-board attendance system for business process outsourcing (BPO) employees and school children with global positioning system (GPS) tracking their vehicles. Start-up also came up with smart sub-station monitoring system for electrical distribution for companies. It can also monitor the real time parameters of transformer, as well as remote data collection from meters using GPS technology. It has successfully created a wireless connectivity option from Rajasthan Technical University (RTU) to supervisory control and data acquisition (SCADA) using transparent channel modem for companies dealing with electricity transmission.

- ***KritiKal Solutions India Pvt. Ltd.***

  The first faculty-student led business incubation unit, KritiKal Solutions India Pvt. Ltd. (http://www.kritikalsolutions.com), was founded in 2002. The company started functioning as a full-scale commercial venture by the year 2005 (Annual Report 2005-06). The main focus of the company is embedded system design and real time computer vision and imaging solutions. As of date, KritiKal can boast of significant presence in India and United States and is also extending to Europe, Africa and other parts of Asia.

- ***Gram Vaani Community Media Pvt. Ltd.***

  Another successful spin-off from TBIU is Gram Vaani (http://www.gramvaani.org), based at IIT-D since 2008. It is a social technology based company, which provides information and community technology based solutions. This company works in collaboration with the institute and encourages internship/trainee students to work on real-life problems and situations. The company is now a 35 employee strong group and has recorded turnover of INR 1-1.5 crores per annum. The company has also won several awards including The Knight News Challenge (2008), The Manthan Award (2009), The Economic Times Power of Ideas Award (2010), The Rising Stars in Global Health Award (2012) and The mBillionth Award South Asia (2012 and 2013).

The TBIU clearly renders a proactive approach towards a judicious and long term partnership amongst the entrepreneur, institute and the outside world. A list of resident companies in the year 2014-15 is depicted in Table 2 (FITT Annual Report 2014-15).

**Table 2: Start-ups (promoters/faculty) resident at TBIU during the financial year 2014-15**

| S. No | Start-up | Work area |
|---|---|---|
| 1. | Carbon Neutral Technologies Pvt. Ltd. | Develop an alternative manufacturing process for isoprene |
| 2. | Credext Technologies Pvt. Ltd. (http://www.credextechnologies.com) | Development of falcon virtual PC device that enables a user to access his/ her desktop at remote locations |
| 3. | Creditas Solutions Pvt. Ltd. | Developing online platform for debt negotiation and settlements |
| 4. | Ekam Eco Solutions Pvt. Ltd. (http://www.ekamecosolutions.com) | Ecological solutions in the field of sanitation, water conservation, nutrient recovery and sustainable habitat |
| 5. | Inkilab Technologies Pvt. Ltd. (http://www.inkilabtechnologies.com) | Diagnostics based technologies to facilitate process design |
| 6. | Innovator Lab Consultants India Pvt. Ltd. (http://www.innovatorlabindia.com) | Development of mechanical heart valve fixation system |
| 7. | Kentellus Welding and Manufacturing Pvt. Ltd. | Production of welding electrodes of better quality using green technology |
| 8. | Novo Informatics Pvt. Ltd. (http://novoinformatics.com) | Bridging the gap between bio-informatics and experimentation |
| 9. | PLANiN Innovation and Consultancy Services Pvt. Ltd. | Basket of innovative products with proprietary technologies (e.g. vehicool, smart wipes, flexible notice board etc) |
| 10. | Silver Knight Technologies Pvt. Ltd. (http://www.silverknight.info/) | Development of Anti-Theft bag with unique features like pilfer proof casing, unique zip and lock mechanism & track and trace system |
| 11. | VM Trans Innovations Pvt. Ltd. | Development of intelligent online platform for road transport management and exchange system |
| 12.. | Wring Nano Systems Pvt. Ltd. (http://www.truehb.com/team.php) | Advanced bioelectronics technologies (e.g. hemometer) |

*(Source: FITT Annual Report 2014-15)*

The above-mentioned list of start-up companies is just a glimpse of what TBIU has done in order to promote entrepreneurship via the I-A interface. In the last two decades, there have been innumerable start-ups and incubates at TBIU and quite a few of them have graduated and are working independently as successful, self-sufficient, profit generating companies (Table 3).

**Table 3: List of a few TBIU start-ups graduated into successful companies**

| S. No. | Name of the Incubating Unit | Technology/product/process in incubation | Residency | |
|---|---|---|---|---|
| | | | Entry | Exit |
| 1 | Ekam Eco Solutions Pvt. Ltd. (http://www.ekamecosolutions.com) | Ecological solutions in the field of sanitation, water conservation, nutrient recovery and sustainable habitat | 2013 | 2015 |
| 2 | Genesis Location Services Pvt. Ltd. (http://genesis-locationservices.com) | Location based products and services | 2011 | 2014 |
| 3 | Gram Vaani Community Media Pvt. Ltd. (http://www.gramvaani.org) | Building innovative models of media delivery for rural areas of india | 2009 | 2013 |
| 4 | Inkilab Technologies Pvt. Ltd. (www.inkilabtechnologies.com) | Analytics to the manufacturer on defective parts and processes | 2013 | 2014 |
| 5 | Innovative Mechatronix Solutions Pvt. Ltd. | Design, development and manufacture of micromachining system, mass production finishing processes and mechatronic embedded systems | 2010 | 2013 |
| 6 | M/s Appin Software Security Pvt. Ltd. (http://www.appinonline.com) | Software security | 2007 | 2009 |
| 7 | M/s Care-pro Biotechnologies Pvt. Ltd. (http://www.careprobio.com) | Fermentation based biomolecules | 2007 | 2010 |
| 8 | M/s eCapital Solutions Pvt.Ltd. / Trigyn Technologies (I) Pvt. Ltd. | Telecommunication and internet application | 1999 | 2001 |
| 9 | M/s INRM Consultants Pvt. Ltd. (http://inrm.co.in) | GIS based integrated watershed management | 2002 | 2004 |
| 10 | M/s KritiKal Solutions Pvt. Ltd. (http://www.kritikalsolutions.com) | Computer vision and image processing, wireless adhoc networks | 2002 | 2005 |
| 11 | M/s LeadInvent Technologies (http://www.leadinvent.com) | Novel drug discovery & computational biology | 2007 | 2010 |

| | | | | |
|---|---|---|---|---|
| 12 | M/s Mechartes Researchers Pvt. Ltd.(http://www.mechartes.com) | Software products for simulation of product development in auto component industry | 2005 | 2008 |
| 13 | M/s SM OnYoMo Infotech Pvt. Ltd. | Consumer searches over the internet | 2005 | 2009 |
| 14 | M/s. Faros Technologies Pvt. Ltd. (http://www.farosindia.com) | Development of simulator sub components, simulators and providing simulation services | 2008 | 2013 |
| 15 | M/s. Innovative Transport Solutions Pvt. Ltd. (http://www.itrans.co.in) | Scientific and technical solutions for traffic and transport systems and development of models for sustainable transport for cities | 2008 | 2012 |
| 16 | M/s. Sunurja Renewable Energy Pvt. Ltd. (http://www.sunurja.com) | Design and development of renewable energy solutions | 2008 | 2011 |
| 17 | Novo Informatics Pvt. Ltd. (http://novoinformatics.com/) | Scientific software application products/tools | 2011 | 2014 |
| 18 | Simplyfeye Softwares Pvt. Ltd. (http://www.simplyfeye.com) | User-friendly operating platform for biopharmaceutical manufacturers to capture, share and analyze information from biopharmaceutical processes | 2010 | 2013 |
| 19 | Sintex ESCO | R&D on insulated lightweight prefabricated building structures for thermal comfort and energy conservation | 2001 | 2003 |
| 20 | Wring Nano Systems Pvt. Ltd. (http://www.truehb.com/team.php) | Advanced blood haemoglobin testing POCT | 2012 | 2014 |
| 21 | Yonyx Infomedia Pvt. Ltd. | Building teacher replication platform to enable teachers to pack instruction with predicted student interaction | 2010 | 2012 |

(*Source: http://www.fitt-iitd.org*)

- **FITT as a Biotech Ignition Grant (BIG) partner**

BIG is one of the highly successful I-A interface programmes of Biotechnology Industry Research Assistance Council (BIRAC), an autonomous body of Department of Biotechnology (DBT), GoI, New Delhi. BIRAC is a section 25 company and is actively involved in transforming the efforts of start-ups into commercially viable products and technologies. The BIG scheme, which aims to invite proposals for the ignition grant twice a year, supports entrepreneurs from the academia and research institutes for the commercialization of technologies resulting from research in the area of biotechnology, which itself has been recognized as an emerging and conspicuous area for growth. BIG has identified a few institutes, including FITT, as official partners. As a partner in the scheme, FITT holds the responsibility of screening the applications received; review the projects that have been shortlisted, provide mentoring in issues related to IPR, legal affairs and other business development related issues, facilitate interaction with experts of the field and other academic partners of the institute etc.

An early stage grant by BIG is provided for the development of an invention into a marketable product. This is a one of a kind scheme, which aims at establishing and validating proof of concept ideas and thereby enabling spin-offs, which is now gaining pace. Some of the key projects under BIG partnerships are:

- Cutting Edge Medical Devices Pvt. Ltd. (http://www.cemd.in) developed portable analyzer SCINTILLA for detection of protein levels in urine samples.
- Sakosh Biotech Pvt. Ltd. is working on development of lateral flow immunoassay based rapid diagnostic tests for various infectious diseases.

- **Bio-accelerator programme**

In 2013, FITT in association with National Institute of Immunology (NII) at New Delhi and BIORxVenture Advisors (http://www.biorxventureadvisors.com) started a Bio-accelerator programme, which laid emphasis on “accelerating innovation to marketplace” (FITT Annual Report 2013-14). This is indeed one aspect of research, which is now gaining pace, and this program provides the impetus to focus on innovation on the basis of market demands. It is a joint initiative to strengthen the bio-economy of the nation by composing a ‘Master Class on Bio-entrepreneurship’. This programme is devised for working executives, research scholars and post-doctoral scientists who aspire to work towards a path of commercialization for their discovery.

- **Biotech Incubator Facility**

DBT, GoI, has recommended supporting the establishment of a Biotech Incubator Facility at FITT, IIT-D (FITT Newsletter, October 2014). A sanction of INR 8.7 crores has been granted for the incubator, for a period of initial three years. This facility, like other incubators, will support start-ups and provide incubation facilities for research and development work at minimal charges so as to promote innovation in the field of biotechnology.

Further, FITT, with funding from BIRAC, has established a **Biotechnology Business Incubator Facility (BBIF),** which was inaugurated in August 2014. BBIF provides incubator facilities such as specialized equipment's, experimental facility, IP guidance, market linkages etc. to the budding biotech start-ups (FITT Annual Report 2014-15). It provides for a very fertile/conducive environment and has a capacity for incubating close to 15 companies/entrepreneurs.

- **Science and Technology Parks**

The most recent endeavour of FITT is to set up Science and Technology Parks as a way of promoting the institute's intellectual capital and providing a platform for better research and development. These parks have been conceptualised in a way such that they will have all facilities for start-ups as well as well established firms. These facilities include legal, banking, research & development, consultancy, networking spaces and so on. In lieu of this concept, a land space of 50 acres for extension of IIT Delhi's research campus and the setting up of a Science and Technology Park, a centre for development of faculty and a high performance-computing centre was been allocated (Indian Institute of Technology Delhi eNewsletter, April 2013).

## 2. Research/Technology Development Projects

The faculty at IIT-D in collaboration with students and/or companies take up several research projects, which eventually lead to the development of technologies that are consequently transferred or commercialised with the help of FITT. It is mainly involved in the transfer of technologies to the industry, initiation of joint research programs, consultancy assignments from the industry. The centre has aided the licensing of technologies developed at the institute; ~40 technologies have been licensed since 2002 and further ~10 technologies have been successful converted into commercially viable market products (Table 4).

**Table 4: List of technologies developed at IIT-D and licensed through FITT since 2002**

| S. No. | Year | Technology Licensed |
|---|---|---|
| 1. | 2002-03 | Know how transfer of fiber optics educational kit |
| | | Low molecular weight organic compound using liquid carbon dioxide |
| | | Pilling tester based on digital image processing |
| 2. | 2003-04 | Three phase watt hour meter |
| | | RUSTGARD (Industrial grade & superior grade) |
| | | Microwave Integrated Circuit (MIC) Kit |
| 3. | 2004-05 | Local FE stress analysis and know how transfer of ASME Div-two reactors for Panipat refinery expansion |
| | | Transfer of technology for *Trichoderma* |
| | | Drape meter based on digital image processing |
| 4. | 2005-06 | Technology transfer- VCO and detector |
| | | Technology for manufacture of alluritic acid |
| 5. | 2006-07 | High pressure bio gas (Gobar Gas) enrichment and bottling system |
| | | Statistical scenario analysis software package |
| | | Vehicle under side scanner |
| | | Design & development of reusable pilfer proof currency carrying FRP cases |
| 6. | 2007-08 | Computer aided design of components at microwave frequencies |
| | | Design and development of active microwave integrated circuit trainer kit |
| 7. | 2008-09 | Limiting torque bolt mechanism |
| | | A smart cane for obstacle detection for the physically impaired |
| | | A novel back panel design for efficient heat transfer in solar cells |
| | | Polymer composite sheets with enhanced properties |
| 8. | 2009-10 | RF magnetron target holder |
| | | Selective and sensitive detection of mercuric ion by novel dansyl- |

| | | |
|---|---|---|
| | | appended Calix[4]arene molecules via fluorescence quenching |
| | | An apparatus and method for packet error correction in networks |
| | | System and method for decorticating hard shell seeds and fruits |
| 9. | 2010-11 | Development of the iontophoratic kit for a transdermal delivery of methotrexate and insulin and validation of iontophoratic parameters for diclofenac |
| | | Odourless, waterless urinal traps and associated structures |
| 10. | 2011-12 | An apparatus for measuring fabric hand value |
| 11. | 2012-13 | Real time based supervisory control of AC drive |
| | | A method for preparation of cross- linked protein coated micro-crystal |
| 12. | 2013-14 | Knowhow for the technologies on drug discovery and proteomics |
| | | In-plane wicking measurement system |
| 13. | 2014-15 | A small chaperone |
| | | Thermal NDE: Modelling framework for crack detection |
| | | A process of generating magnetically controlled ball and smart abrasive laden shape for finishing 3D intricate shaped surface |
| | | Odour prevention device |
| | | Concrete vibration sensor technology |

*(Source: FITT Annual Reports 2002-15)*

One of the most successful projects has been the development of the 'Smart Cane for the Visually Impaired', which was developed as an improvement to the white cane and defeats the limitation of white cane by detecting knee above and hanging obstacles (Singh *et al.*, 2010). This unique device was developed in collaboration with Phoenix Medical Systems, Chennai (industrial partner) and Saksham Trust, Delhi (Non-governmental organization (NGO) working for the visually impaired). Some other successful technologies that have been developed and commercialised are "FruWash" and "EnNatura". FruWash is an emulsion, which is biodegradable and can be used to increase the shelf life of harvested fruits and vegetables (without refrigeration). This technology was designed with an objective of reducing the post harvest losses in the horticulture sector. EnNatura developed offset printing biodegradable ink, using vegetable oils that tend to replace the standard inks that are based on petrochemical products/ crude oils.

FITT undertakes short to medium term problem solving investigative projects that help in establishing mutual confidence and working relationships with industrial sector and is continuously working on transferring technologies outside. During the financial year 2014-15, 96 technology development/transfer projects of worth INR 16.8 crores have been contracted. Out of these projects, 5 Intellectual Property (IP) licenses were executed in financial year 2014-15 (Table 5).

**Table 5: Intellectual Property (IP) Licenses executed during 2014-15**

| S.No | Title | Client |
|---|---|---|
| 1 | A small chaperone | Theramyst Novobiologics Pvt. Ltd., Bangalore |
| 2 | Thermal NDE: Modelling framework for crack detection | GE India Technology Centre Pvt. Ltd., Bangalore |
| 3 | A process of generating magnetically controlled ball and smart abrasive laden shape for finishing 3D intricate shaped structure | Innovative Mechatronix Systems Pvt. Ltd. |
| 4 | Odour prevention device | Ekam Eco Solutions Pvt. Ltd., New Delhi |
| 5 | Concrete vibration sensor technology | Central Electronics Ltd., New Delhi |

*(Source: FITT Annual Report 2014-15)*

FITT also undertakes selected investigative projects involving foreign contribution that aid in technology development and asset share between national and foreign research partners. Some of the successful foreign collaborated projects of year 2014-15 are listed in Table 6.

**Table 6: Select foreign collaborative projects during 2014-15**

| S.No | Title | Client |
|---|---|---|
| 1 | Optimization and growth of pyroelectric thin film stack | Ultrasolar Technologies, Inc, United States of America |

| | | |
|---|---|---|
| 2 | Optimization of chromatography process steps for purification of monoclonal antibody based therapeutics | Purolite Limited, United Kingdom |
| 3. | On line Devanagri handwritten character recognition on a smartphone through touch interface | Qualcomm Inc, United States of America |
| 4 | Polypropylene foaming and recyclability | Borealis AG, Australia |
| 5 | Advice for development of long term monitoring | Asada Lab, University of Tokyo, Japan |
| 6 | EEG signal based recognition module with low computational load | Safran, France |
| 7 | Algorithmic framework for MEMS sensor fusion applications | ST Microelectronics, United States of America |

*(Source: FITT Annual Report 2014-15)*

### 3. Knowledge Augmentation Courses and Professional Development Programmes

Undeviating from its objective of knowledge transfer, FITT is working towards delivering academic options via various professional and human resource developments (HRD) courses. It understands that higher education is a continuing process and there is no limit to the enhancement of one’s qualifications. In order to facilitate this increasing demand and providing a platform for working professionals, FITT in association with the institute, introduced several knowledge augmentation & skill enhancement courses as well as a number of short-term courses devised on emerging technologies. For encouraging professionals to enhance their qualification, programs have been initiated so as to give professionals a chance to study while they work which will aid their professional growth. Various courses are offered by all departments of IIT-D e.g., Electrical Engineering, Computer Science and Engineering, Mathematics, Mechanical Engineering etc. One such programme initiated was “Professional Candidate Registration (PCR)”. This course involves registration of the candidate for one semester (as per the course chosen) and is certified at the end of the program. A graduate in engineering sciences or a postgraduate in science and management studies with relevant industrial experience is eligible for enrolment in these courses. This program is confined to the Delhi region as of now due to accessibility issues although a few selected courses are covered under the on-site delivery program by a two-way audio-video link.

Another programme that was initiated was “Knowledge Augmentation and Skill Enhancement programme”. Various add-on courses for professionals and students have been commenced with the aim of honing the students to be job ready. This also includes HRD programs such as conferences or short workshops for knowledge updating of the latest happenings in various fields. The centre regularly assists the faculty of the institute in designing and organizing national and international workshops/conferences concentrating on prevailing field of science and technology. A few workshops/conferences that were recently conducted focused on renewable energy technologies, inclusive and frugal innovation etc. (FITT Annual Report 2014-15).

Some of the specialized training programmes conducted by FITT are listed below:

1. Advance Course of Software Engineering (S.Tech)
2. Short Course on “Embedded Systems and Its Applications”
3. Training Program on Fibre Optics for ONGC
4. Certificate Programme in Telecom Technology in Management
5. “Super Critical Power Generation Technologies”
6. Certificate Course in Bioinformatics & Computational Biology

Other programmes conducted by FITT for academicians and industry employees are as follows:

1. Frost & Sullivan’s Technology Partnership Program: Initiated by IIT-D has access to the Frost & Sullivan’s portal thereby getting useful market, technology and econometric information along with the latest updates on technology trends across a broad range of industry sectors (FITT Annual Report 2014-15).
2. Technology Incubation and Development of Entrepreneurs (TIDE) and Entrepreneurial and Managerial Development of SMEs through Incubators (MSME scheme): Adopted by FITT to enrich the entrepreneurial ecosystem and technology commercialization efforts at the institute.
3. FITT in association with BIRAC and Association of Biotechnology Led Enterprises (ABLE) conducted short courses on Economic and Financing of Renewable Energy

Technologiesand Nascent Entrepreneurship Development Programme (FITT Annual Report 2014-15).

4. FITT also organized various seminars and awareness workshops for disseminating technologies developed at IIT-Delhi and promotional material and processed applications proposals. One such latest series of seminar on innovation, sustainability and entrepreneurship was organized by FITT in association with Knowledge Resource Development and Welfare group of IIT-D and PHD Chamber promoting entrepreneurship (FITT Annual Report 2014-15).

**4. Intellectual Property Rights (IPR) Management Programmes**

Another important programme initiated by FITT is the IPR management of the institute's academic community. Before FITT had taken up the responsibility of promoting the IPR interests of the institute, the rate of filing for IPRs by the institute was very low. A number of campaigns were initiated at FITT for promoting IPR filing for novel inventions/technologies/research outputs amongst the academic community. Complete assistance for filing of applications was provided by FITT by way of evaluation of proposals for patents and other IPR applications for the final submission to Indian Patent Office and other establishments. The decisions pertaining to the application of technologies are taken by the IPR standing committee. The licensing policy followed by FITT is pliable and the payment terms are mutually secured. A comprehensive list of the technologies developed and being developed can be accessed from FITT website (http://www.fitt-iitd.org). This makes it extremely easy for the industry to search for any technologies of their interest and contact the person in question hence boosting the institute's technology commercialization.

Since the inception of IPR body in 1995, FITT has seen enormous growth with respect to IP generation and technology transfer and in the process it has become more than self-sufficient financially (Figure 2). In the past two decades, more than 200 IPR applications have been filed in the form of patents, copyrights, designs etc. as opposed to a mere count of 15 patent applications filed from IIT-D between the years 1963 and 1995 i.e. before the inception of FITT (Figure 2). The probable projects are submitted to the IPR standing committee, where each project is discussed and thought over in detail for the grant of approval to be further submitted for IPR filing. In the year 2014-15, the IPR standing committee of FITT approved 27 technologies, and 5 IP licenses have been executed for technology transfer from academia to industry (FITT Annual Report 2014-15).

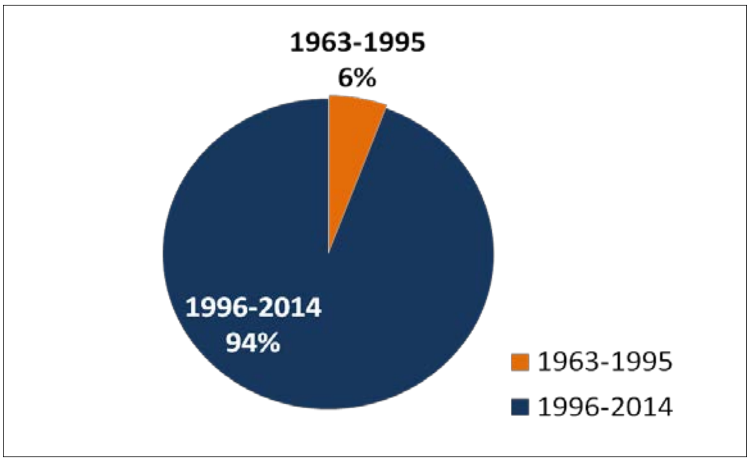


**Figure 2 Patents filed before and after the inception of FITT**

5. **Corporate Partnership**

The fundamental endeavor of FITT is to create an effective relationship between the institute and the industry on a mutually supportive basis. FITT has also started a corporate partnership program on the payment of nominal annual fee, for public and private sector industries, ministries and organizations and industry associations and financial institutes, and offers the advantage of concessional services to its members. The corporate members are regularly updated with the information of various programs at the institute and other opportunities of collaboration. FITT has a large number of big corporations as their corporate members, and with the numbers increasing every year; this clearly seems to be beneficial for the corporate. The corporate members receive, among other benefits, advance notifications of all patent applications/technologies available and marketed by FITT, customized research presentations and seminars, industrial trainings and workshops, newsletters and select information. Most significant, however, is the advantageous working relation that the member develops with FITT thereby allowing them to gain access to research performed at IIT-D, as well as a variety of local businesses and services.

As of date, more than 250 companies worldwide have benefited from the programs of FITT (http://www.fitt-iitd.org). This number speaks volumes not only about the success of the organization but also about the way in which the industry is ready to collaborate with the academia. Some corporate members that are a part of this are: Pfizer India Pvt. Ltd., L'Oreal India Pvt. Ltd., LG Electronics India, Fresenius Kabi Oncology Ltd., Samsung Research Institute, Delhi, Dabur Research Foundation, Cube Software Pvt. Ltd., Reliance Industries Ltd., National Thermal Power Corporation, Bharat Heavy Electricals Ltd., Munjal Showa Ltd., JCB India, Canon India, Danfoss Industries, Carborundum Universal, Tata Chemicals, Jubilant Organosys Ltd., National Research and Development Corporation, Indian Grameen services etc.

Recently, FITT has collaborated with one of the leading pharmaceutical company Pfizer for promoting healthcare innovations in country by commencing IP Programme for young entrepreneurs (Laha, 2015) to provide training and short courses in IP related issues but also to support development of technologies in healthcare sector. Under this corporate collaboration individual support system for healthcare innovations are provided. This is one of the programmes that directly involve active working of wet-lab based biotechnology business incubation facility of FITT which was set up only a year ago to meet growing demands among biotechnology/ healthcare sector. The collaboration has resulted into “the Pfizer IIT Delhi innovation and IP programme (PIDIIP)” which will provide funding support of upto INR 48 lakhs, majorly into two sectors one is from idea to IP and other is IP support. Gamut of advantages can be availed by health science innovators in this facility where engineers, scientists and healthcare professionals are engaged together for solving challenging assignments for developing healthcare innovations that can address some of the issues that our country faces in the healthcare sector (Laha, 2015).

**6. Government Schemes**

FITT is also actively involved in the facilitation of all technology based government schemes. It provides for background checks on government technology development projects. Some of the prominent government schemes that are facilitated by FITT are listed below:

- *N-WISE:* The National Information System for Science and Technology (NISSAT–DSIR) Window to Information Services to Entrepreneurs was initiated in 2001-02.
- *Technopreneur Promotion Program (TePP)* by Department of Scientific and Industrial Research (DSIR) and Technology Information, Forecasting and Assessment Council (TIFAC) of the Department of Science and Technology (DST): FITT has taken up various programmes to enrich the ecosystem of entrepreneurship and technology transfer at the institute, one of them being TePP. FITT is a partner in the program initiated by DSIR & TIFAC and also one of the TePP Outreach Centres (TUCs), wherein a financial support of up to INR 15-45 lakhs is provided by DSIR and all the technical support & mentoring for development of an idea/prototype of the project is provided by FITT.
- *Entrepreneurial and Managerial Development of Small and Medium scale Enterprises (SMEs) through Incubators:* This scheme was started for the promotion of knowledge/technology based innovative ventures, in all fields of science and

technology, to improve the competitiveness of SMEs, through a financial support of up to INR 4.01 crores.

- *PRISM (Promoting Innovation in Individuals, Start-ups and MSMEs):* This program initiated under the aegis of DSIR, aims to support one of the most crucial agenda of the XII$^{th}$ Five Year Plan (2012-17) i.e. inclusive growth and development. This scheme provides support to prototype/models with upto INR 2 lakhs and fabrication of working model/process know-how/testing & trial/patenting/technology transfer upto INR 20-50 lakhs. This program, which is offered in two phases, promotes the development of technologies needed in the market and the transfer of IP of such developed technologies, which is where a major gap lies, mainly due to the lack of funds by start-up firms. FITT as a confederate, through this scheme helps in promotion of the development of such technologies, which could otherwise be shelved only due to lack of resources.
- *Department of Information Technology-Technology Incubation and Development Entrepreneurs (DIT-TIDE):* Department of Information Technology (DIT) has introduced Technology Incubation and Development of Entrepreneurs (TIDE) for providing seed support in the broad area of IT development. FITT has partnered for promoting this scheme, which provides incubators during early stages of the development of various IT and ITES enabled firms.

**7. Memorandum of Understanding (MoU)**

Formal agreement between FITT and other institutes/industrial partners has been set up to promote innovation and technology transfer. Some of the advantageous MoUs (2014-15) are mentioned below:

- MoU with the American Society for Quality (ASQ) India Pvt. Ltd

  An MoU was signed with ASQ India Pvt. Ltd., with a central agenda of achieving forwardness in knowledge/adeptness and its implementation for the benefit of IIT-D community in fields of engineering and management sciences. It also aimed to add virtue for the executives working in the industrial sector and government sector through continuing education. ASQ, being the global knowledge framework that it is, links the best ideas, tools, and experts together, and offers globally accepted individual certification in programs such as six sigma, TQM, process management etc.

- MoU with Security Printing and Minting corporation of India Ltd (SPMCIL), New Delhi to foster collaboration on research, training and professional development and exchange of technical expertise in areas of mutual interest including material science and testing capabilities.
- MoU with Global Aerospace, Defence and Security Leader, Safranto to initiate research and development in the area of advance machine learning.
- MoU with Wallonia Foreign Trade and Investment Agency (AWEX), Belgium in order to create high-profit sustainable global companies from pioneering start-ups using Wallonia as a hub for their expansion in Europe to gain access to the markets in the European Union.

## 8. FITT Awards and Recognitions

FITT, in order to promote the spirit of innovation and entrepreneurship has launched various appreciation ceremonies in the form of awards and rewards. These activities are generally carried out in collaboration with various corporate players and are as follows.

- Launch of Industrial Credit and Investment Corporation of India (ICICI)-trinity program: The program launched by ICICI for budding entrepreneurs is an initiative of the bank to reward innovation and entrepreneurship amongst the youth community in India. The ICICI Trinity programme comprises of three stages – idea generation, prototype and be an entrepreneur. This program has been launched in several top institutes across the country, with IIT-D being one of them.
- POSOCO power system award (PPSA)-2015: The Power System Operation Corporation (POSOCO), a wholly owned subsidiary of PowerGrid Corporation of India Ltd., launched these awards, in the form of cash prizes, to recognise the outstanding contribution made in the field of power systems and its related fields. The collaboration with FITT encompasses the IITs and National Institute of Technologies (NITs) in order to motivate individuals and encourage further research activities in the area of power system.

FITT has instituted two awards one each for Ph.D and M.tech/ M.S projects as best industry relevant projects through which financial and marketing assistance is provided to award winners to incubate their project.

## B. FINANCIAL SYNOPSIS

FITT has not only promoted the intellectual and infrastructural facilities of IIT-D but also added industrial relevance and commercial value to the academic knowledge/ research being performed at IIT-D. Among the many functions and objectives of FITT, marketing and business development is one of the most important aspects of FITT. It is the only way of advertising the expertise available at IIT-D that led to enormous asset generation for FITT and IIT-D.

FITT has bank deposits and bonds worth INR 35.6 crores in financial year 2014-2015. Major earnings of FITT came from interests (INR 3.3 crores), project activities (INR 66 lakhs) and corporate membership fees (INR 1 lakh) for the year 2014-15. On the other hand, total expenditure of FITT cost around INR 1.3 crores. Hence, leading to operational growth worth INR17.7 crores from projects and other activities performed in financial year 2014-15.

Financial assets generated by FITT were achieved by conducting I-A summits, active participation in industry exhibitions at national and international level, publication of a quarterly bulletin, regular propagation of knowledge about IIT-D and FITT through means of articles and write ups in newspapers/magazines and occasional promotional advertisements, initiating corporate membership scheme for the industry, establishment of relationships with associations like Federation of Indian Chambers of Commerce and Industry (FICCI), Associated Chambers of Commerce & Industry of India (ASSOCHAM), Confederation of Indian Industry (CII) and so on. Figures 3 and 4 depict the asset and resource generation for IIT-D by FITT since 2002.

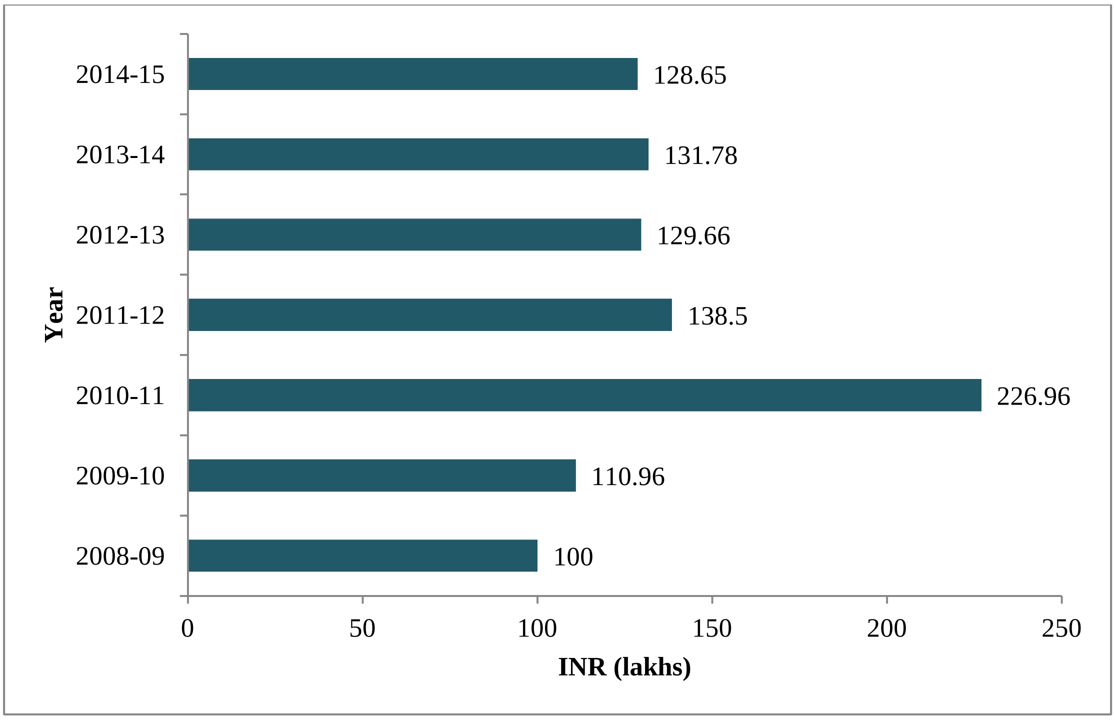


**Figure 3 Asset Generation (infrastructure, equipment's and transfer of funds) from FITT for IIT-D (*Source: FITT Annual Report 2008-15*)**

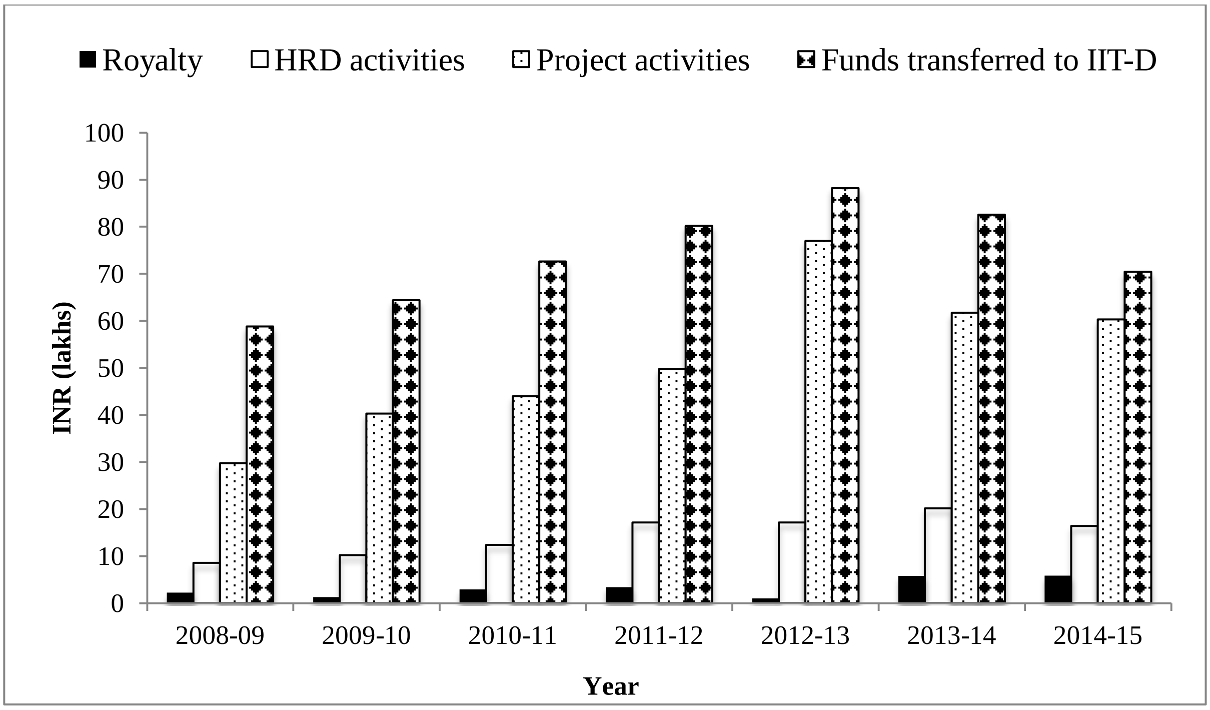


**Figure 4 Resource generation for FITT and IIT-D *(Source: FITT Annual Report 2008-15)***

## C. SUMMARY AND CONCLUSIONS

FITT is one of the highly successful models of I-A interface in India, which can be adopted and embraced by the developing countries. This model aims to bridge the gap between the industrial sector and the academic sector and brings many benefits (tangible and intangible) to its stakeholders i.e. academia and industry. The tangible benefits include creation of entrepreneurs, which later on become owners of start-up companies. In other words, a job seeker becomes a job employer. I-A centres like FITT helps scientific community in bringing its research outputs to the market by way of patenting their innovative research and preparing a business model for their applied research. The setting up of FITT in IIT-D has seen tremendous increase in the number of patents, technology transfers, innovative products, financial gains and creation of first generation entrepreneurs, which has greatly enhanced the branding of the institute. FITT also provides many intangible benefits to the academia. The scientists of IIT-D do not have to worry about the commercial gains of their research out puts and thus can devote 100% of their time in teaching young and bright minds as well as carrying out high end research. Industry is also benefitted by getting state of theart technologies, which gives them a global edge in the highly competitive market.

India has enormous scientific strength as evidenced by its high global ranking ($9^{th}$) for the indicator of number of research publications. In addition, GoI has introduced many schemes, such as DST-INSPIRE Faculty Scheme, Ramalingaswami Fellowship by DBT, Ramanujan Fellowship by DST and Prime Minister’s Fellowship Scheme for Doctoral Research etc. for encouraging young bright researchers, residing in India as well as abroad, to join universities. India can reap the harvest of its scientific intellect for solving the research problems of industrial sector by opening FITT like centres in the universities, which are actively publishing high impact research papers in international journals. By adopting FITT model for the promotion of I-A interactions, we cannot even comprehend the advantages it might provide, not only in financial terms, but by way of promoting the development of indigenous technology, creating entrepreneurial spirit and thereby boosting the Indian economy.

## D. ACKNOWLEDGEMENTS

The authors wish to acknowledge and are grateful to Department of Science and Technology, Ministry of Science and Technology, Government of India, New Delhi for the financial support. The authors are indebted to Dr. Anil Wali (Managing Director, FITT, IIT-

D, New Delhi) and Mr. P. Somarajan (Executive Consultant, Business Development, FITT, IIT, New Delhi) for their advice, guidance and support throughout the case study.

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***(DST/PRC/CPR-03/2013)***

# <u>REPORT-9</u>

# Reforms Needed in Higher Education Sector for the Promotion of Industry-Academia Interactions

**(May 2014- Aug. 2015)**

**<u>Coordinator: Prof Rupinder Tewari</u>**

## Introduction

In developed countries, there is a healthy relationship between R&D of industries and universities. This successful handshake is contributing greatly to the kitty of ‘knowledge economy’ of the nations. It is a win-win situation for both the parties. Unfortunately, in India, Industry-Academia (I-A) interactions are limited to IITs, and a few universities /govt. sponsored national research laboratories. The number of commercially successful technologies/ innovations is not very encouraging, keeping in mind that India has (a) > 700 universities churning out thousands of 2Ph.Ds, in the area of applied sciences on annual basis and (b) > 300 govt. sponsored research laboratories having thousands of scientists.

Moreover, in developed nations two third of the funds for R&D of public funded institutes are contributed by the private sector, whereas in India, private sector contribution is only one third and the remaining funds are provided by the government.

It is a well accepted fact that in India, the academia and private sector are living in different worlds. Both sectors view each other through a ‘tunnel vision.’ But, time has come for hand-holding of each other because, in the 21$^{st}$ century innovations are the key factor for the survival and growth of an industry. The intelligentsia, which exists in the academic sector, has to be roped in by the industrial sector for novel innovations. In addition, industry has to come forward for contributing more towards finances for R&D in public universities. On the other hand, universities have to work in tandem with industry to produce skilled and industry ready manpower. For these things to happen, a change in the mindset of academia and private sector is the need of the hour.

To address the above mentioned issues, an ecosystem has to be created for stimulating I-A research programmes and increasing funding of R&D programmes of universities by the private sector so as enhance their sustainability. To achieve these goals, following suggestions are being put forward:

### A) Creation of ‘National Level Web Portal’

Though, Indian academic sector is engaged in applied research of industrial relevance, but the private sector finds it difficult to access the expertise and facilities existing in the academic institutes. Because of advancements in IT sector, industry has no problem in interacting with a scientist or an institute located at a distant place in India. If web portals can be designed and made accessible to Industry, this will be a big step in enhancing Industry and Academia interactions.

It is suggested that 'National Level Web Portal' be made which display following parameters existing in universities and national research laboratories:

- Availability of the type of scientific expertise
- Centres of Excellence
- Availability of infrastructure facilities, high-end Instruments, animal facility, library, workshops, fermentation facility etc.
- Latest technologies, innovative products and patents developed at the institutes
- IPR policy of the institutes
- I-A / Entrepreneurship / Meets, Symposia and Conferences
- Interactive Web Portal (for addressing the needs of the private sector)

Our Centre have created an 'I-A Web Portal' comprising of academic/research institutes located in and around Chandigarh region.

**B) Networking of Universities with Industries**

There are >1700 DSIR certified labs which enjoy benefits/incentives from the Govt. of India (GoI) for pursuing R&D activities. However, it is being felt that majority of DSIR certified labs are falling short of the research outputs as expected by GoI.

Therefore, it is recommended that:

a) A tight monitoring of the outcome of R&D programmes of DSIR certified labs be ensured.

b) To enhance the research capability of DSIR certified labs and also to rope in public sector scientists belonging to professional streams (Engineering, Biotech, Microbiology, Pharma etc) to work on industrial problems. It will be prudent if DSIR certified labs partner with one such university possessing scientific expertise complimenting the type of research being carried out in a DSIR certified lab.

c) In order to increase I-A interactions, the governing body of industry should have a senior professor/scientist on its Board of Governance and vice versa.

**C) Networking of Universities with National Research Laboratories**

- India has over 300 national research laboratories funded by CSIR, DBT, DST, ICAR, DRDO etc. having *state of the art* instruments, which does not exist in most of the universities. These national research labs are spread all over India (Fig. 1).

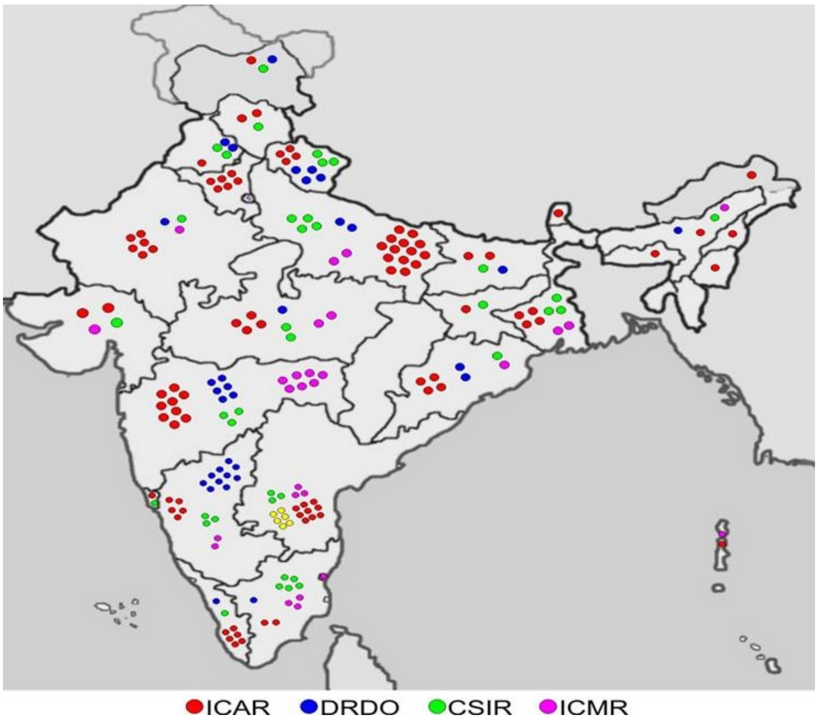


Fig. 1: National Research Laboratories of India

There are nearly 800 universities out of which 77 have been accorded 'A' grade by NAAC. Barring a few universities, many are short of high end instruments but rich in intelligentsia (scientists & research scholars). As Govt. of India has limited funds for R&D of public sector, it will be prudent to allow access to high-end facilities of national research laboratories to such universities. This "University-National lab Partnership" will lead to quality research work. Industries will be attracted to universities, provided they have access to research facilities not available in their own institute but existing in nearby national research laboratories. The modalities for the use of such facilities by the universities can be worked out so as not to impinge upon the research environment of national research laboratories.

- It is recommended that each national research laboratory is mandated to partner with at least one university.

**D) Setting up of Business & Marketing Entities in universities**

- So far, universities were meant for imparting quality education to the students and not to worry about the financial status of the universities. However, with the passage of time, Govt. is showing its inability for 100% funding of the universities. It is asking the institutions to partially generate their own resources.
- To commercialize the intellectual property of the universities, universities may be permitted to establish a legally distinct non-profit entity such as Society, Trust, Foundation or Section 25 Company to exploit/ market its knowledge base, products, databases etc. on the pattern adopted by CSIR institutions.

- *Suggestions for revenue Sharing for Intellectual Property:* The modalities enumerated below which is adopted by Panjab University for revenue sharing regarding IP may be replicated in other Universities.
  - In case the patent filing costs are not borne by the University, the inventor can first deduct the costs incurred in this regard and maintenance of such patents, till licensing, from income accruing from the commercial exploitation of the patent. Excess income beyond such recovered costs will be shared with the University. Any MoU signed by the PU with the sponsoring agency based on which the IP is generated, or with any patent filing organization, may set aside the provisions under this clause.
  - In case there is a third party, the respective shares of the University and inventors will be calculated on the net receipts after deducting the third party's share.
  - The net earnings generated by the exploitation of IP will be shared between the Inventor(s) and the University on 70:30 ratio.
  - The inventor's share will continue to be paid irrespective of whether or not the individual continues as an employee /student/ research scholar of the University. The inventor(s) share would be declared annually and disbursement will be made to the inventor(s), their legal heir.
  - Co-inventors of IP should sign at the time of disclosure or filing for IP protection, a distribution of the IP earnings agreement, which should specify the proportional percentage distribution of earnings from IP to each co-inventor. The inventor(s) may, at any time, by mutual consent, revise the

distribution of IP earnings agreement.

- If there is only one inventor of the IP, the whole amount of inventor’s share will be retained by the inventor. If there is more than one inventor, inventor’s share will be distributed among the co-inventors on the mutually agreed terms and conditions.
- If there are two inventors, the principal investigator/supervisor/team leader will get up to 60%, while the co-inventor will get at least 40% of inventor’s share by mutual agreement.
- If there are more than two inventors, the principal investigator/ supervisor/ team leader will get up to 60% of inventor’s share and the rest will be distributed among the co-inventors in the proportions on the mutually agreed terms and conditions at the time of IP disclosure or at the time of filing for IP protection.
- Students/Project staff may have a share in revenue earned but the share in case of ‘work for hire’ is not as a right, but may be as an incentive at the sole discretion of the principal investigator or supervisor in consultation with the Director, CIIPP, if the need arises.
- Revenue sharing is not necessarily concurrent with the inventor-ship. Mere assistance like assistance in the preparation and conduct of the experiments, data analysis, etc. does not entitle one for inventor-ship, but may entitle for revenue sharing as an acknowledgement of intellectual contributions for routine/mechanical contribution at the sole discretion of the principal Investigator/ Supervisor of the work.
- If any inventor is unable to be contacted/traced for one year because of lack of information, the revenue corresponding to his/her share will be credited to the IP fund.
- Of the University share, 50% will be used for creating a University’s IP fund, which will be utilized for any activity related to commercialization and maintenance of IPR or obtaining IPR in another country, or for capacity building. Further, 10% of the share will be paid to the University as Administrative charges and 40% will be made available to the Department concerned for the purchase of equipments or material or for any academic activity and promotion of industrial partnership.

**E) Suggestions for UGC, New Delhi**

- Promotion policy of UGC is highly biased towards publications (research articles, books etc.). Weightage given to technology development, patents, and consultancy etc. is much below expectations. A relook into the promotion policy of university teachers is direly needed.

**Recommendations for modifications in API Criteria**

| S. No | API's | Existing | | Recommendations |
|---|---|---|---|---|
| | | **Particulars** | **Maximum Points** | |
| 1 | Consultancy Projects (Clause IIICi) | Amount mobilized with minimum of Rs.10.00 lakhs | 10/Rs. 10 lakhs | The lower limit of Rs. 10 lakhs should be amended to include all consultancy projects with scoring scale based on the amount involved |
| 2 | Projects Outcome / Outputs (Clause IIICiv) | Patent/Technology transfer/ Product/Process | 30/National level and 50/International level | Technology Transfer (TT) need to be given a separate category and enhanced scores in relation to Patents as TT involves more intensive R&D activities and also increased industrial interactions.<br><br>The inclusion of Product/ Process under |

- UGC should set aside special budget for filing and protection of patents by university professors, as is the practice in CSIR institutions for its scientists.
- To promote the commercialisation of academic intellectual resource (research), it is suggested that UGC-Tech should be established on the lines of CSIR-Tech Pvt. Ltd. which is an initiative of the Council of Scientific and Industrial Research (CSIR), and was founded in 2011 in response to recommendations of a high powered committee constituted by the CSIR (http://www.csirtech.com/) .
- Faculty members engaged in applied research should avail sabbatical leave to spend time in the industry to understand the industrial environment for at least 6 months at each level (Assistant Professor, Associate Professor and Professor level).

- Industrial consultancies/projects etc should be made mandatory for Associate Professors being promoted to Professor level.

**F) Suggestions for Universities**

- Industry should be involved from the very beginning of the university research projects having industrial implications. Using this approach, the project will be more focussed and shorten the time for commercialization of the technology developed.
- Crash-courses on Business Management for science faculty.
- A serious re-look is needed on the academic syllabi of science subjects. Syllabi should be in tune with the requirements of the industries. Dedicated courses on entrepreneurship development, IPRs and business management programmes should be introduced.
- In universities engaged in applied-research, Govt. may set up ‘Industrial Zones’ which cater to entrepreneurship programmes, business management programmes, space for incubates/ start-up companies. This facility may be created under PPP mode.
- Universities should have an *Industry Web-Portal* catering to
    - Latest technologies which can be adopted by industry
    - Patents held by the universities
    - Start-up companies by university alumni
    - Innovative products generated
    - Entrepreneurship programmes
    - Availability of jobs in the public and private sectors
    - I-A meets / IPR / Entrepreneurship meets
    - Business Management programmes
- Each academic institute should have web portals of databanks for easy access by the industrial sector. Suggested databanks are as under:
    - Availability of scientific expertise in the universities
    - List of high-end instruments
    - List of infrastructure facilities like animal facility, library, workshops, fermentation facility etc.