Framework of Industry-University Linkage in Research

सत्यमेव जयते

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH
MINISTRY OF SCIENCE AND TECHNOLOGY
GOVERNMENT OF INDIA

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सचिव
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Foreword

The Research and Development forms the bedrock of all inventions and innovations that bring about a quality change in the society. It is therefore imperative to promote and support quality research in various sectors to come out with new products and services that will improve the living conditions of the people.

In the present times, with the global economy becoming more and more inter-connected and economic environment turning extremely dynamic, working in collaboration rather than in silos would only render significant results. Thus, continuous research has to be undertaken at both university and industry level. Universities and industries must work in collaboration with each other to facilitate enhanced research that would benefit the economy, industry and society at large. The association between the two stakeholders produces remarkable results as universities provide the research and technical-knowhow and the industry provides expertise in translating the research into product and process for use by society.

I congratulate DSIR and PHD Chamber of Commerce and Industry for undertaking this study, which is of immense significance in the current scenario. I am sure this report will serve as an important policy document for the universities and industries to expand their horizons and collaborate more and more in the coming times.

[Shekhar C. Mande]

New Delhi
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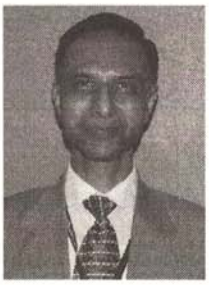

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Preface

University-Industry linkages is a win-win situation for both the industries as well as the universities. These collaborative projects among universities and industry will foster new relationships and forge new ties and alliances for industrial development and economic growth.

The report analyses university – industry linkages (UIL) in 29 states of India based on a survey. The UIL were analysed based upon 10 parameters, which included availability of research institutes, frequency of interaction between institutes and industry, student – industry interaction, MoUs/Collaborations forged and patents filed/granted. The findings of the study are:

- Average UIL across the states in India is moderate, although the linkages vary from strong to moderate to weak across states. University – Industry (UIL) linkages were found to be strong in 14 states, which included Karnataka, Kerala, Gujarat, Maharashtra, Andhra Pradesh, Tamil Nadu, Punjab and Haryana. UIL were found to be moderate in 10 states, which included West Bengal, MP, Bihar, Goa and J&K. UIL were found to be weak in 5 North-eastern states of Assam, Arunachal Pradesh, Mizoram, Nagaland and Manipur.

- There are 32 sectors, in which the states across the country are engaged in R&D and innovation activities. Of these, 10 sectors, common in 6 or more states are agriculture, agro food processing, drugs & pharma, automotive & auto components, power, IT & ITeS, cement, textiles, handicrafts & handlooms and tourism. Steps need to be taken to strengthen UIL in these sectors.

- Of the 500 odd industrial clusters across India, 30 to 35% do not have any research institute or university in their vicinity.

- There is a need to locate a university/institute or incubation centre near the concentration of industrial clusters so as to facilitate translation of research into products and processes.

I congratulate PHD Chamber of Commerce and Industry for undertaking this study which emphasizes on the necessity of University-Industry linkages and also illustrates the benefits of such collaboration. I hope that the findings of this study would initiate policy reforms required to strengthen the University-Industry linkages.

Ashwani Gupta

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Dr D K Aggarwal

Message from President, PHD Chamber

University-Industry linkages refer to the interaction between firms and universities or public research centers with the goal of solving technical problems, working on R&D, innovation projects and gathering scientific as well as technological knowledge. It involves the collaboration of Industries and Universities in various areas that would foster the research ecosystem in the country and enhance growth of economy, industry and society at large.

The increased linkages between industries and universities facilitate the industries to access quality research being produced by the universities and involve great minds on important projects that can help in new inventions to create history. The universities are also in a complete win-win situation as the professors and students can gain exposure to real time solutions which may/ may not be available in the universities.

I am happy to know that the government has given major impetus to enhancing University-Industry Linkages as this is the need of the hour to impart quality education and make students employable, going forward. The Study for improving the overall ecosystem of collaborations between the two stakeholders is a right step in this direction and I am contented that the Government had entrusted this big task on PHD Chamber.

I hope that the study is instrumental in establishing strong relations between the universities and industries in the coming times. The discussions during the Launch of the Report would provide fruitful outcomes that would spur the growth of quality research in the country.

Moving further, I believe, there exists tremendous potential to re-embark on the path of accelerated growth supported with effective and strong linkages between universities and industry.

I wish all the best to the Report Launch and looking forward to enriching deliberations.

(Dr D K Aggarwal)

Shri Sanjay Aggarwal

Message from Senior Vice President, PHD Chamber

Linkages between universities and industries are increasingly important for innovations in the country. When universities and industries work together, the different skill sets and experiences amalgamate to produce research which pushes frontiers of knowledge and this becomes a powerful engine for accelerating innovative solutions and economic growth in the long run.

The government, over the last many years, has given major impetus to the growth of research ecosystem in the country. Various schemes and programmes have been launched in this regard which have had a major impact in the recent times. It may be mentioned that the demand of the industry over the past few years is to evolve the skill sets of the students in universities and colleges so that they are 'job ready'. Further, the industries in the country are evolving their manufacturing processes and enhancing their technological appetite to reduce costs.

This can be achieved effectively with the development of strong University-Industry Linkages. When universities and industry work together, the different skills and experiences integrate to generate research which will further push the frontiers of knowledge and become a dominant engine for accelerating economic growth in the long run.

Going forward, both central and state governments should continue with their effective reform measures for promotion of university-industry linkages in research in the country to spur industry growth and foster an ecosystem of novel research in the universities.

PHD Chamber is working diligently towards nation building and our Study on Framework of University-Industry Linkages in Research aims at strengthening the collaborative arrangement in the country.

(Sanjay Aggarwal)

Shri Pradeep Multani

Message from Vice President, PHD Chamber

There is no denying that the University-Industry Linkages are crucial for scaling up technological development in the economy. The analysis of select countries shows that concerted efforts with effective policy regime and strong coordination between the industry and university can strengthen UILs which may lead to socio-economic development in an economy. The collaborations between the two have always produced best results that have promoted better living in the society.

Thus, the linkages between the two stakeholders viz industries and universities are essential for producing high quality innovations for benefit of the society at large and for building a strong brand name for the stakeholders.

Going ahead, the policy framework of the government has to be built in this direction to support maximum collaborations between the universities and industries. The universities and industries need to engage in greater interactions at a common platform to foster new relationships and forge new ties and alliances.

While there are numerous collaborations in scientific research in various parts of the countries, the linkages should also extend in the field of humanities. The linkages must focus on research that not only addresses the local economic and social problems but also global problems.

I am sure that the findings of our study would help bring the issues related to University-Industry linkages in research to the fore and also serve as a reference point for the imminent need to pursue reforms to strengthen these linkages.

(Pradeep Multani)

Dr Mahesh Y Reddy

Message from Secretary General, PHD Chamber

The University-Industry linkages are one of the key elements to build strong research environment in the country. It has immense role to play in bringing about a revolutionary change through technological advancement and provide an economic boost to the country.

Consequently, many advanced, emerging and developing countries have been promoting linkages between universities and industries through strong policy framework for the growth and advancement of their respective economies.

Our Study on Framework of University-Industry Linkages in Research focuses on elaborating on the strengths of states in which the linkages between the two stakeholders can be developed to facilitate higher growth of the states. The states can play a massive role in being the harbingers of improved universities-industries linkages by implementing policies and providing state of the art infrastructure.

The PHD Chamber has always aimed to be an important stakeholder in the development of the nation. I hope this study helps in further policy implementation at the Centre as well as in the States, so as to serve as a vehicle for high growth and overall socio-economic development of the country.

(Dr Mahesh Y Reddy)

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- PHD Research Bureau
PHD Chamber of Commerce and Industry

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Abbreviations

ACS	American Chemical Society
AICRP	All India Coordinated Research Project
APEDA	Agricultural and Processed Food Products Export Development Authority
AYUSH	Ayurveda, Yoga & Naturopathy, Unani, Siddha and Homoeopathy
BFSI	Banking, financial services and insurance
BICS	Bureau of Industrial Consultancy Services
BMW	Bavarian Motor Works
bn	Billion
BPO	Business Process Outsourcing
CAD	Computer-Aided Design
CAGR	Compound Annual Growth Rate
CalTech	California Institute of Technology
CAM	Computer-Aided Manufacturing
CAS	China Academy of Science
CKI	Center of Knowledge Interchange
CLRI	Central Leather Research Institute
CNPq	Council for Scientific and Technological Department
CoEs	Centres of Excellence
CSO	Central Statistics Office
DRDO	Defence Research and Development Organisation
etc	et cetera
ETH	Eidgenössische Technische Hochschule
EU	European Union
FDI	Foreign Direct Investment
FMCG	Fast-Moving Consumer Goods
FY	Financial Year
G&J	Gems and Jewellery
GDP	Gross Domestic Product
GII	Global Innovation Index
GJEPC	Gems and Jewellery Export promotion Council
GSK	GlaxoSmithKline
GST	Goods and Services Tax
GVA	Gross Value Added
GW	Gigawatt
HELP	Hydrocarbon Exploration and Licensing Policy
HPCL	Hindustan Petroleum Corporation Limited
IARI	Indian Agricultural Research Institute
IBDCs	Integrated Beekeeping Development Centres
IBM	International Business Machines

ICT	Information and Communication Technology
ICAR-CIFRI	Indian Council of Agricultural Research-Central Inland Fisheries Research Institute
IIM	Indian Institute of Management
IISc	Indian Institute of Science
IIT	Indian Institute of Technology
IIT-B	Indian Institute of Technology-Bombay
INR	Indian Rupees
IOC	Indian Oil Corporation
IP	Intellectual property
IPR	Intellectual Property Rights
IT	Information Technology
ITeS	Information Technology enabled Services
IUCs	Industry-University Collaborations
IUG	Industry-University and Industry-Government Research Institute Cooperation
JNTU	Jawaharlal Nehru Technological University
JPMC	JP Morgan Chase
Kg	Kilograms
MEXT	Ministry of Education, Culture, Sports, Science and Technology
MICO	Motor Industries Company Ltd
MIDH	Mission for Integrated Development of Horticulture
MIT	Massachusetts Institute of Technology
MNCs	Multi-National Companies
MOE	Ministry of Education of China
MOFPI	Ministry of Food Processing Industries
MoU	Memorandum of Understanding
MSMEs	Micro, Small and Medium Enterprises
MT	Million Tonnes
MTPA	Million Tonnes Per Annum
MW	Mega Watt
NAREDCO	National Real Estate Development Council
NASSCOM	National Association of Software and Services Companies
NATRiP	National Automotive Testing and R&D Infrastructure Project
NBB	National Bee Board
NGOs	Non-Government Organizations
NIS	National Innovation System
NITK	National Institute of Technology Karnataka
NIT	National Institutes of Technology
NLAs	National Level Agencies
NMEP	National Mineral Exploration Policy
OECD	Organisation for Economic Co-operation and Development
ONGC	Oil and Natural Gas Corporation Limited


OTL	Offices of Technology Licensing
PHD	Progress Harmony Development Chamber of Commerce and Industry
PhD	Doctor of Philosophy
PPP	Public Private Partnership
PSEs	Public Sector Enterprises
PUPFIP	Protection and Utilization of Public-Funded Intellectual Property
R&D	Research and Development
RBI	Reserve Bank of India
RECAI	Renewable Energy Country Attractiveness Index
RGCA	Rajiv Gandhi Centre for Aquaculture
RINL	Rashtriya Ispat Nigam Limited
RTBI	Rural Technology Business Incubator
RTE	Right of Children to Free and Compulsory Education Act
SAIL	Steel Authority of India Limited
SKF	Svenska Kullagerfabriken AB
SMAC	Social, Mobility, Analytics and Cloud
SMEs	Small and Medium-sized Enterprises
SU	Syracuse University
TCS	Tata Consultancy Services
TE-QIP	Technical Education Quality Improvement Program
TIFAC	Technology Information, Forecasting & Assessment Council
TLO	Technology Licensing Organization
TT	Technology transfer
TU	Technical University
UCL	University College of London
UGC	University Grants Commission
UIC	University Industry Collaboration
UIL	University-Industry linkage
UIRC	university–industry research collaboration
UK	United Kingdom
UNESCO	United Nations Educational Scientific and Cultural Organization
US	United States
USA	United States of America
USD	US Dollars
VLSI	Very Large Scale Integration
WIPO	World Intellectual Property Organization

Executive Summary

The University-Industry linkages (UILs) are essentially the collaboration of industry and university in diverse areas that propels economic growth and accelerates socio-economic development in an economy. UILs are important for various spheres of economy such as skill development, innovations and technology transfer, promotion of entrepreneurship and start-ups, among others. There are greater benefits to both industry and university in collaborating with each other to contribute in the technological advancement and to give an economic boost to the country.

The analysis of the international scenario shows that Bayh Dole Act of United States implemented in the 1980s had been the best model in strengthening university-industry linkages. This act has been implemented by many countries world over. The present study analyses the UIL models of United States, Germany, Japan, China, United Kingdom and Australia. Most of these countries have well developed UILs; significant collaborations and strategic partnerships between universities and industries. These entities have strived to foster long term collaborations by identifying the objectives and adopting a win-win approach.

India, on the other hand, is at a very nascent stage of developing strong UILs. Though some improvement has been observed of late, one of the biggest bottleneck in the country has been the absence of clear policy for strengthening linkages between the university and industry. The Protection and Utilization of Public-Funded Intellectual Property (PUPFIP) Bill which was prepared on the lines of the Bayh Dole Act has been withdrawn from the parliament. There are various challenges in implementing an Act on the lines of Bayh Dole in India as one of the major concerns has been lack of transparency and receiving inputs from some of the important organizations. An institutionalized framework for industry-academia connect is absent in the country.

There are few successful partnerships and collaborations between the universities and industries in the area of research and development in India and abroad. The analysis of global and Indian case studies reveal that the universities and industries entering into strategic alliances and collaborations across the world have managed to sustain long lasting relationships without government interventions in most cases.

Going ahead, many international agencies and organizations are positive about India's growth story. It is expected that the economy would grow at higher trajectory in the coming times. In order to sustain such a growth, it is imperative that the technological advancements and innovations must accelerate the manufacturing sector which would propel economic growth, in the near future. Hence, it is imperative that the country must work towards developing strong UILs to sustain the growth momentum.

There is a rich literature related to university industry linkages in research in various countries which entail that the linkages should be mutually beneficial for both the universities and the industries. The industries should gain from the research developed

while the universities/institutes should get funds, knowledge-sharing and exposure of the industry, amongst others.

The present study focuses on analysing the UILs in all States of India with respect to the top five sectors of each state based on ten parameters such as availability of University(s), interaction with University(s), continuity in interactions, frequency of interaction, support in providing quality solutions, MoUs/Collaboration/Agreement with University, patents gained in the past 5 years, continuity of research activities, interaction with students and frequency of interaction with students. The objective of the study is to entail suggestions to enhance the growth and competitiveness of the sectors. This study is done not only at the aggregate level but also with state specific suggestions which will be useful to enhance the growth and competitiveness of our industries. This will facilitate Make in India programme of the Government to provide fruitful results as well as create synergies between Industry and Academia to create more and more employment opportunities in the economy.

The analysis conducted on the basis of ten parameters shows that University – Industry Linkages are found to be moderate in India with a score of 4.7 points out of 10 but surprisingly lot of disparities are observed among the States. Some States are good in University – Industry Linkages and others are found to have moderate or weak University – Industry Linkages. University – Industry Linkages are strongest in the State of Karnataka with a score of 7.8 points out of 10 and Kerala with a score of 7.3 while the linkages are strong in the state of Gujarat (score of 6.7), Maharashtra (score of 6.4) and Uttar Pradesh (score of 6.2).

The study identifies top 10 sectors of the Indian economy for capacity building, research and development activity and innovation viz. (i) agriculture and allied activities, (ii) agro and food processing, (iii) tourism, (iv) textiles, (v) IT and ITeS, (vi) power, (vii) automotive and auto components, (viii) cement, (ix) drugs and pharmaceuticals and (x) handicrafts and handlooms.

Apart from the top 10 sectors, the study analyses 32 sectors which have been arrived by identifying the top 5 sectors in each of the states, cumulating them to know their frequencies and the sectors with highest frequency are categorized as top 10 sectors of the economy as they are prevalent in majority of the states.

The UIL score of IT & ITeS- 17.7, Tourism with a score of 17.35, Textiles- 17.1, Agro and Food Processing with a score of 15, Agriculture and Allied activities have a UIL Score of 14.1, Drugs and Pharmaceuticals- 13.8, Automobiles and Auto components- 12.8, Engineering - 11.5, Power- 11.3 and Cement- 10.7.

Further, Biotechnology has a UIL score of 10.3, Mining- 8.9, Oil and Gas- 8.8, Handicrafts and Handlooms 8.8, Iron & Steel- 8.7, Finance-8.5, Electronics- 8.1, Ayurveda- 8.1, Seafood and other marine products- 7.9, Spices and Spice Extracts- 7.8, Chemicals and Petrochemicals- 7.2, Sericulture- 7.1, Leather & Leather Products-6.6, Minerals- 6.2, Real

Estate-6.2, Gems & Jewellery- 6.2, Dairy- 6.1, Sports Goods- 6.1, Horticulture- 5.2, Fisheries-5, Floriculture- 4.7 and Apiculture- 2.2.

The study attempts to know the linkages between industrial clusters and centres of excellence in each state. It is observed that there is a lot of incubation centres across the states but their research activities are not associated with industrial clusters vis-à-vis non availability of industrial cluster to conduct research in the respective industry sectors.

An analysis is conducted on University-Industry linkage with respect to employment scenario in the country through variables such as industry consultation in setting of pedagogy, working on gaining patents, regular interaction with industry, students' internship, providing specific solutions to industry and links with industry to know if it influences level of placement in the university. The results indicate that industry consultation in setting pedagogy; gaining patents and regular interaction with industry have significant impact on placement level. Hence the universities must ensure more collaboration with industries particularly in pedagogy and gaining patents which will facilitate higher employment level of students.

There is an urgent need to re-draft and re-introduce The Protection and Utilization of Public-Funded Intellectual Property Bill, 2008 which will enable increased focus on R&D activities and greater interest from the private sector and universities. In the present scenario, India needs to adopt a model wherein the concentration of clusters must be facilitated by state – of-the art research centres together with centres for excellence and incubation centres providing up to date research. Thereby the concept of Universities working in isolation needs to be eliminated by bringing forward a more collaborative framework of both universities and industries working together in strong alliance. The government should create an online portal to facilitate 'Ease of Forming Linkages in Industries and Universities' wherein Industries, Universities and Government can come together to identify the need for linkages and ease in the process of co-ordination between the stakeholders.

In a nutshell, there is no denying that the UILs are crucial for scaling up technological development in the economy. The analysis of selected countries shows that concerted efforts with effective policy regime and strong coordination between the industry and university can strengthen UILs which may lead to socio-economic development in an economy. However, as far as India is concerned, the UILs continue to remain weak due to structural issues and challenges in implementing legislation similar to the Bayh Dole Act.

It is essential that the universities and industries should come together and take concerted efforts to strengthen the university-industry linkages in the country. The government must also ensure full support to both the stakeholders which would facilitate accelerating innovations in the country thereby making India globally competitive and a strong economic power in the coming times.

The study is planned in 12 Chapters of which Chapter I is devoted towards an elaborative discussion on the models of various countries viz. United States, Germany, Japan and China.

Chapter II analyses the impact of UIL models and the best practices adopted in selected countries. Chapter III of the study enunciates how India lags behind other countries and what benefits it could avail from strong linkages and the challenges before the economy to implement an act on lines of Bayh Dole Act. Chapter IV of the study gives the statistical outlook in terms of vital statistics in University Industry Linkages in India. Chapter V of the study gives review of the literature on the topic. Chapter VI outlines the objectives and research methodology adopted in the study. Chapter VII analyses the UILs in the states of the Indian economy. Chapter VIII is devoted to Research & Development in major sectors of the Indian Economy. Chapter IX pin points the action points to be adopted by the 30 states. Chapter X enunciates on employment generation and UILs in the country. Chapter XI talks about the role of intermediaries in facilitating collaborations between universities and industries. Chapter XII brings forward the conclusions and suggestions to strengthen UILs in the country in the coming times and talks about India's model on the lines of Bayh Dole Act and gives suggestions for the same.

Chapter 1

University-Industry Linkages: International Scenario

University-Industry linkages (UILs) primarily involve Industries and Universities coming together to collaborate in various areas that would benefit the economy, industry and society at large**.** Linkages between universities and industries are important in various spheres of economy such as skill development, innovations and technology transfer, promotion of entrepreneurship and start-ups, among others. These linkages are important for enhancing the value of university research for industrial and socio-economic development. UILs contribute to the technological advancement and provide an economic boost to the country.

Linkages between universities and industries are increasingly important for innovations in the country. When universities and industries work together, the different skill sets and experience amalgamate to produce research which pushes frontiers of knowledge and this becomes a powerful engine for accelerating innovative solutions and economic growth in the long run.

There are greater benefits the industry if they increase their focus or emphasis on building linkages with the universities; some of which are:

1. Gaining access to the research being produced by the universities[1]
2. Making good use of the faculties and students to reach solutions to an industry's specific problem
3. Gaining access to competitive students for training and placements
4. Remaining competitive in the global economy by accelerating innovation process[2]
5. Building a good reputation of the organization through innovative solutions developed through these linkages

On the other hand, it is equally beneficial for the universities as well if they build linkages with the industries, some of which are:

1. Students gain exposure to real-time solutions which may/ may not be available in the universities
2. Universities can make use of some government funds that are available for research for the joint efforts between university and industry
3. Access to funds
4. The administrative hurdles are lesser in linkages with the industry
5. Universities also improve their brand name by collaborating with top industrial houses.

[1]The research produced by universities include technological knowledge including tacit knowledge and patents

[2]FelekJachimowicz, Jennifer Umali, *Working for mutual benefit, ACS Publication*, Chemical Innovation, September 2000, Vol. 30, No. 9, 17-20

1. University-Industry Linkages: International Scenario

This section studies the status of University-Industry Linkages in various countries with a focus on United States, Germany, Japan and China. The University-Industry Linkages are particularly strong in United States and Germany. In fact, United States witnessed an upsurge in innovation post the Bayh-Dole Act, passed in 1980 and Germany witnessed a strong positive influence on manufacturing due to a focus on research and development. On the other hand, University-industry linkages (UILs) are not very well developed in Asian countries, but the scenario is improving. In Japan, the importance of university-industry linkages are strongly recognized as there are three ways in which companies collaborate with national universities—collaborative research, contract research and academic donation. In China, the state led model of development gives the government a central role for coordinating between industries and universities. In India, the linkages are still weak as there is no legislation in place to facilitate University-Industry Linkages (UILs) in Research. Going ahead, there is a need to strengthen UILs in India by developing legislation on the lines of Bayh-Dole Act in the coming times.

1.1 United States

United States (US) is considered to be extremely strong in University-Industry Linkages. The model followed by the country is primarily a 'triple helix model'[3]. Etzkowitz and Leydesdorff in Schiller and Diez (2007) described it as an interplay between the government, industries, and universities within a structure of overlapping sphere. To promote linkages between University and Industry in Research, the country is acting from bottom, upwards, criss-cross, sideways as well as top down approach[4] although in a discrete manner. Further, universities are encouraged to form linkages with industry through technology transfer which is called Patent-licence-start-up model[5]. In this model, the universities foster growth of their own start ups and provide patents to them. In 1980, the US Congress passed the Bayh-Dole Act, which enabled incentivizing, patenting, licensing, and technology transfer of university research. The main aim of the implementation of the Act was to promote research activities and usage of innovations resulting from R&D sponsored by the Government.

BAYH-DOLE ACT 1980

The Bayh- Dole Act or Patent and Trademark Law Amendments Act adopted by the Government in 1980 is a Legislation that deals with intellectual property arising from federal government funded research.

[3] The triple helix model is a spiral model of innovation that captures multiple reciprocal relationships at different points in the process of knowledge capitalization. The triple helix denotes the university-industry-government relationship as one of relatively equal, yet interdependent, institutional spheres which overlap and take the role of the other.

[4] Bottom up approach essentially means interaction of individual and organizations from different spheres of institutions; top down approach entails policy interventions in areas of research

[5] In this model, universities nurture their own start-ups and make available their patents to them


The key change brought by the Bayh-Dole Act was in regard to the ownership of the intellectual property created by the federal government funded research. Before the advent of the Bayh-Dole Act, inventors had to assign the inventions they made back to the federal government. The US Government believed that a single company should not benefit from publicly funded research, Hence, only non-exclusive licenses were granted. This was not an attractive proposition for a company to take on the research, make substantial investments and the same research being passed on to other companies without having to take similar financial risk. To elaborate, if a Pharma company was taking over an intellectual property by a University prior to Bayh-Dole Act, and making substantial investment and finding out whether the same would turn into a successful marketable product. It was not an attractive proposition for the Pharma Company if other companies later on were taking over the same intellectual property without undertaking the risk of making a substantial investment to determine the success of the same. Consequently, by 1978, the US Government had acquired 28,000 patents and had licenced fewer than 4% of them[6]. The Bayh-Dole Act enabled the Universities to retain the inventions and take the lead in patenting and licensing of ground-breaking discoveries.

Major provisions of the Act:

- The title to innovations developed under federally-funded research programs by non-profit institutions, including universities, and small businesses could be retained by them
- To promote the utilization of inventions arising from federal funding by encouraging universities to collaborate with commercial concerns.

1.2 Germany

Europe does not have well-developed collaborations between higher education institutes and industry, barring a few economies. However, Germany is one such exception. The European university-industry linkages are influenced by many factors such as perception of benefits arising from linkages, barriers in the way of linkages and drivers of the R&D linkages. Further, situational factors such as age, gender, years at the higher education institutes, years in business, type of higher education institutes and country also influence the extent of linkages undertaken.[7] There is a huge cultural gap between universities and industry. It continues to act as a hurdle in successful and productive linkages with the industry.

Germany is the best example of University-Industry linkages and has witnessed a huge impact on the manufacturing sector of the German economy. Germany has a legislation similar to that of Bayh-Dole Act in the USA. Germany has approximately 400 higher education bodies offering a wide range of academic disciplines. The German higher

[6] V. Loise, A. J. Stevens, The Bayh-Dole Act turns 30. Sci. Translation Med. 2, (2010)

[7] Todd Davey, Prof. Dr. Thomas Baaken, Victoria Galan Muros, Arno Meerman, The State of European University- Business Cooperation, Münster University of Applied Sciences Germany, 2011

education system incorporates a close bond between learning, teaching and research**.** It is one of the world's most attractive research and higher education countries.

Prior to 2002, the policy that was prevalent in regards to research activity was 'Professor's privilege'[8]. As the benefit under the policy was being achieved by only a single individual, it was argued that the University and the economy were losing out on an economically valuable intangible asset. The German university professors were exempted from the legal obligation of notifying their employer (the university) of their inventions. Inventions made by professors were "free" inventions, belonging to the inventors.

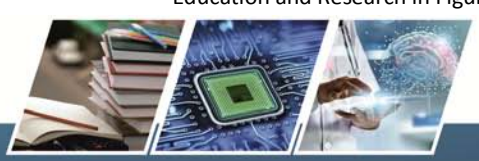
Inventors' Law

Subsequently, a law was passed in 2002, namely the Inventors' Law which was the emulation of United States' Bayh-Dole Act. The act aims to increase patenting activity and redistribute the profits generated by inventions made at universities. Under this law, university professors no longer hold exclusive intellectual property (IP) rights to their inventions. According to Inventors' Law, an employee must give his or her employer written notice of a technical invention. The employer can claim rights to the invention or leave these rights with the employee. If the invention leads to revenues and the employer has made a claim to the invention, the employer must remunerate the employee in accordance with a legal framework.

Post 2002, Universities are able to protect all commercially valuable inventions by patenting them. Presently, university scientists give their university notice once an invention has been made unless they do not have an intention of publishing their findings. The university scientist is entitled to receive 30% of all revenues generated in future through usage of an invention in exchange for the loss of the professor's privilege. According to the law, the same invention is remunerated differently depending on whether the employer is in industry or academia. Hence, a professor could receive more than 100 times the remuneration than a colleague who makes an equivalent invention in industry. However, the professor gets nothing if the university does not gain any money.

In terms of innovation, German companies are ahead of other European nations. About two-thirds of all R&D funding in Germany is done by Industry. State and industry together spent almost €90 bn on R&D in 2015 which is around 3% of Germany's Gross Domestic Product (GDP). This reflects that Germany has achieved the target of the Europe 2020 Strategy of spending an annual 3% of GDP on R&D[9]. The German national innovation system has a balanced structure, and is strongly influenced by decision-making in private companies and the governance of capital markets. Principles of academic freedom and scientific independence are a constituent element of the German research system, and the Federal

[8]Under the 'Professor's privilege', the inventor professor used to be the sole beneficiary of the financial gain achieved by the commercialization of the invention.
[9] Education and Research in Figures 2017, Federal Ministry of Education & Research



Government has much less influence on research and education than in many other countries.

Chart 1: Fact Sheet of Germany	
	• 428 higher education bodies offering a wide range of academic disciplines • In 2015, 27,58,000 students were in higher education
	• About two-thirds of all funding in R&D are done by Industry • Government's expenditure on R&D rose by €9 bn between 2005 and 2017 to €17.2 bn (target) in 2017.
	• More than 97,000 researchers working at higher education institutions and university hospitals • In 2015, it was reported that 35.2% of the enterprises implemented product or process innovations

Source: PHD Research Bureau, compiled from various sources

Universities in Germany offer a broad range of research activities, including basic research and applied research and development (R&D). In 2013, it was reported that Germany has more than 97,000 researchers working at higher education institutions and university hospitals. Particularly in the field of applied research, companies work with universities and research institutes on joint projects that are co-funded by public institutions. More than 25% of R&D employees in industry are employed by the automotive industry, while over 20% work in the electrical engineering sector and approximately 11% in the chemical and pharmaceutical industry.

1.3 Japan

UILs are not widely spread in Asian countries, but their extent is increasing. Different modes of linkages exist in different countries. For instance, in Korea, China and Malaysia- formal channels such as contract-based research are preferred whereas in Thailand small-scale consulting is more common.

The importance of university-industry linkages are strongly recognized in Japan. There are three ways for companies to collaborate with national universities in Japan- collaborative research, contract research and academic donation[10]. The Japanese firms have faced the challenge of funding support from their government because of the inadequate budget

[10]Collaborative research is based on contract and requires both a university and a company to devote their resources and work together to achieve a common objective. Contract research is conducted by university researchers on the basis of a contract with a company. The cost of research is borne by the company. Academic donation is made by a company to an individual university researcher and it carries no obligation from the university researcher.

unlike in the United States and United Kingdom, which have enjoyed government's support in terms of funding. However, over time the government started supporting the programme financially after witnessing its benefits to the national development. The collaborations between academia and industry has been taking place since the 1990s, when programmes mostly focused on boosting manufacturing development but it declined during the two decades of recession.

Table 1: Timeline of enactment of laws relating to University-Industry Linkages in Japan

Year	Act/ Initiatives
1983	A system of joint research involving universities and private sector launched
1998	The TLO Act (Act on Promotion of Technology Transfer from Universities to Private Industry)
1999	The Act on Special Measures for Industrial Revitalization enacted

Source: PHD Research Bureau, compiled from various sources

In 1983, a system of joint research involving universities and private sector was launched before which the research activities were primarily undertaken under the contract research method. In 1998, the TLO Act[11] (Act on Promotion of Technology Transfer from Universities to Private Industry) was enacted. According to the Act, the policy of promoting technology transfers from Universities to Industry was spelled out.

Bayh Dole Act

Bayh-Dole Act in Japan was enacted in 1999 as a part of the Industrial Revitalization Special Law [12]. The main function of Japanese Bayh-Dole Act is similar to US Bayh- Dole Act. It aims at giving ownership to universities and research institutions and promote transfer of their technology to industry for commercialization. Before the enactment of Japanese Bayh-Dole Act, the government retained patents and all intellectual property rights resulting from contracting research and developments. The only exceptions to this rule were the international research projects where foreign governments or non-profit organizations collaborated with Japanese contractors. The enactment of the Japanese Bayh-Dole Act changed the rule of ownership for inventions developed by universities and research institutions. The Japanese Bayh-Dole Act permits universities and research institutions to retain ownership of intellectual property rights arising from government contracted research and developments under the following conditions:

- First, universities and research institutions must report an invention to the government without delay after disclosure from researchers.

[11]The TLO Promotion Law aims to promote a) the progress of industry and creation of new industry and b) research activities through technology transfer of research developed by universities and public research institutions to industry

[12] Sangyou Katsuryoku Saisei Tokubetsu Sochiho, Chapter 3, Art. 30 to 33, Japanese Law No. 131 of 1999.The Act on Special Measures for Industrial Revitalization which was enacted in 1999, was modeled on the USA's Bayh Dole Act. It allowed universities to retain title to inventions resulting from state-funded research.

- Second, with respect to the subject matter that universities and research institutions have acquired title, universities and research institutions must grant the government a royalty free license to harness the subject matter if the government makes clear reason that the usage of the subject matter is necessary for the public interest.

- Third, they must grant a license to a third party if they have not exploited the subject matter for a reasonable period of time without any excuse, and the government makes clear a reason that the exploitation of the subject matter is necessary for public interest.

The Japanese Bayh-Dole Act does not provide any requirement of compensation for inventors. This is because the Patent Act provides a requirement of compensation. Regarding the compensation for university professors, Ministry of Education, Culture, Sports, Science and Technology (MEXT) publishes an instruction for compensating employee inventions and other intellectual property rights developed by employees of MEXT.

The instruction provides that when a patent right or rights to obtain a patent is transferred to the government, resulting from an application filed prior to the 1987 Patent Law Revision, the government must pay the inventor-university professor 4500 yen for each patent right or application in addition to the 4500 yen for each claim included in the patent right or application. When a patent right or right to obtain a patent, resulting from an application filed after the 1987 Patent Law Revision, is transferred to the government, the government must pay an inventor professor 7500 yen for each patent or application in addition to 7500 yen for each claim included in the patent right or application. The same rule applies to a foreign patent right or a right to obtain a foreign patent right[13].

Research linkages between Japanese universities and Industries are expanding, with increasing industrial funding coming in for technology. The Government is pushing for scientific development to boost economic growth. In the past, official support for science and technology was for basic research. Now it is moving towards application and commercialization.[14]

1.4 China

The relationship between Universities and Industries in China is driven largely by government policy. In 1992, a policy named **"University-Industry Alliances on Collaborative Development Engineering"** was initiated in China, by the former State National Economic and Trade Committee[15], Ministry of Education of China (MOE), and the China Academy of Science (CAS). Several Regulations relating to Intellectual Property Management of State Scientific & Research Program Result (Regulations) were issued by the Ministry of Finance and the Ministry of Science and Technology in March 2002 to improve the process of

[13]Toshiko Takenaka, Technology Licensing and University Research in Japan, International Journal of Intellectual Property, Law, Economy and management (2005) 27-36, 28 p.
[14]Suvendrini Kakuchi, New era of university-industry collaboration launched (July 2015)University World News, Issue 00462
[15] The main body of current Ministry of Commerce and National Economic Development & Reform Committee

technology licensing or transfer. The Regulations were based on the core spirit of the United States' Bayh-Dole Act and ownership of intellectual property was established by these regulations. The state granted the intellectual property developed in scientific research programs sponsored by government funding to the performing organization to implement, license, or transfer the intellectual property independently except in cases of national interests, national security, or significant public interests. The state retained the right to use the intellectual property freely. If the performing organization — as the intellectual property owner — does not implement the intellectual property or obstructs the public from utilizing the intellectual property, the state can intervene by licensing a designated party to implement it freely or by paying royalties to the performing organization, depending on the specific circumstances. The Regulations do not detail the circumstances, leaving the decision up to government discretion.

In December 2007, China passed the **Scientific and Technological Progress Law**, which upgraded the provisions of the Regulations pertaining to intellectual property ownership to the level of national law. The law sub-divides intellectual property rights into four items, namely, computer software copyrights, exclusive rights to layout-design of integrated circuits, invention patents and new variety right of plant. Utility model patents and design patents as well as other intellectual property are excluded from the scope of intellectual property defined in the law. The law grants the intellectual property ownership that is formed through a project sponsored by treasury money to the project undertaker, which encourages the project undertaker to continue being innovative. With intellectual property ownership in hand, the project undertaker has more motivation for the highly efficient commercial development of the intellectual property. Besides implementation by the project undertaker himself, the project undertaker can transfer or license the intellectual property. However, there is restriction on such transfer or license as it can be utilized domestically. The transfer of intellectual property rights to organizations or individuals outside China, or the licensing of exclusive usage rights to organizations or individuals overseas, is subject to government approval. For the licensing of non-exclusive usage rights, no license is required.

It is important for companies to secure key positions in their intellectual property. The acceleration of IP creation and protection for Chinese innovation under the Plan creates increased commercial opportunity for licensing and technology transfer. For companies seeking to acquire government-funded technology through license or technology transfer in China, it is important to become familiar with the regulations governing such transactions. Consequently, by 2014, there were 2246 regular colleges and universities in China, (including 444 non-public ones) and 296 colleges and universities for adults (including 1 non-public one). In 2016, 19,81,051 enrolled in post graduate programs while 5,58,781 degrees were awarded in the same.

In China, the public sector has a significant presence in all spheres of innovation. It involves presence of Government bodies which define R&D objectives, government labs that conduct R&D, state-run banks and state-owned enterprises as well. The role of private sector is increasing in the innovation despite its limited role due to the underdeveloped


capital markets of the country. There are three ways through which universities in China collaborate with industrial organizations in typical technology and industrial fields: 1) technology transfer between universities and industries, 2) collaborative R&D between universities and industries in practical fields, and finally 3) university-run high-tech companies. The universities in China have a 'downstream' tendency which in turn has led to a number of established university-run enterprises. Beyond the triple-helix model, these firms provide a more direct industrialization of knowledge generated by universities.

1.5 Australia

Australia generates good amount of research and innovations. However, the R&D spending as a percentage of GDP (2.1%) is less than the OECD countries average (2.4%) during 2013-2016. Other countries with similar academic cultures are ahead in university-industry linkages. According to Department of Education and Industry of Australia, the country is not capitalizing on its public investment in research. One of the reasons for the same is lesser proportion of researchers working in industry and academic-industry research publications. There are structural changes resulting in lower university-industry linkages. Industry in Australia is keen to adopt or modify existing innovations for its increased competitiveness at the global marketplace. The reasons for lesser university-industry collaborations in Australia ranges from inadequate networking and collaboration, lower levels of private equity and venture capital, stringent regulations of the government and dominance of small businesses in the country. New South Wales Business Chamber[16] has identified the barriers to effective collaboration between Universities and Industries in Australia. The same are as follows-

- Most research and development expenditure by businesses in Australia is not used to fund research in higher education institutions, thus constraining knowledge exchange. The share of higher education research funded by business is less than 5%. The private sector spending is mostly focused on business model innovation, commercialization and adoption of innovation from other sources, such as suppliers, customers and consultants.

- Australia has a higher number of researchers in higher education as compared to businesses. Thus, the knowledge created is in a form/format which cannot be applied immediately in a commercial situation. Hence, the companies are unwilling to invest in research by institutions.

- Australia has a very high proportion of SMEs which are resource constrained and hence the linkages with universities become difficult.

- The large geographical dispersion in Australia creates proximity challenges for companies seeking to collaborate with the best and brightest researchers in the

[16]The New South Wales Business Chamber, established in 1826, has a membership base of around 19000 members from microenterprises and startups to the leading companies in Australia. In 2016, their advocacy to government saved business owners in New South Wales more than $500 million.

country. Proximity matters when it comes to business collaboration, especially for SMEs.

- Fragmentation and instability of the Government programs that support innovation is a constraint when it comes to university-industry linkages.

- Cultural differences between universities and Industries also have an impact on the linkages between universities and Industries in Australia.

1.6 United Kingdom

In the United Kingdom (UK), there are seven model research collaboration agreements for universities and companies to form R&D linkages. This is the result of Lambert Model Agreement which makes universities in the UK have linkages mostly in the research domain[17]. The linkage model here also takes the form of 'triple helix'. Their concern is mostly on intellectual property protection. The seven model research collaboration agreements for universities and companies that wish to undertake collaborative research projects together are as follows:

1. **Lambert model research collaboration agreement 1:** The Institution owns the Results and grants the Collaborator a non-exclusive license to use the Results.

2. **Lambert model research collaboration agreement 2:** The Institution owns the Results and grants the Collaborator a non-exclusive license to use the Results. The Collaborator has the right to call on the Institution to negotiate an exclusive license.

3. **Lambert model research collaboration agreement 3:** The Institution owns the Results and grants the Collaborator a non-exclusive license to use the Results. The Collaborator has the right to call on the Institution to negotiate an assignment.

4. **Lambert model research collaboration agreement 4:** The Collaborator owns the Results and Institution has the right to use the Results for Academic and Research Purposes. Academic Publication is permitted.

5. **Lambert model research collaboration agreement 4a:** Each Party has the right to exploit certain Results created in the course of the Project and takes an assignment of those Results. The Institution has the right to use the Results owned by the Collaborator for Academic and Research Purposes and its students and staff have Academic Publication Rights. The Collaborator has the right to use the Results owned by the Institution for Research Purposes.

6. **Lambert model research collaboration agreement 5:** The Collaborator owns the Results and Institution does NOT have the right to use the Results for Academic and

[17] Intellectual Property Office, 2010, published on 16 October 2016

Research Purposes. Academic Publication is NOT permitted. This form of Agreement is more suited to Contract Research.

7. **Lambert model research collaboration agreement 6:** This Agreement contains the terms for a Knowledge Transfer Partnership (KTP) where a graduate or postgraduate student carries out the Project. The Company owns the Results. The Institution has the right to use the Results owned by the Company for Academic and Research Purposes and its students and staff have Academic Publication Rights. Its terms are very similar to those of Collaboration Agreement 4 with additional terms in the light of the KTP programme.

Such engagement of companies or employers with higher education institutions has a particular emphasis on the role of universities/high academic bodies in the economic growth of the country. Majorly, they act through the supply of highly skilled and qualified personnel (that is, graduates), through other forms of linkages such as provision of research and development and as a supplier of continuous professional development.

In a nutshell, the study of the international scenario of University-Industry Linkages reveals that the strength of linkages differs from country to country and region to region. University-Industry Linkages are strongest in the United States because of the efforts of the government since last three to four decades. Linkages between higher education institutes and industry in Europe are still beginning to develop. Asia is still in a nascent stage of linkages between Universities and Industries. Different modes of University-Industry Linkages correspond to different stages of economic development of nations and/or different capabilities of firms in each country. Going forward, there is an urgent need to increase the level of capabilities of developing economies followed by the utilization of diverse modes of University-Industry Linkages, depending on specific conditions and contexts in order to develop strong university-industry linkages in the coming times.

Table 2: Snapshot of University-Industry Linkages in Different Countries

S.No	Country	University-Industry Linkages (UILs)
1.	United States	• UILs are extremely strong • The Bayh-Dole Act was passed in 1980 to incentivize, patenting, licensing, and technological transfer of university research. • UIL model is described as 'triple helix model' • Consultancy service is also common • Another model which is encouraged in US is 'patent-license-start-up model'.
2.	Germany	• Germany is the best example of UILs in Europe. • German national innovation system has a balanced structure, and is strongly influenced by decision-making in private companies and the governance of capital markets. • The government enacted the Inventors' Law which aims to increase patenting activity and redistribute the profits generated by inventions made

		at universities. • The employer can claim rights to the invention or leave these rights with the employee.
3.	Japan	• UILs are not widely spread in Asian countries, but their extent is increasing. Different modes of linkages exist in different countries. E.g. in Korea, China and Malaysia- formal channels such as contract-based research are preferred whereas in Thailand small-scale consulting is more common. • The Japanese Bayh-Dole Act permits universities and research institutions to retain ownership of intellectual property rights arising from government contracted research and developments. • There are three ways for companies to collaborate with national universities in Japan. They are- collaborative research, contract research and academic donation. In the recent times, university collaboration is gaining importance.
4	China	• UILs in China are motivated by a Government Policy named University-Industry Alliances on Collaborative Development Engineering' launched in 1992. • There are three ways in which universities in China collaborate with industrial organizations in typical technology and industrial fields: 1) technology transfer between universities and industries 2) collaborative R&D between universities and industries in practical fields 3) finally university-run high-tech companies.
5.	Australia	• Australia spends less on research as compared to OECD average • Low proportion of researchers working in business and academic-industry research • R&D spending as a percentage of GDP (2.1%) is less than the OECD countries average (2.4%) during 2013-2016. • According to Department of Education and Industry of Australia, the country is not capitalizing on its public investment in research. One of the reasons for the same is lesser proportion of researchers working in industry and academic-industry research publications. • Australian companies prefer to adopt or modify existing innovations
6.	United Kingdom	• There are seven model research collaboration agreements • These collaborations can be either the Institution owns the Results and grants the Collaborator a non-exclusive license to use the Results or Collaborator has the right to call on the Institution to negotiate an exclusive license. • The Collaborator has the right to call on the Institution to negotiate an assignment. The agreement 4 entails on publication while 5th model suggests contact research. • The Lambert Model also takes the form of 'triple helix' • The concern in UK is mostly on intellectual property agreement

Source: PHD Research Bureau, PHD Chamber of Commerce and Industry, compiled from various sources


Table 3: Macroeconomic parameters and UILs in select countries

S.No.	Parameter	United States	Germany	Japan	China	Australia	United Kingdom
1	UILs	Strong UILs	Strong UILs	Relatively developed UILs	Well-developed UILs	Less-developed UILs	Strong UILs
2	GDP Size*	18,569	3,467	4,939	11,218	1,259	2,629
3	GDP Growth[@]	2.50%	2.90%	1.50%	6.80%	2.8%[##]	1.40%
4	Growth of Industry	3.7%[%]	6.5%[@]	4.4%[@]	6.2%[@]	3.6%[##]	0%[@]
5	Unemployment[@]	4.1%[%]	3.60%	2.80%	3.90%	5.5%[%]	4.40%
6	Gross Domestic Spending on R & D**	462765	101681.2	154689.3	376858.9	21551.9$	42115
7	R & D Expenditure (% of GDP)^	2.79	2.88	3.28	2.07		1.7
8	Global Innnovation Index[@@]	4	9	14	22	23	5
9	Global Manufacturing Competitiveness Index[#]	2	3	4	1	21	6
10	Ease of Doing Business Rankings[^^]	6	20	34	78	14	7
11	Global Competitiveness Index~	3	5	8	28	22	7
12	Share in Global Exports[$$]	9.12	8.4	4.04	13.15	1.19	2.57
13	Logistics Performance Index[#]	10	1	12	27	19	8

Source: PHD Research Bureau, compiled from various sources. Note: *Data in US$ bn in 2016, %Data pertains to January 2018, @Data pertains to December 2017,** Data in US$ mn in 2015, $ Data pertains to 2013, ^Data pertains to 2015, ## Data pertains to September 2017,# Rankings pertain to the year 2016, @@ Rankings pertain to the year 2017, ^^Rankings pertain to the year 2018, $$ Data pertains to the year 2016, ~Rankings pertain to 2017-2018

Table 4: Ranking of countries on Global Innovation Index 2017

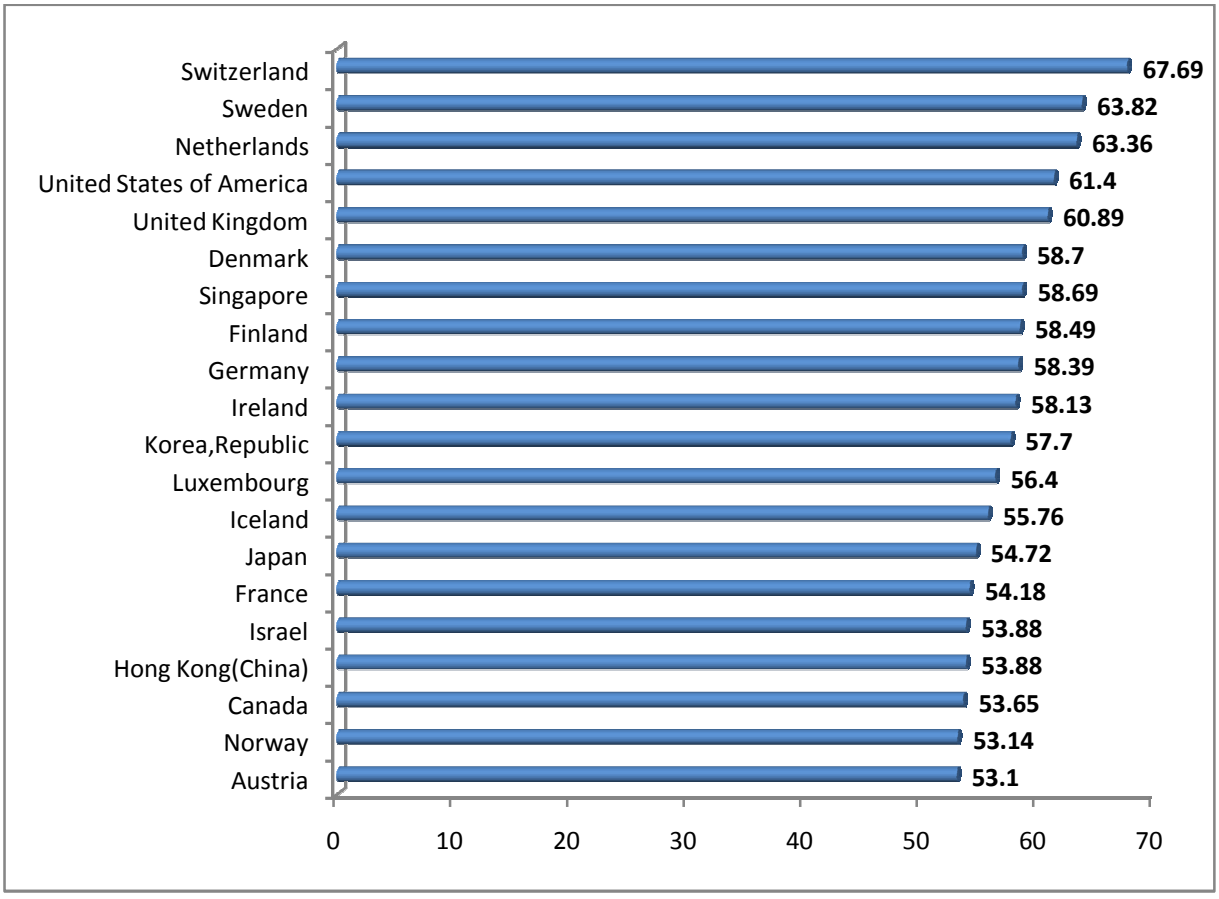
Rank	Country	Rank	Country	Rank	Country
1	Switzerland	44	Greece	87	Indonesia
2	Sweden	45	Russian Federation	88	Belarus
3	Netherlands	46	Chile	89	Botswana
4	United States of America	47	Viet Nam	90	Sri Lanka
5	United Kingdom	48	Montenegro	91	Trinidad and Tobago
6	Denmark	49	Qatar	92	Ecuador
7	Singapore	50	Ukraine	93	Albania
8	Finland	51	Thailand	94	Tajikistan
9	Germany	52	Mongolia	95	Kyrgyzstan
10	Ireland	53	Costa Rica	96	Tanzania, United Rep.
11	Korea,Rep.	54	Moldova, Rep.	97	Namibia
12	Luxembourg	55	Saudi Arabia	98	Guatemala
13	Iceland	56	Kuwait	99	Rwanda
14	Japan	57	South Africa	100	Senegal
15	France	58	Mexico	101	Cambodia
16	Hong Kong(China)	59	Armenia	102	Uganda
17	Israel	60	India	103	El Salvador
18	Canada	61	TFYR of Macedonia	104	Honduras
19	Norway	62	Serbia	105	Egypt
20	Austria	63	Panama	106	Bolivia, Plurinational St.
21	New Zealand	64	Mauritius	107	Mozambique
22	China	65	Colombia	108	Algeria
23	Australia	66	Bahrain	109	Nepal
24	Czech Republic	67	Uruguay	110	Ethiopia
25	Estonia	68	Georgia	111	Madagascar
26	Malta	69	Brazil	112	Cote d'Ivoire
27	Belgium	70	Peru	113	Pakistan
28	Spain	71	Brunei Darussalam	114	Bangladesh
29	Italy	72	Morocco	115	Malawi
30	Cyprus	73	Philippines	116	Benin
31	Portugal	74	Tunisia	117	Cameroon
32	Slovenia	75	Iran, Islam Rep.	118	Mali
33	Latvia	76	Argentina	119	Nigeria
34	Slovakia	77	Oman	120	Burkina Faso
35	United Arab Emirates	78	Kazakhstan	121	Zimbabwe
36	Bulgaria	79	Dominican Republic	122	Burundi
37	Malaysia	80	Kenya	123	Niger
38	Poland	81	Lebanon	124	Zambia


39	Hungary	**82**	Azerbaijan	**125**	Togo
40	Lithuania	**83**	Jordan	**126**	Guinea
41	Croatia	**84**	Jamaica	**127**	Yemen
42	Romania	**85**	Paraguay		
43	Turkey	**86**	Bosnia and Herzegovina		

Source: PHD Research Bureau, compiled from 'The Global Innovation Index 2017' report of United Nations.

According to the Global Innovation Index 2017, Switzerland leads the rankings for the seventh consecutive year. Some economies in the top 20 economies— such as the Netherlands, Denmark, Germany, Japan, France and Israel—have moved up in terms of ranking in comparison to their previous rankings. Yet rich countries take most of the top 20 spots, with middle-income countries growing more distant to the top 20 in the year 2017, rather than closing the gap. The gap between the 11–20 ranked economies remains large, especially in Institutions, Human capital and research, Infrastructure, and Creative outputs.

Graph 2: Top 20 Economies in the Global Innovation Index 2017



Source: PHD Research Bureau, compiled from 'The Global Innovation Index 2017' report of United Nations.

Chapter 2

Impact of UIL Models

Various countries have adopted different models as per their economic conditions in order to strengthen University-Industry Linkages. It is important to highlight the outcomes of each of the models adopted by the countries to have a better understanding of how these countries have been able to develop stronger linkages in research. This has been done in Table 6. Subsequently, the case studies ie international best practices of collaborations between the universities and industries have been discussed and their key learnings are enunciated which can serve as a model for the Indian universities and industries for possible collaborations in the future.

Table 5: Matrix of University Industry Linkages (UILs) in Select Countries

S. No.	Country	UIL Model	Impact
1.	United States	• Bayh-Dole Act, which is a landmark Act for University-Industry Linkages was passed in United States (US) in 1980. • The university-industry linkage model in the United States of America is described as 'triple helix model'- an interplay between universities, industry and government. • Another mechanism which is common in US is consultancy service. • Universities in US are encouraged to form linkages with the industry via technology transfer called patent-license-startup model.	• **Rise in the Offices of Technology Licencing in Universities-** Before the advent of Bayh-Dole, only 23 Universities had Offices of Technology Licensing (OTL). Post 1983, the rate of creation rose dramatically and today all major research institutions have OTLs. • **Emergence of diverse pattern of commercial arrangements by the universities**- Existing small companies (i.e. companies with 500 employees or fewer) account for 50% of licenses, while large companies account for 35% of licenses. Spin-out[18] companies formed specifically to commercialize a particular academic technology—account for 15% of licenses. These proportions have held fairly constant for a

[18] A spin out is a type of corporate restructuring. Spin outs occur when a corporation breaks off parts or divisions of itself to form a new corporation. The new company that is spun out brings with it some of the parent company's assets and equipment.

			number of years. • **Increasing trend towards non-exclusive licensing** and in FY2008, non-exclusive licenses accounted for 56 percent of all licenses issued. Licenses to spin-out companies and to potential drugs, where substantial investments will be required, are almost always exclusive. • **Increase in income-** The income earned by universities from licensing has increased substantially, from $7.3 million in 1981 to $3.4 billion in 2008. **However, Bayh-Dole has been criticized for the following-** - Changing the nature of academia - Shifting the focus of research away from ground breaking, fundamental research to incremental applied research - Instilling a culture of secrecy on campus. - Non protection of the public good.
2.	Germany	• Germany as well has a similar legislation as that of Bayh-Dole Act of US. • The German national innovation system has a balanced structure, and is strongly influenced by decision-making in private companies and the governance of capital markets. • Principles of academic freedom and scientific independence are a constituent element of the German research system, and the Federal	• German manufacturers have been particularly successful in translating research into new products and technologies due to a dense network of universities, public research organizations, state and federal governments, industrial research organizations, and foundations.

		Government has much less influence on research and education than in many other countries.	• The institutions work collaboratively and across multiple levels of government to support manufacturing through basic scientific research, applied industrial research, innovation incentives, and targeted strategies to develop industry clusters and new technologies. • The public-private collaborations of Germany, around technology and its dual model for vocational education are considered international best practices.
3.	Japan	• In 1998, the Act on Promotion of Technology Transfer from Universities to Private Industry (the TLO Act) was enacted. • The Act on Special Measures for Industrial Revitalization (the "Japanese Bayh–Dole Act"), was enacted in 1999. • In 2000, Japan enacted the 'Strengthening Industrial Technology Bill' which allowed faculty in national universities to assume management positions in companies established to develop their technologies, to work after office hours with pay and to take upto three years off to commercialise discoveries and then return to their faculty positions (Lehrer and Asakawa 2004). • There are three ways for companies to collaborate with national universities- collaborative research, contract research & academic donation. •	• As a result of the implementation of policy of promoting TLOs to activate technology transfers under the TLO Act, 47 TLOs were established by 2009. • The academic spin-off activities in Japan increased in 2000, when the regulation on national university professors to serve as board members of private companies was relaxed[19] • Research linkages between Japanese universities and Industries are expanding, with increasing industrial funding coming in for technology. The Government is pushing for scientific development to boost economic growth.

[19] Masayuki Kondo, University-Industry Partnerships in Japan, 2009

4.	China	• China has a legislation similar to the US • There are three ways in which universities in China collaborate with industrial organizations in typical technology and industrial fields: 1) technology transfer between universities and industries 2) collaborative R&D between universities and industries in practical fields 3) finally university-run high-tech companies.	• A study by Hu and Mathews (2008) reveals the strong role played by the Chinese universities in building China's national innovative capacity. The main source of innovative activities in China is universities and China relies heavily on universities for innovative activity and enterprises spun-off from universities. These university spin-off ventures are either wholly owned by universities or operated jointly with other entities. • A study by Hu, Li and Hughes (2012) shows that the Chinese version of the Bayh-Dole Act introduced by China in 1999 allowing universities to own inventions that were funded by the government went far beyond the US Act in rewarding academic inventors. This has resulted in a rapid increase in the transfer of knowledge to industries from the universities.
5.	Australia	• There is no specific model for Australia. Universities have been using a variety of engagement instruments, including adjunct appointment policies, to build business relationships. In addition, senior university staff participates actively in business forums and regional development councils[20]. • Nonetheless, the government is committed to innovation and had	• The review of select Australian Government Programmes by the Innovation and Science Australia, suggest there are some programmes, or components of them, that are particularly effective such as the Cooperative Research Centres (CRCs) which is highly effective in linking researchers with

[20] Dr. John H. Howards, A Vision For University-Business Engagement in Australia, published on 20 June 2017

		launched National Innovation and Science Agenda (NISA) in 2015	domestic and international end users. In 2012, it was estimated that CRCs accounted for $14.5 billion of gross direct economic impacts and community benefits [21]. • However, the majority of government funding for innovation in Australian businesses is indirect, which gives recipients a high degree of autonomy over how funds are used[22] .
6.	United Kingdom	• The UK Lambert Agreements give sponsors the option to control publications in return for paying the full economic cost of a project. • Under the UK Patents Act of 1977, section 39(1), inventions made by employees in their normal course of work belong to their employers. Most UK universities rely on these default provisions to assert ownership over inventions by their faculty – especially in the case of collaborative research inventions arising under contracts between companies and the universities	• Lambert toolkit has been successful in achieving its aims of making negotiations faster, cheaper and easier. It is providing useful information and support to facilitate the negotiations. • As speculated by Kneller, Mongeon, Cope, Garner, Ternouth (2014) in their research article on Industry-University Collaborations in Canada, Japan, the UK and USA – With Emphasis on Publication Freedom and Managing the Intellectual Property Lock-Up Problem, there are lesser disputes over publication rights in the UK due to Lambert Agreement.

Source: PHD Research Bureau, compiled from various sources

[21] Performance Review of the Australian Innovation, Science and Research System 2016, Innovation and Science, Australia
[22] ibid

2.1 International Scenario of University-Industry Linkages: Select case studies

The previous chapter covers the university-industry linkages of select countries to know the international scenario in terms of efforts of the respective governments to create an ecosystem conducive for growth of research and development. Consequently, this section entails the case studies of successful collaboration between universities and industries, mostly undertaken without government intervention. These case studies cover different countries and the industries are from different sectors to have a wide-encompassing picture of the successful collaborations worldwide.

2.1.1 Case Study: Collaboration between Siemens-Technical University of Berlin (TU) in Germany, Massachusetts Institute of Technology (MIT) in United States

Siemens[23] have been into partnerships with many universities in different countries such as Europe, United States and China. The company chooses its key university partners on the basis of topics that are of strategic value to it. The company works on innovations related to energy-efficient cities in association with the Technical University of Berlin. With MIT, the partnership is for developing health care and medical technologies.

The results of partnerships with universities range from the creation of basic knowledge that leads to development of future products, innovations in existing products to paving the way for evolution towards open innovation.

Key learnings -

- **Understanding the objectives** of the university and needs of the company is the first step that should be taken for ensuring successful and meaningful collaborations between the Industries and universities.
- **Establish strong structures to cooperate with universities:** For successful partnerships, it is important that right structures are in place. For its strategic partnerships with academia, Siemens places a Center of Knowledge Interchange (CKI) as a single point of contact on each campus to manage the projects and the relationship with researchers.
- **University technology transfer organizations should not hinder strategic partnerships with industry:** Often, the most difficult thing about partnering is the start, including negotiations with the legal and technology transfer organization.

[23] The highest level of research partnership in Siemens is that of the Centers of Knowledge Interchange (CKIs). Such centers have been established at only a few universities whose research meets the highest international standards and which are selected on the basis of strict criteria. These universities include the RWTH Aachen, the Technical University of Berlin, the Technical University of Munich, and the University of Erlangen-Nuremberg in Germany, Graz University of Technology in Austria, the Georgia Institute of Technology, the University of California at Berkeley, Danish Technical University (DTU) in Copenhagen, and the Tsinghua University in China.

Universities should not go overboard to extract the opportunity of making money from patents. This happens once in the lifetime of big organizations and is hard to predict. Intellectual Property (IP) is a critical topic, but it is totally overestimated by universities.

- **Collaboration on teaching soft skills can accelerate innovation:** Understanding both Information Technology (IT) and the business aspects of international collaboration as well as training in soft managerial skills, working in a global organization, teamwork skills and entrepreneurial skills will accelerate innovation.

2.1.2 Case Study: Collaboration between JPMorgan Chase and Syracuse University in United States

JPMorgan Chase (JPMC) and Syracuse University (SU) collaborated in 2007 on a range of activities, including research, curriculum and internships to work towards a shared vision of long term relationship. The specific objectives with which both the parties entered into a collaborative agreement are as under-

- Transform the classroom and on the job training methodology for technologists
- Drive innovation in education at the university level and in financial services
- Deliver long-term value to all stakeholders
- Develop a sustainable model for state of the art university-industry collaboration

The collaboration occurred at all levels of the organization, right from the junior-most to senior executives along with involvement of technologists and faculty within JPMC. The project results are in the form of joint applied research, development of curriculum, internships and community engagements.

Key learnings -

- Both the industry and the university must support the mission of each other. The university and the industry must focus on fostering long term collaborations between the two stakeholders.
- Long-term relationships ensure cross pollination of ideas across the work streams which are imperative for the growth of both the stakeholders. Thus, the universities and industries must enter into strategic long-term partnerships for fruitful results.
- The negotiations should be streamlined so as to ensure timely conduct of the research. The negotiations need to be focused on deliverables and outcomes primarily to develop a strategy plan on time so that the focus is more on research and less on negotiations.

- The collaboration provides employees, avenues to spend time in university and find solutions to their problems. Thus collaborations help in finding solutions to practical problems in a much easier and conducive way.

The successful collaboration between JPMC and SU has resulted in amalgamation of ideas across the work-streams which have encouraged the employees of JPMC to share their expertise.

2.1.3 Case Study: Strategic Partnership between International Business Machines (IBM)-Eidgenössische Technische Hochschule Zurich (ETH) in Switzerland

IBM and ETH Zurich collaborated for almost a decade which led to the creation of the $90 million Binnig and Rohrer Nanotechnology Centre[24] in 2011. The Center produces research on novel nanoscale structures and devices to advance energy and information technologies. One goal of the partnership is to attract and foster top nanotechnology talent in Europe by investing in cutting-edge exploratory research.

Scientists and engineers from IBM and ETH Zurich pursue joint and independent projects ranging from exploratory research to applied projects, as well as generating knowledge about the scientific foundations of nanoscale devices at the atomic level.

Key learnings -

- The negotiations act as a good ice breaker between the two entities that is the industry and university. It is easy for the researchers from two organizations to negotiate instead of lawyers from both the parties engaging in discussions.
- It takes work and leadership from the top to create and maintain good relationships between companies and universities. Both IBM and ETH have devoted over a decade to forge strong relationships.
- Both sides benefited greatly from the ability of ETH to join in the project. This is because the ability of university to get involved and its ability to share the costs made it easier to set up a laboratory. As IBM had land already earmarked for expansion at the Rüschlikon research centre, and ETH having the expertise, the two parties coming together brought about synergies which were beneficial to both the stakeholders.
- Long term partnerships can be forged if there is a constant flow of ideas, talent and resources from industries to universities and vice versa which has been in the case of ETH and IBM.

[24]The IBM-ETH Zurich nanotechnology centre is a state-of-the-art facility for exploratory research and is not a production or pilot line with fixed processes or wafer sizes. According to IBM, the new centre is the first time that industry and academia have created shared research facilities in Switzerland.

2.1.4 Case Study: Strategic Collaboration between California Institute of Technology (CalTech) and Boeing in United States

Boeing[25] and California Institute of Technology (CalTech) entered into a strategic agreement in 2004 to address key issues of importance to both the institutions including Intellectual Property. The initial areas of research focus for CalTech were Systems Integration Technologies. Once the agreement was made, Boeing received three proposals from Caltech based on the faculty who had visited the Airline giant. Boeing assigned a single technical staff member to manage the portfolio.

In addition, a Principal Investigator is used by Boeing to manage each research project with corresponding work at Boeing in the same area. Apparently, both the organizations have expressed an interest in expanding the collaboration to other aerospace technologies. Boeing's senior executives have access to key faculty and administration at CalTech while students of Caltech have been encouraged to seek internships with the company.

Further, researchers in key areas have been hired by Boeing. The company and CalTech scientists interact regularly. Both the organizations hold an annual "Research Review" to discuss key projects and their findings. On account of significant achievements and technology transitions, Boeing has increased the funding of CalTech scholarships.

Key learnings -

- Effective collaborative relationships can be developed without government intervention, when the stakeholders, university and industry work together towards identifying each other's capabilities to achieve long term strategic well defined goals.
- The collaborations also help to examine state and local government economic development agencies as another source of funding which may serve as an advantage in case of limited funding or reducing the risks involved in developing new inventions and innovations.
- The collaborations facilitate in forging new collaborations for different projects between the university and industry. Hence, new avenues can be explored which either the university or industry may not have decided to pursue if they were on their own.

As a result of this partnership, the relationship continues to expand with pursuing other sources of finance, other federal funded agencies and other corporate research centers.

[25]Boeing has signed long-term comprehensive research agreements with nine of the world's top universities in specific critical technology areas to focus on scientific research.

2.1.5 Case Study: Strategic Partnership between Svenska Kullagerfabriken AB (SKF) Group-University of Cambridge in United Kingdom

(Svenska Kullagerfabriken AB) SKF Group, a Sweden based multi-national has developed five university technology centres since 2008 as part of a move towards highly strategic, long-term collaborations on core technologies. The centres developed so far focuses on strategic alliances with universities instead of ad hoc research projects which are modeled on a concept pioneered by Rolls Royce in the 1980s.

In 2009, SKF established a University Technology Centre at the University of Cambridge's materials science and metallurgy department. According to the terms of partnership, the University of Cambridge is conducting both pure and applied research, with SKF providing funding, technical expertise and practical knowledge. The goal of partnership between the two organizations isto advance the knowledge of the physical metallurgy of bearing steels, and use it to accelerate the development of new and improved bearing products.

Key learnings -

- Companies which develop strategic relationships with universities may deepen research ties through their university work and decide to innovate together. Both SKF and Rolls Royce have set up separate strategic research partnerships with University of Cambridge which focuses on material research. This has got the two companies together and they are entering into partnerships.

- Be selective; Develop strategic partnerships. The partnerships have to be based on some kind of complementary relationship where companies approach universities to do something they cannot do by themselves. Many companies seek to harness universities as an inexpensive source of research which in the end turns out disappointing. For a successful relationship, the companies should engage with universities because of their ability, creativity and different mindset about the world rather than expensive research.

- The strategic alliances with universities are more productive than the ad-hoc research. This is because research is an ongoing activity which takes years sometimes. Hence it is essential to forge long term partnerships based on strategic alliances where the two parties can know each other better and communicate the outcomes in a much better way.

2.1.6 Case Study: Collaborations that result in new funding stream for universities--Imperial Innovations Group Public Limited Company and Imperial College, London, United Kingdom

The Imperial Innovations Group Public Limited Company[26] began in 1986 as the technology transfer office for Imperial College London and has now become a wholly owned subsidiary of the university in 1997. In 2006, it was registered on the Alternative Investment Market of the London Stock Exchange and raised £26 million in an initial public offering which is one of the first University Technology Transfer Office to make the transition to listed company.

Imperial Innovations has an agreement with Imperial College London which extends until 2020, under which the College continues to act as the technology transfer office for the university and has a right to IP emerging from research.

The group invests in technology spin-outs in energy, engineering, environment and the healthcare and provides scientist-entrepreneurs with investments as well as operational expertise.

Key learnings -

- Significant funding can be attracted by universities by re-modeling traditional Technology Transfer Office model. The Imperial Innovations convinced GlaxoSmithKline (GSK) that University College London had deep expertise in a new technology which could support a new company. Consequently, the University College London's Ear Institute alongwith Spinout firm Autofiny is developing treatments for hearing disorders in which Imperial Innovations also holds a stake. The benefit is that the university gets funding and it gets access to latest technology from which the science could progress.

- To create large companies out of spinoffs, there is a need for the universities to accompany them further. This is because the establishment is job half done. The spin-off company may experience many roadblocks later which needs handholding from the universities.

- Managing a publicly listed Technology Transfer Office requires huge resources and commitment from the university. It is essential to develop Technology Transfer Office as a separate entity with its own resources right from technical to human resources. Commitment of both the industry and university are essential to keep the entity working efficiently.

[26] Since 2005, Imperial Innovations has raised approximately £206 million (before issue costs) from investors. The group has invested a total of £83 million and the portfolio of 78 companies has raised investment of over £300 million. In 2011, an additional £140 million (before issue costs) were raised by Imperial Innovations, supported by its collaborations with Oxford Spin-out Equity Management, Cambridge Enterprise and UCL Business.

In a nutshell, the universities and industries entering into strategic alliances and collaborations across the world have managed to sustain long lasting relationships without government interventions in most cases. These entities have strived to foster long term collaborations by identifying the objectives and adopting a win-win approach. Both the stakeholders have entered into partnership with some kind of complementary relationship so as to harness each other's potential and contribute to the growth of research and development of the country.

Table 6: Snapshot of International Case Studies and their key learnings

S.No.	Country	Firm	University	Key learnings
1	Germany	Siemens	Technical University of Berlin and Massachusetts Institute of Technology, USA	Understanding the objectives is the first and foremost step of building effective collaboration. Strong structures should be established which do not hinder strategic partnerships.
2	United States	JPMorgan Chase & Co.	Syracuse University	Both the parties must support the mission of each other and focus on fostering long term collaborations. The negotiations should be streamlined so as to ensure timely conduct of the research.
3	Switzerland	IBM	ETH	Both the parties should adopt a win-win approach to partnership and devote time and leadership to maintain good relationships between them. Long term partnerships can be forged if there is a constant flow of ideas, talent and resources.
4	United States	Boeing	CalTech	The university and industry must work towards achieving long term strategic well defined goals by identifying each others' capabilities. The collaborations also help to examine government economic development agencies as another source of funding.
5	United Kingdom	SKF Group	University of Cambridge	The partnerships have to be based on some kind of complementary relationships. The strategic alliances with universities are a more productive alliance than the ad-hoc research.
6	United Kingdom	Imperial Innovations Public Limited Company	Imperial College	A public listed company requires huge resources and commitment from the university. Significant funding can be attracted by universities by re-modeling traditional Technology Transfer Office model.

Source: PHD Research Bureau, PHD Chamber of Commerce & Industry

Chapter 3

University-Industry Linkages in India

India is at a very nascent stage when it comes to University-Industry Linkages. Although India's top educational institutions have done relatively well over the years, but it is still facing some important issues on the higher education front that needs immediate attention. Some of them are constraints in research capacity, innovation and low enrolment in PhD programmes. There are very few opportunities for interdisciplinary working, because of a weak innovation ecosystem in academia and low industry-university linkages. During the past 60 years, there has not been any major technological contribution to the world from Indian Universities. The degree of university-industry linkages in India is minuscule as compared to that of other developed nations.

In India, a number of initiatives for industry-academic linkages have shown positive results in research, but these remain erratic in nature. India's share in the world researchers has persisted at about 2% as compared to 20% of the USA and Chinas. The share of research and development (R&D) global spending of USA is 34%, China is 12.9%, Japan is 12.1% and it is only 3% in India for the FY2011[27] . Significantly, an analysis of the share of R&D expenditure shows that in India, the government share is between 75-80%, the private sector's share is 20- 25%, and that of universities is 3%. While in OECD countries, the government share is 10%, share of private sector is 69%, share of universities is 18% and that of the non-profit organizations is 3%.[28]

Table 7: Share of R&D global spending country wise

S. No.	Country	Share of R&D global spending (% of GDP)
1.	United States of America	2.79^
2.	Canada	1.62#
3.	United Kingdom	1.70^
4.	Germany	2.88^
5.	Netherlands	2.01^
6.	Japan	3.28^
7.	China	2.07^
8.	India	0.63^
9.	Singapore	2.20#
10.	Malaysia	1.30^
11.	Indonesia	0.08*
12.	South Korea	4.23^
13.	Thailand	0.63^
14.	Sri Lanka	0.10*
15.	Denmark	3.01^
16.	Austria	3.07^
17.	South Africa	0.72*

[27] Sectoral Innovation Council on Industrial R&D, White Paper, February 2013

[28] Report on Academia-Industry Collaborations by Ministry of Human Resource Development, March 2013

18.	Brazil	1.17#
19.	Russia	1.13^
20.	Australia	2.20*

Source: PHD Research Bureau, Compiled from The World Bank;*Data Pertains to 2013;#Data Pertains to 2014; ^Data Pertains to 2015;& Data is not available

As a share of GDP, India's R&D spends around 1% against the target of at least 4%, which is required to achieve the double digit GDP growth. Currently, global investments in R&D are $1.2 trillion and significant share originates from private sector through their joint research with academia. China has 300 research parks; and MIT has over 700 companies working with its faculty on projects of mutual interest.[29] There has been an increase in the gender-wise pass-out at various levels as the PhD pass outs have increased by around 20% in females in 2015-16 and around 9% in males during the same period. The women pass outs are higher than males in all categories particularly PhD, M. Phil and PG Diploma.

Table 8: Gender Wise Out-turn/Pass Out at various levels

S. No.	Description	Gender Wise	Year		
			2011-12	2015-16	Growth
1	PhD	Male	13696	14887	8.70%
		Females	7763	9284	19.59%
2	M. Phil	Male	9581	8701	-9.18%
		Females	11036	14423	30.69%
3	Post Graduate	Male	578451	665846	15.11%
		Females	535575	739150	38.01%
4	Under Graduate	Male	2757412	3128466	13.46%
		Females	2711918	3203533	18.13%
5	Integrated	Male	11826	12477	5.50%
		Females	8305	10127	21.94%
6	P G Diploma	Male	56086	95013	69.41%
		Females	32699	80340	145.70%
7	Diploma	Male	324980	500999	54.16%
		Females	232735	287323	23.46%
8	Certificate	Male	32893	37321	13.46%
		Females	36094	41467	14.89%

Source: PHD Research Bureau, Compiled from Ministry of Human Resource Development, AISHE Report 2011-12, 2015-16

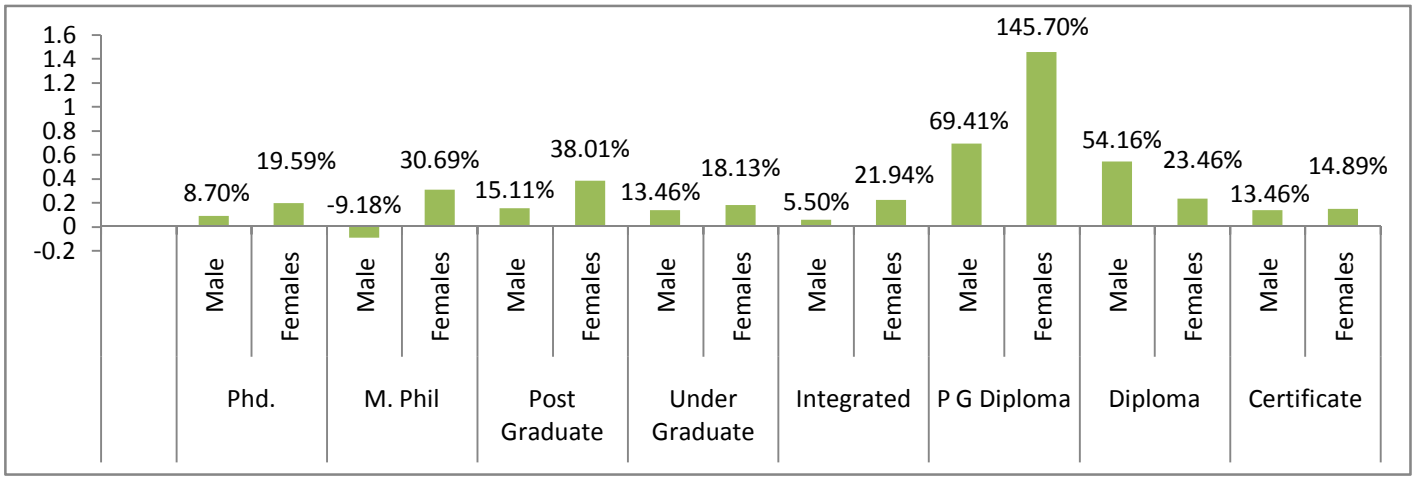
India has highly renowned educational institutes such as Indian Institute of Technology (IITs), Indian Institute of Management (IIMs) and Indian Institute of Science (IISc). Most of these institutes conduct R&D in collaboration with the central and state governments as well as with industry players on regular basis. The linkages between the universities and industries have significant opportunities, especially with multinational companies marking

[29] Ibid

their R&D presence in India; however they are not as strong as they should be. Moreover, most of these engagements tend to be short-term or "project-based".[30] There are a few gaps in terms of policies and on ground reality of university-industry relations. The current level of industry–university linkages, R&D institutions in India have to go a long way to work in-line. There are several institutional bottlenecks such as relationships and these obstacles need to be overcome in the larger interest and competitiveness of the Indian industry in the international arena. Public Private Partnership (PPP) programmes is one such way to enhance such interactions, which need to be multiplied in many other ways.[31]

To enhance the PhD education in the country, the office of Prime Minister in 2013 launched the Prime Minister's Fellowship Scheme for Doctoral Research, which is unique for its promotion of industrial research. According to this scheme, the government provides 50% of the total cost of fellowship to students for performing research in real-time industry environment[32]. Industry provides the rest, and any Intellectual Property Rights (IPR) once created is owned jointly by the student and the industry concerned.[33]

Graph 3: Gender wise out - turn growth rate



Source: PHD Research Bureau, Compiled from Ministry of Human Resource Development, AISHE Report 2011-12, 2015- 16

Until recently, the private sector in India was not very much research oriented, partly because of the lack of competitive pressures and partly because the bulk of research was being conducted in the public institutions. Within public institutions, with a few exceptions, the research moved out of the Indian universities and other academic institutions over the years. For many years, the public sector research institutions have been the main centers of research activity and universities have largely converted into teaching institutions.

However there is a change in pattern; firstly, the private sector is showing interest in research, secondly, the academic institutions are facing financial difficulties, which are

[30] Article in Smart-Socities.com by Professor Mohan Krishnamoorthy, IIT Bombay, Jan 2013
[31] 'No invention, earth shaking idea from India in 60 years: Narayan Murthy'
[32] Prime Minister's Fellowship Scheme for Doctoral Research, 2013 ,www.primeministerfellowshipscheme.in
[33] World Intellectual Property Organization Report on The Global Innovation Index 2015

partly being addressed through sponsored research. The lack of industry- R&D orientation has limited the links between industries and universities over the years. As both change, one would expect more university-industry links. Incubation and new enterprise creation activities may also pick up as these processes mature.[34]

There are several issues when it comes to technology transfer, for instance lack of applicability of research at the institutional level, no transfer of technology mechanism from universities to industries, inadequate funds and less focus of university researchers on publishing their research papers/articles in journals etc.

There is a substantial gap in the focus areas or the objective of universities and industries. While the industry's objective is to develop research or innovate products which are relevant to their industries in a particular time frame, the university's objective is different- to follow a long term approach or focusing on areas which are more beneficial to society or humanistic goals at large.

India lacks an enabling policy environment for a strong focus on R&D area when it comes to university-industry linkages. An ecosystem needs to be created which facilitates transfer of knowledge from lab to market. India also does not have a law in place which leads to strong University-Industry Linkages.[35] For comparison, India has 7.8 scientists per 1000 people compared to 180.7 in Canada, 53.1 in South Korea, and 21.2 in the United States.

Harvard University's endowment in 2008 stands at $250 billion, whereas the total extramural grants provided to Indian universities is roughly Rs 12 billion.[36] Clearly, India needs to do a lot more to uplift its research capacity.

Table 9: Researchers in R&D (per million people)

S. No.	Country	Researchers in R&D (per million people)
1.	United States of America	4,232*
2.	Canada	4519&
3.	United Kingdom	4,471^
4.	Germany	4,431^
5.	Netherlands	4,548^
6.	Japan	5,231^
7.	China	1,177^
8.	India	216^
9.	Singapore	6,658*
10.	Malaysia	2,261^
11.	Indonesia	90#
12.	South Korea	7,087^

[34]Department of Management Studies Report on University-Industry Links and Enterprise Creation in India

[35]The Protection and Utilization of Public-Funded Intellectual Property Bill, 2008 was introduced in the Parliament and now the current status stands withdrawn.

[36]'Modi's got homework fixing India's education system', foreignpolicy.com, June 2014

13.	Thailand	874^
14.	Sri Lanka	111&
15.	Denmark	7,484^
16.	Austria	4,955^
17.	South Africa	437&
18.	Brazil	698@
19.	Russia	3,131^
20.	Australia	4,531@

Source: PHD Research Bureau, Compiled from The World Bank; #Data Pertains to 2009; @Data Pertains to year 2010;&Data Pertains to year 2013; *Data Pertains to year2014; ^Data Pertains to year 2015

Strong IPR Law and awareness on the IPR issues amongst MSMEs is important for strong University-Industry Linkages in India. The number of IP applications in India lags behind that of countries such as US, China, Japan, European Patent Office and Germany.

Going forward, there is a need to strengthen the linkages between Universities and Industries in India, so that they are able to take advantage of each other's strengths. The Government is making an all-out effort to establish India as a manufacturing hub in the world economic system. Hence, the timing is apt for the Universities and Industries to take a leap forward and increase linkages both ways.

3.1 Why India lags behind other countries

India is still nascent in terms of Research in University-Industry Linkages in various aspects out of which some are mentioned below-

- India does not have legislation in place to facilitate University-Industry Linkages in Research. The Protection and Utilization of Public-Funded Intellectual Property (PUPFIP) Bill[37] and Higher Education and Research Bill were pending and now have been withdrawn from the Parliament.[38] The Protection and Utilization of Public-Funded Intellectual Property (PUPFIP) Bill was on the lines of Bayh-Dole Act in US, which led to great benefit for the country and many other countries have benefited by adopting a similar legislation.

- An institutionalized framework for industry-academia connect is absent in the country. The best place to increase the entrepreneurial spirit is the campus; centers for learning could serve as the base to develop the start-up ecosystem. Almost all the leading international universities have functional research and incubation cells. However, there are very few institutes in India currently that offer programs in entrepreneurship and have active incubation/entrepreneurship cells. As per the data collected from college websites in US and India, the University Of Berkeley, USA has

[37]The Protection and Utilization of Public-Funded Intellectual Property Bill, 2008 was introduced in the Parliament and now the current status stands withdrawn.
[38]The Higher Education and Research Bill, 2011 current status stands withdrawn.

incubated more start-ups (~700)[39] than all the higher education institutions combined in India. In fact, the higher educational institutes in India have recently recognized the significance of entrepreneurship programs but there are only few which have a functional incubation center. Having more research and incubation cells will also resonate with the Hon'ble Prime Minister's call for 'Start-up India' which can be realized only if higher education institutions emerge as a fertile ground for innovation and entrepreneurship.

- Stronger Government support is needed in the area of University-Industry Linkages. For instance, in countries like China, Government has a huge role to play as far as University-Industry Linkages are concerned. The public sector has a significant presence in all spheres of innovation. It involves presence of Government bodies which define R&D objectives, government labs that conduct R&D, state-run banks and state-owned enterprises as well.

In a nutshell, the universities and industries entering into strategic alliances and collaborations across the world have managed to sustain long lasting relationships without government interventions in most cases.[40] These entities have strived to foster long term collaborations by entering into partnership with some kind of complementary relationships and adopting a win-win approach.

3.2 Benefits of University-Industry Linkages

In a fast and developing economy like India[41], the importance of linkages between Universities and Industries has increased more than ever. It is beneficial not only to the Industry and Universities, but also to the national innovation system. It is important to recognize these benefits for the economic growth and vitality of the country. Some of the benefits are listed below-

- A successful university-industry collaboration results in increased workforce participation and development of the students.[42]
- To enhance the innovation through adopting different open innovation strategies, to have a better access to external sources of knowledge, leading to a stronger collaboration with the universities.[43]
- The universities and industries conduct joint commissioned research, which in future will benefit both the parties.

[39]Sidharth Sonawat 'Entrepreneurship : Let's 'start-up' at the campus', yesinstitute.in, November 2015
[40]The detailed case studies are available in Chapter II.
[41]According to the second advanced estimates of National Income Account FY2016-17, released by MOSPI, the growth of India's GDP stands at 7.1% for the FY2017.
[42]German Center for Research and Innovation Report on 'Keeping Manufacturing Competitive: Industry-University Collaboration in Germany and US'
[43]Social Science Research Network Report on Universities-Industry Collaboration

- The universities and industries make joint investments in the laboratories and equipments required for the necessary research.
- Funds are provided to the students' for their graduate research in terms of scholarships.
- The industries provide support to the universities for establishing technology incubators and science parks for conducting research.
- Both the universities and industries build expertise in intellectual property as it is important to highlight that an improper management of IPR may result in unfair benefits for some private businesses as well as loss of revenues to governments.
- The universities build their business and management skills, in order to support the industries.
- The university industry collaborations will increase employment opportunity for the people consequently, which will help in alleviating poverty[44] and also help in achieving a higher growth in the national economy.

3.3 Challenges before India in implementing Bayh-Dole Act

Due to various challenges, The Protection and Utilization of Public-Funded Intellectual Property Bill, 2008 to become a law has been withdrawn from the Parliament. Some of these challenges are listed below-

- One of the major concerns has been lack of transparency in receiving inputs from some of the important organizations. For the Law to be successful, it is important that suggestions are taken from all the important organizations such as Indian Institute of Science, IITs etc.
- Lack of resources and poor infrastructure is another major constraint as universities are not equipped with state of the art technology and resources due to which the industries do not come forward to collaborate with the universities.
- The Bill lacks specific clauses that take into consideration the health care needs in the country. In fact, the Bill needs to cover all spheres of research, the initial draft attracted criticism for focusing mainly on IT sector.
- The legislation completely ignores provisions for the identification and segregation of basic research inventions from applied research and it does not include any special clauses that provide access for such inventions.
- Lack of clarity as far as the definition of Intellectual Property is concerned in the legislation and strong penalties for not disclosing such IP leads to discouragement of

[44] International Journal of Scientific and Educational Studies Report on 'University-Industry Linkages and Graduate Employability in Nigerian Universities', 2012

social welfare which can promote innovation, research and creativity. Building strong IPR protection by allowing innovators to appropriate a share of the benefits of their creative activities encourages R&D further leading to innovation and higher long-run growth.

- The Bill makes no distinction between the characteristics of ingestions that should be patented, and those that would more effectively produce social benefits via placement in the public domain.
- The current form of the Bill is a similar version of the US Bayh-Dole Act. There is a growing concern that the bill is drafted without a full impact assessment of grass root realities and complexities of the Indian scenario.
- There is a growing apprehension that the bill will benefit only those scientists who have industry contacts and the acumen to commercialize their inventions. The main drawback is that it does not protect the public interest.
- The environmental conditions that prefaced the adoption of Bayh-Doyle in the US are very different from those prevailing in India. Therefore, the implications could be drastically different from what the bill intends to do.
- A detailed study needs to be carried out on the research patenting landscape of India, which will create more awareness about patents (like institutions and laws that reduce costs of obtaining patents) may be useful where patents are needed for technology transfer, and their absence would limit benefits from publicly funded research.

3.4 University-Industry Linkages in India: Select Case Studies

The importance of academic -industry relationships can be emphasized from way back in time, and recently, it has become a necessity for both the academic institutions and the industries. Several efforts are being made by the universities, industries, and the Government to promote this relationship and transfer the knowledge between academic institutions and industries, such as establishment of legal frameworks, increase in the number of researchers to the industries and substantial cooperative R&D programs, among others. There are various case studies in India which can be considered at the broader level. These case studies can serve as best practices for strengthening the university-industry linkages at the macro-level.

3.4.1 Case Study: A success story of strategic collaboration of Indian Institute of Technology -Kanpur and Boeing

Multinational company Boeing launched the Boeing-University Relations Program in 2008 to promote 'aerospace engineering' as a career alternative for students. Boeing identified IIT-Kanpur (among other universities) to participate in the Boeing-University Relations Program and the Boeing Technical Externship program. IIT-Kanpur was selected due to its ability to provide expert technological research support in the form of operating models (simulation or prototypes), designs and analytics. In addition to the student driven research, Boeing

started a Boeing Technical Externship program in 2009 in IIT-Kanpur among other universities. The Externship was a 'student-oriented experiential learning opportunity' designed to expose a select group of third year undergraduate engineering students to the aerospace industry.

Key objectives of strategic collaboration

1. To provide scholarships to undergraduate and post graduate students in Aerospace related to engineering disciplines.
2. To support design competitions that would encourage students to innovate and think differently so as to come up with new ideas thereby stimulating innovation in the country.
3. To provide innovation opportunities to students in order to produce various working prototypes of autonomous vehicles and this also helped the students to gain some exposure.
4. To provide students with an opportunity to interact directly with aerospace experts, practitioners and executives from Boeing.
5. To extend funding in order to undertake the industry-relevant research in areas of mutual interest such as aerospace engineering as a career among students.

Key learnings -

- This collaboration helped assimilate new ideas and innovative processes not only to meet the emerging needs of the country but also to meet the requirements of the global aerospace industry.
- Many specialty industries require multi-disciplinary research support for their working. Other institutions can also develop a concept similar to the Boeing and venture on specialised fields of study and also establish industry-supported externship.
- This industry collaboration resulted in increasing the number of patents filing in India by 4 folds. In addition to these Indian patents, the institute also filed 4 International Patents and contributed to 24 technology transfers.
- This collaboration helped in mobilizing capacity, harness creativity, access market expertise, create value and drive growth. Thus, this collaboration mutually benefitted both the stakeholders.
- The externship was aimed at providing students with a better understanding and opportunity for practical application of engineering and technology skills in aerospace. This facilitated the students to become job ready.

3.4.2 Case Study: A success story of strategic collaboration of the National Institute of Technology Karnataka and Bosch

Bosch Power Tools Training facility was established at the National Institute of Technology, Karnataka in order to tap the high market potential for power tools in the State of Karnataka. The same was funded by Technical Education Quality Improvement Program (TE-QIP) and which was supported by the Power Tools Division of Bosch.

Key objectives of strategic collaboration

1. The aim of this linkage was to provide students an access to the state of art and power tools facility so as to have the best of facilities, thereby encouraging R&D activities.
2. To identify skill gaps in the market and potential for the industry collaboration to ensure mutual benefits, and benefits to the society at large.
3. To enable the students to gain hands-on experience with the support of industry experts from Mico-Bosch.
4. To maintain successful collaborations and ensure that it holds periodic review through meetings of the joint working group dedicated to the industry.
5. It also aimed at improving the curriculum to make the students more market-ready and to enhance their innovative thinking.

Key learnings -

- An important outcome from this training centre was that the University also utilized the laboratory as a part of its social responsibility initiative. The lab facilities were being used for training purposes in respect to the Community Development Programs for skilling local people.
- The workshops were being conducted on a regular basis and were helping the rural artisans in upgrading their skills.
- This collaboration included a combination of product demonstration and training in order to empower the self-employed artisans so that they could further negotiate trade on their own.
- This collaboration also focused on giving hands on experience of using a power tool for carpentry, metalworking and construction which facilitated the students to undertake research and activities with the state of the art technology.
- This collaboration believed in providing an opportunity not only to interact with current students but also to influence the curriculum being taught in Universities so as to ensure that they have both practical and theoretical elements which would guarantee

that the students are not only academically qualified but also trained in practical skills that are relevant to the market.

3.4.3 Case Study: A success story of strategic collaboration of the Indian Institute of Technology-Bombay and Society for Innovation & Entrepreneurship

The critical factors favouring the IIT-B among the industries for its long standing success were Quality Research at Competitive costs, Consistent contributions to technological innovations, and Strategic location (proximity to industrial hubs).

Key objectives of strategic collaboration

1. To provide a platform for the industry experts to mentor their incubatee companies and help students and the faculty to commercialise the Intellectual Property developed through their entrepreneurial ventures.

2. To interact with industry through several channels including consultancy projects, industry sponsored research, industry-sponsored laboratories, collaborative research, technology business incubators, continuing education programs, industry sponsored student fellowships, summer placements of faculty and students in industry and faculty members acting on the Boards of Directors of Industry.

3. To ensure active participation and involvement of its alumni as well as consistent investments into collaborative research.

4. To identify new innovations that have the potential to be developed into new commercial ventures thus, generating new employment opportunities and helping the technological ventures sustain.

5. To maintain the status of being the dependable source of innovation that lead industries to find a competitive place within the market, and consistent meaningful engagement of industries and relationship management in order to be successful.

Key learnings -

- Following the footsteps of Indian Institute of Technology-Bombay and/ or collaborating with IIT-B, other engineering institutions could find their means to strengthen their Research portfolio in relation to the real-time industry challenges and thereby support industries to innovate and in return secure the required fund-support from them.

- This collaboration also helped in contributing towards a larger economy by promoting/ incubating entrepreneurs as the IIT-B provided technical know-how and the entrepreneurs provided idea which turned out to be an excellent amalgamation.

- This collaboration made a wide range of successful technological innovations, which were patented, commercialised and promoted as entrepreneurial ventures, cutting across the sectors like energy and power, IT & software, green technology, AI& robotics and manufacturing among others.

- This collaboration planned to further help other engineering schools, following suit through a partnership that would encourage entrepreneurship on their campuses.

- This collaboration facilitated faculties from other engineering colleges in order to set up and sustain a business incubator through a series of workshops which focused on procedures, methodology, access to funding & mentoring among other activities.

3.4.4 Case Study: A strategic collaboration between GITAM University and Tata Consultancy Services

A Memorandum of Understanding was signed between GITAM University and IT giant Tata Consultancy Services Limited in order to bridge the gap between the campus and the corporate and thereby enhancing the employability of the emerging workforce.

Key Objectives of strategic collaboration

1. To bridge the gap between the university and corporate structure; thereby, enhancing the skills of the students and generating new employment avenues for them.

2. To strengthen the academic community around the world through TCS-Academic Interface Programme (AIP).

3. To encourage students with internship training opportunities, student awards, workshops, faculty development programmes and campus placements.

4. This collaboration was undertaken to concentrate more on the latest digital technologies and cloud skills, among others; before getting an exposure of the IT industry.

5. To enhance the IT skills and employability of emerging workforce and widen opportunities for the students by informing them about the latest technologies, before entering into the job industry.

Key learnings -

1. This collaboration helped in bridging the gap between the university and the corporate by strengthening the academic community through various programmes.

2. This collaboration enhanced the IT skills of students and generated new employment opportunities for them. At the same time, it also provided innovative solutions to the industry, thereby creating a win-win situation for both the stakeholders.

3. This collaboration helped in encouraging the students with remote internships by providing them with workshops and campus placement opportunities among others. This provided students with practical knowledge and hands on experience which is essential for overall development of the skills of the students.

Other Major Memorandum of Understanding

3.4.5 Case Study: A success story of Memorandum of Understanding (MoU) signed between National Association of Software and Services Companies and University Grants Commission

In a bid to meet the burgeoning demand for skilled IT manpower, software association Nasscom on 17th March, 2005 signed a Memorandum of Understanding (MoU) with University Grants Commission (UGC), to strengthen the professional education through curricula, faculty, and infrastructural improvements. Due to the growing demand for skilled professionals and the rapid changes in technology, there is an increasing need to keep the academia alongside the skill-set requirement of the industry.

Under the MoU, the two sides would work together to increase student and faculty interface with the IT industry by way of mentorship programmes, workshops, seminars and projects. Some of the established IT companies already have programmes in place for industry-academia interface. Under this programme, students would work on live projects of IT companies and get trained in their processes, so that they can be considered for employment at a later stage.

Key learnings -

- The case studies formulated during these programmes, could be used by other companies to further strengthen their university - industry collaboration. This collaboration helped in enhancing the technical and management skills of the people working in various IT industries and also helped them in gaining exposure.

This encouraged development of technical, entrepreneurship and knowledge based enterprises by fostering better linkages between universities and industries. This also helped in upgrading the physical and intellectual infrastructure of the education sector, and ensured an adequate supply of quality manpower to the industry.

3.4.6 Case Study: Collaboration between Tata Consultancy Services and National Skills Development Council

Tata Consultancy Services (TCS) has included skills building within its corporate social responsibility focus areas. The company's skills-building initiatives span BPO training, partnerships with industrial training institutes and train-the-trainer programmes. TCS's Business Process Outsourcing employability programme reached underprivileged rural youth in the states of West Bengal, Odisha, Maharashtra, Gujarat and Tamil Nadu, providing them free training in English, corporate etiquette and computer skills.

TCS partnered with the National Skills Development Council to offer Kashmiri youth a 14 week-training programme, designed and developed by the TCS Foundation. The course focused on soft skills and BPO processes. The company also offers InfoTech-enabled vocational courses. With its computer operator-cum-programming assistant course, the company conducts workshops for instructors at industrial training institutes (68 instructors have been trained and certified in Kolkata, Bengaluru, Mumbai and Lucknow).

Key learnings -

- This helped to develop the faculty for academic institutes, improved the employability of students and developed curriculum as per industry requirements. This helped in upgrading the colleges and enhancing their skills especially, the youth living in the rural areas. This also helped the industries in recruiting the students even before they completed their graduation.

In a nutshell, despite the prevalence of a weak ecosystem for the universities and industries to collaborate in India, there have been many successful partnerships and collaborations between the universities and industries in the area of research and development. There are few gaps in terms of policies and ground realities of university-industry relations. In India, the linkages are still weak as there is no legislation in place to facilitate Universities-Industries Linkages (UILs) in Research. Going ahead, there is a need to strengthen UILs in India by developing legislation on the lines of Bayh-Dole Act in the coming times.

On the other hand, the incubation centers are essential for enhanced research and development in a country. Institutions can not only be used just for skill development but also for translating research into successful entrepreneurship. There have been various success stories of university - industry linkages in the past such as IIT - Kanpur-BOEING, THE NITK-BOSCH, THE IIT-Bombay, and GITAM University - TCS etc. The linkages have been mutually beneficial for both the universities and the industries. The industries have gained from the research while the universities/institutes received funds, knowledge-sharing and exposure from the industries, amongst others.

Table 10: Snapshot of Indian Case Studies and their key learnings

S.No.	Firm	University	Key learnings
1	BOEING	IIT- Kanpur	This collaboration helped assimilate new ideas and innovative processes not only to meet the emerging needs in the country but also to meet the requirements of the global aerospace industry.
2	BOSCH	NITK	An important outcome from this training centre is that the University is also utilising the laboratory as a part of its social responsibility initiative.
3	Society for Innovation & Entrepreneurship	IIT - Bombay	Following the footsteps of Indian Institute of Technology-Bombay and/ or with collaboration with IIT-B, other engineering institutions could find their means to strengthen their Research portfolio in relation to real-time industry challenges and thereby support industries to innovate and in return secure the require fund-support from them.
4	GITAM University	Tata Consultancy Services	This collaboration was created in order to bridge the gap between campus and corporate and thereby enhancing the employability of the emerging workforce.
Other Major Memorandum of Understanding			
5	NASSCOM	UGC	This collaboration helped in enhancing the technical and management skills of the people working in various IT industries and will also help them in gaining exposure.
6	TCS	NSDC	This helped to develop the faculty for academic institutes, improved the employability of students and developed curriculum as per industry requirements. This helped in upgrading the colleges and enhancing the skills of the people especially, the youth living in the rural areas.

Source: PHD Research Bureau, Compiled from various sources

Chapter 4

Intellectual Property Rights: Statistical Outlook

The chapter presents an overview of the role of Intellectual Property Rights (IPR) in University Industry Linkages (UIL) and highlights the key observations. Further, trends in patent, design and trademarks applications of the last five years have been mentioned. The chapter focuses on the state wise patent application filed during the year 2014-15 and 2015-16 in addition to the representation of the top ten Patent Applications from Scientific and Research & Development Institutes/ Originations and the top ten Patent Applications from Institutes and Universities.

4.1 Role of Intellectual Property Right in University Industry Linkages

Intellectual Property Rights[45]- a product of human imagination, creativity and inventiveness is one of the most complex issues for successful University Industry linkage. The experience of industries in managing the collaboration with the universities is still diverse as the information is not well collected. Universities across the globe and especially in Asia lack the clear and coherent set of policies to manage Intellectual Property Rights (IPRs). Given these challenges, it is important to highlight that an improper management of IPR may result in unfair benefits for some private businesses as well as loss of revenues to the government. Thus, there is a need for a proper tracking mechanism which highlights all projects and activities of the University-Industry collaborations.

4.2 Key Observations

The main benefit stated for strong IPR protection is allowing innovators to appropriate a share of the benefits of their creative activities. R&D is encouraged which leads to innovation and higher long-run growth. This regime further helps to promote social welfare through stimulation of innovation, research and creativity.

4.3 Trend in Intellectual Property Rights

4.3.1 Patents

During the financial year 2015-16, **46904 patent applications** were filed exhibiting about **10% growth** in filing as compared to the previous year. The trends in the last five years with respect to patent applications filed, examined, granted and disposed are given below. Disposal of application includes patent granted, refused, withdrawn and abandoned during the year.

[45]Intellectual property rights" refers to the general term for the assignment of property rights through patents, copyrights and trademarks. These property rights allow the holder to exercise a monopoly on the use of the item for a specified period"

Table 11: Trend in Patent Applications

Year/Category	2011-12	2012-13	2013-14	2014-15	2015-16
Filed	43,197	43,674	42,951	42,763	**46,904**
Examined	11,031	12,268	18,615	22,631	**16,851**
Granted	4,381	4,126	4,227	5,978	**6,326**
Disposal (granted+ refused +withdrawn + abandoned)	8,488	9,027	11,411	14,316	**21,987**

Source: Annual Report 2015-16, Intellectual Property India Office, Government of India

During the reporting year, the Patent Office disposed **21987 applications** which include **6,236 grants of patents**, **13908 applications** abandoned, **432 applications** withdrawn and **1321 applications** refused by the office after due process.

4.3.2 Designs

In the year 2015-16, **11,108 design applications** were filed, which showed an increase of **19% as compared** to the last year. The number of design applications examined also increased to 9,426 in 2015-16 as compared to 7,459 during 2014-15. 7,904 designs were registered during the year as compared to 7,147 during 2014-15. The trend of the last five years is as follows:

Table 12: Trend in Design Applications

Year/Category	2011-12	2012-13	2013-14	2014-15	2015-16
Filed	8,373	8,337	8,533	9,327	**11,108**
Examined	6,511	6,776	7,281	7,459	**9,426**
Registered	6,590	7,252	7,178	7,147	**7,904**
Disposal of Applications	6,705	7,300	7,226	7,128	**8,023**

Source: Annual Report 2015-16, Intellectual Property India Office, Government of India

4.3.3 Trade Marks

In the year 2015-16 **2,83,060 trade mark applications** were filed. As compared to the previous year there is an **increase of 34.47% in the filing**. **2,67,861 applications** were examined recording 59.42% increase in the examination and **65,045 trade marks** were registered recording 56.42 % increase in the registration as compared to the last year. The trend for the last five years is as follows:

Table 13: Trend in Trade Mark Applications

Year/Category	2011-12	2012-13	2013-14	2014-15	2015-16
Filed	1,83,588	1,94,216	2,00,005	2,10,501	**2,83,060**
Examined	1,16,263	2,02,385	2,03,086	1,68,026	**2,67,861**
Registered	51,735	44,361	67,796	41,583	**65,045**
Disposal	57,867	69,736	1,04,756	83,652	**1,16,167**

Source: Annual Report 2015-16, Intellectual Property India Office, Government of India


4.3.4 Indian Patentees

Among the top 5 Indian Patentees, Council of Scientific and Industrial Research stands on the first position with 113 patents granted. The second position was acquired by Samsung R&D Institute, India Bangalore Private Limited with 55 patents granted and with 45 patents granted Bharat Heavy Electricals Limited stands at third position. The top 5 Indian Patentees including research organizations, industry and universities are as follows:

Table 14: Top 5 Indian Patentees

S.No.	Name of the Organization	Patents Granted
1.	Council of Scientific and Industrial Research	**113**
2.	Samsung R&D Institute, India Bangalore Private Limited	**55**
3.	Bharat Heavy Electricals Limited	**45**
4.	Indian Institute of Technology	**40**
5.	Defence Research and Development Organization	**32**

Source: Annual Report 2015-16, Intellectual Property India Office, Government of India

4.4 State Wise Patent Analysis

Since the study focuses on bringing about a state wise analysis , the patent filed in the year 2015-16 as against 2014-15 , classified according to the state of origin has been listed below. It was observed that out of the total number of patent applications filed, the state of Maharashtra continued to occupy the first position in the year 2015-16 over its own filing during 2014-15. The states with the **lowest patent application were Manipur, Arunachal Pradesh and the Union Territory of Dadra and Nagar Haveli.**

Table 15: State Wise Patent Application for the Year 2014-15 and 2015-16

State/ Union Territory	Patent Filed	
	2014-15	**2015-16**
Andaman &Nicobar	0	1
Andhra Pradesh	532	265
Arunachal Pradesh	1	0
Assam	46	55
Bihar	31	25
Chandigarh	24	41
Chhattisgarh	28	22
Dadra and Nagar Haveli	2	0
Daman & Diu	0	1
Delhi	1099	1139
Goa	16	32
Gujarat	583	514
Haryana	339	389
Himachal Pradesh	16	55
Jammu & Kashmir	17	23
Jharkhand	109	126

Karnataka	2012	1989
Kerala	259	277
Madhya Pradesh	98	158
Maharashtra	3193	3654
Manipur	5	0
Meghalaya	0	1
Mizoram	0	9
Nagaland	0	1
Orissa	88	73
Pondicherry	16	12
Punjab	97	191
Rajasthan	147	150
Sikkim	1	9
Tamil Nadu	1412	1739
Telengana	459	790
Tripura	8	12
Uttar Pradesh	660	651
Uttaranchal	61	45
West Bengal	406	452
Total	**11855**	**12901**

Source: Annual Report 2015-16, Intellectual Property India Office, Government of India

4.5 Patent Applications from Scientific and Research & Development Institutes/ Organizations:

Considering the picture of the patent applications received from Scientific and Research and Development Institutes/Organizations, the highest applications were received from Council of Scientific and Industrial Research Institute with Samsung R& D Institute India- Bangalore Private Ltd occupying the second position and the applications ranging from 20 and below were filed by Centre for Development of Advanced Computing (C-DAC) and Sun Pharma Advanced Research Company Limited. The top 10 applications received are as under:

Table 16: Top 10 Patent Applications from Scientific and R&D Institutes/ Organisations

S. No.	Name of Scientific and Research & Development Organizations	Applications Filed
1.	Council of Scientific and Industrial Research	323
2.	Samsung R& D Institute India- Bangalore Private Ltd.	271
3.	Director General, Defense Research and Development Organization	85
4.	Indian Council of Agricultural Research	63
5.	Hetero Research Foundation	40
6.	G.H.R. Labs and Research Centre/G.H. Raisoni College of Engineering	33
7.	Indian Space Research Organization	25
8.	Sandip Institute of Technology and Research Centre	21
9.	Centre for Development of Advanced Computing (C-DAC)	20
10.	Sun Pharma Advanced Research Company Limited	19

Source: Annual Report 2015-16, Intellectual Property India Office, Government of India


4.6 Top 10 Patent Applications from Institutes and Universities

It was observed that of the patent applications filed from the Universities and Institutes, the highest number of 391 applications was filed by Indian Institute of Technology followed by Amity University at 99, Bharath University at 65 and the King George's Medical University filing 14 applications. The top 10 applications filed by the Universities and Institutes are as under:

Table 17: Top Patent Applications from Institutes and Universities

S. No.	Name of Institutes/Universities	Applications filed
1.	Indian Institute of Technology	391
2.	Amity University	99
3.	Bharath University	65
4.	Indian Institute of Science	46
4.	Chitkara University	46
5.	Saveetha School of Engineering, Saveetha University	33
5.	G.H. Raisoni College of Engineering/G.H.R. Labs and Research Centre	33
6.	Shoolini University of Biotechnology and Management Sciences	22
6.	Janardan Rai Nagar Rajasthan Vidyapeeth (Deemed) University	22
7.	Veltech Dr. RR & Dr. SR Technical University	20
8.	Siddaganga Institute of Technology an Institution of Sree Siddaganga Education Society	17
9.	National Institute of Pharmaceutical Education and Research (NIPER)	15
9.	Dr. M.G.R Educational and Research Institute	15
10.	King Geogre's Medical University	14

Source: Annual Report 2015-16, Intellectual Property India Office, Government of India

In a nutshell, Intellectual Property Rights (IPRs) encourage innovations, facilitate development of knowledge based organizations and create a favorable climate for technology transfer. It plays a significant role in the economic and industrial growth of the country. Intellectual Property Rights (IPRs) framework in India is well established from legal, judicial and administrative point of view and keeps pace with the international developments in IPR. It has been found that the Indian states are becoming aware of the importance of protecting and disseminating their knowledge through patents. Going ahead, the Government of India must take more active measures to create a conducive environment for the protection of Intellectual Property Rights by bringing about policy as well as legislative changes.

Chapter 5

Review of Literature

There is a rich literature related to research in university industry linkages in India and at international level. Therefore, before formulating objectives for the proposed project, several studies have been reviewed to gain in-depth information about the present scenario of university industry linkage in research. The chapter provides a brief contour of the studies, which is expected to help formulate an idea of trend in university industry linkages, their implications and causes, among others. Thereby, the chapter begins with the description of the studies reviewed followed by an analysis of these studies. Further, a detailed justification and reasoning of how the study undertaken will contribute to the existing studies has been provided.

5.1 The study undertaken by Hung and Chen (2016)[46] utilises a two-stage approach, including secondary data analysis and the Decision-Making Trial and Evaluation Laboratory, to identify and explore the interrelationships of determinants for the performance of the university–industry research collaboration (UIRC) **at the National TsingHua University, one of Taiwan's elite universities.** The study investigates how university –industry collaboration factors influence the academic innovation and performance of universities. The factors include implementing a formal UIC management mechanism, implementing UIC regulations and supporting an innovative climate. As a part of the results from the investigation, it was seen that UIC-subsidized universities have more advantages for developing their UIC environment and improving academic innovation performance. The study observed that a formal UIC management mechanism might be the most essential factor for enhancing the academic innovation performance of non-UIC-subsidized universities. The innovation climate was found to moderate the relationship between formal UIC management mechanisms and academic innovation performance.

5.2 The paper undertaken by Chau, Gilam and Serbanica (2016)[47] aims to offer a holistic framework for the role of technology and knowledge transfer **in UK universities** operating as a 'boundary unit'. Currently, this interface between academics and external organizations is blurred, but it is indisputable that the performance of these units has a role to play in the overall performance of the university and the external society in which it serves. The study aimed at mapping traditional 'players' in interactions between university and industry to advance a conceptual framework that links them all and offers grounds for organizational alignment. Utilizing 'alignment'[48] brings many different concepts into play: coordination, integration, fit, synergy, fusion, congruence, etc. **The major observation of the study was that "neither the Government & knowledge users, nor academics can be blamed for difficulties in university- industry interactions; and looking to identify 'guilty' persons does**

[46]Mei-Chih Hu, Shih-Chang Hung, Hsien-Chen Lo , Yung-Ching Tseng, February 2016, Determinants of university–industry research collaborations in Taiwan: The case of the National TsingHua University .

[47]Chau, V.S., et al., Aligning university–industry interactions: The role of boundary spanning in intellectual capital transfer, Technol. Forecast. Soc. Change (2016).

[48]Aligning the strategy that comes from the value-proposition with funding units' criteria (especially with the HEIF) is perceived as the most important challenge by respondents in decision units.

not help". As the study reveals that there is still much room for coordination within universities and challenges exist for all traditional 'players'. The study has its own limitations namely the generalization purposes that carry the risks of over-simplification.

The study is thus exploratory, not descriptive, and its instrumental levers helped in capturing evidence from practice and in designing a framework that posits an understanding on the social dynamics of university intellectual capital.

5.3 The paper undertaken by Zavale and Macamo (2016)[49] addresses the stage of **university-industry linkages (UILs) in Sub-Saharan Africa**, from the perspective of universities. The paper examines the kind of knowledge universities transfer to industry, the knowledge channels used, the incentives and barriers faced, including influencing contextual conditions. The methodology followed in the study consist of two phases wherein the former consisted of collecting data from universities concerning their collaboration with companies and the latter attempted to minimize the sampling constraints and consisted of interviewing selected key informants , to obtain their perception on the stage of UILs in Mozambique, particularly knowledge transferred, channels used, incentives and barriers faced, including how the nature of their departments impacted the process. The three major implications drawn from the research findings were: **Firstly,** the need to acknowledge that UILs in low-income countries, like Mozambique, are shaped by structural and technological conditions: UILs are hardly knowledge-intensive, but based on embodied personal skills. **Secondly;** knowledge-intensive UILs, based on exchange of disembodied knowledge, are weak but possible in low-income countries, provided, favorable policies are adopted. **Thirdly**, to enable embodied and disembodied knowledge-based UILs, government intervention is essential through specific policies, structures and funding.

5.4 The paper undertaken by Saha (2015)[50] attempts to understand the university-industry interactions in **India** to capture issues of quality, objectives and incentives. It highlights that while India's emergence as a rising economic power is an outcome of dynamic advantages based on technological learning and skills, innovation driven competitiveness has been much less prominent. The study outlines that as far as Indian academia is concerned, there is extreme heterogeneity in terms of research quality. The probability of market success of a university technology is prima facie low because these technologies are allegedly short of significant technological value addition. The model undertaken by him in the study has indicated how various parameters like royalty fees and scientist's share of royalty and consultancy revenue from the university could be used to promote cutting edge research at universities. For technology commercialization inducing the university to spend more on research infrastructure is important and the scientists should choose complex and rigorous research problems and devote larger time to research.

[49] Nelson CasimiroZavale and ElísioMacamo, How and what knowledge do universities and academics transfer to industry in African low-income countries? Evidence from the stage of university-industry linkages in Mozambique , April 2016

[50] SabyasachiSaha, Promoting Innovations in Indian Universities: A Theoretical Model of University-Industry Interface, May 2015.

5.5 The study undertaken by Ankrah and AL-Tabbaa, (2015)[51] presents the results of a systematic review on University Industry Collaboration (UIC) for the period 1990-2014 in United Kingdom. The review and framework have not only provided a substantial contribution by creating a clear integrated analysis of the state of the literature, but also have indicated areas that require further investigation.
The study made the following observations:

- The evaluation of the outcome of technology translation, including the benefits and the success of the alliance, is normally based on judgment of the industry or universities actors who might have determined the outcomes by comparison of prior needs and expectations and a posteriori, actual or perceived satisfaction. It was also observed that the impact of academic engagement in the process of UIC is almost overlooked.

- It was evident in the review that there is a need to examine the extent to which the UIC can move from resources complementary approach to leverage the competitive advantages of the engaged companies. More research is needed to examine the role of government in UIC. There is a need to conduct comparative studies across different countries in relation to UIC.

- Finally, this study reveals that majority of the reviewed papers are actually cross-sectional studies. Therefore, there is a need for longitudinal line of research to provide additional insights into cause and effect dynamics and also help in assessing the 'value' of the full range of outcomes of these relationships in both short term and long term scales.

5.6 The paper undertaken by Ornella Wanda Maietta (2015)[52] examines the research and development collaboration between firms on the one hand and universities or public research labs on the other; with particular attention to the role such collaboration plays among the determinants of product and process innovation in the **Italian food and drink industry**. One of the major observations made in the study is that university–industry R&D collaboration affects process innovation. Evidence of a more novel kind suggests that product innovation is positively affected by geographical proximity to a university but is negatively affected by the amount of its codified knowledge production. Degree programmes in fields useful for local firms, favour R&D collaborations. Academic policies that aim to commercialize research output negatively impact both product and process innovations of local firms.

[51] Ankrah and AL-Tabbaa, (2015) , Social capital to facilitate 'engineered' university–industry collaboration for technology transfer: A dynamic perspective , November 2015
[52] Ornella Wanda Maietta, Determinants of R&D University-Firm Collaboration and Its Impact on Innovation: a Perspective from the Italian Food and Drink Industry, 2015

5.7 The study undertaken by Teller and Validova (2015)[53] investigated the perceptions of **Hungarian and Russians** in the context of university-industry Linkages to determine whether their common socialist background is reflected in their way of thinking. The study outlines the challenges and suggests solutions which could improve the efficiency of linkages between University and Industry. The study is comparative in nature, while the type of data collected and analyzed is cross-sectional to detect the variations between the countries. The study found that in both the countries, problems and suggested solutions are similar. The study reveals that most common barriers for university-industry collaborations in both the countries were the lack of shared vision and the growing influence of differing interests between the universities and industries collaborating. However, the preferred manager style, that is ought to handle these issues, differed between the two countries as the Russian respondents had a higher preference for transitional leadership style while Hungary preferred Transformational leadership style.

5.8 The paper undertaken by Kliebert (2015)[54], an analysis has been done to know the extent to which companies engage in linkages and collaborations with universities along with the response of the education sector to the new demands of the knowledge economy. The study pertains to understand the linkages of academia with industry in the growing business process outsourcing sector in the **Philippines**. The study reports that to access human resources needed for business processing operations of foreign investors, the investors engage in active embedding and localization strategy. They confine the industry-academia collaborations to lower-end skills for narrow job tasks. Industry-academia collaboration has not advanced to managerial or higher-end technical skills. Further, the study also reports that the current collaborations between industry and academia have not led to realization of national economic development goals and curriculum changes and may also be in contrast with those goals in the long run.

5.9 The paper undertaken by Ramli and Senin (2015)[55] in their research conducted **in Kuala Lampur, Malaysia** aims to determine the success factor to reduce orientation and resources-related barriers. The methodology of the study includes choosing eight leaders for interview, consisting of four academicians and four employees from Research University, private as well as government linked companies. All these eight respondents were chosen based on their collaborations which had received financial support from Ministry of Sciences and Technology and Innovation. The study revealed that majority of the researchers face orientation-related barriers in regard to limited time with academicians due to their traditional role and responsibilities, such as teaching, administrative tasks and attending seminars. Further, resources-related barriers are related to changes of research assistants, financial issues and unavailability of proper infrastructure. The study suggests that in order to reduce orientation-related barriers, universities must employ full time staffs, with a proper schedule to be developed from the early planning process. Further, the universities

[53] Rita Teller and Asiya F. Validova, Innovation Management in the Light of University-Industry Collaboration in Post-socialist Countries, July 2015

[54] Kleibert, J.M. (2015). Industry –academia linkages in the Philippines: Embedding foreign Investors, capturing institutions.

[55] MohamadFaizalRamli and AslanAmatSenin , Success Factors to Reduce Orientation and Resources-related Barriers in University-industry R&D Collaboration Particularly during Development Research Stages, January 2015.

must ensure representatives of all stakeholders during meetings and ensure that researchers are committed to the suggested planning. On the other hand, to reduce barriers related to resources, an expert should be appointed for the evaluation of the proposal. The stakeholders should spend their money on the project for which they have collaborated and support should be provided to the researchers by the universities. The companies must facilitate universities by using their money first, the academicians must train new assistants, and industries must provide facilities for university research.

5.10 The research paper conducted in the University of New South Wales, Sydney, Australia by Kornfeld and Kara (2015)[56] discusses the problem of dealing with sustainability at a global level and argues that a localized approach is also necessary. It explores how industry and academia can collaborate to achieve their common interests and develop sustainable manufacturing approaches. The paper is linked to the Tragedy of Commons- a situation in which independent actions guided by self-interest motives are contrary to overall and long-term interest of the many to the industry-university collaborations in sustainable manufacturing. The study finds that the academia wants to support industry but their work is left unfunded without industry investments. Therefore, it is imperative that governments aid and publicize collaborative sustainability research and development efforts so that the outcomes benefits present as well as future generations also.

5.11 The research paper undertaken by Nomakuchi and Takahashi (2015)[57] analyses the predicament of conflict of interest between the academic ventures and production in **Japan**. The study suggests some management measures that may be effective for resolution of conflicts such as common goal for academic and production should be sought; incentives should be given to both academics (internal incentives) and enterprises (external incentives). Further, in order to promote industry-university cooperation, it is necessary to design system incentives. Therefore, based on the principal-agency theory, the study takes incentives into consideration. Both the industry side and the university side are the agents and also the principals. Therefore, by taking actions giving priority to interests of the agent themselves, both industries and universities cause the agency to lag. Suitable incentives for each respective type of academia collaboration should be considered.

5.12 The study undertaken by Gandhi (2014)[58] discusses the importance of Industry Academia partnership and emphasizes that Collaboration between academia and industry had been rather restricted in India, in the past, possibly because of differences in values and attitudes, lack of appreciation of each other's abilities, skills, needs and the absence of economic compulsions. The paper elaborately discusses on the emerging trends in Industry and Academia Collaboration and efforts made and role being played by/on the part of all concerned. It further suggests various modes, modalities, methods of the Industry and Academia Interaction. One of the significant recommendations made in the paper is that

[56] Bernard J. Kornfelda , Sami Karaa, Industry-university collaboration in sustainable manufacturing, 2015.
[57] Takao Nomakuchi, Masakazu Takahashi , A Study about Project Management for Industry-UniversityCooperation Dilemma, Oct 2015
[58] MM. Gandhi, Industry-academia collaboration in India: Recent initiatives, issues, challenges, opportunities and strategies, August 2014

"**Institutions should set up special cells, which help liaise with industry".** The paper brings about the initiatives taken by institutions/ academia so far in strengthening relations between university and industry and brings about significant discussions around the implications of the initiatives made so far.

5.13 The research study undertaken by Yumusak, Ozcelik, Iskefiyeli, Adaka, KÕrktepeli[59], (2014) suggests that universities controlling or organizing the senior projects, project proposals, thesis and internship of students require an online system for their working. The study was undertaken in Sakarya University, Turkey. If some project brings university and industries together, it will be useful for the society. In such a case an online system would simplify the process and brings academics and industry together. In this study a web based application was created and there were 5 types of users in this system. In this application the industry has a project and if they require any employee for it, then they will add the project on the system and an academician would be a consultant for this project, wherein the students will be applying. Owners of the industry can provide their comments about the students employed by this system and can then further send it to the consultant. A case study[60] related to this management system was done in Computer Engineering department.

5.14 The study undertaken by Haller JA, (2014)[61] suggests that the scientific collaboration between academia and industry has a long history in the **United States and abroad**. Initially US companies used to provide patents and licensing discoveries for the collaboration with universities. More recently, universities have negotiated their own patent and licensing activities. The difficulty of scientists and physicians dealing directly with industry stimulated much public discussion in the past, with a result in decreasing collaboration. This evolution with models of possible productive collaboration and rules of engagement are discussed in the paper. The study emphasizes on the ethical pitfalls of scientists and physicians dealing directly with industry stimulated much public discussion in the past decade, with a resultant backlash discouraging collaboration.

5.15 The study undertaken by Sendogdu, Diken[62], (2013) assessed that industrial sector needs to collaborate with the universities in order to reach the information that will contribute towards its performance. The aim of this research was to investigate the level at which the university and industry collaboration exists in **Kenya Province,** the frequency of collaboration of subjects and the problems encountered during this collaboration. According to the research they conducted on 142 firms in Kenya, they found that collaborating degree is weak and concluded that the research performance of university academicians who

[59]Nejat Yumusak, Ibrahim Ozcelik, Murat Iskefiyeli, M. Fatih Adaka, Tunahan Krktepeli, University Industry linkage projects management system, 2014

[60]Motoyama, Y. (2014). Long-term collaboration between university and industry: A case study of nanotechnology development in Japan.Technology in Society, 36, 39-51.

[61]Haller, J. A. 2014. 'Strengthened Ties between Industry and Academia are Historical, Productive, and Crucial.' Survey of Ophthalmology.

[62]A research on the problems encountered in the collaboration between university and industry, Aslan Sendogdu and Ahmet Diken, 2013.

collaborate with private sectors has been more outstanding than the people who do not collaborate.

5.16 The research paper undertaken by MS Liew, TN Tengku Shahdan, ES Lim[63], (2012) provides a commercial approach which can be adopted by the **University of Management & Technology, Petaling Jaya, Selangor, Malaysia** in propagating the collaboration of both universities and industries. The message derived in this paper is that common best practices being maintained out in the industry maintain a strong sense of similarity between each other. The paper elaborates that strategic measures require long-term planning before initiating a University-industry collaborations (UIC) while tactical measures are seen as day-to-day practices that need to be upheld in order to maintain good working order of the project. Also, the paper highlighted that the case of conventional industrial relations should be well-adopted by universities themselves in order to succeed in UICs. However, applying these best practices may not be as easy in execution and therefore a strong project champion and an understanding working group is required to work in tandem with such values.

5.17 The study conducted by Motohashi and Muramatsu[64], (2012)is a quantitative analysis of **Japanese patent** information to examine the changes in the nature and the outcome of university–industry collaborations (UICs) following the enactment of UIC policies in the late 1990s. By considering UIC patents not only in joint university–industry patent applications but also in joint inventions organized by university personnel and corporate researchers, the status of UICs before the incorporation of national universities is discussed in this report. The analysis in this report indicates that these policies increased the number of UIC patents in the late 1990s, while the quality of UIC patents did not fall during this period. The study indicates that Japanese UIC policies in the late 1990's provided favorable results in general. However, strong IP policies pursued by universities may reduce the incentive for firms to commercialize inventions resulting from UIC collaborations, so that patent policies at universities should be re-examined.

5.18 The research paper undertaken by Muscio, Nardone[65], (2012) focuses on the linkages between **Universities and Food Industry in Europe** and has assessed the drivers of knowledge transfer from academic departments to industry. In the paper, they have analysed the dynamics of private funding of university research activities, investigated the drivers of university knowledge transfer from food science university departments and have identified how they differ from drivers in other areas of science. The empirical investigation is based on the econometric analysis[66] of financial data on the whole population of university departments in Italy. The paper has given some implications for policy,

[63]M. S. Liew, T.N. Tengku Shahdan , E.S.Lim, Strategic and Tactical Approaches on University - Industry Collaboration, 2012

[64] Kazuyuki Motohashi and Shingo Muramatsu, "Examining the university industry collaboration policy in Japan: Patent analysis", Technology in Society, Volume 34, Issue 2, pp.149-162, 2012/05

[65]Alessandro Muscio , Gianluca Nardone , The determinants of university–industry collaboration in food science in Italy, September 2012

[66]The econometric procedure provides empirical evidence on what determines the university department's capability to raise private funding.

highlighting whether and how university food science departments differ from university departments engaged in other areas of science, and how their interactions with industry can be increased.

5.19 The research paper undertaken by Purwaningrum, Evers, Yaniasih (2012)[67], focuses on whether clustering enhances performances of companies. The paper explored the various linkages of knowledge flow in the **Jababeka Industrial Cluster, Indonesia**. The research is based on semi- structured interviews and ethnographic fieldwork. The paper revealed that there are two types of linkages in the Jababeka cluster, first is the vertical hierarchical linkage cultivated by the Keiretsu between automaker and first tier suppliers and the second is the horizontal linkage between second tier and third tier industries. These linkages form clusters within clusters. However what was found was that, the horizontal linkage between academia and industry is limited and restricted. Further, the paper has augmented that in order to develop a strong knowledge based cluster in the Jababeka Industrial Estate, it will require strengthening of both the horizontal linkage between companies and the academia-industry interactions.

5.20 The research study undertaken by Freitas, Marques, Paula e Silva[68] (2012) assessed the role of university- industry collaboration for the development of innovation in emergent industries in the new industrialized countries. There are evidences from 24 research groups in the science and engineering departments of the universities where public research **organizations in Brazil** provide preliminary empirical confirmation for the proposal in that context. The role of university-industry collaboration in mature and emergent industries is diverse. Informal and professional networks of PROs[69] and industry researchers in emergent activities are underdeveloped as compared to the networks of mature industries. The national research system cannot promote the emergence and growth of technological capabilities, especially in high-technology industries. On one hand, focus on national policies targeting high-technology industries may be ineffective because, combined with the technological characteristics of these industries, policies may work to reinforce over-investment, excessive competition and sustained subnormal profits.

5.21 The research study undertaken by Siyanbola, Oladipo, Oyewale, Famurewa, Ogundari[70], (2012) examines the various types, nature and intensity of university-industry interactions in **Nigeria's pharmaceutical innovation system**. The sample size considered the eight top ranked universities with Pharmaceuticals as a course, 2 Pharmaceutical research institutes and 25 pharmaceuticals firms. The study revealed that Nigeria's pharmaceutical researchers are of high quality, with many of them providing PhDs. Research & Development activities are concentrated within the foreign-owned firms, with a focus on

[67] Farah Purwaningrum, Hans-Dieter Evers, Yaniasih, Knowledge Flow in the Academia-industry Collaboration or Supply Chain Linkage? Case Study of the Automotive Industries in the Jababeka Cluster, 2012

[68] Isabel Maria Bodas Freitas, Rosane Argou Marques, Evando Mirra de Paula e Silva, University–industry collaboration and innovation in emergent and mature industries in new industrialized countries, March 2013

[69] Public Research Organizations

[70] Academia-Industry Interactions in Nigeria Pharmaceutical Innovation System, W.O. Siyanbola, *O.G. Oladipo, A.A. Oyewale, A.J. Famurewa and I.O. Ogundari, 2012

diabetes, malaria, High Blood Pressure etc. University-Industrial interactions have been found to be severely limited. The firms acknowledged collaborations with researchers whereas no indigenous firm in Nigeria acknowledged the same. The industry reports were limited to collaboration with the researchers, it is only logical to conclude that Nigerian researchers collaborate with pharmaceutical firms outside Nigeria. It might also be logical to conclude that the direction of interaction is from the industry to the researchers. This is because only one firm acknowledged collaboration with researchers and from a strategic management viewpoint that firms are at a critical advantage being able to determine which researcher it will collaborate with.

5.22 The study undertaken by **Salleh, Omar (2012)**[71] a successful model has been proposed for university-industrial collaboration focusing on the interaction between university, industry and government in **Malaysia.** Their work highlights the relevance of university-industrial (higher education) collaboration council to enhance the collaboration and benefits for the graduates by promoting their skills to employers in the industries. **A review of various models has been conducted which focuses on collaboration management, formation of knowledge integration community and research collaboration activities between university and industry.** The findings in the study have identified the universities role and the factors to collaborate with the industries. Factors like researcher motivation, engagement mode, student training and facilities in universities were selected for universities to identify the opportunity to collaborate with the industries. Their study suggests that the function of the government is to facilitate successful collaboration between these two parties and that Government should also identify the strength of every university to collaborate with specific industries. University-industrial collaboration council must be established and the role of council would be to coordinate the collaborative effect between the three parties (government, industry and university). The study suggests that such interactions will bring huge opportunities and advantages between the parties including promoting skills of the graduate students to the employers in the industry. Universities should be proactive at strengthening their linkages with the industries. The MNCs, SMEs can help universities by providing internships to students, consultation and commercialization. Large companies should setup their research laboratories in the universities and provide funding for research activities. The university-industrial linkage will have a tremendous effect on successful collaboration between university, industry and government.

5.23 The study undertaken by Stefan Brehm & Nannan Lundin[72]**, (2012)** analyzed the contribution of universities to innovative performance **in China's manufacturing sector**. The empirical analysis is on the basis of matched data set comprising of about 20,000 large- and medium-sized companies aggregated at the three-digit industry level and information on university knowledge output for 31 provinces between 1998 and 2004. The study has revealed that the impact of universities on commercial innovation varies with the type of

[71] M.S.Salleh and M.Z. Omar, University-Industry Collaboration Models in Malaysia, 2012

[72] University–industry linkages and absorptive capacity: an empirical analysis of China's manufacturing industry, Brehm, Stefan and Lundin, Nannan, 2012.

activity performed and is contingent on the manufacturing sector's investment in absorptive capacity. Further, the results confirm organizational theory and mentioned that there is a complementary relationship between capabilities to acquire and assimilate external knowledge on one hand and the capacity to transform and exploit this knowledge on the other.

5.24 The study undertaken by Wen-Hsiang Lai,[73](2011), in the Feng Chia University, Graduate Institute of Management of Technology, Seatwen, Taichung, Taiwan analyses the willingness to engage in technology transfer (TT) in IUCs from the three vantage points of the technology transferor (university), the technology transferee (industry) and the TT intermediary institute. The study assesses the pair-wise relationships between influencing variables and sub-variables and willingness to participate in TT in an IUC. Further, the study highlights the results for the three vantage points wherein, from the point of university, the transferor's incentive and capability of transferor variables positively influence willingness to participate in TT in an IUC. Whereas the results for industry indicate that capability of transferee and incentive for establishing technological resources have major influences on willingness to participate in TT in an IUC. From the vantage point of TT intermediary institutes, the results show that intermediary's fundamental resources and intermediary's transferring process have a positive impact on willingness to participate in TT in an IUC.

5.25 The research paper undertaken by Bruneel, D'Este, Salter (2010)[74],looks at mechanisms that may mitigate the barriers to university industry collaboration and may help to set in place policies that will alleviate the problems before they undermine what might be rewarding sets of collaborations through which they found that the university-industrial links began to uncover the reasons for, and types of collaboration between universities and businesses. This paper highlights the obstacles faced by the collaborations between university and industry, exploring influence of different mechanisms in lowering barriers related to the orientation of universities and the transactions involved in working with universities at a **global level**. The paper explored the effects of collaboration, length of interaction and inter-organizational trust on lowering different types of barriers. The analysis showed that the breadth of interaction diminishes the orientation-related, but increases transaction-related barriers. The implications of these findings for policies were aimed at facilitating university -industry collaboration**.**

5.26 The study undertaken by Boo- Young Eom, Keun Lee,[75] (2010), utilizes **the Korea Innovation Survey data** to identify the determinants of industry-university and industry-government research institute (IUG) cooperation, and its impact on firm's performance. First, we find that among the determinants of IUG cooperation, traditional firm characteristic variables of size and R&D intensity are not significant, while participation in national R&D project turns out be most significant and robust in both cooperation modes. This is in contrast to the results from the cases in European countries and reflects the

[73] Willingness-to-engage in technology transfer in industry–university collaborations, Wen-Hsiang Lai, 2011

[74] Johan Bruneel, Pablo D'Este, Ammon Salter, Investigating the factors that diminish the barriers to university–industry collaboration, May 2010.

[75] Determinants of industry-academy linkages and, their impact on firm performance: The case of Korea as a latecomer in knowledge industrialization, Boo-Young Eom and Keun Lee, 2010

significance of government policies in promoting IUG cooperation in latecomer economies. Second, with regard to the impact of IUG cooperation, we conspicuously find no significant impact on the innovation probability of firms when we control the possible endogeneity in such a manner that the already innovative firms would participate more at such cooperation modes. This implies that the IUG cooperation cannot guarantee the success of a firm in technological innovation. Rather, it may have an influence on the selection or direction of the research projects of a firm. When we limited the analysis to innovative firms, we do find a positive impact of the IUG cooperation on patents generated from new product innovation but none in terms of volume of sales or labour productivity. These results seem to reflect the still transitional nature of the national innovation system (NIS) and knowledge industrialization in Korea.

5.27 The research paper undertaken by D'Costa (2006)[76] argues that Bangalore's (and India's) information technology (IT) industry is predicated on an Indian business model which does not encourage thick institutional linkages such as those encapsulated by the triple helix model. The study highlights major lessons that Developing countries can learn from Bangalore's experience. **First,** in a knowledge-driven economy technical education in emerging industries is critical. Both public and private parties can be involved and collaboration between the industry and public educational institutions is important. **Second,** Bangalore's high growth illustrates a cumulative outcome of history, changing business strategies and global (mainly US) demand. **Third,** rapid growth could lead to increased enrolments and lower quality of applied technical education and push some firms to upgrade their activities. **Fourth,** the retention and return of expatriate talent can assist in intensive growth.

5.28 The study undertaken by Basant and Chandra (2006)[77] explores the role played by academic institutions **in Bangalore and Pune and National Capital Region,** the paper develops a framework to analyze the role of academic institutions in a city cluster. It delineates the variety of linkages that an institution can potentially have in a cluster and how these linkages may change with different developments in cluster in the rest of the economy and in the world as a whole. The paper suggests that a framework to analyze the role of academic institutions in a city cluster. It delineates the variety of linkages that an institution can potentially have in a cluster and how these linkages may change with different developments in the cluster, in the rest of the economy and in the world as a whole. The paper observes that academia-industry linkages in India need to be analyzed in context to few larger processes.

[76] Anthony P. D'Costa, Exports, University-Industry Linkages, and Innovation Challenges in Bangalore, India , April 2006

[77] Basant and Chandra,Role of Educational and R&D Institutions in City Clusters: An Exploratory Study of Bangalore and Pune Regions in India, 2006

Table 18: Review of Literature (Brief Summary)

S.No.	Name of the Study	Author	Year	Country	Findings
1.	Determinants of university–industry research collaborations in Taiwan: The case of the National Tsing Hua University.	Mei-Chih Hu, Shih-Chang Hung, Hsien-Chen Lo , Yung-Ching Tseng	2016	Taiwan	The study observed that, subsidized universities have more advantages for developing their UIC environment and improving academic innovation performance.
2.	Aligning university–industry interactions: The role of boundary spanning in intellectual capital transfer, Technology, Forecast, Social, Change.	Chau, Gilam and Serbanica	2016	United Kingdom	A major finding of the study is that, neither the Government, knowledge users, nor academics can be blamed for difficulties in university- industry interactions: and looking to identify 'guilty' persons does not help.
3.	How and what knowledge do universities and academics transfer to industry in African low-income countries? Evidence from the stage of university-industry linkages in Mozambique	Nelson Casimiro Zavale and ElísioMacamo	2016	Mozambique	The study reveals that UILs in low-income countries, like Mozambique, are shaped by structural and technological conditions. Knowledge-intensive UILs, based on exchange of disembodied knowledge, are weak but possible in low-income countries, provided that favorable policies are adopted.
4.	Promoting Innovations in Indian Universities: A Theoretical Model of University-Industry Interface	Sabyasachi Saha	2015	India	The study outlines that as far as Indian academia is concerned, there is extreme heterogeneity in terms of research quality.

5.	Social capital to facilitate 'engineered' university–industry collaboration for technology transfer: A dynamic perspective	Ankrah and AL-Tabbaa	2015	United Kingdom	The study entails that more research is needed to examine the role of government in UIC.
6.	Determinants of R&D University-Firm Collaboration and Its Impact on Innovation: a Perspective from the Italian Food and Drink Industry	Ornella Wanda Maietta	2015	Italy	The study reveals that academic policies that aim to commercialize research output negatively impact both product and process innovations of local firms.
7.	Innovation Management in the Light of University-Industry Collaboration in Post-socialist Countries	Rita Teller and Asiya F. Validova	2015	Hungary and Russia	The study reveals that, the most common barriers for university-industry collaborations in both the countries were the lack of shared vision and the growing influence of differing interests between the universities and industries collaborating.
8.	Industry –academia linkages in the Philippines: Embedding foreign Investors, capturing institutions	Kleibert, J.M.	2015	Philippines	The study reports that to access human resources needed for business processing operations of foreign investors, they engage in active embedding and localization strategy. The industry-academia collaborations are confined to lower-end skills for narrow job tasks.
9.	Success Factors to Reduce Orientation and Resources-related Barriers in University-industry	MohamadFaizalRamli and AslanAmatSenin	2015	Malaysia	The study suggests that in order to reduce orientation-related barriers, universities must employ full time staffs,

	R&D Collaboration Particularly during Development Research Stages				with a proper schedule to be developed from the early planning process.
10.	Industry-university collaboration in sustainable manufacturing	Bernard J. Kornfelda, Sami Karaa	2015	Australia	The study entails, it is imperative that governments aids and publicize collaborative sustainability research and development efforts so that the outcomes benefit all and future generations also.
11.	A Study about Project Management for Industry-University Cooperation Dilemma	Takao Nomakuchi, Masakazu Takahashi	2015	Japan	The study reveals that by taking actions giving priority to interests of the agent themselves; both industries and universities cause the agency to lag. Both suitable incentives for each respective type of academia collaboration should be considered.
12.	Industry-academia collaboration in India: Recent initiatives, issues, challenges, opportunities and strategies	M.M. Gandhi	2014	India	The study suggests that Institutions should set up special cells, which help liaise with industry.
13.	University Industry linkage projects management system	Nejat Yumusak, Ibrahim Ozcelik, Murat Iskefiyeli, M. Fatih Adaka, Tunahan Krktepeli	2014	Turkey	The study suggests that, Universities controlling or organizing the senior projects, project proposals, thesis and internship of students requires an online system for their working.

14.	Strengthened Ties between Industry and Academia are Historical, Productive, and Crucial.' Survey of Ophthalmology	Haller J.A.	2014	United States	The study reveals that, the difficulty of scientists and physicians dealing directly with industry stimulated much public discussion in the past, with a result in decreasing collaboration.
15.	A research on the problems encountered in the collaboration between university and industry	Aslan Sendogdu and Ahmet Diken	2013	Kenya Province	The study observes that collaborating degree is weak and concluded that the research performance of university academicians who collaborate with private sectors has been more outstanding than the people who do not collaborate.
16.	Strategic and Tactical Approaches on University - Industry Collaboration	M. S. Liew, T.N. Tengku Shahdan , E.S.Lim,	2012	Malaysia	The study observes that, the case of conventional industrial relations should be well-adopted by universities themselves in order to succeed in University-industry collaborations.
17.	Examining the university industry collaboration policy in Japan: Patent analysis	Kazuyuki Motohashi and Shingo Muramatsu	2012	Japan	The study focuses that, Japanese UIC policies in the late 1990's provide favourable results in general. However, strong IP policies pursued by universities may reduce the incentive for firms to commercialize inventions resulting from UIC collaborations, so that patent policies at university should be re-examined.
18.	The determinants of university–industry collaboration in food science in Italy	Alessandro Muscio , Gianluca Nardone	2012	Italy	The study gives implications for policy, by highlighting whether and how university food science departments

					differ from university departments engaged in other areas of science, and how their interactions with industry can be increased.
19.	Knowledge Flow in the Academia-industry Collaboration or Supply Chain Linkage? Case Study of the Automotive Industries in the Jababeka Cluster	Farah Purwaningrum, Hans-Dieter Evers, Yaniasih	2012	Indonesia	The study reveals that the horizontal linkage between academia and industry is limited and restricted. Further, the paper has augmented that in order to develop a strong knowledge based cluster in the Jababeka Industrial Estate, it will require strengthening both the horizontal linkage between companies and the academia-industry interactions.
20.	University–industry collaboration and innovation in emergent and mature industries in new industrialized countries	Isabel Maria Bodas Freitas, Rosane Argou Marques, Evando Mirra de Paula e Silva	2012	Brazil	The study shows that, the roles of university-industry collaboration in mature and emergent industries are diverse. Informal and professional networks of PREOs[78] and industry researchers in emergent activities are underdeveloped as compared to the networks of mature industries.
21.	Academia-Industry Interactions in Nigeria Pharmaceutical Innovation System	Siyanbola, Oladipo, Oyewale, Famurewa, Ogundari	2012	Nigeria	The study reveals, that firms acknowledged collaborations with researchers, whereas no indigenous firm in Nigeria acknowledged the same. The industry reports were limited collaboration with the researchers, it is only

[78] Ibid

					logical to conclude that Nigerian researchers collaborate with pharmaceutical firms outside Nigeria.
22.	University-Industry Collaboration Models in Malaysia	M.S.Salleh and M.Z. Omar	2012	Malaysia	The study suggests that such interactions will bring huge opportunities and advantages between the parties including promoting skills of the graduate students to the employers in the industry. Universities should be proactive in strengthening their linkages with the industries.
23.	University–industry linkages and absorptive capacity: an empirical analysis of China's manufacturing industry	Brehm, Stefan and Lundin, Nannan	2012	China	The study highlights the impact of universities on commercial innovation varies with the type of activity performed and is contingent on the manufacturing sector's investment in absorptive capacity.
24.	Willingness-to-engage in technology transfer in industry–university collaborations	Wen-Hsiang Lai	2011	Taiwan	The study highlights the results for the three vantage points wherein, from the point of university, the transferor's incentive and capability of transferor variables positively influence willingness to participate in TT in an IUC. Whereas the results for industry indicate that capability of transferee and incentive for establishing technological resources have major influences on willingness to participate in TT in an

					IUC.
25.	Investigating the factors that diminish the barriers to university–industry collaboration	Johan Bruneel, Pablo D'Este, Ammon Salter	2010	Global	The study reveals the obstacles faced by the collaborations between university and industry, exploring influence of different mechanisms in lowering barriers related to the orientation of universities and the transactions involved in working with universities at a global level.
26.	Determinants of industry-academy linkages and, their impact on firm performance: The case of Korea as a latecomer in knowledge industrialization	Boo-Young Eom and Keun Lee	2010	Korea	The study shows results from the cases in European countries and reflects the significance of government policies in promoting IUG cooperation in latecomer economies. Second, with regard to the impact of IUG cooperation, we conspicuously find no significant impact on the innovation probability of firms when we control the possible endogeneity, such that already innovative firms would participate more at such cooperation modes.
27.	Exports, University-Industry Linkages, and Innovation Challenges in Bangalore, India	Anthony P. D'Costa	2006	Bangalore, India	The study shows that In a knowledge-driven economy technical education in emerging industries is critical. Both public and private parties can be involved and collaboration between the industry and public educational institutions is important.

28.	Role of Educational and R&D Institutions in City Clusters: An Exploratory Study of Bangalore and Pune Regions in India	Basant and Chandra	2006	Bangalore and Pune and National Capital Region	The study delineates the variety of linkages that an institution can potentially have in a cluster and how these linkages may change with different developments in the cluster, in the rest of the economy and in the world as a whole.

Source: PHD Research Bureau, complied from the review of literature

In a nutshell, UILs are found important across the countries. Various studies across the countries have analyzed the UILs and dynamics of collaborations. Most of the studies have focused to check the existing UILs in their respective areas such as innovative performance, academic policies etc. Various studies have concluded that research performance of universities which collaborate with private sector has been more outstanding thus promoting the skills of graduate students and employers in the industry than the universities which do not collaborate. Some of the studies reveal a negative impact of UILs on innovations of local firms which can be due to lack of shared vision and growing influence of differing interests between University Industry collaboration. However the approach of almost all the studies was to analyze the University-Industry linkage at the macroeconomic level of their respective economies whereas this study has been undertaken in the Indian context with the focus of the University-Industry linkage in the Indian states.

Chapter 6

Objectives of the Study & Research Methodology

The previous chapters entail that University-Industry linkages at the international level vary from country to country. The US has the strongest R&D policy in the world. On the other hand, the German national innovation system has a balanced structure, and is strongly influenced by decision-making in private companies and the governance of capital markets. China also has well-developed research linkages between universities and industries which is driven by government policy.

In terms of University-Industry Linkages (UILs) in India, the country is at a very nascent stage with constraints in research capacity, innovation and low enrolment in PhD programmes. Apart from this, there are few opportunities for interdisciplinary working, weak innovation ecosystem in academia, and low industry-university collaboration. This is primarily due to absence of any legislation to facilitate UILs in research. The Protection and Utilization of Public-Funded Intellectual Property (PUPFIP) Bill and Higher Education and Research Bill which was pending for a long time, has been withdrawn from the Parliament. It may be highlighted at this juncture that the share of India's Research and Development (R&D) investments in GDP has not been robust. Further, India's share in global R&D spending (as a percentage of GDP) has been reported at 0.63% in 2015 compared to 2.79% by United States, around 3.28% by Japan, 2.88% by Germany and 2.07% by China in the same period.

It may be mentioned that due to strong macroeconomic fundamentals coupled with effective policy measures of the government, India is expected to grow at a higher trajectory in the coming times. Therefore, it is essential to develop leadership in innovation, science and technology to compete in the global knowledge economy and contribute to India's growth story. Hence, it becomes imperative to develop strong UILs in the country to accelerate innovations in various spheres which will contribute to the growth of all sectors of the economy. Growth of research and development through successful collaboration between universities and industries more often leads to the development of new products/ solutions which promote economic growth in the long run.

6.1 Relevance of the Study

There is a rich literature related to university-industry linkages in research in various countries such as US, UK, Germany, Japan, China, Russia, Brazil & Malaysia among others. These studies have facilitated us to have an idea of trend in university industry linkages, their implications, barriers to UILs & causes, among others.

There are some studies on "strengthening university-industry linkages", conducted by International institutes such as 'Government mediated program on intensifying industry-academia linkages for human resource development; Experiences of an innovative model from TIFAC' (2010) conducted by Dr. Jancy Ayyaswamy, Dr. Neeraj Saxena (Scientist 'E',

TIFAC) & Dr. Antaryami Parida Technology Information, Forecasting & Assessment Council (TIFAC), 'University-Industry Interactions and innovations in India: Patterns, Determinants, and Effects in select Industries' (2009) by Dr. K. J. Joseph, Professor, Centre for Development Studies, Kerela and Dr. Vinoj Abraham, 'University Industry Links and Enterprise Creation in India-Some Strategic and Policy Issues' (2007) by Prof. Rakesh Basant and Prof. Pankaj Chandra, and 'Technology transfer, Intellectual Property and Effective University-Industry Parternerships: The Experience of China, India, Japan, Philippines, The Republic of Korea, Singapore and Thialand' (2005) conducted by Dr. Risaburo Nezu, Fujitsu Research Institute apart, among others.

The objectives of these studies were to explore the level of university-industry linkages. Inferences are made in generic terms at all India level; not state specific level. Data used are also up to 2007. However, with the onset of global financial crisis in 2008 and its contagion effect spread all over developed, emerging and developing economies, industry growth dynamics are also changing and the role of innovation has become a major growth driver. Going ahead, the competitiveness of the industry sector especially the manufacturing sector would be critical to the innovation explored by research and development activities.

At this backdrop, the objective of the present study is different from the previous available literature. Though at aggregate level, our focus in the study is on 10 growth oriented promising sectors of the Indian economy, the study pertains to explore the top 5 growth oriented industries of each and every state. These industries differ from state to state. The study focuses on state specific and industry specific inputs with regard to university-industry linkages.

The study pertains to conduct a comprehensive and exhaustive analysis with suggestions to explore the growth and competitiveness of the growth oriented and promising sectors not only at the aggregate level but also with state specific suggestions which will be useful to enhance the growth and competitiveness of our industry sectors to create synergies between industry and Academia to create more and more employment opportunities in the economy. The study pertains to provide pinpointed recommendations for each of the states by identifying the incubation centres, centres of excellence and industrial clusters and accordingly, the study aims at providing suggestions to strengthen the UILs in each of the state. Further, the study pertains to emphasize on the role of intermediaries and technology transfers in creating strong UILs.

6.2 Objectives of the Study

- To study the current state of university-industry linkages and to give suitable recommendations

6.2.1 Scope:

- To analyse the growing sectors of the Indian economy (top 10 sectors would be selected) with respect to capacity building, research and development activity and innovation
- To analyse UILs with respect to employment generation in the economy
- To analyse the issues and challenges to the university-industry linkages
- To assess and formulate various case studies with regard to university-industry linkages
- To study the international scenario (4 countries viz. USA, Germany, Japan and China) of university-industry linkages and to draw suggestions for India
- To draw conclusions on the above and suggestions for increased efficacy of university-industry linkages

6.3 Research Methodology

The study aims to analyse the UILs in 30 states of India on ten parameters to know the issues and challenges in collaboration with universities and industries and to provide suggestions for strengthening the UILs.

6.3.1 Data collection

Primary and secondary data sources have been taken into consideration. The primary data comprise of in-depth field survey of the universities and industries of all major sectors in all 30 states through structured questionnaires and discussions with the key representatives of the universities and Industries. Both qualitative and quantitative methods have been used. The secondary data has been used to identify the top five sectors in each state. Further, the international scenario and case studies of Indian firms and firms operating in other parts of the world have been undertaken. Inferences regarding university-industry linkages in the states have been analysed from inputs received from various universities and industrial firms.

Table 19: Mode of data collection

Primary Data	Secondary Data
Quantitative Aspect: Questionnaire was designed targeting companies, regarding company specific linkages in terms of availability of university in the vicinity, frequency in interaction, patents gained and frequency of interaction with students.	Statistics and trend analysis regarding national data and international data of UILs have been undertaken on the basis of various reports on Intellectual Property Rights in various countries, Patents filed in diverse fields, Success Stories of Collaborations, Models of Collaborations, among

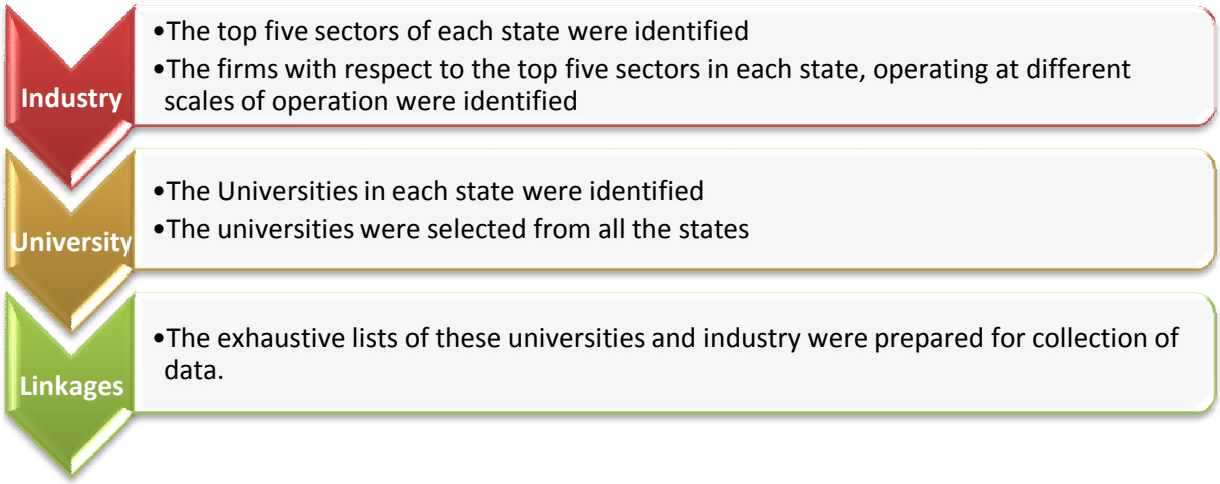

Similar questionnaire was prepared for university regarding university specific issues such as agreements/MoUs with industry, benefit of innovation to industry, internship record, queries dealt in a year among others.	others.
Qualitative Aspect: Face to face as well as telephonic interviews of universities and industries to better understand the scenario of UILs in India and their suggestions for improvement of the same in the coming times.	Gathering information for university-industry linkages in research at the international level; case studies of Indian and international UILs.

Source: PHD Research Bureau, PHD Chamber of Commerce & Industry

6.3.2 Data collection technique

The data collection has been done firstly by identifying the top five sectors of each of the states. The firms, operating at different scales were then identified with respect to the top five sectors in the state. The universities were also identified from each of the states. Finally, an exhaustive list of universities and industries was prepared for the collection of data.

Chart 4: Steps of Data Collection



Systematic sampling technique has been used in case of University's survey, while stratified random sampling technique has been used in case of industry's survey. In systematic sampling technique respondents were chosen on the basis of data available with PHD Chamber as well as the data available on public domain and lists were prepared. In stratified random sampling technique, respondents were chosen on the basis of top five sectors of states. As there was no information on top five sectors, so the sectors were identified and then a list of firms was prepared, after which the firms were chosen. Thus, disproportionate

stratified random sampling[79] was undertaken and the firms were chosen in each of the top 5 sector of each state. Thus, the strata of industry firms operating at different scales were formed on the basis of top five sectors and then the firms in each of those top sectors for which the survey was conducted were considered.

PHD Research Bureau has received in total 241 responses from Universities and 840 responses from industry. Hence, the responses received from them have been put together and inferences drawn based on the aggregation are represented in terms of averages and percentages. The field survey ensured the representation of all categories of universities and industries across all the states.

Table 20: Process of data collection

Questionnaire	Technique	Description	No. of respondents
University	Systematic Sampling[80]	The universities of each state were identified and an exhaustive list was prepared	241
Industry	Stratified Random sampling[81]	Responses were received from major cities of all states where the industry of the top five sectors of that particular state are prevalent	840

Definitions in our study

i. **University** includes all universities, colleges, research institutes as well as IITs, IIMs, IIS
ii. **Industry** includes large, medium, small as well as micro enterprises in diverse sectors

The number of firms surveyed from each of the state varied. Our process of data collection showed that the number of respondents from large states is higher as compared to small and medium states. From the large states, on an average, the responses were from around 34 firms while from medium size states, the responses received on an average were from around 26 firms. Around 19 firms on an average responded from the small states. The

[79] In disproportionate stratified random sampling, each strata may have different fraction

[80] It is used in those cases where a complete list of population from which the sample is to be drawn is available.
[81] In this technique, the division of a population into smaller groups known as strata is involved. In stratified random sampling, the strata are formed based on members' shared attributes or characteristics.

highest response has been from the states of Karnataka and Punjab while the lowest has been from the state of Mizoram. The number of firms surveyed in each state is as under-

Table 21: Number of firms surveyed in each state

S.No.	State	Number of firms surveyed
1	Andhra Pradesh	34
2	Arunachal Pradesh	21
3	Assam	22
4	Bihar	28
5	Chhattisgarh	35
6	Delhi	27
7	Goa	18
8	Gujarat	38
9	Haryana	32
10	Himachal Pradesh	30
11	Jammu & Kashmir	20
12	Jharkhand	26
13	Karnataka	39
14	Kerela	25
15	Madhya Pradesh	34
16	Maharashtra	35
17	Manipur	18
18	Meghalaya	17
19	Mizoram	16
20	Nagaland	17
21	Odisha	28
22	Punjab	39
23	Rajasthan	36
24	Sikkim	18
25	Tamil Nadu	34
26	Telangana	28
27	Tripura	18
28	Uttar Pradesh	33
29	Uttarakhand	36
30	West Bengal	38
Total		**840**

6.3.3 Few explanations about the chapters-

The chapters 1 to 6 of the report have been prepared on the basis of secondary analysis from various sources as mentioned in Table 19: Mode of Data Collection. Going ahead,

chapters 8 to 11 are based on primary survey of industries and universities conducted to know about their linkages. The methodology for each of the chapters is given as under-

6.4 Analysis of UILs in States

In Chapter 7 (Analysis of UILs in States), a structured questionnaire was framed with specific questions and expected answers with defined credits on the answers. (Questionnaires annexed in the report on page number 249)

a) **Selection of sectors and firms for the survey:** The top five sectors of each state were identified wherein atleast 25 firms with respect to the selected sectors in each state, operating at different scales of operation were considered.

b) **Identification of parameters for the analysis of University – Industry Linkage in the States:** The top 10 parameters considered for the analysis of University – Industry Linkage in the States are as follows:

1. **Availability of University(s):** This parameter pertains to assess the availability of University to facilitate the firms in their R&D activity in the state.
2. **Interaction with University(s):** This parameter pertains to assess whether firms have interacted with universities for their R&D activity or not.
3. **Continuity in University(s):** This parameter pertains to assess whether firms have interacted with University(s) to facilitate them in their R&D activity in the last 3 months or not.
4. **Frequency of interaction:** This parameter pertains to assess the number of times firms have interacted with University(s) to facilitate them in their R&D activity in the past one year.
5. **Support in providing quality solutions:** This parameter pertains to assess whether firms have received any solutions to their production processes from the University(s) in the last one year or not.
6. **MoUs/Collaboration/Agreement with University(s):** This parameter pertains to assess whether firms have signed any MOU or agreement for research with the University(s) or not.
7. **Patents gained in the past 5 years:** This parameter pertains to assess whether firms have gained any patent during the last 5 years with the help of University(s) or not.
8. **Continuity of research activities:** This parameter pertains to assess whether firms are conducting any ongoing research activity with University(s) for improvement in their production process/unit or not.


9. **Interaction with students:** This parameter pertains to assess whether firms are interacting with students from University(s) in their office/plants for internships or not.

10. **Frequency of interaction with students:** This parameter pertains to assess the number of internship opportunities given to students by the firms during the last one year in order to understand their frequency of interaction with students in terms of number of students selected for internship.

c) Calculation of scores of the firms: Equal weightage was given to each parameter for calculation of the scores of firms as only top 10 parameters which hold equal significance in analysis of University-Industry Linkage score were considered. The firms were scored on the scale of 10. Then parameter wise scores are enlisted below:

Table 22: Pattern of Scores

S.No	Parameter	Score			
1	Availability of University(s)	Yes : 1		No: 0	
2	Interaction with University(s)	Yes : 1		No: 0	
3	Continuity in University(s)	Yes : 1		No: 0	
4	Frequency of interaction with University(s) in past one year	Once: 0.25	2 times : 0.5	3 times : 0.75	4 times & above : 1
5	Support in providing quality solutions	Yes : 1		No: 0	
6	MoUs/Collaboration/Agreement with University(s)	Yes : 1		No: 0	
7	Patents gained in the past 5 years	Yes : 1		No: 0	
8	Continuity of research activities	Yes : 1		No: 0	
9	Interaction with students	Yes : 1		No: 0	
10	Frequency of interaction with students in past one year	One student : 0.25	2 students : 0.5	3 students : 0.75	4 & above: 1

Based on the scores of the firms of each sector, the UIL score of top 5 sectors in the state was calculated which was then averaged out to calculate the cumulative UIL score of the state on the scale of 10.

d) Ranking of states:

On the basis of scores, 30 states were ranked on the scale of 10 as follows:

- More than 7 (≥7) : Very strong linkage
- 5≤ UIL Score < 7 : Strong Linkage
- 3≤ UIL Score < 5: Moderate linkage
- Less than 3 (<3): Weak Linkage

The states with score more than 7 were categorized with very strong University-Industry Linkage, states with score between 5 to 7 were categorized with strong University-Industry


Linkage, states with score between 3 to 5 were categorized with moderate University-Industry Linkage and states with score less than 3 were categorized with weak University-Industry Linkage.

6.5 Research & Development in major sectors of Indian Economy

In Chapter 8 (Research & Development in major sectors of Indian Economy), to identify the top 10 sectors of the Indian economy, the top 5 sectors of each state have been identified on the basis of capacity building, research and development activity and innovation. These top 5 sectors of the states are then cumulated wherein the sectors of all the states have been compiled to arrive at 32 major sectors of the country. After this, a frequency analysis of the top 5 sectors of each state has been conducted. The sectors with the highest frequencies are then re-arranged to arrive at top 10 sectors of the country from the list of all 32 sectors. These top 10 sectors are the ones which have the highest frequency.

6.5.1 Identification of top 10 sectors of the Indian economy

To identify the top 10 sectors of the Indian economy, firstly, the top 5 sectors in each of the states were identified. This was done on the basis of secondary analysis. There are diverse sectors that are prevalent in different states of the Indian economy based on the state's inherent strengths, presence of natural resources and skill sets of the workforce in the state, among others. The top sectors in each of the states are elaborated as under-

Table 23: Identification of top 5 sectors in each state

S.No.	State	Top 5 Sectors in each State
1.	**Andhra Pradesh**	1.Agro and food processing
		2. Drugs and Pharmaceuticals
		3. IT and ITeS
		4. Textiles
		5. Leather
2.	**Arunachal Pradesh**	1. Power
		2.Tourism
		3.Textiles
		4. Minerals
		5. Agriculture and forest
3.	**Assam**	1. Tea
		2.Oil and gas
		3. Limestone and Cement
		4. Agro andFood Processing
		5. Sericulture

4.	**Bihar**	1. Textiles
		2. Oil and Gas
		3. IT and ITeS
		4. Tourism
		5. Agro and food processing
5.	**Chhattisgarh**	1. Mining
		2. Iron and Steel
		3. Cement
		4. Agro and Food Processing
		5. Herbal medical industry
6.	**Delhi**	1. Finance
		2. Agro and Food processing
		3. Real Estate
		4. IT and ITeS
		5. Tourism
7.	**Goa**	1. Tourism
		2. Agro and Food Processing
		3. Mining
		4. Drugs and Pharmaceuticals
		5. Fishing
8.	**Gujarat**	1. Agro and food processing
		2. Gems and Jewellery
		3. Chemicals and petrochemicals
		4. Textiles
		5. Engineering
9.	**Haryana**	1. Automotive and Auto Components
		2. IT and ITeS
		3. Agro and Food Processing
		4. Textiles
		5. Real Estate
10.	**Himachal Pradesh**	1. Drugs and Pharmaceuticals
		2. Agro and Food processing
		3. Hydropower
		4. Cement
		5. Tourism
11.	**Jammu & Kashmir**	1. Horticulture


		2. Floriculture
		3. Tourism
		4. Sericulture
		5. Handicrafts and Handlooms
12.	**Jharkhand**	1. Mining
		2. Engineering
		3. Fertilizers
		4. Cement
		5. Automotive and auto components
13.	**Karnataka**	1. IT and ITeS
		2.Biotechnology
		3. Engineering
		4. Automotive and Auto components
		5. Textiles
14.	**Kerala**	1.Rubber
		2. Spices and spice extracts
		3. Coir
		4. Seafood and other marine products
		5. Ayurveda
15.	**Madhya Pradesh**	1. Auto and Auto Components
		2. Textiles
		3. Cement
		4. Drugs and Pharmaceuticals
		5.Tourism
16.	**Maharashtra**	1. Finance
		2. Drugs and Pharmaceuticals
		3. Oil and Gas
		4. Automotive and Auto Components
		5. Textiles
17.	**Manipur**	1. Agro and Food Processing
		2. Handicrafts and Handlooms
		3. Tourism
		4. Minerals
		5. Sericulture
18.	**Meghalaya**	1. Horticulture
		2.Tourism

		3. Hydropower
		4. Sericulture
		5. Handicrafts and Handlooms
19.	**Mizoram**	1. Bamboo
		2.Energy
		3. Sericulture
		4. Agriculture and allied activities
		5.Fisheries
20.	**Nagaland**	1. Handicrafts and Handlooms
		2. Hydropower
		3.Apiculture
		4. Floriculture
		5. Bamboo
21.	**Odisha**	1.Tourism
		2. ITand ITeS
		3. Mining
		4. Iron and Steel
		5. Handicrafts and Handlooms
22.	**Punjab**	1.Agro and food Processing
		2. Textiles
		3. Sports Goods
		4. Agricultural and allied activities
		5. Automotive and Auto Components
23.	**Rajasthan**	1.Cement
		2. Gems and Jewellery
		3. ITand ITeS
		4. Textiles
		5. Tourism
24.	**Sikkim**	1. Floriculture
		2. Medicinal Plants
		3. Tea
		4. Drugs and Pharmaceuticals
		5. Hydropower
25.	**Tamil Nadu**	1. Textiles
		2. Automotive and auto components
		3. Engineering


		4. IT and ITeS
		5. Cement
26.	**Telangana**	1. IT and ITeS
		2. Drugs and Pharmaceuticals
		3. Tourism
		4. Minerals
		5. Textiles
27.	**Tripura**	1. Tea
		2. Agro and Food Processing
		3. Rubber
		4. Bamboo
		5. Handicrafts and Handlooms
28.	**Uttarakhand**	1. IT and ITeS
		2. Agro and Food Processing
		3. Tourism
		4. Engineering
		5. Hydropower
29.	**Uttar Pradesh**	1.Leather
		2. Agro and food Processing
		3. IT and ITeS
		4. Dairy
		5. Electronics
30.	**West Bengal**	1. Tea
		2. Chemical and Petrochemicals
		3. Biotechnology
		4. Iron and Steel
		5. Leather

Source: PHD Research Bureau, compiled from the study on Framework for University-Industry Linkages in Research

6.5.2 Total sectors covered across all the states along with their frequencies

On the basis of the analysis of the top 5 sectors of each state in different industrial areas, it has been found that there are 32 industrial areas vis-à-vis common areas in many of the states. Some of the sectors are prevalent in many states of the Indian economy. The major sectors of the Indian economy (on the basis of its frequency in states) are listed below-

Table 24: Major sectors of states of Indian economy

S.No.	Sector/Industry	States	Frequency
1	Tourism	Goa, Arunachal Pradesh, Himachal Pradesh, Jammu & Kashmir, Madhya Pradesh, Manipur, Meghalaya, Odisha, Rajasthan, Uttarakhand, Telangana, Bihar, Delhi	13
2	Textiles	Maharashtra, Arunachal Pradesh, Gujarat, Karnataka, Madhya Pradesh, Rajasthan, Telangana, Haryana, Bihar, Punjab, Tamil Nadu, Andhra Pradesh	12
3	Agriculture and allied activities*	Andhra Pradesh, Arunachal Pradesh, Kerala, Mizoram$, Nagaland, Sikkim, West Bengal, Assam, Tripura~, Punjab, Jharkhand	11
4	IT and ITeS	Tamil Nadu, Delhi, Uttar Pradesh, Uttarakhand , Haryana, Bihar, Telangana, Rajasthan, Odisha, Karnataka, Andhra Pradesh	11
5	Agro and Food processing	Andhra Pradesh, Gujarat, Himachal Pradesh, Bihar, Chhattisgarh, Goa, Punjab, Tripura, Uttar Pradesh, Delhi	10
6	Power^	Arunachal Pradesh, Meghalaya, Nagaland, Himachal Pradesh, Sikkim, Uttarakhand, Mizoram	7
7	Automotive and auto components	Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Haryana, Punjab, Tamil Nadu	7
8	Cement&	Himachal Pradesh, Jharkhand, Madhya Pradesh, Rajasthan, Chhattisgarh, Tamil Nadu, Assam	7
9	Drugs and Pharmaceuticals	Goa, Maharashtra, Himachal Pradesh, Madhya Pradesh, Sikkim, Telangana, Andhra Pradesh	7
10	Handicrafts and Handlooms	Jammu & Kashmir, Manipur, Meghalaya, Nagaland, Odisha, Tripura	6
11	Engineering	Tamil Nadu, Uttarakhand, Karnataka, Jharkhand, Gujarat	5
12	Sericulture	Assam, J&K, Manipur, Meghalaya, Mizoram	5
13	Mining	Jharkhand, Odisha, Chhattisgarh, Goa,	4
14	Floriculture	Sikkim, J&K, Nagaland	3
15	Iron and Steel	West Bengal, Odisha, Chhattisgarh	3
16	Leather and leather products	Andhra Pradesh, West Bengal, Uttar Pradesh	3
17	Minerals	Arunachal Pradesh, Manipur, Telangana	3

18	Oil and Gas	Bihar, Maharashtra, Assam	3
19	Ayurveda[#]	Kerala, Sikkim, Chhattisgarh	3
20	Biotechnology	West Bengal, Karnataka	2
21	Chemical and Petrochemicals	Gujarat, West Bengal	2
22	Finance[!]	Maharashtra, Delhi	2
23	Fisheries	Kerala, Goa	2
24	Gems and Jewellery	Gujarat, Rajasthan	2
25	Horticulture	J&K, Meghalaya	2
26	Real Estate	Delhi, Haryana	2
27	Apiculture	Nagaland	1
28	Electronics	Uttar Pradesh	1
29	Seafood and other marine products	Kerala	1
30	Spices and spice extracts	Kerala	1
31	Sports Goods	Punjab	1
32	Dairy	Uttar Pradesh	1

Source: PHD Research Bureau, compiled from the study on Framework of University-Industry Linkages in Research
Note: * Includes tea, bamboo, rubber, coir, fertilizers and forest based products, ^includes hydroelectric power, [&]includes limestone, [#]includes medicinal plants and herbal medical industry, [!]includes banking and financial services, [$]in the state of Mizoram, there is prevalence of Bamboo and agriculture is also a major sector, hence the two are counted separately and the frequency is 2 from Mizoram, ~In the state of Tripura, there is prevalence of Tea, Rubber and Bamboo which are also under agriculture but they are counted as three separate sectors, hence the frequency is 3 from Tripura.

6.5.3 Top 10 Sectors across all the states along with their frequencies

After the identification of the top 5 sectors in each state, these sectors are compiled and an analysis based on the frequency with which they occur have been calculated to arrive at top 10 sectors of the country.

Table 25: Top 10 sectors of the Indian Economy

1	Tourism	Goa, Arunachal Pradesh, Himachal Pradesh, Jammu & Kashmir, Madhya Pradesh, Manipur, Meghalaya, Odisha, Rajasthan, Uttarakhand, Telangana, Bihar, Delhi	13
2	Textiles	Maharashtra, Arunachal Pradesh, Gujarat, Karnataka, Madhya Pradesh, Rajasthan, Telangana, Haryana, Bihar, Punjab, Tamil Nadu, Andhra Pradesh	12
3	Agriculture and allied activities[*]	Andhra Pradesh, Arunachal Pradesh, Kerala, Mizoram[$], Nagaland, Sikkim, West Bengal, Assam, Tripura~, Punjab, Jharkhand	11
4	IT and ITeS	Tamil Nadu, Delhi, Uttar Pradesh, Uttarakhand, Haryana, Bihar, Telangana, Rajasthan, Odisha, Karnataka, Andhra Pradesh	11
5	Agro and Food processing	Andhra Pradesh, Gujarat, Himachal Pradesh, Bihar, Chhattisgarh, Goa, Punjab, Tripura, Uttar Pradesh, Delhi	10
6	Power^	Arunachal Pradesh, Meghalaya, Nagaland, Himachal Pradesh, Sikkim, Uttarakhand, Mizoram	7


7	Automotive and auto components	Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Haryana, Punjab, Tamil Nadu	7
8	Cement[&]	Himachal Pradesh, Jharkhand, Madhya Pradesh, Rajasthan, Chhattisgarh, Tamil Nadu, Assam	7
9	Drugs and Pharmaceuticals	Goa, Maharashtra, Himachal Pradesh, Madhya Pradesh, Sikkim, Telangana, Andhra Pradesh	7
10	Handicrafts and Handlooms	Jammu & Kashmir, Manipur, Meghalaya, Nagaland, Odisha, Tripura	6

Source: PHD Research Bureau, compiled from the study on Framework of University-Industry Linkages in Research, Note: * Includes tea, bamboo, rubber, coir, fertilizers and forest based products, ^includes hydroelectric power, [&]includes limestone.

6.6 Action Taken Plan to improve UILs in states

In Chapter 9 (Action Plan to improve UILs in states), after the analysis of top 5 sectors of each of the states and top 10 sectors of the Indian economy, the action plan for states has been suggested in order to strengthen UILs in states which would lead to strengthening of university-industry linkages at the all-India level. Thus, to give the pinpointed suggestions for states, an analysis of incubation centres, centres of excellence and industrial clusters were undertaken. To conduct the analysis and provide suggestions, various industrial clusters in the states were identified and were mapped with the centres of excellence, research centres in the state with respect to those industrial clusters. An attempt has been made to find out the gaps in the industrial clusters and availability of centres of excellence in the same state. Accordingly, various suggestions for the state have been provided which will help strengthen the university-industry linkages in research in the respective state in the coming times.

6.7 Employment Generation and UILs

In Chapter 10 (Employment Generation and UILs), primary data has been taken into consideration to perform the analysis of various indicators on the level of placement in a university in Indian states. To test the efficacy of UILs in generating employment in the country, the following data variables were used-

- **Industry consultation in setting up of pedagogy**
- **Working on gaining patents**
- **Regular interaction with industry**
- **Student's Internship**
- **Providing specific solutions to the industry**
- **Links with industry**


These variables were used to estimate a multiple regression model in which placement level has been treated the dependent variable.

$$Y = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6$$

Where,

Y = Placement
X_1 = Industry consultation in setting up of pedagogy
X_2 = Working on gaining patents
X_3 = Regular interactions with industry
X_4 = Student's Internship
X_5 = Providing specific solutions to industry
X_6 = Links with industry
β_o = Constant or intercept
β_1 = Slope (Beta coefficient) for X_1
β_2 = Slope (Beta coefficient) for X_2
β_3 = Slope (Beta coefficient) for X_3
β_4 = Slope (Beta coefficient) for X_4
β_5 = Slope (Beta coefficient) for X_5
β_6 = Slope (Beta coefficient) for X_6

6.8 Limitations of the Study

- The study is based on industry perception on few observations as the total observations are 840 out of about 2,33,116 industries.
- The UILs are only on the basis of top 5 sectors of the states but the UILs can be in other sectors which are not in top 5 sectors considered in the study.
- The universities' definition is too broad apart from central and state level universities as it includes management and engineering institutes also.

6.9 Scope of the study

The study will serve as a beginning tool for promoting university-industry linkages in research to accelerate R&D in the economy. The study suggests measures to promote UILs at the aggregate level and also at state level in terms of pinpointed suggestions for their consideration to strengthen UILs in their respective states.

Chapter 7

Analysis of University - Industry Linkages in States

In the previous chapters, it has been observed that University – Industry Linkages are useful for the growth of the industrial environment and to enhance the level of R&D activity in the economy. Various economies have adopted one or the other model of University – Industry Linkages. However, India is at a very nascent and moderate stage when it comes to University-Industry Linkages. The University – Industry Linkages are observed moderate for the innovation and generation of employment opportunities for the young population in India. Also, the level of University – Industry Linkages differs from State to State. Some States are good in University – Industry Linkages and others are found to have moderate or weak University – Industry Linkages. Therefore, the study attempts to assess the degree and strength of University – Industry Linkages across Indian States

A structured questionnaire was framed with specific questions and expected answers with defined credits on the answers. (Questionnaires are annexed). The top five sectors of each state were identified wherein the firms with respect to the selected sectors in each state, operating at different scales of operation were considered. Equal weightage was given to each parameter for calculation of the scores of firms as only top 10 parameters which hold equal significance in analysis of University-Industry Linkage score were considered. The firms were scored on the scale of 10.

The top 10 parameters for the analysis of University – Industry Linkage in the States are as follows:

1) **Availability of University(s)**
2) **Interaction with University(s)**
3) **Continuity in interaction**
4) **Frequency of interaction**
5) **Support in providing quality solutions**
6) **MoUs/Collaboration/Agreement with University**
7) **Patents gained in the past 5 years**
8) **Continuity of research activities**
9) **Interaction with students**
10) **Frequency of interaction with students**

The methodology for the ranking of the States out of 10 points is as follows:

- **More than 7 (≥7) : Very strong linkage**
- **5≤ UIL Score < 7 : Strong Linkage**
- **3≤ UIL Score < 5: Moderate linkage**
- **Less than 3 (<3): Weak Linkage**

The states with score more than 7 were categorized with very strong University-Industry Linkage, states with score between 5 to 7 were categorized with strong University-Industry Linkage, states with score between 3 to 5 were categorized with moderate University-Industry Linkage and states with score less than 3 were categorized with weak University-Industry Linkage.

Though University – Industry linkages with a score of 4.7 points out of a 10 are considered to be moderate in India but surprisingly lot of disparities have been observed among the States. On the basis of the analysis of States (based on above parameters), it has been observed that University – Industry Linkages are very strong in the States of Karnataka and Kerala with a score of 7.8 and 7.3 points out of 10 respectively. This is due to regular interaction of Universities with the industries for various research activities to facilitate them in conducting their R&D activities and for improvement in their production process/unit. Also, the industries in these states have collaborated with the various Universities through agreements and MoUs to provide them quality solutions for business purposes.

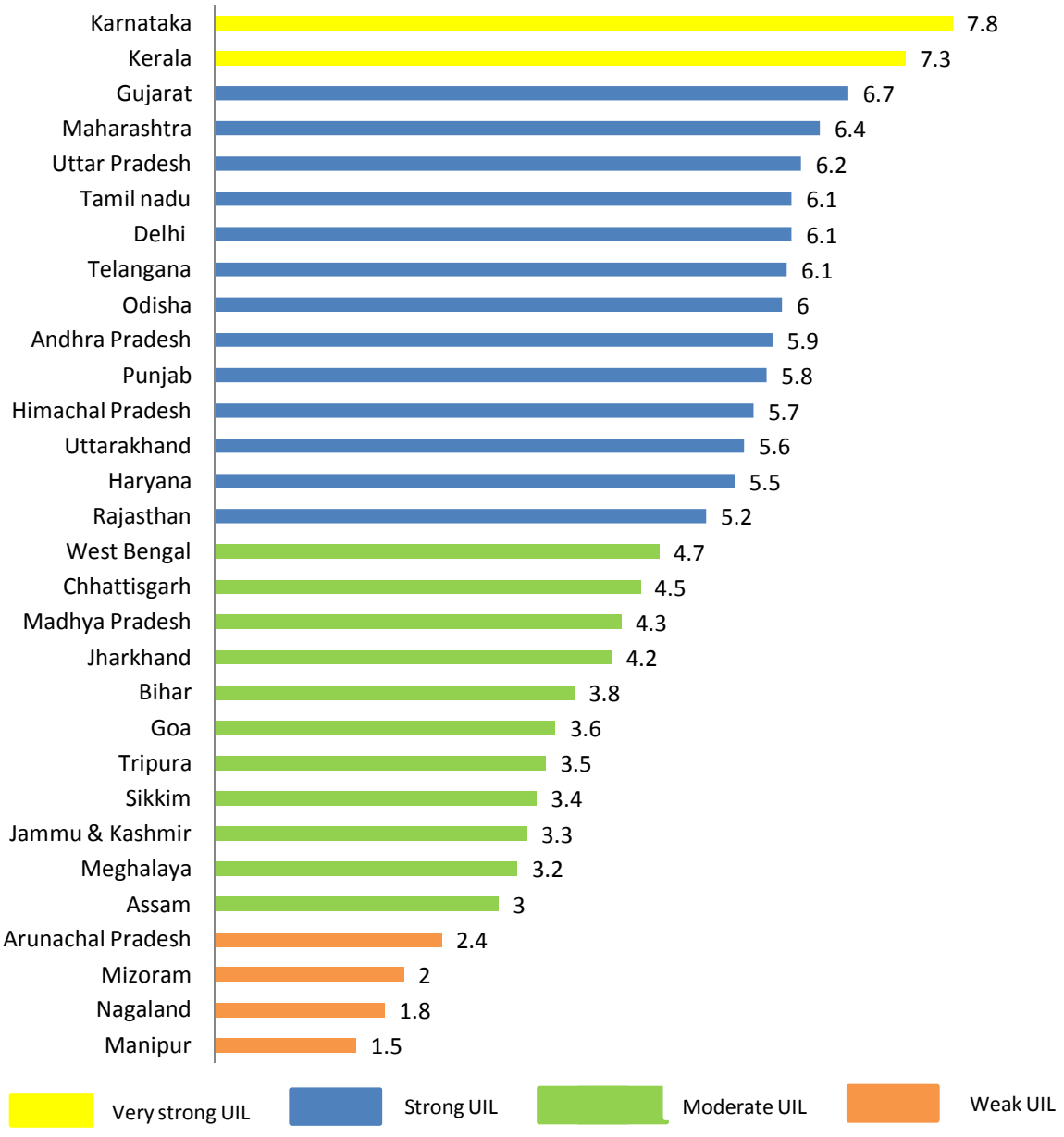
Strong University-Industry Linkages are observed in Gujarat (6.7), Maharashtra (6.4), Uttar Pradesh (6.2), Tamil Nadu (6.1), Delhi (6.1), Telangana (6.1), Odisha (6), Andhra Pradesh (5.9), Punjab (5.8), Himachal Pradesh (5.7), Uttarakhand (5.6), Haryana (5.5) and Rajasthan (5.2). The industries in these states hold regular interactions with the Universities for providing them support in conducting research. Also, the industries provide frequent internship opportunities to students in their firms for providing them industrial experience.

Moderate University-Industry Linkages are observed in West Bengal (4.7), Chhattisgarh (4.5), Madhya Pradesh (4.3), Jharkhand (4.2), Bihar (3.8), Goa (3.6), Tripura (3.5), Sikkim (3.4), Jammu & Kashmir (3.3), Meghalaya (3.2) and Assam (3). The industries in these states have interacted moderately with the universities depending upon their requirements for improvement in their production processes and R&D activities. Also, they have received quality solutions from Universities for their production process through various MoUs/Collaboration/Agreements.

Further, weak University – Industry Linkages are observed in the states of Arunachal Pradesh (2.4), Mizoram (2), Nagaland (1.8) and Manipur (1.5). This weak University-Industry Linkages in these states can be linked to very less number of research projects being conducted by Universities in collaboration with the Universities and fewer interactions between Universities and industries for improvement in their production process/unit

among others. The industries have signed very less number of MoUs/Collaboration/Agreement with Universities for projects and research with regards to their production processes. Further, these states face challenges in terms of less number of Universities to facilitate industries in their R&D activities which weakens their UIL scores.

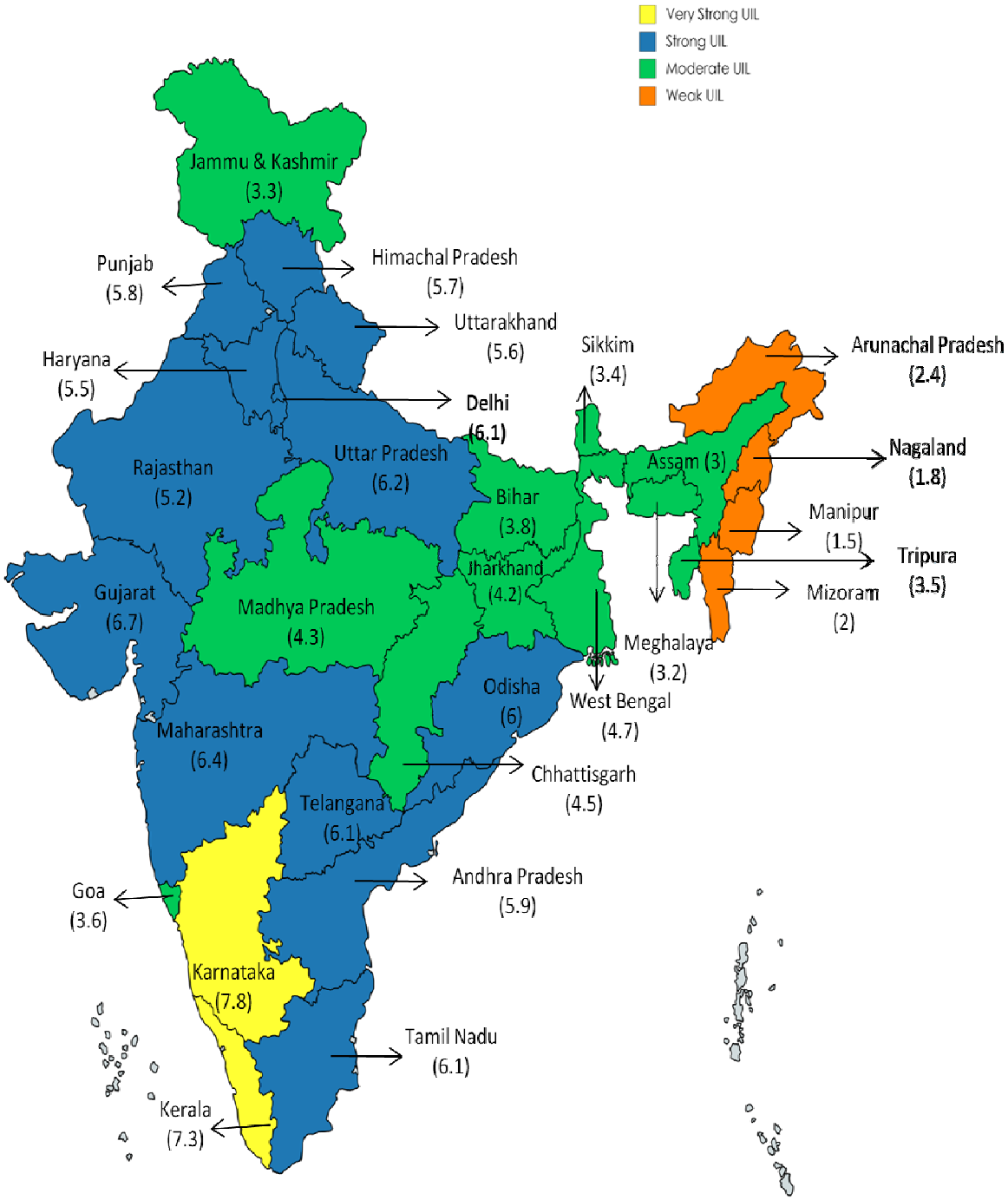
Graph 5: Ranking of the States with strong University –Industry Linkages



Source: PHD Research Bureau, compiled from the study on Framework for University-Industry Linkages in Research

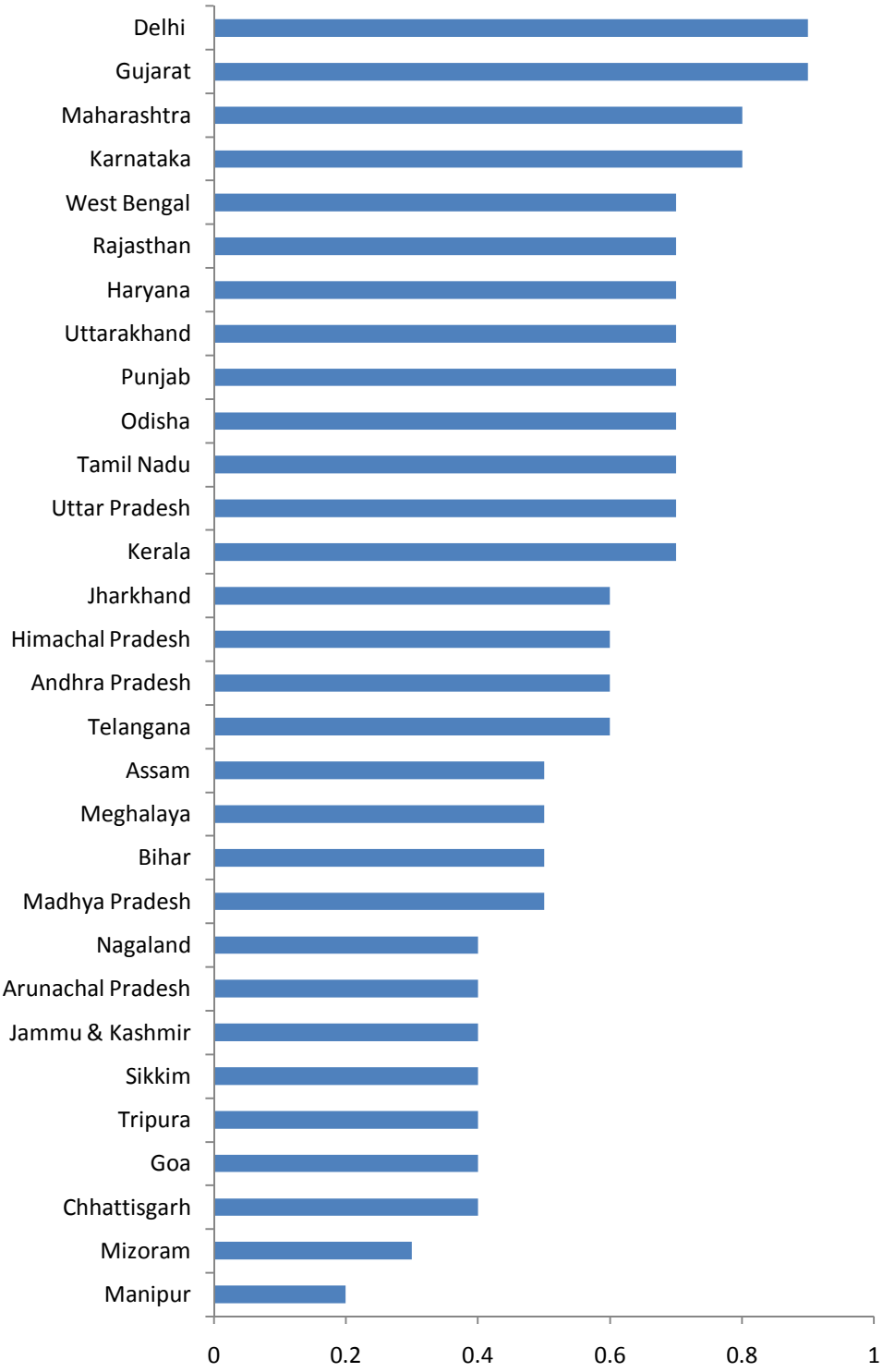
Note : The states are ranked in the decreasing order based on University-Industry Linkages score i.e from very strong to weak industry linkages. Ranking of Tamil Nadu, Delhi and Telangana have ranked 6th on the basis of average score, however, their actual score are: Tamil Nadu :6.1, Delhi: 6.06, Telangana: 6.05

Graph 6: Ranking of the States with strong University –Industry Linkages



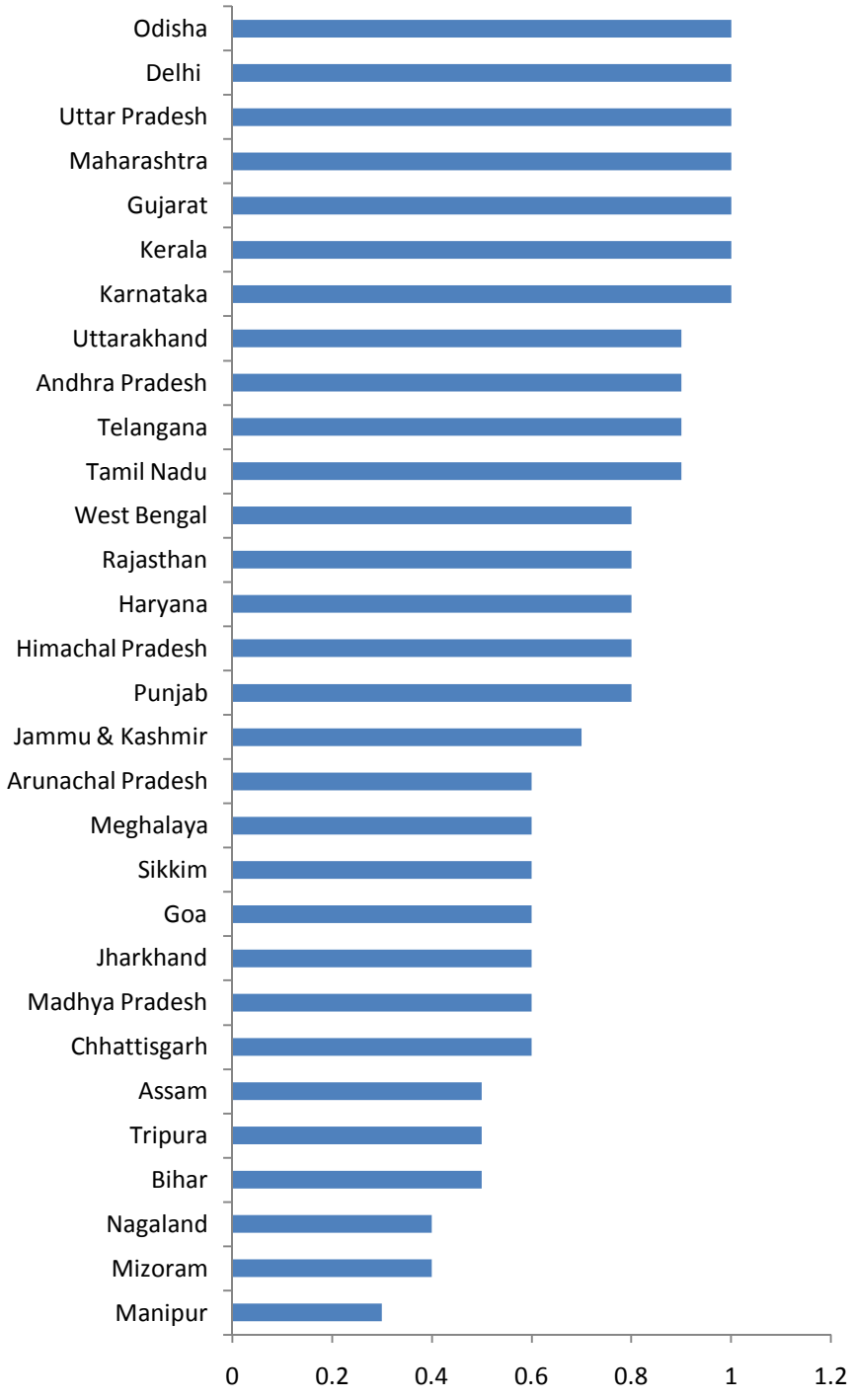
Source: PHD Research Bureau, compiled from the study on Framework for University-Industry Linkages in Research

Graph 7: UIL: Availability of University(s) for industries



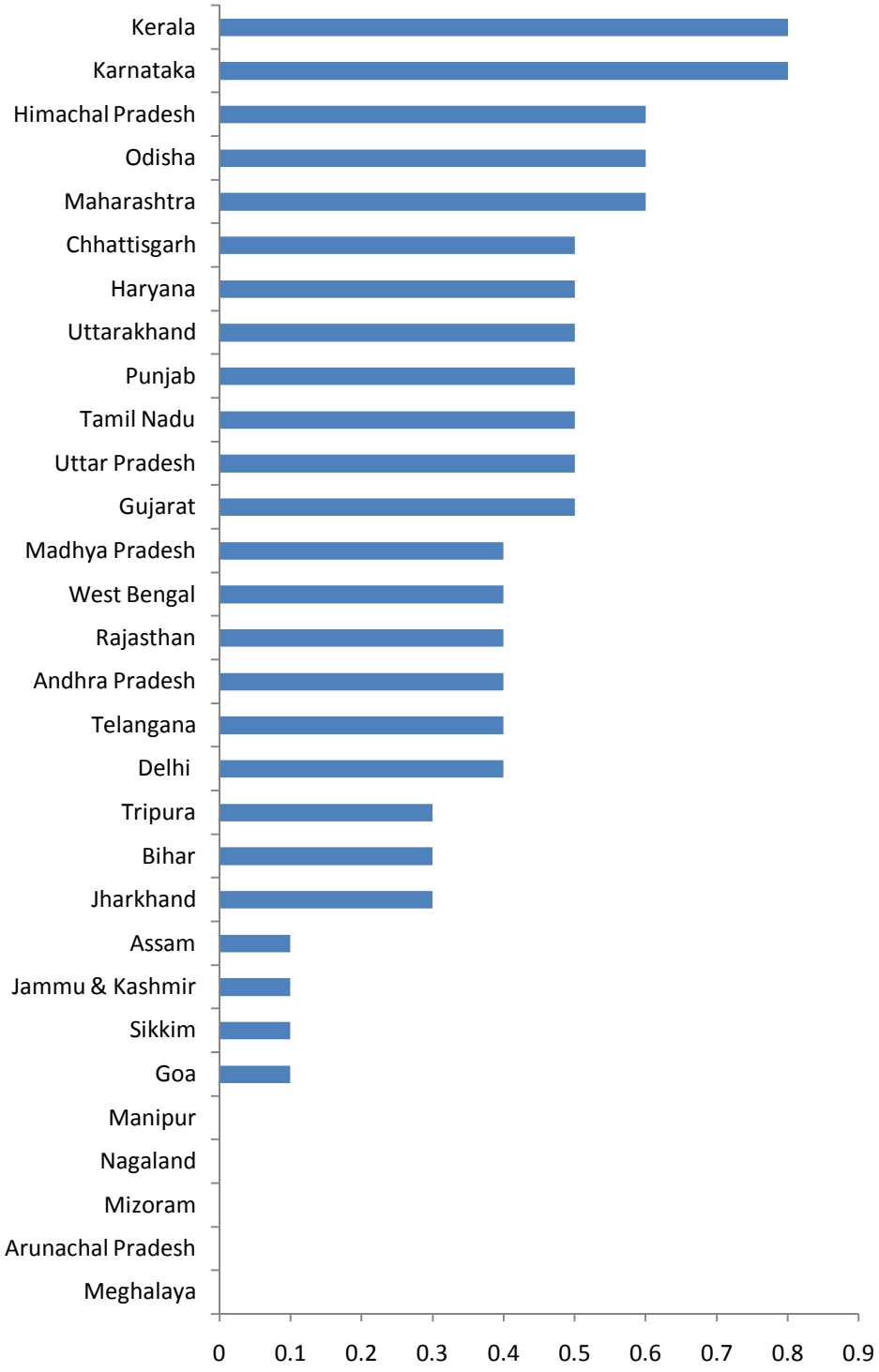
Source: PHD Research Bureau, compiled from the study on Framework for University-Industry Linkages in Research

Graph 8: UIL: Interaction of industries with University(s)



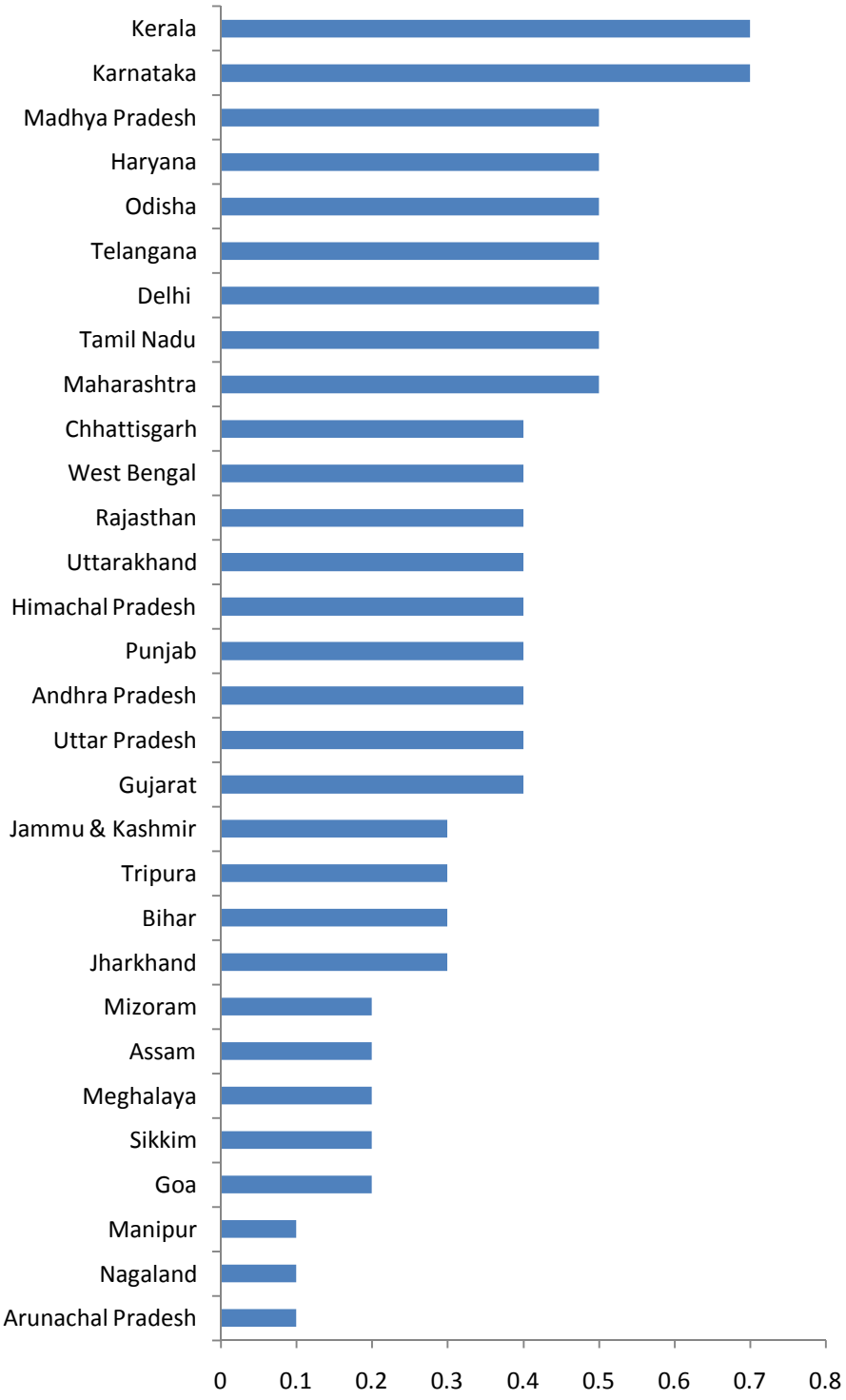
Source: PHD Research Bureau, compiled from the study on Framework for University-Industry Linkages in Research

Graph 9: UIL: Continuity in interaction



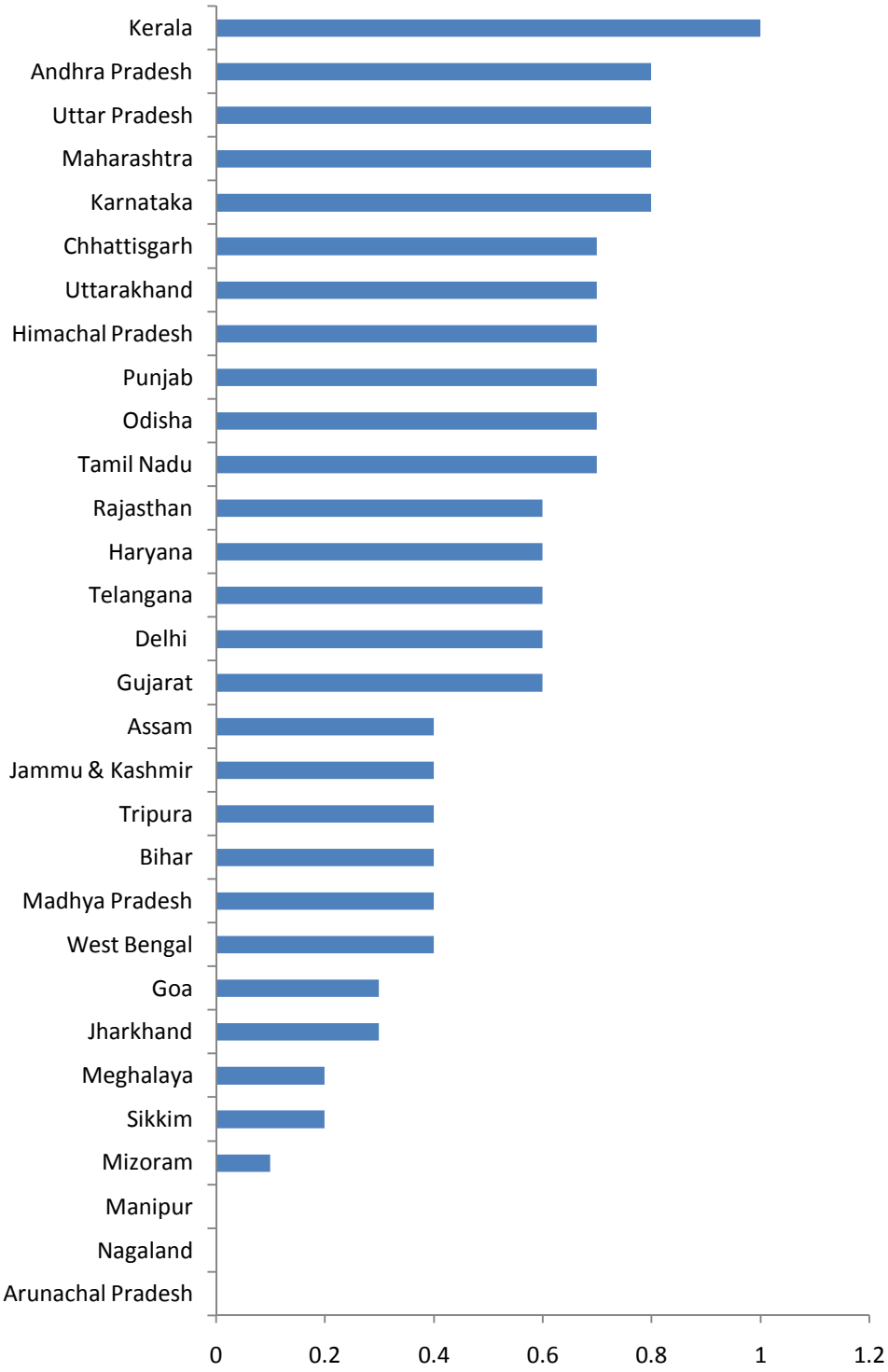
Source: PHD Research Bureau, compiled from the study on Framework for University-Industry Linkages in Research

Graph 10: UIL: Frequency of interaction with University(s)



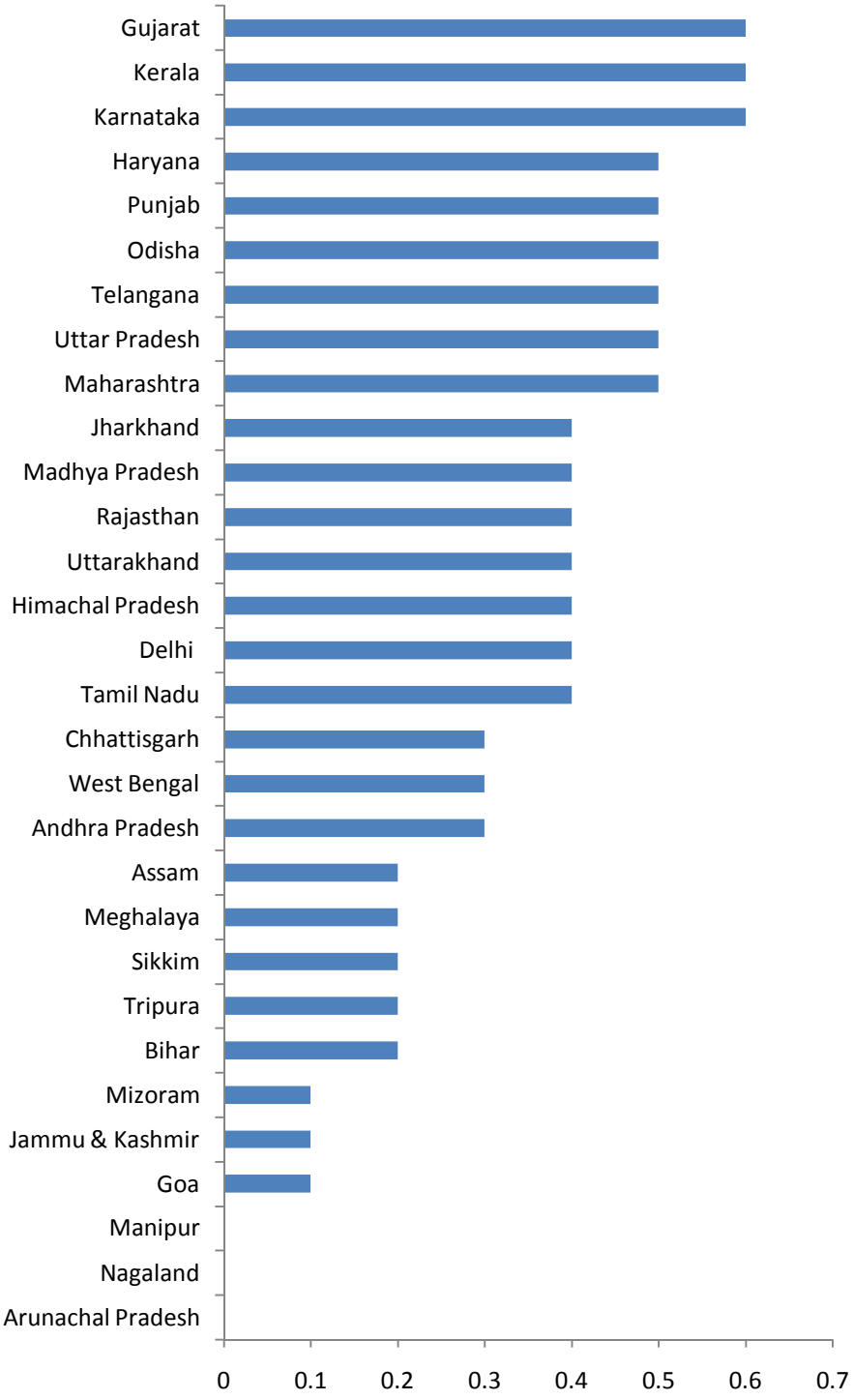
Source: PHD Research Bureau, compiled from the study on Framework for University-Industry Linkages in Research

Graph 11: UIL: Support in providing quality solutions to industries from University(s)



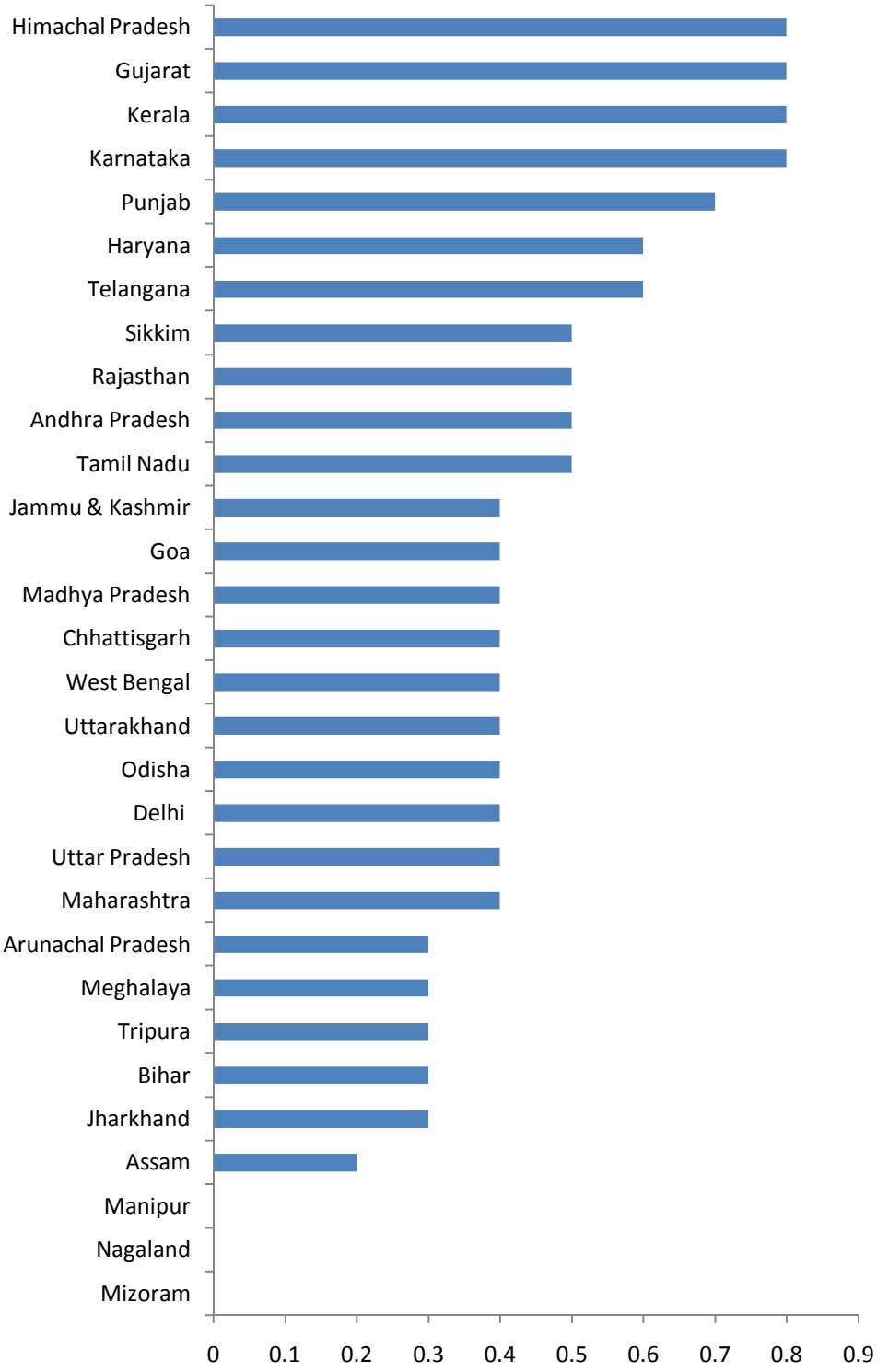
Source: PHD Research Bureau, compiled from the study on Framework for University-Industry Linkages in Research

Graph 12: UIL: MoUs/Collaboration/Agreement of industries with Universities



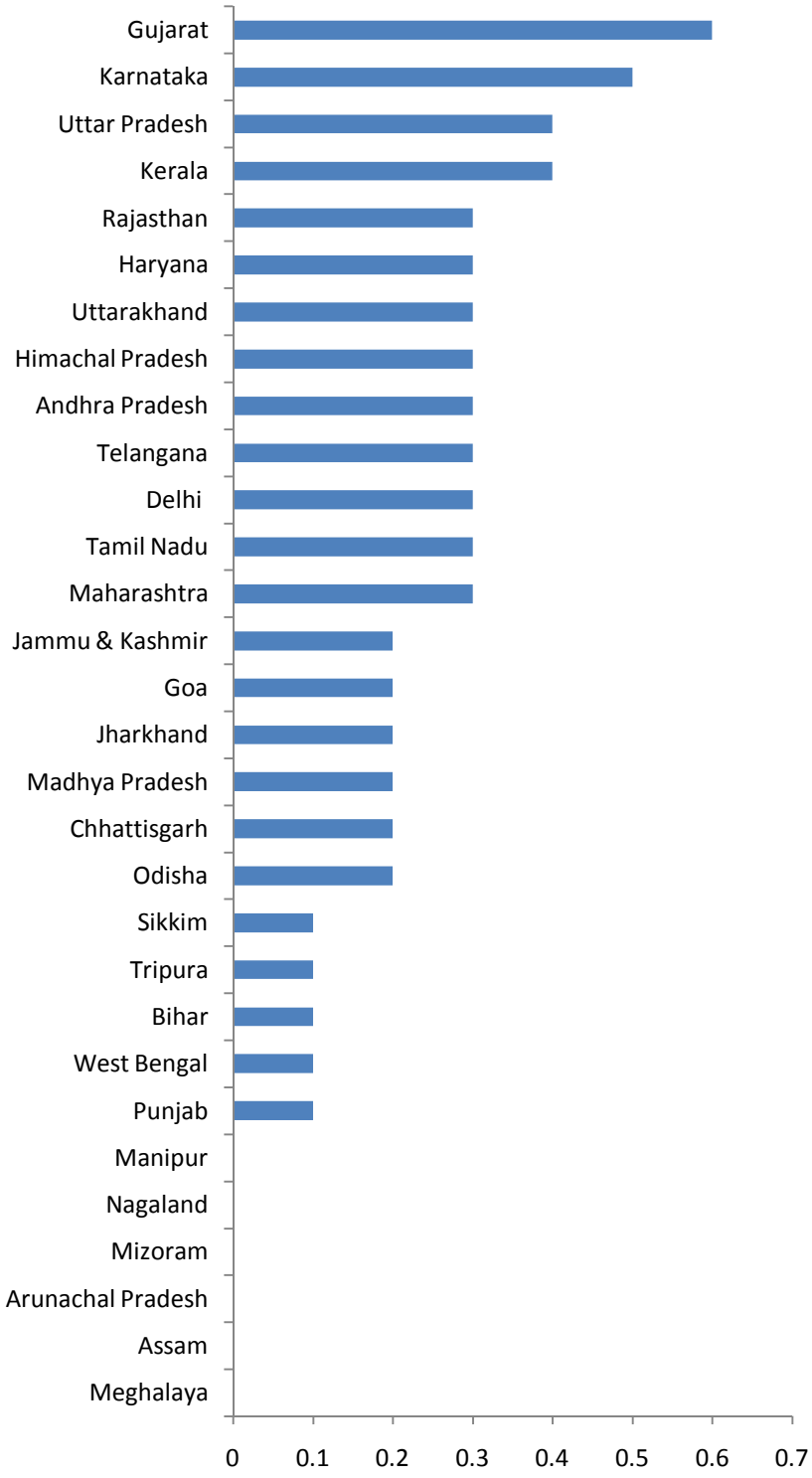
Source: PHD Research Bureau, compiled from the study on Framework for University-Industry Linkages in Research

Graph 13: UIL: Patents gained in the past 5 years



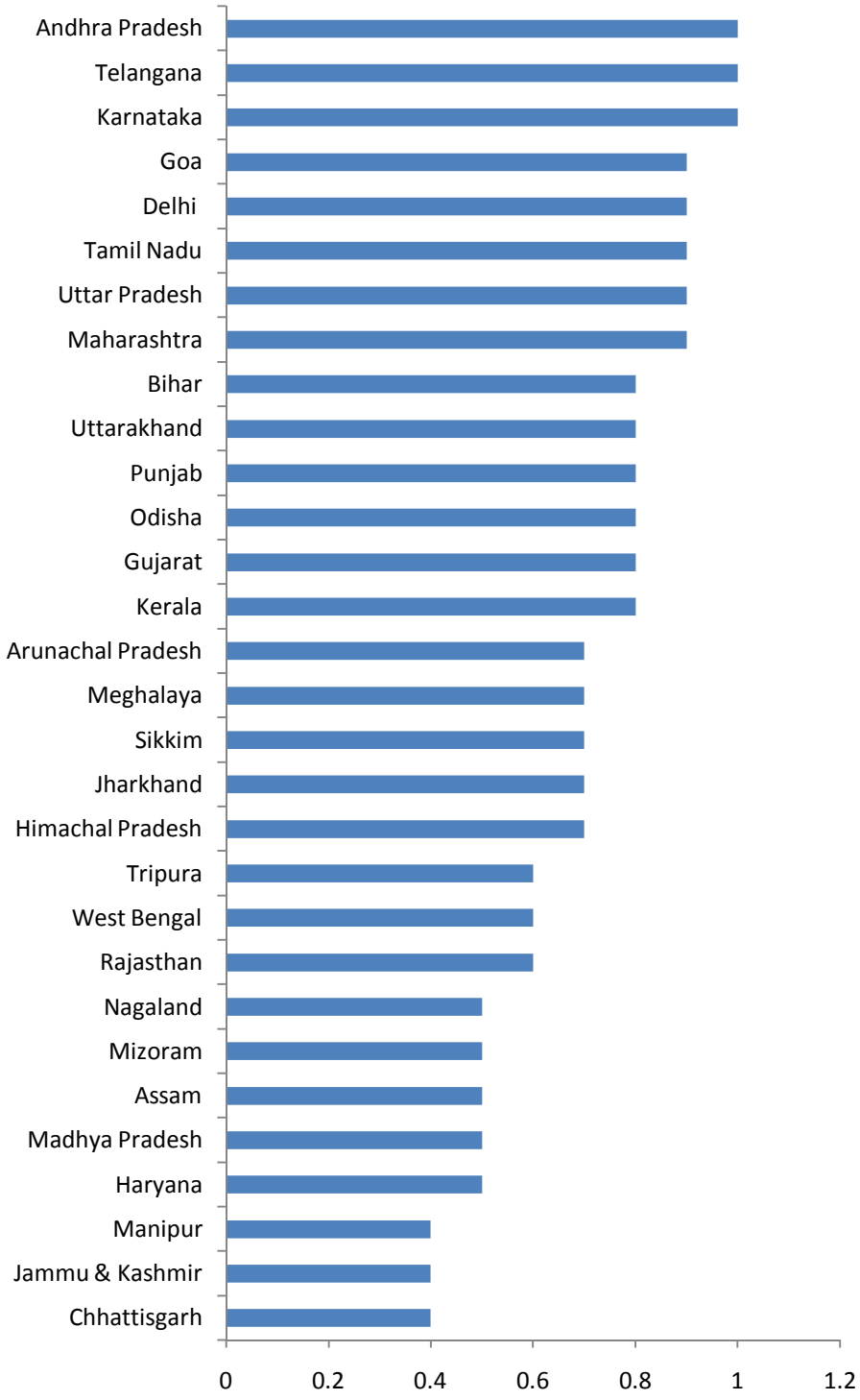
Source: PHD Research Bureau, compiled from the study on Framework for University-Industry Linkages in Research

Graph 14: UIL: Continuity of research activities with Universities



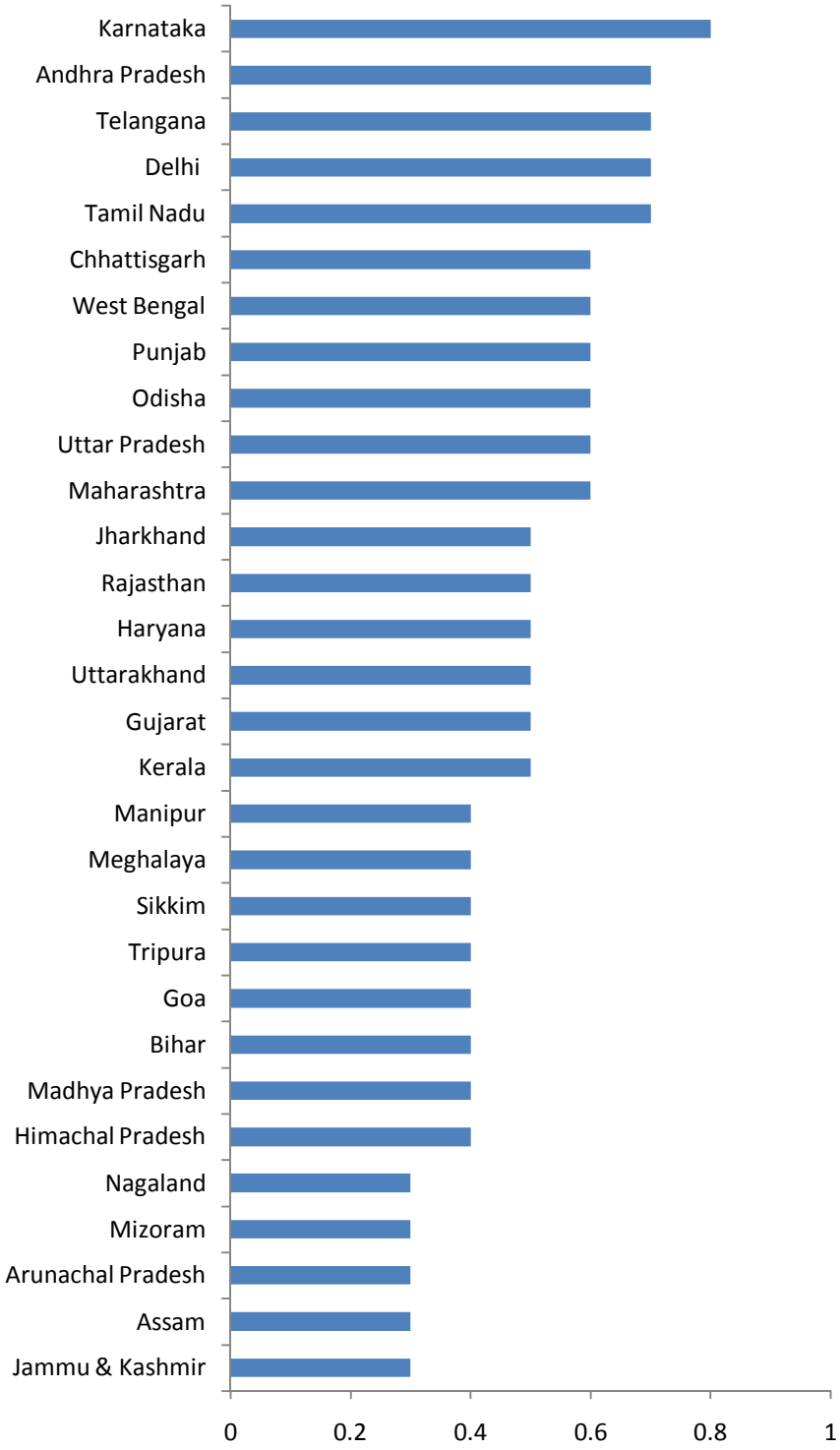
Source: PHD Research Bureau, compiled from the study on Framework for University-Industry Linkages in Research

Graph 15: UIL: Interaction of industries with students



Source: PHD Research Bureau, compiled from the study on Framework for University-Industry Linkages in Research

Graph 16: UIL: Frequency of interaction of industries with students



Source: PHD Research Bureau, compiled from the study on Framework for University-Industry Linkages in Research

7.1 Karnataka – UIL Rank 1st

Score in UIL: 7.8

The State of Karnataka is known as the IT hub of India and is home to the fourth largest technology cluster in the world. Also, the State is one of the leading producers of cotton, silk and wool in the country. According to the survey/analysis, the State has very strong University – Industry Linkages and has scored 7.8 points out of 10. All the major industries of the State including engineering, biotechnology, automotive and auto components, IT and IT-Enabled Services have very strong University – Industry Linkages followed by strong University – Industry Linkages in the textiles industries.

UIL Key findings

- **Availability of University(s) (0.8/1):** Industries have Universities to facilitate R&D activities. Biotechnology, engineering, automotive and auto components, IT and IT enabled services have maximum availability of Universities.
- **Interaction with University(s) (1/1):** Industries interact with the Universities for various purposes such as for research activities and business processes/modeling.
- **Continuity in interaction (0.8/1):** Industries hold quarterly interactions with the Universities for finding solutions with regards to their business processes.
- **Frequency of interaction (0.7/1):** Industries interact with the Universities once/twice/thrice in a year depending upon their requirement with the Universities.
- **Support in providing quality solutions (0.8/1):** Industries in the State have received quality solutions from Universities for their production process in the last one year.
- **MoUs/Collaboration/Agreement with University (0.6/1):** Industries sign MoU/agreement for research and specific projects with the University in the State. Maximum number of MoUs are signed by engineering and biotechnology industries followed by IT and IT enabled services, automotive and auto components and textile industries.
- **Patents gained in the past 5 years (0.8/1):** Industries have gained patents through collaboration with the Universities in the area of biotechnology during the last 5 years.
- **Continuity of research activities (0.5/1):** Biotechnology, Engineering, automotive and auto components, IT and IT enabled and textiles industries are involved in ongoing research activities being conducted by various Universities for improvement in their production process/unit.
- **Interaction with students (1/1):** Industries interact regularly with the students for providing them internship opportunities in their respective plants.
- **Frequency of interaction with students (0.8/1):** Business firms generally on an average give internship opportunities to three students in their firms in a year. IT and IT enabled services have provided maximum number of internship opportunities to

the students followed by engineering, biotechnology, automotive and auto components and textile industries.

7.2 Kerala – UIL Rank 2nd

Score in UIL: 7.3

The State of Kerala is one of the leading agricultural State and the largest producer of rubber, pepper, coconut and coir in the country. The State has a wide range of fiscal and policy incentives for businesses under the Industrial and Commercial Policy and has well-drafted sector-specific policies. According to the survey/ analysis, the State has very strong University – Industry Linkages with a score of 7.3 points out of 10. Rubber and ayurveda industries have very strong University – Industry Linkages followed by strong University – Industry Linkages in the seafood and other marine products, spice and spice extracts and coir industries in the state.

UIL Key findings

- **Availability of University(s) (0.7/1):** Industries have Universities to facilitate R&D activities. Rubber industries have maximum availability of Universities to facilitate R&D activities in the State.
- **Interaction with University(s) (1/1):** Rubber, ayurveda, seafood and other marine products, spice and spice extracts and coir industries interact with the Universities for various purposes such as research activities and business processes/modeling.
- **Continuity in interaction (0.8/1):** Industries hold quarterly interactions with the Universities for finding solutions with regards to their business processes.
- **Frequency of interaction (0.7/1):** Industries interact with the Universities once/twice/thrice in the year depending upon their requirements with the Universities.
- **Support in providing quality solutions (1/1):** Rubber, ayurveda, seafood and other marine products, spice and spice extracts and coir industries have received quality solutions from Universities for their production process in the last one year.
- **MoUs/Collaboration/Agreement with University (0.6/1):** Industries sign MoU/agreement for research and specific projects with the University in the State. Maximum number of MoUs are signed by rubber industry followed by ayurveda, spice and spice extracts, coir, seafood and other marine products industries.
- **Patents gained in the past 5 years (0.8/1):** Rubber, seafood and other marine products, ayurveda and spice and spice extracts and coir industries have gained patents during the last 5 years through collaboration with the Universities in the State.

- **Continuity of research activities (0.4/1):** Coir, rubber and ayurveda industries are involved in ongoing research activities being conducted by various Universities for improvement in their production process/unit.
- **Interaction with students (0.8/1):** Industries interact regularly with the students for providing them internship opportunities in their respective plants and units.
- **Frequency of interaction with students (0.5/1):** Business firms generally on an average give internship opportunities to two students in their firms in a year. Seafood and other marine products industry has provided maximum number of internship opportunities to the students followed by spice and spice extracts, coir, rubber and ayurveda industries.

7.3 Gujarat – UIL Rank 3rd

Score in UIL: 6.7

The State is the world's largest producer of processed diamonds and is considered to be the petroleum capital of India due to the presence of large refining capacity set up by private and public sector companies. According to the survey/ analysis, the State has scored 6.7 points out of 10 with strong University – Industry Linkages. Among the major industries, agro and food processing, engineering and textile industries hold very strong University – Industry Linkages followed by strong University – Industry Linkages in the chemicals and petrochemicals and gems and jewellery industries.

UIL Key findings

- **Availability of University(s) (0.9/1):** Industries have Universities to facilitate R&D activities. Agro and food processing, engineering, textiles, chemicals and petrochemicals and gems and jewellery industries have availability of Universities to facilitate R&D activities.
- **Interaction with University(s) (1/1):** Industries such as gems and jewellery, interact with the Universities for various purposes such as for business modeling in the State.
- **Continuity in interaction (0.5/1):** Agro and food processing, engineering and textiles industries hold interactions with the Universities for finding solutions for their business.
- **Frequency of interaction (0.4/1):** Firms related to engineering and textiles industries interact with the Universities once/twice in the year depending upon their requirement with the Universities.
- **Support in providing quality solutions (0.6/1):** Industries in the State have received quality solutions from Universities for their production process in the last one year.
- **MoUs/Collaboration/Agreement with University (0.6/1):** Firms related to engineering, textiles and chemicals and petrochemicals have signed MoU/agreement for specific projects with the University in the State.

- **Patents gained in the past 5 years (0.8/1):** Agro and food processing**,** engineering and textiles industries have gained maximum patents during the last 5 years through collaboration with the Universities.
- **Continuity of research activities (0.6/1):** Industries such as gems and jewellery, engineering, chemicals and petrochemicals, textiles and food processing industries are involved in ongoing research activity being conducted by various Universities for improvement in their production processes.
- **Interaction with students (0.8/1):** Industries interact regularly with the students for providing them internship opportunities in their respective plants and units.
- **Frequency of interaction with students (0.5/1):** Business firms generally on an average give internship opportunities to two students in their firms in a particular year. Textiles and agro and food processing industry has provided maximum number of internship opportunities to the students followed by engineering, chemicals and petrochemicals and gems and jewellery industries.

7.4 Maharashtra – UIL Rank 4th

Score in UIL: 6.4

The State of Maharashtra has emerged as a key hub for IT electronics and captive business outsourcing industries. The State has a well-developed social, physical and industrial infrastructure which has given a substantial rise in the number of industrial clusters and public-private partnership (PPP) projects. According to the survey/ analysis, the State has strong University – Industry Linkages with score of 6.4 points out of 10. Among the key industries, drugs and pharmaceuticals and textiles industries have very strong University – Industry Linkages, followed by strong University – Industry Linkages in the oil and gas, automotive and auto components and finance industries.

UIL Key findings

- **Availability of University(s) (0.8/1):** Drugs and pharmaceuticals, oil and gas, textiles, automotive and auto components and finance industries have availability of Universities to facilitate R&D activities in the state.
- **Interaction with University(s) (1/1):** Industries interact with the Universities for various purposes such as research activities and business processes/modeling.
- **Continuity in interaction (0.6/1):** Industries hold regular interactions with the Universities for finding solutions with regards to their business modeling.
- **Frequency of interaction (0.5/1):** Industries interact with the Universities once/twice/thrice in the year depending upon their requirement with the Universities.
- **Support in providing quality solutions (0.8/1):** Industries have received quality solution from Universities for their production process in the last one year.

- **MoUs/Collaboration/Agreement with University (0.5/1):** Textiles, oil and gas and drugs and pharmaceuticals industries sign MoU/agreement for specific projects with the Universities.
- **Patents gained in the past 5 years (0.4/1):** Industries have gained patents through collaboration with the Universities in the area of oil and gas and drugs and pharmaceuticals during the last 5 years.
- **Continuity of research activities (0.3/1):** Industries of the State are involved in ongoing research activities being conducted by various Universities for improvement in their production process/unit.
- **Interaction with students (0.9/1):** Firms related to finance, drugs and pharmaceuticals, automotive and auto components and textiles industries interact regularly with the students for providing them internship opportunities in their respective plants.
- **Frequency of interaction with students (0.6/1):** Business firms generally on an average give internship opportunities to two students in their firms in a particular year. Drugs and pharmaceuticals and textiles industries have provided maximum number of internship opportunities to the students followed by oil and gas, automotive and auto components and finance industries.

7.5 Uttar Pradesh – UIL Rank 5th

Score in UIL: 6.2

The State of Uttar Pradesh is the largest producer of food grains in India. The State offers a wide range of subsidies, policies and fiscal incentives as well as assistance for businesses under the industrial and services sector. On the basis of survey/ analysis, the State has strong University – Industry Linkages with a score of 6.2 points out of 10. Among the key industries, electronics industry have very strong University – Industry Linkages, followed by strong University – Industry Linkages in the IT and IT enabled Services, agro and food processing industries, dairy and leather industries.

UIL Key findings

- **Availability of University(s)(0.7/1):** Industries such as agro and food processing, leather and dairy industries have Universities to facilitate R&D activity in the state.
- **Interaction with University(s)(1/1):** Firms related to leather, electronics, IT and IT enabled services interact with the Universities for various purposes such as business processes and research activities.
- **Continuity in interaction (0.5/1):** Industries hold regular quarterly interactions with the Universities for finding solutions with regards to their business modeling.

- **Frequency of interaction (0.4/1):** Industries interact with the Universities once/twice/thrice in the year depending upon their requirement with the Universities.
- **Support in providing quality solutions (0.8/1):** Industries in the State such as leather, electronics, IT and IT enabled services, dairy and agro and food processing industries have received quality solutions from Universities for their production process in the last one year.
- **MoUs/Collaboration/Agreement with University (0.5/1):** Agro and food processing, IT and IT enabled services, electronics, leather and dairy industries have signed MoU/agreement for specific projects with the Universities in the state.
- **Patents gained in the past 5 years (0.4/1):** Leather, IT and IT enabled services and electronics industries have gained patents during the last 5 years through collaboration with the Universities.
- **Continuity of research activities (0.4/1):** IT and IT enabled services, electronics and leather industries are involved in ongoing research activities being conducted by various Universities for improvement in their production process/unit.
- **Interaction with students (0.9/1):** Leather, electronics, dairy, IT and IT enabled services and agro and food processing industries interact regularly with the students for providing them internship opportunities in their respective plants.
- **Frequency of interaction with students (0.6/1):** Business firms generally on an average give internship opportunities to two students in their firms in a particular year. Electronics, agro and food processing, Dairy, IT and IT enabled services and leather industries provide internship opportunities to the students.

7.6 Tamil Nadu – UIL Rank 6th

Score in UIL: 6.1

The State of Tamil Nadu is known for its diversified manufacturing sector and is featured among the leaders in several industries including automobiles and auto components, engineering, drugs and pharmaceuticals, garments, textile products, leather products, chemicals, plastics, etc. On the basis of the survey/ analysis, the State has strong University – Industry Linkages with score of 6.1 points out of 10. Among the major industries, automotive and auto components industry have very strong University – Industry Linkages followed by strong University – Industry Linkages in the engineering, textiles industries and IT and IT- enabled Services and moderate University - Industry Linkages in the cement industry.


UIL Key findings

- **Availability of University(s) (0.7/1):** Automotive and auto components, engineering, IT and IT-enabled Services, textiles and cement industries have Universities to facilitate R&D activities in the state.
- **Interaction with University(s) (0.9/1):** Industries interact with the Universities for various purposes such as business processes and research activities.
- **Continuity in interaction (0.5/1):** Industries hold regular interactions with the Universities for finding solutions with regards to their business processes.
- **Frequency of interaction (0.5/1):** Automotive and auto components, engineering, textiles and IT and IT-enabled Services industries interact with the Universities once/twice/thrice in the year depending upon their requirements with the Universities.
- **Support in providing quality solutions (0.7/1):** Engineering, IT and IT-enabled Services, automotive and auto components and textiles industries have received quality solutions from Universities for their production process in the last one year.
- **MoUs/Collaboration/Agreement with University (0.4/1):** Automotive and auto components, textiles, engineering, IT and IT-enabled Services and cement industries have signed sign MoU/agreement for specific projects with the University.
- **Patents gained in the past 5 years (0.5/1):** Firms related to automotive and auto components, textiles and engineering and IT and IT-enabled Services have gained patents during the last 5 years through collaboration with the Universities.
- **Continuity of research activities (0.3/1):** Industries are involved in ongoing research activities being conducted by various Universities for improvement in their production process/unit.
- **Interaction with students (0.9/1):** Firms related to textiles, engineering and IT and IT-enabled Services industries interact regularly with the students for providing them internship opportunities in their respective plants.
- **Frequency of interaction with students (0.7/1):** Engineering industry has provided maximum number of internship opportunities to the students followed by cement, textiles, automotive and auto components and IT and IT-enabled Services based industries.

7.7 Delhi – UIL Rank 6th

Score in UIL: 6.1

Delhi is one of the fastest growing States of the country and is committed towards creating a progressive business environment. According to the survey/ analysis, the State has strong University – Industry Linkages with score of 6.1 points out of 10. Among the major industries, finance industry has very strong University – Industry Linkages followed by strong University – Industry Linkages in the IT and IT-enabled Services and real estate industries

and moderate University – Industry Linkages in tourism and agro and food processing industries.

UIL Key findings

- **Availability of University(s)(0.9/1):** Firms related to finance, IT and IT-enabled Services and agro and food processing industries have maximum availability of Universities; however, there are very few Universities for tourism industry to facilitate R&D activities.
- **Interaction with University(s)(1/1):** Firms related to finance, IT and IT-enabled Services, real estate, agro and food processing and tourism industries interact with the Universities for various purposes such as business processes and research activities.
- **Continuity in interaction (0.4/1):** Agro and food processing, real estate, IT and IT-enabled Services, finance and tourism industries hold fewer interactions with the Universities for finding solutions with regards to their business modeling.
- **Frequency of interaction (0.5/1):** Firms related to finance, IT and IT-enabled Services, real estate, agro and food processing and tourism industries interact with the Universities once/twice/thrice in the year depending upon their requirement with the Universities.
- **Support in providing quality solutions (0.6/1):** Industries have received quality solution from Universities for their production process in the last one year.
- **MoUs/Collaboration/Agreement with University (0.4/1):** Industries sign MoU/agreement for specific projects with the University in the State. Maximum number of MoUs are signed by IT and IT-enabled Services industry followed by finance, agro and food processing and tourism industries.
- **Patents gained in the past 5 years (0.4/1):** Industries have gained patents during the last 5 years through collaboration with the Universities.
- **Continuity of research activities (0.3/1):** Firms related to IT and IT-enabled Services are involved in ongoing research activity being conducted by various Universities for improvement in their production process/unit.
- **Interaction with students (0.9/1):** Finance, agro and food processing and real estate industries interact regularly with the students for providing them internship opportunities in their respective plants.
- **Frequency of interaction with students (0.7/1):** Finance industry has provided maximum number of internship opportunities to the students followed by real estate, agro and food processing, tourism and IT and IT-enabled Services based industries.

7.8 Telangana – UIL Rank 6th

Score in UIL: 6.1

The State of Telangana is one of the promising States of India and is known for its rich culture and has large reserves of minerals which make it an attractive State for industrial investments. According to the survey/ analysis, the State has scored 6.1 points out of 10 points with strong University – Industry Linkages. Among the major industries, IT and IT-enabled Services and drugs and pharmaceuticals industries hold very strong University – Industry Linkages in the State followed by strong University – Industry Linkages in tourism industry, moderate University – Industry Linkages in minerals industry and weak University – Industry Linkages in the textiles industries.

UIL Key findings

- **Availability of University(s) (0.6/1):** Industries have Universities to facilitate R&D activities. Firms related to drugs and pharmaceuticals industry have maximum availability of Universities to facilitate R&D activities followed by IT and IT-enabled Services, tourism, minerals and textile industries.
- **Interaction with University(s) (0.9/1):** Drugs and pharmaceuticals, IT and IT-enabled Services, tourism, minerals and textile industries interact with the Universities for various purposes such as research activities and business processes/modeling.
- **Continuity in interaction (0.4/1):** IT and IT-enabled Services and drugs and pharmaceuticals industries hold quarterly interactions with the Universities for finding solutions with regards to their business processes.
- **Frequency of interaction (0.5/1):** Industries in the State interact with the Universities once/twice/thrice in the year depending upon their requirement with the Universities.
- **Support in providing quality solutions (0.6/1):** Industries in the State have received quality solution from Universities for their production process in the last one year.
- **MoUs/Collaboration/Agreement with University (0.5/1):** IT and IT-enabled Services, drugs and pharmaceuticals and tourism Industries have signed MoU/agreement for specific projects with the University in the State.
- **Patents gained in the past 5 years (0.6/1):** Industries have gained patents during the last 5 years through collaboration with the Universities in the various areas.
- **Continuity of research activities (0.3/1):** IT and IT-enabled Services industries are involved in ongoing research activity being conducted by various Universities for improvement in their production processes.
- **Interaction with students (1/1):** Industries interact regularly with the students for providing them internship opportunities in their respective plants.
- **Frequency of interaction with students (0.7/1):** Business firms generally on an average give internship opportunities to three students in their firms in a particular

year. Tourism industry has provided maximum number of internship opportunities to the students followed by IT and IT-enabled Services, minerals, drugs and pharmaceuticals and textile industries.

7.9 Odisha – UIL Rank 7th

Score in UIL: 6

The State of Odisha is one of the richest States in terms of mineral reserves and is the first State for undertaking reforms and restructuring initiatives in the power sector across India. According to the survey/analysis, Odisha has strong University - Industrial Linkages and has scored 6 points out of 10. Among the key industries, IT and IT-enabled Services and tourism industries have very strong University – Industry Linkages followed by strong University – Industry Linkages in the mining industry and moderate linkages in the handloom and handicrafts and iron and steel industries.

UIL Key findings

- **Availability of University(s) (0.7/1):** Industries have Universities to facilitate R&D activities. Firms related to IT and IT-enabled Services, tourism and minining have maximum availability of Universities to facilitate R&D activities.
- **Interaction with University(s)(1/1):** Industries interact with the Universities for various purposes such as research activities and business processes/modeling.
- **Continuity in interaction (0.6/1):** Industries hold quarterly interactions with the Universities for finding solutions with regards to their business processes.
- **Frequency of interaction (0.5/1):** Industries usually interact with the Universities once/twice/thrice in the year depending upon their requirements with the Universities for business modeling and research activities.
- **Support in providing quality solutions (0.7/1):** Industries in the State including tourism, IT and IT-enabled Services and mining industries have received quality solutions from Universities for their production process in the last one year.
- **MoUs/Collaboration/Agreement with University (0.5/1):** Industries sign MoU/agreement for research and specific projects with the University. Maximum number of MoUs are signed by IT and IT-enabled Services followed by mining and tourism based firms.
- **Patents gained in the past 5 years (0.4/1):** Industries have gained patents during the last 5 years through collaboration with the Universities in the area of IT and mining.
- **Continuity of research activities (0.2/1):** Industries are involved in ongoing research activity being conducted by various Universities for improvement in their production processes.
- **Interaction with students (0.8/1):** Industries interact regularly with the students for providing them internship opportunities in their respective plants.

- **Frequency of interaction with students (0.6/1):** Business firms generally on an average give internship opportunities to two students in their firms in a year. Tourism industry has provided maximum number of internship opportunities to the students followed by IT and IT-enabled Services, mining, iron and steel and handloom and handicrafts industries.

7.10 Andhra Pradesh – UIL Rank 8th

Score in UIL: 5.9

The State of Andhra Pradesh is known for its rich natural resources and is home to many global and national pharmaceutical industries. According to the survey/ analysis, the State has scored 5.9 points out of 10 with strong University – Industry Linkages. Among the major industries, drugs and pharmaceuticals and textile industries have very strong University – Industry Linkages followed by strong University – Industry Linkages in the IT and IT-enabled Services and moderate linkages in agro and food processing and leather and leather products industry.

UIL Key findings

- **Availability of University(s)(0.6/1):** Firms related to drugs and pharmaceuticals, textile and leather products industries have availability of Universities for the facilitation of R&D activities.
- **Interaction with University(s)(0.9/1):** Agro and food processing, textiles, drugs and pharmaceuticals, leather and IT and IT-enabled services based firms interact with the Universities for various purposes such as research activities and business processes/modeling.
- **Continuity in interaction (0.4/1):** Textiles and drugs and pharmaceuticals industries hold regular interactions with the Universities for finding solutions with regards to their business processes.
- **Frequency of interaction (0.4/1):** Industries interact with the Universities once/twice/thrice in the year depending upon their requirement with the Universities.
- **Support in providing quality solutions (0.8/1):** Industries such as drugs and pharmaceuticals followed by agro and food processing and textile and IT and IT-enabled services based firms have received quality solutions from Universities for their production process in the last one year.
- **MoUs/Collaboration/Agreement with University (0.3/1):** Industries sign MoU/agreement for specific projects with the University with maximum number of MoUs signed by drugs and pharmaceuticals industry.
- **Patents gained in the past 5 years (0.5/1):** Firm related to drugs and pharmaceuticals and IT and IT-enabled have gained patents during the last 5 years through collaboration with the Universities.


- **Continuity of research activities (0.3/1):** Drugs and pharmaceuticals, textile and agro and food processing industries are involved in ongoing research activity being conducted by various Universities for improvement in their production processes.
- **Interaction with students (1/1):** Agro and food processing, IT and IT-enabled, drugs and pharmaceuticals and textiles industries interact regularly with the students for providing them internship opportunities in their respective plants.
- **Frequency of interaction with students (0.7/1):** Business firms generally on an average give internship opportunities to three students in their firms in a particular year.

7.11 Punjab – UIL Rank 9th

Score in UIL: 5.8

The State of Punjab contributes a considerable share in national food grain production. The State's fertile and productive soil coupled with excellent network of irrigation facilities plays a significant role in developing and boosting the agro-based industries. According to the survey/ analysis, the State has scored 5.8 points out of 10 with strong University – Industry Linkages. Among the major industries, agro and food processing industry has very strong University – Industry Linkages followed by strong University – Industry Linkages in the textiles and sports equipment industries and moderate linkages in agriculture and allied activities and automotive and auto components industries.

UIL Key findings

- **Availability of University(s)(0.7/1):** Firms related to textiles, agro and food processing and sports equipment industries have Universities to facilitate R&D activities.
- **Interaction with University(s)(0.8/1):** Industries interact with the Universities for various purposes such as research activities and business processes/modeling.
- **Continuity in interaction (0.5/1):** Agro and food processing and sports equipment industry hold regular interactions with the Universities for finding solutions for their business.
- **Frequency of interaction (0.4/1):** Industries interact with the Universities once/twice/thrice in the year depending upon their requirement with the Universities. Agro and food processing and textiles industry interact either once/twice in a year with the Universities.
- **Support in providing quality solutions (0.7/1):** Firms related to agro and food processing, automotive and auto components and sports equipments have received quality solutions from Universities for their production process in the last one year.
- **MoUs/Collaboration/Agreement with University (0.5/1):** Firms related to textiles industry have signed MoU/agreement for specific projects with the Universities.

- **Patents gained in the past 5 years (0.7/1):** Agro and food processing and sports equipment industries have gained patents during the last 5 years through collaboration with the Universities in the various areas.
- **Continuity of research activities (0.1/1):** Firms related to agro and food processing industry are involved in ongoing research activity being conducted by various Universities for improvement in their production processes.
- **Interaction with students (0.8/1):** Industries interact regularly with the students for providing them internship opportunities in their respective plants and units.
- **Frequency of interaction with students (0.6/1):** Business firms generally on an average give internship opportunities to two students in their firms in a particular year. Agro and food processing and textile industry has provided maximum number of internship opportunities to the students followed by automotive and auto components, agriculture and allied activities and sports equipment industries.

7.12 Himachal Pradesh – UIL Rank 10th

Score in UIL: 5.7

The State of Himachal Pradesh is primarily an agrarian economy and has exhibited rapid growth in the tertiary sector especially on account of the flourishing tourism sector. The State has attracted investments in the sectors including engineering, IT and drugs and pharmaceuticals. According to the survey/ analysis, the State has scored 5.7 points out of 10 with strong University – Industry Linkages. Among the major industries, drugs and pharmaceuticals, hydropower, tourism and cement industries have strong University – Industry Linkages followed by weak University – Industry Linkage in the agro and food processing industries.

UIL Key findings

- **Availability of University(s) (0.6/1):** Firms related to drugs and pharmaceuticals, hydropower and cement industries have availability of Universities to facilitate R&D activities.
- **Interaction with University(s) (0.8/1):** Firms related to drugs and pharmaceuticals, hydropower, cement and tourism industries interact with the Universities for various purposes such as research activities and business processes/modeling.
- **Continuity in interaction (0.6/1):** Industries are in regular interactions with the Universities for finding solutions with regards to their business processes.
- **Frequency of interaction (0.4/1):** Cement and drugs and pharmaceuticals industries interact with the Universities once/twice/thrice in the year depending upon their requirement with the Universities.
- **Support in providing quality solutions (0.7/1):** The Universities have provided quality solution to the industries for their production process in the last one year.

- **MoUs/Collaboration/Agreement with University (0.4/1):** Industries sign MoU/agreement for specific projects with the University. Maximum number of MoUs are signed by tourism and drugs and pharmaceuticals industry in the state.
- **Patents gained in the past 5 years (0.8/1):** Industries have gained patents during the last 5 years through collaboration with the Universities.
- **Continuity of research activities (0.3/1):** Firms related to drugs and pharmaceuticals industry are involved in ongoing research activity being conducted by various Universities for improvement in their production processes.
- **Interaction with students (0.7/1):** Drugs and pharmaceuticals, tourism and hydropower industries are in regular interaction with the students for providing them internship opportunities in their respective plants.
- **Frequency of interaction with students (0.4/1):** Business firms in general give internship opportunities to three students in their firms on an average in a particular year. Drugs and pharmaceuticals industries have provided maximum number of internship opportunities to the students followed by tourism, hydropower, agro and food processing and cement industries.

7.13 Uttarakhand – UIL Rank 11th

Score in UIL: 5.6

The State of Uttarakhand has abundant natural resources and has almost all agro-geo climatic zones, which provide commercial opportunities for floriculture and horticulture. The State is one of the fastest growing States due to its massive growth in capital investments arising from conducive industrial policy and generous tax benefits. According to the survey /analysis, the State has strong University – Industry Linkages with score of 5.6 points out of 10. Among the major industries, agro and food processing industry and IT and IT enabled Services have very strong University–Industry Linkages followed by moderate University – Industry Linkages in hydropower, engineering and tourism industries.

UIL Key findings

- **Availability of University(s) (0.7/1):** Industries have Universities to facilitate R&D activity. Agro and food processing has maximum availability of Universities to facilitate R&D activities in the state.
- **Interaction with University(s) (0.9/1):** Industries interact with the Universities for various purposes such as research activities and business processes/modeling.
- **Continuity in interaction (0.5/1):** Industries holds interactions with the Universities for finding solutions with regards to their business processes.
- **Frequency of interaction (0.4/1):** Industries usually interact with the Universities once/twice in the year depending upon their requirement with the Universities for business modeling and research activities.


- **Support in providing quality solutions (0.7/1):** Industries in the State related agro and food processing and IT and IT enabled Services have received quality solutions from Universities for their production process in the last one year.
- **MoUs/Collaboration/Agreement with University (0.4/1):** Agro and food processing, IT and IT enabled Services and hydropower industries have signed MoU/agreement for research and specific projects with the University.
- **Patents gained in the past 5 years (0.4/1):** Industries have gained patents during the last 5 years through collaboration with the Universities in the area of agro and food processing.
- **Continuity of research activities (0.3/1):** Agro and food processing and tourism industries are involved in ongoing research activity being conducted by various Universities for improvement in their production process/unit.
- **Interaction with students (0.8/1):** Industries interact regularly with the students for providing them internship opportunities in their respective plants.
- **Frequency of interaction with students (0.5/1):** Business firms generally on an average give internship opportunities to two students in their firms in a year. IT and IT enabled Services based firms has provided maximum number of internship opportunities to the students followed by agro and food processing, engineering, hydropower and tourism industries.

7.14 Haryana – UIL Rank 12th

Score in UIL: 5.5

The State of Haryana is mainly an agrarian economy and is a significant contributor to country's agricultural output. The State is one of India's largest automobile hubs and has emerged as a base for the knowledge industry, including IT and biotechnology. On the basis of the survey/analysis, the State has strong University – Industry Linkages with score of 5.5 points out of 10. Among the major industries, agro and food processing and automotive and auto components industries hold very strong University–Industry linkages followed by strong University – Industry Linkages in the IT and IT enabled Services and weak University – Industry Linkages in the textiles and real estate industries.

UIL Key findings

- **Availability of University(s) (0.7/1):** Industries have Universities to facilitate R&D activity. Agro and food processing and automotive and auto components industries have availability of Universities to facilitate R&D activities.
- **Interaction with University(s) (0.8/1):** Firms related to automotive and auto components, textiles and IT and IT enabled Services industries interact with the Universities for various purposes such as research activities and business processes/modeling.
- **Continuity in interaction (0.5/1):** Industries hold regular interactions with the Universities for finding solutions with regards to their business processes.
- **Frequency of interaction (0.5/1):** Industries interact with the Universities once/twice/thrice in the year depending upon their requirement with the Universities.
- **Support in providing quality solutions (0.6/1):** Industries have received quality solutions from Universities for their production process in the last one year.
- **MoUs/Collaboration/Agreement with University (0.5/1):** Industries sign MoU/agreement for specific projects with the University in the State. Maximum number of MoUs are signed by agro and food processing and automotive and auto components industries in the states.
- **Patents gained in the past 5 years (0.6/1):** Industries have gained patents during the last 5 years through collaboration with the Universities in the various areas such as for agro and food processing products.
- **Continuity of research activities (0.3/1):** Agro and food processing industry is involved in ongoing research activity being conducted by various Universities for improvement in their production processes.
- **Interaction with students (0.5/1):** Industries interact regularly with the students for providing them internship opportunities in their respective plants.
- **Frequency of interaction with students (0.5/1):** Business firms generally on an average give internship opportunities to two students in their firms in a particular year. Automotive and auto components industry has provided maximum number of internship opportunities to the students in the state.

7.15 Rajasthan – UIL Rank 13th

Score in UIL: 5.2

The State of Rajasthan is endowed with tremendous opportunities in the areas of organic and contract farming. On the basis of the survey/ analysis, the State has strong University – Industry Linkages with a score of 5.2 out of 10. Among the key industries of the State, IT and IT enabled Services and textile industries have very strong University – Industry Linkages


followed by strong University – Industry Linkages in the tourism industry and weak University – Industry Linkages in the cement and gems and jewellery industries.

UIL Key findings

- **Availability of University(s) (0.7/1):** Industries have Universities to facilitate R&D activity. IT and IT enabled Services, tourism, textiles and gems and jewellery industries have availability of Universities to facilitate R&D activities in the State.
- **Interaction with University(s) (0.8/1):** Industries including gems and jewellery, tourism, textiles industries and IT and IT enabled Services interact with the Universities for various purposes such as research activities and business processes/modeling.
- **Continuity in interaction (0.4/1):** Industries hold regular interactions with the Universities for finding solutions with regards to their business processes.
- **Frequency of interaction (0.4/1):** Industries in the State interact with the Universities once/twice/thrice in the year depending upon their requirement with the Universities.
- **Support in providing quality solutions (0.6/1):** Industries in the State have received quality solution from Universities for their production process in the last one year.
- **MoUs/Collaboration/Agreement with University (0.4/1):** Industries sign MoU/agreement for specific projects with the University. Maximum number of MoUs are signed by textiles industry followed by IT and IT enabled Services and tourism industries.
- **Patents gained in the past 5 years (0.5/1):** During the last 5 years, industries have gained patents through collaboration with the Universities in the various areas such as textiles and IT and IT enabled Services.
- **Continuity of research activities (0.3/1):** Industries of the State including IT and IT enabled Services and tourism industries are involved in ongoing research activity being conducted by various Universities for improvement in their production processes.
- **Interaction with students (0.6/1):** Industries interact regularly with the students for providing them internship opportunities in their respective plants.
- **Frequency of interaction with students (0.5/1):** On an average, business firms generally give internship opportunities to two students in a particular year. Textiles industry provide maximum number of internship opportunities to the students followed by IT and IT enabled Services and tourism industries.


7.16 West Bengal – UIL Rank 14th

Score in UIL: 4.7

The State of West Bengal is the second largest tea-producing States in India and has abundant natural resources of minerals and suitable agro-climatic conditions for agriculture, horticulture and fisheries. According to the survey/ analysis, the State has moderate University – Industry Linkages with a score of 4.7 points out of 10, wherein the biotechnology and iron and steel industry have very strong University – Industry Linkages followed by moderate University – Industry Linkages in the chemical and petrochemicals industry and weak University – Industry Linkages in the tea and leather industries.

UIL Key findings

- **Availability of University(s) (0.7/1):** Firms related to biotechnology, iron and steel and chemical and petrochemicals industries have availability of Universities to facilitate R&D activities in the state.
- **Interaction with University(s)(0.8/1):** Biotechnology, iron and steel, chemical and petrochemicals and tea industries interact with the Universities for various purposes such as research activities and business processes/modeling.
- **Continuity in interaction (0.4/1):** Firms related to biotechnology, iron and steel and chemical and petrochemicals industries hold regular interactions with the Universities for finding solutions with regards to their business processes.
- **Frequency of interaction (0.4/1):** Industries interact with the Universities once/twice/thrice in the year depending upon their requirement with the research institutions.
- **Support in providing quality solutions (0.4/1):** Biotechnology iron and steel, chemical and petrochemicals industries have received quality solutions from Universities for their production process in the last one year.
- **MoUs/Collaboration/Agreement with University (0.3/1):** Industries sign MoU/agreement for specific projects with the University. Maximum number of MoUs have been signed by biotechnology and iron and steel industries.
- **Patents gained in the past 5 years (0.4/1):** Firms related to biotechnology and chemical and petrochemicals industries have gained patents during the last 5 years through collaboration with the Universities.
- **Continuity of research activities (0.1/1):** Biotechnology and iron and steel industries are involved in ongoing research activity which is being conducted by various Universities for improvement in their production processes.
- **Interaction with students (0.6/1):** Industries interact regularly with the students for providing them internship opportunities in their respective plants.
- **Frequency of interaction with students (0.6/1):** Business firms generally on an average give internship opportunities to two students in their firms in a particular

year. Maximum number of internship opportunities to the students have been provided by biotechnology and iron and steel industries.

7.17 Chhattisgarh – UIL Rank 15th

Score in UIL: 4.5

The State of Chhattisgarh is one of the leading producers of minerals such as coal, iron ore and dolomite. The State has emerged as one of the most preferred investment destinations in India. Additionally, the State has well-drafted policies for the IT, solar energy, agro and food processing, minerals and biotechnology sectors. According to the survey / analysis, the State has scored 4.5 points out of 10 indicating moderate University – Industry Linkages. Among the major industries, herbal medical industry and iron and steel industries have strong University – Industry Linkages followed by moderate linkages in the mining, agro and food processing and cement industries.

UIL Key findings

- **Availability of University(s) (0.4/1):** Firms related to herbal medical and iron and steel industries have maximum availability of Universities to facilitate R&D activities in the state.
- **Interaction with University(s)(0.6/1):** Industries in the State interact with the Universities for various purposes such as research activities and business processes/modeling.
- **Continuity in interaction (0.5/1):** Firms related to iron and steel and herbal medical industries hold regular interactions with the Universities for finding solutions with regards to their business processes.
- **Frequency of interaction (0.4/1):** Industries in the State usually interact with the Universities once/twice/thrice in the year depending upon their requirement with the Universities for business modeling and research activities.
- **Support in providing quality solutions (0.7/1):** Firms related to iron and steel, herbal medical, cement and agro and food processing industries have received quality solutions from Universities for their production process in the last one year.
- **MoUs/Collaboration/Agreement with University (0.3/1):** Herbal medical, cement, agro and food processing, mining and iron and steel industries have signed MoU/agreement for research and specific projects with the University.
- **Patents gained in the past 5 years (0.4/1):** Industries have gained patents during the last 5 years through collaboration with the Universities in the area of herbal medicine.
- **Continuity of research activities (0.2/1):** Industries related to herbal medical are involved in ongoing research activity being conducted by various Universities for improvement in their production process/unit.

- **Interaction with students (0.4/1):** Industries interact regularly with the students for providing them internship opportunities in their respective plants.
- **Frequency of interaction with students (0.6/1):** Business firms generally on an average give internship opportunities to two students in their firms in a year. Iron and steel industry has provided maximum number of internship opportunities to the students followed by herbal medical, cement, mining and agro and food processing industries.

7.18 Madhya Pradesh – UIL Rank 16th

Score in UIL: 4.3

The State of Madhya Pradesh is blessed with vast natural resources and rich cultural heritage along with excellent industrial base coupled with a progressive and investor friendly environment. According to the survey/ analysis, the State has moderate University – Industry Linkages with a score of 4.3 points out of 10. Among the key industries, drugs and pharmaceuticals industry has strong University – Industry Linkages followed by moderate University – Industry Linkages in the tourism, textiles and cement industries and weak University – Industry Linkages in the automotive and auto components industries.

UIL Key findings

- **Availability of University(s) (0.5/1):** Drugs and pharmaceuticals industry has maximum availability of Universities followed by automotive and auto components, tourism, textiles and cement industries to facilitate R&D activities.
- **Interaction with University(s)(0.6/1):** Industries in the State interact with the Universities for various purposes such as business modeling.
- **Continuity in interaction (0.4/1):** Firms related to drugs and pharmaceuticals hold quarterly interactions with the Universities for finding solutions with regards to their business processes.
- **Frequency of interaction (0.5/1):** Industries interact with the Universities once/twice/thrice in the year depending upon their requirement with the Universities for business modeling and research activities.
- **Support in providing quality solutions (0.4/1):** Industries have received quality solution from Universities for their production process in the last one year.
- **MoUs/Collaboration/Agreement with University (0.4/1):** Industries sign MoU/agreement for research and specific projects with the University. Maximum number of MoUs have been signed by tourism industry followed by cement, drugs and pharmaceuticals and textiles industries.
- **Patents gained in the past 5 years (0.4/1):** Industries have gained patents during the last 5 years through collaboration with the Universities in the area of drugs and pharmaceuticals.

- **Continuity of research activities (0.2/1):** Industries of the State are involved in ongoing research activity being conducted by various Universities for improvement in their production process/unit.
- **Interaction with students (0.5/1):** Industries interact regularly with the students for providing them internship opportunities in their respective plants.
- **Frequency of interaction with students (0.4/1):** Business firms generally on an average give internship opportunities to two students in their firms in a year. Drugs and pharmaceuticals industry has provided maximum number of internship opportunities to the students followed by textiles, tourism, cement and automotive and auto components industries.

7.19 Jharkhand – UIL Rank 17th

Score in UIL: 4.2

The State of Jharkhand is endowed with rich mineral reserves and is known for its mining and mineral extraction activities. The major growth drivers of the engineering industry in Jharkhand are availability of raw materials (iron and steel, aluminum, copper and other metals and non-metals), power, water and industrial labour. According to the survey/analysis, the State has moderate University – Industry Linkages and has scored 4.2 points out of 10. Among the major industries, mining and engineering industries have strong University – Industry Linkages followed by moderate University – Industry Linkages in the fertilizer and automotive and auto components industries and weak University – Industry Linkages in the cement industry.

UIL Key findings

- **Availability of University(s)(0.6/1):** Firms related to engineering, cement, mining and fertilizer industries have Universities to facilitate R&D activities in the state
- **Interaction with University(s)(0.6/1):** Firms related to engineering, mining, cement, fertilizers and automotive and auto components industries interact with the Universities for various purposes such as business processes and research activities.
- **Continuity in interaction (0.3/1):** Industries hold quarterly interactions with the Universities for finding solutions with regards to their business modeling.
- **Frequency of interaction (0.3/1):** Engineering, mining and automotive and auto components industries interact with the Universities once/twice/thrice in the year depending upon their requirement with the Universities.
- **Support in providing quality solutions (0.3/1):** Industries have received quality solutions for business modeling from Universities for their production process in the last one year.

- **MoUs/Collaboration/Agreement with University (0.4/1):** Engineering, mining, fertilizers and cement industries have signed MoU/agreement for specific projects with the Universities in the state.
- **Patents gained in the past 5 years (0.3/1):** Firms related to engineering and mining industries have gained patents during the last 5 years through collaboration with the Universities in the State.
- **Continuity of research activities (0.2/1):** Firms related to engineering, mining and fertilizer industries are involved in ongoing research activity being conducted by various Universities for improvement in their production process/unit.
- **Interaction with students (0.7/1):** Industries interact regularly with the students for providing them internship opportunities in their respective plants.
- **Frequency of interaction with students (0.5/1):** Business firms generally on an average give internship opportunities to two students in their firms in a particular year. Mining industry has provided maximum number of internship opportunities to the students followed by cement, engineering, automotive and auto components and fertilizers industries.

7.20 Bihar – UIL Rank 18th

Score in UIL: 3.8

The State of Bihar is known for its large base of cost effective industrial labour which makes it an ideal destination for a wide range of industries such as agro and food processing, dairy, sugar, manufacturing and healthcare. On the basis of survey/ analysis, the State has moderate University – Industry Linkages with a score of 3.8 points out of 10. Among the key industries of the State, oil and gas industry has strong University – Industry Linkage followed by moderate University – Industry Linkages in the agro and food processing, IT and IT enabled Services and weak University – Industry Linkages in the tourism and textiles industries.

UIL Key findings

- **Availability of University(s) (0.5/1):** Industries have Universities to facilitate R&D activities. Oil and gas industry has maximum availability of Universities to facilitate R&D activities in the state.
- **Interaction with University(s)(0.5/1):** Industries in the State interact with the Universities for various purposes such as research activities and business processes/modeling.
- **Continuity in interaction (0.3/1):** Industries hold quarterly interactions with the Universities for finding solutions with regards to their business processes.

- **Frequency of interaction (0.3/1):** Industries interact with the Universities once/twice/thrice in the year depending upon their requirement with the Universities for business modeling and research activities.
- **Support in providing quality solutions (0.4/1):** Industries have received quality solution from Universities for their production process in the last one year.
- **MoUs/Collaboration/Agreement with University (0.2/1):** oil and gas, agro and food processing and IT and IT enabled Services have signed MoU/agreement for research and specific projects with the Universities in the state.
- **Patents gained in the past 5 years (0.3/1):** Industries have gained patents during the last 5 years through collaboration with the Universities in the area of oil and gas and agro and food processing.
- **Continuity of research activities (0.1/1):** IT and IT enabled Services based firms are involved in ongoing research activity being conducted by various Universities for improvement in their production process/unit.
- **Interaction with students (0.8/1):** Industries interact regularly with the students for providing them internship opportunities in their respective plants.
- **Frequency of interaction with students (0.4/1):** Business firms generally on an average give internship opportunities to two students in their firms in a year. Oil and gas industry has provided maximum number of internship opportunities to the students followed by textiles, tourism, agro and food processing and IT and IT enabled Services based firms.

7.21 Goa – UIL Rank 19th

Score in UIL: 3.6

The State of Goa is one of the fastest growing States in the country and has a well-developed social, physical and industrial infrastructure. The State's economic growth is driven by the strong performance of industrial sectors such as mining, tourism and drugs and pharmaceuticals. According to the survey/analysis, the State has a moderate University – Industry Linkage with a score of 3.6 points out of 10. Among the major industries, drugs and pharmaceuticals and fishing industries hold strong University – Industry Linkages in the State followed by moderate University – Industry Linkages in mining industry and weak University – Industry Linkages in the tourism and agro and food processing industries.

UIL Key findings

- **Availability of University(s) (0.4/1):** Firms related to drugs and pharmaceuticals have Universities to facilitate R&D activities in the state followed by agro and food processing and fishing industries.


- **Interaction with University(s)(0.6/1):** Agro and food processing, mining, drugs and pharmaceuticals, fishing and tourism industries interact with the Universities for various purposes such as research activities and business processes/modeling.
- **Continuity in interaction (0.1/1):** Industries hold regular interactions with the Universities for finding solutions with regards to their business processes.
- **Frequency of interaction (0.2/1):** Industries including drugs and pharmaceuticals, fishing and mining industries interact with the Universities once/twice/thrice in the year depending upon their requirement with the Universities.
- **Support in providing quality solutions (0.3/1):** Industries in the State have received quality solution for their production processes from the Universities in the last one year.
- **MoUs/Collaboration/Agreement with University (0.1/1):** Fishing and drugs and pharmaceutical industries have signed MoU/agreement with the University in the State for taking up specific projects.
- **Patents gained in the past 5 years (0.4/1):** Industries have gained patents during the last 5 years through collaboration with the Universities in the various areas.
- **Continuity of research activities (0.2/1):** For the improvement in their production processes, industries of the State including drugs and pharmaceuticals and fishing are involved in ongoing research activity which is being conducted by various research institutions.
- **Interaction with students (0.9/1):** Agro and food processing, mining, drugs and pharmaceuticals and fishing industries interact regularly with the students for providing them internship opportunities in their respective plants.
- **Frequency of interaction with students (0.4/1):** In general, business firms in the State on an average give internship opportunities to two students in their firms in a particular year. Maximum number of internship opportunities to the students has been provided by agro and food processing, drugs and pharmaceuticals and fishing industries in the state.

7.22 Tripura – UIL Rank 20th

Score in UIL: 3.5

The State of Tripura is endowed with diverse bamboo resources, strong tea plantation base and rich natural resources such as gas, natural rubber, tea and medicinal plants. On the basis of survey/ analysis, the State has a moderate University – Industry Linkage with a score of 3.5 points out of 10. Among the key industries of the State, bamboo industry has strong University – Industry Linkage followed by moderate University – Industry Linkages in the tea and handloom and handicrafts industries and weak University – Industry Linkage in the rubber and agro and food processing industries.

UIL Key findings

- **Availability of University(s) (0.4/1):** Industries have Universities to facilitate R&D activity. Bamboo and tea industries have maximum availability of Universities facilitate R&D activities.
- **Interaction with University(s) (0.5/1):** Bamboo, tea, rubber, handloom and handicrafts and agro and food processing Industries interact with the Universities for various purposes such as research activities and business processes/modeling.
- **Continuity in interaction (0.3/1):** Bamboo, tea, rubber, handloom and handicrafts and agro and food processing industries hold fewer interactions with the Universities for finding solutions with regards to their business processes.
- **Frequency of interaction (0.3/1):** Industries interact with the Universities once/twice/thrice in the year depending upon their requirement with the Universities.
- **Support in providing quality solutions (0.4/1):** Industries in the State related to tea, bamboo and handloom and handicrafts industries have received quality solutions from Universities for their production process in the last one year.
- **MoUs/Collaboration/Agreement with University (0.2/1):** Industries sign MoU/agreement for specific projects with the University in the State. Maximum number of MoUs have been signed by tea and bamboo industries in the state.
- **Patents gained in the past 5 years (0.3/1):** Firms related to tea and bamboo industries have gained patents during the last 5 years through collaboration with the Universities.
- **Continuity of research activities (0.1/1):** Industries of the State aren't involved in ongoing research activity being conducted by various Universities for improvement in their production processes.
- **Interaction with students (0.6/1):** rubber and handloom and handicrafts Industries interact regularly with the students for providing them internship opportunities in their respective plants and units.
- **Frequency of interaction with students (0.4/1):** Business firms generally on an average give internship opportunities to two students in their firms in a particular year. Bamboo and rubber industries have provided maximum number of internship opportunities to the students followed by tea, agro and food processing and handloom and handicrafts industries.

7.23 Sikkim – UIL Rank 21st

Score in UIL: 3.4

The State of Sikkim is richly endowed with rare and exotic flora and fauna which makes it one of the leading States in the Northeast region in terms of production and supply of cut flowers to mainland consumer markets. According to the survey/ analysis, the State has a

moderate University – Industry Linkage with a score of 3.4 points out of 10. Among the key industries of the State, drugs and pharmaceuticals industry has strong University – Industry Linkages followed by moderate University – Industry Linkages in the hydropower and tea industries and weak University – Industry Linkages in the floriculture and medicinal plants industries.

UIL Key findings

- **Availability of University(s)(0.4/1):** Industries in the State related to drugs and pharmaceuticals, hydropower and floriculture industries have few Universities to facilitate R&D activities.
- **Interaction with University(s) (0.6/1):** Industries interact with the Universities for various purposes such as research activities and business processes/modeling.
- **Continuity in interaction (0.1/1):** Industries hold fewer interactions with the Universities for finding solutions with regards to their business.
- **Frequency of interaction (0.2/1):** Industries interact with the Universities once/twice/thrice in the year depending upon their requirement with the Universities.
- **Support in providing quality solutions (0.2/1):** Drugs and pharmaceuticals and hydro power industries have received quality solutions from Universities for their production process in the last one year.
- **MoUs/Collaboration/Agreement with University (0.2/1):** Industries sign MoU/agreement for specific projects with the University. Maximum number of MoUs are signed by drugs and pharmaceuticals and hydropower industries.
- **Patents gained in the past 5 years (0.5/1):** Drugs and pharmaceuticals and hydro power industries have gained patents during the last 5 years through collaboration with the Universities.
- **Continuity of research activities (0.1/1):** Industries are involved in ongoing research activity being conducted by various Universities for improvement in their production processes.
- **Interaction with students (0.7/1):** Industries interact regularly with the students for providing them internship opportunities in their respective plants and units.
- **Frequency of interaction with students (0.4/1):** Business firms generally on an average give internship opportunities to two students in their firms in a particular year. Hydropower and drugs and pharmaceuticals industries have provided maximum number of internship opportunities to the students followed by floriculture, medicinal plants and tea industries.

7.24 Jammu & Kashmir – UIL Rank 22nd

Score in UIL: 3.3

The State of Jammu & Kashmir is known for its agro-climatic conditions best suited for horticulture and floriculture industries. Horticulture industry is the mainstay of the State's rural economy which provides employment to the people in the State. On the basis of survey/analysis, moderate University – Industry Linkage is observed in the State with a score of 3.3 points out of 10. Among the key industries of the State, tourism industry has strong University – Industry Linkage followed by moderate University – Industry Linkages in the sericulture and horticulture industries and weak University – Industry Linkages in the handloom and handicrafts and floriculture industries.

UIL Key findings

- **Availability of University(s) (0.4/1):** Industries in the State related to tourism, horticulture, sericulture and handloom and handicrafts industry have few Universities to facilitate R&D activities in the State.
- **Interaction with University(s) (0.7/1):** Industries interact with the Universities for various purposes such as research activities and business processes/modeling.
- **Continuity in interaction (0.1/1):** Tourism and sericulture industries hold interactions with the Universities for finding solutions with regards to their business modeling.
- **Frequency of interaction (0.3/1):** Industries interact with the Universities once/twice/thrice in the year depending upon their requirement with the Universities.
- **Support in providing quality solutions (0.4/1):** Industries related to tourism, sericulture, horticulture and handloom and handicrafts industries have received quality solutions from Universities for their production process in the last one year.
- **MoUs/Collaboration/Agreement with University (0.1/1):** Industries have signed very less MoU/agreement for specific projects with the University in the State.
- **Patents gained in the past 5 years (0.4/1):** Horticulture, sericulture and handloom and handicrafts industries have gained patents during the last 5 years through collaboration with the Universities.
- **Continuity of research activities (0.2/1):** Very few industries are involved in ongoing research activity being conducted by various Universities for improvement in their production processes.
- **Interaction with students (0.4/1):** Industries interact regularly with the students for providing them internship opportunities in their respective plants and units.
- **Frequency of interaction with students (0.3/1):** Business firms generally on an average give internship opportunities to one student in their firms in a particular year. Tourism industry has provided maximum number of internship opportunities to

the students followed by sericulture, handloom and handicrafts, floriculture and horticulture industries.

7.25 Meghalaya – UIL Rank 23rd

Score in UIL: 3.2

The State of Meghalaya is primarily known for its climate that supports agricultural and horticultural activities. The State holds immense potential to attract investments for horticulture and floriculture industries. According to the survey/ analysis, the University – Industry Linkages in the State is moderate and has scored 3.2 points out of 10. Among the key industries of the State, strong University – Industry Linkages are observed in the hydropower industry while moderate University – Industry Linkages are observed in the horticulture and handloom and handicrafts industries and weak University – Industry Linkages in the tourism and sericulture industries.

UIL Key findings

- **Availability of University(s) (0.5/1):** Firms related to hydropower and handloom and handicraft have few Universities to facilitate R&D activities in the state. However, sericulture, tourism and horticulture industries have less access to Universities for R&D activities in the state.
- **Interaction with University(s) (0.6/1):** Hydropower and handloom and handicraft industries interact with the Universities for various purposes such as for business processes/modeling.
- **Continuity in interaction (0/1): All the** Industries hold fewer interactions with the Universities for finding solutions for their business in the state.
- **Frequency of interaction (0.2/1):** Hydropower and handloom and handicraft industries interact with the Universities once/twice in the year depending upon their requirement with the Universities.
- **Support in providing quality solutions (0.2/1):** Industries in the State related to hydropower have received quality solutions from Universities for their production process in the last one year.
- **MoUs/Collaboration/Agreement with University (0.2/1):** Industries sign MoU/agreement for specific projects with the University. Maximum numbers of MoUs have been signed by hydropower industry.
- **Patents gained in the past 5 years (0.3/1):** Hydropower, handloom and handicrafts and horticulture industries have gained patents during the last 5 years through collaboration with the Universities in the various areas.
- **Continuity of research activities (0/1):** Industries are not involved in ongoing research activity being conducted by various Universities for improvement in their production processes.

- **Interaction with students (0.7/1):** Industries interact regularly with the students for providing them internship opportunities in their respective plants and units.
- **Frequency of interaction with students (0.4/1):** Business firms generally on an average give internship opportunities to two students in their firms in a particular year.

7.26 Assam – UIL Rank 24th

Score in UIL: 3

The State of Assam is rich in water resources and is known as the third-largest producer of petroleum and natural gas in the country. The State has adopted numerous investor-friendly policies to attract investments and accelerate industrial development. On the basis of survey/ analysis, moderate University – Industry Linkages are observed in the State with a score of 3 points out of 10. Among the key industries, oil and gas industry and agro and food processing industries have moderate University – Industry Linkages whereas tea industry, limestone and cement and sericulture industries have weak University – Industry Linkages.

UIL Key findings

- **Availability of University(s) (0.5/1):** Oil and gas, limestone and cement, sericulture, tea industries and agro and food processing industries have few Universities to facilitate R&D activities.
- **Interaction with University(s) (0.5/1):** Oil and gas, agro and food processing, tea, limestone and cement and sericulture industries interact with the Universities for various purposes such as research activities and business processes/modeling.
- **Continuity in interaction (0.1/1):** Industries hold very less interactions with the Universities for finding solutions with regards to their business modeling/processes.
- **Frequency of interaction (0.2/1):** Industries interact with the Universities once/twice in the year depending upon their requirement with the Universities.
- **Support in providing quality solutions (0.4/1):** Oil and gas, agro and food processing, tea and sericulture industries have received quality solution from Universities for their production process in the last one year.
- **MoUs/Collaboration/Agreement with University (0.2/1):** Tea and agro and food processing industries have signed MoU/agreement for research activities and specific projects with the University.
- **Patents gained in the past 5 years (0.2/1):** Limestone and Cement, oil and gas and agro and food processing industries have gained patents during the last 5 years through collaboration with the Universities.
- **Continuity of research activities (0/1):** Strong linkages between the universities and industries have not been observed on this parameter.

- **Interaction with students (0.5/1):** Oil and gas, limestone and cement and agro and food processing industries interact regularly with the students for providing them internship opportunities in their respective plants.
- **Frequency of interaction with students (0.3/1):** Business firms generally on an average give internship opportunities to one student in their firms in a particular year. Oil and gas industry has provided maximum number of internship opportunities to the students followed by agro and food processing, limestone and cement, tea and sericulture industries.

7.27 Arunachal Pradesh – UIL Rank 25th

Score in UIL: 2.4

The State's economy is largely agrarian, based on terraced farming of rice and cultivation of crops such as maize, millet, wheat, pulses, sugarcane, ginger, oilseeds, cereals, potato, and pineapple. According to the survey/analysis, the State has weak University – Industry Linkages and has scored 2.4 points out of 10 wherein moderate University – Industry Linkages are observed in the textiles and tourism industries and weak University – Industry Linkages in the mineral, agriculture and forest-based and power industries.

UIL Key findings

- **Availability of University(s) (0.4/1):** Only textiles industry has Universities to facilitate R&D activities in the state, while firms related to tourism, mineral, agriculture and forest-based and power industries face challenges in terms of less Universities to facilitate them in R&D activities.
- **Interaction with University(s)(0.6/1):** Textiles, tourism, minerals, agriculture and forest-based and power industries interact with the Universities for various purposes such as research activities and business processes/modeling.
- **Continuity in interaction (0/1):** Industries hold very less interactions with the Universities for finding solutions with regards to their business modeling/processes.
- **Frequency of interaction (0.1/1):** Textiles, tourism, minerals, agriculture and forest-based and power industries interact with the Universities once/twice in the year depending upon their requirement with the Universities.
- **Support in providing quality solutions (0/1):** Due to lack of availability of Universities, industries haven't received solutions from Universities for their production process in the last one year.
- **MoUs/Collaboration/Agreement with University (0/1):** Mineral industry has signed MoU/agreement for research activities and specific projects with the Universities.
- **Patents gained in the past 5 years (0.3/1):** Textiles and tourism industries have gained patents during the last 5 years through collaboration with the Universities in the state.

- **Continuity of research activities (0/1):** Industries are not involved in ongoing research activity being conducted by various Universities for improvement in their production process/unit.
- **Interaction with students (0.7/1):** Tourism, mineral, textiles and power industries interact with the students for providing them internship opportunities in their respective plants.
- **Frequency of interaction with students (0.3/1):** Business firms generally on an average give internship opportunities to one student in their firms in a particular year. Textiles and minerals industry has provided maximum number of internship opportunities to the students followed by tourism, power and agriculture and forest-based industries.

7.28 Mizoram – UIL Rank 26th

Score in UIL: 2

Industries in the State enjoy unique location-specific advantage which offers a gateway for engagement in international trade with Southeast Asian countries. Also, the State offers immense potential for commercial exploitation of the natural resources for export-oriented industries. According to the survey/ analysis, the State has weak University – Industry Linkages with a score of 2 points out of 10. Also, moderate University – Industry Linkages are observed in the power industry followed by weak University – Industry Linkages in the sericulture, bamboo, agriculture and allied and fisheries industries.

UIL Key findings

- **Availability of University(s)(0.3/1):** Firms related to bamboo, power, fisheries, agriculture and allied industries face challenges in terms of unavailability of Universities to facilitate R&D activities.
- **Interaction with University(s)(0.4/1):** Power, bamboo, sericulture, fisheries, agriculture and allied industries interact with the Universities for various purposes such as research activities and business processes/modeling.
- **Continuity in interaction (0.2/1):** Power, fisheries and agriculture and allied industries hold very less interactions with the Universities for finding solutions with regards to their business modeling.
- **Frequency of interaction (0.2/1):** Industries interact with the Universities once/twice in the year depending upon their requirement with the Universities.
- **Support in providing quality solutions (0.1/1):** Due to unavailability of Universities, industries haven't received quality solutions from Universities for their production process in the last one year.

- **MoUs/Collaboration/Agreement with University (0.1/1):** Industries have signed very less MoU/agreement for research activities and specific projects with the Universities. Only power industry has collaborated with the Universities in the state.
- **Patents gained in the past 5 years (0/1):** Industries haven't gained patents during the last 5 years since they have not collaborated with the Universities for production/business purposes.
- **Continuity of research activities (0/1):** None of the industries have responded on any ongoing research activity being conducted with various Universities for improvement in their production process/unit.
- **Interaction with students (0.5/1):** Power and sericulture industries interact with the students for providing them internship opportunities in their respective plants.
- **Frequency of interaction with students (0.3/1):** Business firms generally on an average give internship opportunities to one student in their firms in a particular year. Power industry has provided maximum number of internship opportunities to the students followed by bamboo, sericulture, fisheries, agriculture and allied industries.

7.29 Nagaland – UIL Rank 27th

Score in UIL: 1.8

The State of Nagaland has considerable resources of natural minerals, petroleum and hydropower. The State offers excellent policy and fiscal incentives for agro-based and forest-based industries, horticulture, agro and food processing, mining, tourism and handlooms and handicrafts. According to the survey/ analysis, the State has weak University – Industry Linkages with a score of 1.8 points out of 10. Also, moderate University – Industry Linkages are observed in the hydropower industry followed by weak University – Industry Linkages in the handloom and handicrafts, floriculture, apiculture and bamboo industries.

UIL Key findings

- **Availability of University(s)(0.4/1):** Hydropower, handloom and handicrafts, floriculture and bamboo industries face challenges in terms of less availability of Universities to facilitate R&D activities in the state.
- **Interaction with University(s)(0.4/1):** Hydropower and floriculture industries interact with the Universities for various purposes such as research activities and business processes/modeling.
- **Continuity in interaction (0/1):** Industries hold very less interactions with the Universities for finding solutions with regards to their business modeling in the state.
- **Frequency of interaction (0.1/1):** Hydropower, handloom and handicrafts, floriculture, apiculture and bamboo industries interact with the Universities once/twice in the year depending upon their requirement with the Universities.

- **Support in providing quality solutions (0/1):** Due to unavailability of Universities, industries haven't received solutions from Universities for their production process in the last one year.
- **MoUs/Collaboration/Agreement with University (0/1):** Industries have signed very less MoU/agreement for research activities and specific projects with the University.
- **Patents gained in the past 5 years (0/1):** Strong linkages between universities and industries have not been observed on this parameter.
- **Continuity of research activities (0/1):** Industries are not involved in ongoing research activities being conducted by various Universities for improvement in their production process/unit.
- **Interaction with students (0.5/1):** Handloom and handicrafts and hydropower industries interact regularly with the students for providing them internship opportunities in their respective plants.
- **Frequency of interaction with students (0.3/1):** Business firms generally on an average give internship opportunities to one student in their firms in a particular year. Handloom and handicrafts and hydropower industries have provided maximum number of internship opportunities to the students followed by bamboo, floriculture and apiculture industries.

7.30 Manipur – UIL Rank 28th

Score in UIL: 1.5

The State of Manipur is known for its tourism, handloom and handicrafts, mineral, agro and food processing and sericulture. According to the survey/ analysis, the State has weak University – Industry Linkages with a score of 1.5 points out of 10. Also, weak University – Industry Linkages are observed in all the key sectors of the State including agro and food processing, handloom and handicrafts, tourism, mineral and sericulture industries.

UIL Key findings

- **Availability of University(s)(0.2/1):** Agro and food processing, handloom and handicrafts, tourism, mineral and sericulture industries face challenges in terms of less number of Universities to facilitate them in their R&D activities.
- **Interaction with University(s) (0.3/1):** Agro and food processing, mineral and sericulture industries interact with the Universities for various purposes such as research activities and business processes/modeling.
- **Continuity in interaction (0/1):** Firms related to agro and food processing, handloom and handicrafts, tourism, mineral and sericulture industries hold less interactions with the Universities for finding solutions with regards to their business processes.

- **Frequency of interaction (0.1/1):** Tourism and handloom and handicrafts industries interact with the Universities once in the year depending upon their requirement with the Universities.
- **Support in providing quality solutions (0/1):** Due to unavailability of Universities, industries haven't received solutions from Universities for their production process in the last one year.
- **MoUs/Collaboration/Agreement with University (0/1): All the** Industries have signed very less MoU/agreement for research activities and specific projects with the University in the state.
- **Patents gained in the past 5 years (0/1):** Firms related to agro and food processing, handloom and handicrafts, tourism, mineral and sericulture industries have not gained patents during the last 5 years.
- **Continuity of research activities (0/1):** Industries are not involved in ongoing research activity being conducted by various Universities for improvement in their production process/unit.
- **Interaction with students (0.4/1):** Tourism and mineral industries interact regularly with the students for providing them internship opportunities in their respective plants.
- **Frequency of interaction with students (0.4/1):** Business firms generally on an average give internship opportunities to two students in their firms in a particular year. Tourism industry has provided maximum number of internship opportunities to the students followed by handloom and handicrafts, mineral, sericulture and agro and food processing, industries.

In a nutshell, there are moderate University-Industry Linkages in India with a UIL score of 4.7 out of 10 points. Very strong UIL scores are observed in Karnataka and Kerala followed by strong University-Industry Linkages in Gujarat, Maharashtra, Uttar Pradesh, Tamil Nadu, Delhi, Telangana, Odisha, Andhra Pradesh, Punjab, Himachal Pradesh, Uttarakhand, Haryana and Rajasthan.

Moderate University-Industry Linkages in West Bengal, Chhattisgarh, Madhya Pradesh, Jharkhand, Bihar, Goa, Tripura, Sikkim, Jammu & Kashmir, Meghalaya and Assam.

Also, weak University – Industry Linkages are observed in Arunachal Pradesh, Mizoram, Nagaland and Manipur.

The state of Karnataka is ranked 1st out of 30 states with very strong University-Industry Linkages. The state has a good number of Universities to facilitate industries in conducting their R&D activities. Further, industries interact with these Universities regularly for finding solutions with regards to their business processes and research activities. Also, the industries in the state have gained patents through collaboration and agreements with the Universities in the diverse sectors including biotechnology.


On the basis of analysis, Kerala is ranked 2nd out of 30 states due to very strong University-Industry Linkages. The state is one of the leading agricultural states and the largest producer of coconut, coir, rubber and pepper in the country. The industries in the state related to rubber, ayurveda, seafood and other marine products among others interact regularly with the Universities for various purposes including research activities, business modeling and providing internships to the students. Further, the state has scored well on the parameter of receiving quality solutions from the Universities for their production process.

The state of Gujarat is ranked 3rd out of 30 states with strong University-Industry Linkages. Among the major industries in the state, agro and food processing, engineering and textile industry holds very strong University – Industry Linkages followed by strong University – Industry Linkages in the chemicals and petrochemicals and gems and jewellery industries. The state has good number of Universities to facilitate industries in getting solutions for their production process. Industries such as gems and jewellery, engineering, chemicals and petrochemicals, textiles and food processing industries are involved in ongoing research activities being conducted by various Universities for improvement in their production processes.

Table 26: Matrix of National UIL parameters

S. No	Parameter / States	Availability of University(s)	Interaction with University(s)	Continuity in interaction	Frequency of interaction	Support in providing quality solutions	MoUs /Collaboration/Agreement with University(s)	Patents gained in the past 5 years	Continuity of research activities	Interaction with students	Frequency of interaction with students	Cumulative Score
1	Karnataka	0.8	1	0.8	0.7	0.8	0.6	0.8	0.5	1	0.8	**7.8**
2	Kerala	0.7	1	0.8	0.7	1	0.6	0.8	0.4	0.8	0.5	**7.3**
3	Gujarat	0.9	1	0.5	0.4	0.6	0.6	0.8	0.6	0.8	0.5	**6.7**
4	Maharashtra	0.8	1	0.6	0.5	0.8	0.5	0.4	0.3	0.9	0.6	**6.4**
5	Uttar Pradesh	0.7	1	0.5	0.4	0.8	0.5	0.4	0.4	0.9	0.6	**6.2**
6	Tamil Nadu	0.7	0.9	0.5	0.5	0.7	0.4	0.5	0.3	0.9	0.7	**6.1**
7	Delhi	0.9	1	0.4	0.5	0.6	0.4	0.4	0.3	0.9	0.7	**6.1**
8	Telangana	0.6	0.9	0.4	0.5	0.6	0.5	0.6	0.3	1	0.7	**6.1**
9	Odisha	0.7	1	0.6	0.5	0.7	0.5	0.4	0.2	0.8	0.6	**6**
10	Andhra Pradesh	0.6	0.9	0.4	0.4	0.8	0.3	0.5	0.3	1	0.7	**5.9**
11	Punjab	0.7	0.8	0.5	0.4	0.7	0.5	0.7	0.1	0.8	0.6	**5.8**
12	Himachal Pradesh	0.6	0.8	0.6	0.4	0.7	0.4	0.8	0.3	0.7	0.4	**5.7**
13	Uttarakhand	0.7	0.9	0.5	0.4	0.7	0.4	0.4	0.3	0.8	0.5	**5.6**
14	Haryana	0.7	0.8	0.5	0.5	0.6	0.5	0.6	0.3	0.5	0.5	**5.5**
15	Rajasthan	0.7	0.8	0.4	0.4	0.6	0.4	0.5	0.3	0.6	0.5	**5.2**
16	West Bengal	0.7	0.8	0.4	0.4	0.4	0.3	0.4	0.1	0.6	0.6	**4.7**
17	Chhattisgarh	0.4	0.6	0.5	0.4	0.7	0.3	0.4	0.2	0.4	0.6	**4.5**

18	**Madhya Pradesh**	0.5	0.6	0.4	0.5	0.4	0.4	0.4	0.2	0.5	0.4	**4.3**
19	**Jharkhand**	0.6	0.6	0.3	0.3	0.3	0.4	0.3	0.2	0.7	0.5	**4.2**
20	**Bihar**	0.5	0.5	0.3	0.3	0.4	0.2	0.3	0.1	0.8	0.4	**3.8**
21	**Goa**	0.4	0.6	0.1	0.2	0.3	0.1	0.4	0.2	0.9	0.4	**3.6**
22	**Tripura**	0.4	0.5	0.3	0.3	0.4	0.2	0.3	0.1	0.6	0.4	**3.5**
23	**Sikkim**	0.4	0.6	0.1	0.2	0.2	0.2	0.5	0.1	0.7	0.4	**3.4**
24	**Jammu & Kashmir**	0.4	0.7	0.1	0.3	0.4	0.1	0.4	0.2	0.4	0.3	**3.3**
25	**Meghalaya**	0.5	0.6	0	0.2	0.2	0.2	0.3	0	0.7	0.4	**3.2**
26	**Assam**	0.5	0.5	0.1	0.2	0.4	0.2	0.2	0	0.5	0.3	**3**
27	**Arunachal Pradesh**	0.4	0.6	0	0.1	0	0	0.3	0	0.7	0.3	**2.4**
28	**Mizoram**	0.3	0.4	0.2	0.2	0.1	0.1	0	0	0.5	0.3	**2**
29	**Nagaland**	0.4	0.4	0	0.1	0	0	0	0	0.5	0.3	**1.8**
30	**Manipur**	0.2	0.3	0	0.1	0	0	0	0	0.4	0.4	**1.5**
Total		0.6	0.7	0.4	0.4	0.5	0.3	0.4	0.2	0.7	0.5	**4.7**

Source: PHD Research Bureau, compiled from the study on Framework for University-Industry Linkages in Research

Chapter 8

Research & Development in Major Sectors of Indian Economy

The chapter unfolds the present scenario of various sectors of the Indian economy including Agriculture and Allied Activities, Agro and Food Processing, Sericulture, Floriculture, Ayurveda, Fisheries, Horticulture, Apiculture, Seafood and other marine products, Spices and spice Extracts, Dairy, Textiles, Automobile and Automobile Components, Cement Industry, Drugs and Pharmaceuticals, Handicrafts and Handloom Industry, Biotechnology, Chemicals and Petrochemicals, Electronics, Engineering, Gems and Jewellery, Leather and Leather Products, Oil and Gas, Iron and Steel, Mining, Minerals, Sports Goods, Tourism, Information Technology and IT Enabled Services (ITeS), Finance, Power, Real Estate. The sectoral performance has been highlighted along with the present scenario of research and development in each of the sector.

Agriculture

8.1 Agriculture and Allied Activities

The agriculture sector is the principal means of livelihood for over 58% of the rural households[82]. Agriculture, along with fisheries and forestry, is one of the largest contributing sectors to the Gross Domestic Product (GDP) of our country. Agriculture and allied sectors (including livestock, forestry and fishery) constituted 15.35% of the Gross Value Added (GVA) during the financial year 2015–16 at 2011–12 prices as per estimates by the Central Statistics Office (CSO). However, the share of agriculture and allied sector in aggregate GDP has declined steadily over the past several decades from as high as over 50% in the 1950s to around 14% in recent years, a pattern typically observed in economies as they develop. The sector has observed a growth rate of about 3% each year on an average over the last four decades.

India's current expenditure on agricultural research and development is around 0.7% of the agricultural GDP, while experts have time and again suggested that India needs to raise this share to 1% of the GDP for it to raise its agricultural production and make it sustainable.[83] Breakthroughs in basic and other modern sciences offer various opportunities for developing transformative technologies for agriculture sector. However, this has not been happening in India for a variety of reasons. While public sector research institutes have important strengths, they face serious challenges in meeting future needs of the agriculture sector. Resources have been thinly spread on increasing the number of agricultural universities around the country while there are numerous leading research institutes facing severe resource crunch simultaneously. There is thus a need to reform the system of agricultural education and research and take urgent action to overhaul the public sector

[82] The Economic Survey 2016–17, Agricultural and Processed Food Products Export Development Authority (APEDA), Department of Commerce and Industry, Union Budget 2017–18, Press Information Bureau, Ministry of Statistics and Programme Implementation, Press Releases, Media Reports,
[83] Article titled 'Spend more on Agriculture R&D', New Indian Express, 2014

R&D institutions while creating favorable environment for private sector participation in agricultural research and technology development.

8.2 Agro and Food Processing

Indian food processing industry contributes around 32% to the country's total food market, 14% to the manufacturing GDP, 13% to the exports and 6% to the total industrial investment. India's food processing sector ranks fifth in the world in exports, production and consumption. The food processing sector serves as a vital link between agriculture and industrial segments of the economy. As per the Ministry of Food Processing Industries (MOFPI), the size of the Indian food market is estimated at US$191 bn and the processed food market is projected to be over US$300 bn in the next five years. According to the Ministry of Food Processing Industry, India is the largest producer of wheat and rice and accounts for about 10% of the global fruit production, with the country topping the charts in mango and banana production. The nodal agency responsible for R&D in food processing sector is MOFPI. Commercial R&D activities in the food industry have remained confined to only a few areas. R&D activities have scarcely emerged from the laboratory to be extensively adopted on the field.[84]

8.3 Sericulture

Sericulture involves growing of host plants, rearing of silkworms, reeling, twisting, weaving and marketing of various value added products and services.[85] The establishment of rural based industries like sericulture, in particular, can be very effective in creating new job opportunities and providing supplemental income. Sericulture is a farm-based, labour intensive and commercially attractive economic activity falling under the cottage and small-scale sector. It particularly suits rural-based farmers, entrepreneurs and artisans, as it requires low investment but, with the potential of relatively higher returns. In order to co-ordinate the sericulture development programmes in different states & for undertaking pre-shipment inspection of silk goods meant for exports, the Central Silk Board has established 10 Regional Offices.[86] R&D achievements like development of indigenous mulberry varieties, farmer-friendly technologies, cost-effective new package of practices for cultivation of food plants, rearing and reeling coupled with huge natural and man-made resources and trained manpower clearly indicates the future prospects of sericulture industry to emerge as a promising indicator of economic development for the upliftment of the socially deprived communities and the downtrodden.[87]

[84] Report titled 'Human Resource and Skill Requirements in the Food Processing Sector', NSDC
[85] Central Sericultural Research & Training Institute (CSRTI), Mysore
[86] Central Silk Board, Ministry of Textiles, Govt. of India.
[87] Article titled 'Sericulture Industry in India – A Review', by D. Gangopadhyay *in 2008.*


8.4 Floriculture

Government of India has identified floriculture as a sunrise industry and accorded it 100% export oriented status. Floriculture in India, is being viewed as a high growth Industry. Commercial floriculture is becoming important from the export angle. The liberalization of industrial and trade policies paved the way for development of export-oriented production of cut flowers. About 248.51 thousand hectares area was under Cultivation in floriculture in 2014-15. Production of flowers is estimated to be 1,658 thousand tonnes loose flowers and 472 thousand tonnes cut flowers in 2014-15. The country has exported 22,086.10 MT of floriculture products to the world for the worth of Rs. 548.74 crores/ 82.05 USD Millions in 2016-17.[88] Newly established Directorate of Floricultural Research with the help of All India Coordinated Research Project (AICRP) network is playing an important role in strengthening floricultural research and augmenting the technological base in floriculture in different regions of the country. Outreach of the technologies and creating awareness about the benefits of practicing floriculture among rural population is the need of the hour, which would be achieved through the network of coordinated centres spread all over the country.[89]

8.5 Ayurveda

India is the Second largest exporter of Ayurvedic and alternative medicine in the world with 6200 indigenous herbal plants. The sector has the potential to generate three million job opportunities in the coming times. India has developed vast Ayurveda, Yoga & Naturopathy, Unani, Siddha and Homoeopathy (AYUSH) infrastructure comprising of 736,538 registered practitioners.[90] Ayurveda has been the oldest system with documented history of its practice since more than 5000 years which is being practised in the country with diverse preferences of people and infrastructural facilities. Ayurveda is more prevalent in the States of Kerala, Maharashtra, Himachal Pradesh, Gujarat, Karnataka, Madhya Pradesh, Rajasthan, Uttar Pradesh, Delhi, Haryana, Punjab, Uttarakhand, Goa and Orissa.[91]

Department of AYUSH under the Ministry of Health & Family Welfare is responsible for policy formulation, development and implementation of programmes for the growth, development and propagation of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy systems of Health Care in India. Besides the infrastructure under the Department of AYUSH and Central Council for Research in Ayurvedic Sciences, the research in this sector is being undertaken by Indian Council of Medical Research, Council of Scientific and Industrial Research, Department of Science and Technology, Department of Biotechnology, various Universities, Medical Colleges, AYUSH Colleges, Non Government Organisations, Hospitals, Pharmaceutical Industry etc.

[88] APEDA, Ministry of Commerce and Industry, GoI.
[89] Directorate of Floricultural Research (DFR), Indian Council of Agricultural Research.
[90] Make in India Website
[91] Annual report 2016-17, Ministry of Ayush, GoI.

8.6 Fisheries

The present contribution from inland open water resources is 1.3 million tonnes with a percentage contribution of around 21% to the total inland fish production. The estimated demand for fish by 2025 in the Indian domestic market would be around 16 million tonnes (MT) against the present production of 9.58 MT coming from inland (65%) and marine (35%) sectors. In this context, the projected second blue revolution of the country demands fish production from inland open water bodies as a promising option for providing high quality protein food, livelihood to the rural populace and doubling the fisher's income.[92] This necessitates proper resource management, based on sound and informed decision making and location specific technological interventions for protecting the goods and ecological services to sustain the fisheries. In this context, Indian Council of Agricultural Research - Central Inland Fisheries Research Institute (ICAR-CIFRI) has considerably accomplished significant scientific and technological milestones towards generating current knowledge base through interdisciplinary research for enabling sustainability of their ecosystem services and fisheries.

8.7 Horticulture

India has been bestowed with wide range of climate and physio-geographical conditions and as such is the most suitable for growing various kinds of horticultural crops such as fruits, vegetables, flowers, nuts, spices and plantation crops (coco nut, cashew nut and cocoa). Its horticulture production has increased significantly which has placed India among the foremost countries in horticulture production, just behind China. During 2012-13, its contribution in the world production of fruits & vegetables was 12.6 % & 14% respectively. Total production of fruits during 2012-13 was 81.2 million tonnes while that of vegetables was 162 million tonnes.[93] Various Institutes like Indian Agricultural Research Institute (IARI), Horticulture Wing in Indian Council of Agricultural Research (ICAR), Indian Institute for Horticulture Research, Bangalore, Agricultural universities etc have been continuously striving to improve the quality of the horticultural products as well as to increase their productivity.

8.8 Apiculture

Beekeeping is an agro-based activity which is being undertaken by farmers/landless labours in rural area as an integrated farming practice. Beekeeping supplements income & employment generation and nutritional intake of rural population. [94] National Bee Board (NBB) is one of the National Level Agencies (NLAs) under MIDH aimed at increasing the income of farmers/beekeepers. Presently, the main thrust of NBB is setting up of Integrated Beekeeping Development Centres (IBDCs)/Centres of Excellence (CoEs) on beekeeping, at least one in each State. Centres will help the beekeepers/farmers of the area in adopting scientific beekeeping and encourage/promote scientific beekeeping in integrated manner in

[92] Annual report 2016-2017, Central Inland Fisheries Research Institute, ICAR.
[93] Statistical Year Book 2017, Ministry of Statistics and Programme Implementation.
[94] Press Information Bureau, GoI, January 2017

the Country. [95] Beekeeping is one of the thrust areas and flagship programmes of Ministry of Agriculture & Farmers Welfare. Beekeeping has been included as an activity for promoting cross pollination of Horticultural Crops under National Horticulture Mission since May, 2005, which has been merged with Mission for Integrated Development of Horticulture (MIDH). MIDH has been in implementation in all parts of the country. Khadi and Village Industries Commission, Ministry of Micro, Small and Medium Enterprises, State Khadi Board etc. are also implementing beekeeping schemes. [96]

8.9 Seafood and other marine products

Riding on a robust demand for its frozen shrimp and frozen fish in international markets, India exported 11,34,948 MT of seafood worth, an all time high of US$ 5.78 billion (Rs 37, 870.90 crore) in 2016-17 as against 9,45,892 tons and 4.69 billion dollars a year earlier, with USA and South East Asia continuing to be the major importers while the demand from the European Union (EU) grew substantially during the period. [97] Rajiv Gandhi Centre for Aquaculture (RGCA) continued Research and Development activities for developing new aquaculture technologies by innovative methods, implementing several species specific R & D projects for increasing production of commercially important Finfish, Shellfish, export oriented ones in particular, to strengthen the aquaculture production base in the country.[98]

8.10 Spices and spice extracts

During 2015 - 16, Indian spices exports have continued to show an increasing trend in value. The total export of Spices during 2015 - 16 has exceeded the target in terms of both volume and value. During the financial year, a total of 8,43,255 tonnes of spices and spice products valued ` 16238.23 crore (US$ 2482.83 Million) have been exported from the country as against 8,93,920 tonnes valued ` 14899.68 crore (US$ 2432.84 Million) in 2014 - 15 registering an increase of 9% in rupee terms and 2% in dollar terms of value. The Indian plantation industry including spices is in a paradox, caught between the inability to introduce large-scale mechanisation on one hand, and the need to improve crop productivity on the other. While there is a need to address this issue, the research in spices is carried out by the Commodity Board with full funding by the government. A proactive R&D department is necessary to deliver cutting-edge technological advances in production, productivity, agronomical practices and post-harvest technology in this sector. [99]

8.11 Dairy

Since the last 15 years, India has been the largest producer of milk in the world. Annual growth rate of Milk Production during the period 2011-14 was 4%, which has increase to 6% during 2014-17. About 70 million rural households are engaged in dairying in India with 80%

[95] National Bee Board
[96] Press Information Bureau, GoI, January 2017
[97] Press Information Bureau, Ministry of Commerce and Industry, GoI, June 2017.
[98] Ministry of commerce and industry, GoI.
[99] Article titled 'R and D crucial to save Plantation Industry', Business line, 2017.

of total cow population. [100] In the case of dairying, the National Dairy Research Institute pursues research and education in all aspects of dairying: microbiology, chemistry, technology, engineering, animal genetics and breeding, livestock production and management, animal nutrition, animal physiology, dairy economics and dairy extension education.

Manufacturing

8.12 Textiles

India's textiles sector is one of the mainstays of the Indian economy. The sector contributes around 14% to India's industrial production and 13% to the country's export earnings. It is also one of the largest contributing sectors of India's exports, contributing around 11% to the country's total exports basket. The textiles industry is labour intensive and creates immense employment opportunities. The industry provides direct employment to over 45 million and 60 million people indirectly. The Indian textiles industry holds a promising future and is expected to reach US $ 150 billion by 2021. Ministry of Textiles has been providing financial support to the Textile Research Associations engaged in the work of research and development. Research and development is the key to the growth of the textiles industry and the government has already invested in R&D in the textile machinery manufacturing sector. The government has added R&D investments in textile machinery manufacturing to get all benefits as any other sector.

8.13 Automobile and Automobile Components

The Indian auto industry being one of the largest in the world, accounts for 7.1% of the country's Gross Domestic Product (GDP). The data of FY2014-15 reflects that manufacturing of around 31% of small cars sold globally is done in India. The growing middle class and young population in the country has resulted in rise in demand of two wheelers segment with 81% market share and the segment has emerged as the leader of the Indian Automobile market. India's auto exports are also prominent and there are strong export growth expectations in the future. Exports of Commercial Vehicles grew at 18.36% in April-January 2016 over April-January 2015. By 2020, India is expected to become a world leader in the Two Wheeler (2W) and Four Wheeler (4W) market segment.[101]

The automotive market is heavily dependent on their innovation quotient to meet the demands. Various top automobile manufacturers have set up their R&D centres in India. The key reason for setting up in India was to tap the country's engineering base and cost advantage.[102]

As a part of Make in India initiative, Government has set up NATRIP (National Automotive Testing and R&D Infrastructure Project) centre. This is one of the most important initiatives

[100] PIB, Ministry of agriculture and Farmers Welfare, November 2017.
[101] India Brand Equity Foundation Report on Automobile Sector, January 2016
[102] Article titled 'India: The New R&D Hub for Automotive Industry', The AutomotiveIndia.com, December 2015

in the automotive sector, representing a unique joining of hands between the Government of India, a number of State Governments and Indian Automotive Industry in order to create a state of the art infrastructure in testing, Validation and R&D infrastructure.

8.14 Cement Industry

India is the second largest producer of cement in the world. Cement demand in India is expected to increase due to government's push for large infrastructure projects, leading to 45 million tonnes (MT) of cement needed in the next three to four years. According to the data released by the Department of Industrial Policy and Promotion (DIPP), cement and gypsum products attracted Foreign Direct Investment (FDI) worth US$ 3.117 billion between April 2000 and September 2017.However the Indian Cement Industry is dominated by a few companies. The top 20 cement companies account for almost 70 per cent of the total cement production of the country.

The private sector companies thrive in the industry; the government has been approving their investment schemes. The Union Budget proposed to assign infrastructure status to affordable housing projects and facilitate higher investments and better credit facilities, in line with the government's aim to provide housing for all by 2022 which will boost cement demand. The R&D in cement industry is presently average as there are only few companies who are involved in application of advanced science, technology and engineering platforms comprising of fundamental process analysis, computational fluid dynamics, process modeling and simulation, process control, process development and laboratory experiments.

8.15 Drugs & Pharmaceuticals

The Indian pharmaceuticals market is the third largest in terms of volume and thirteenth largest in terms of value. Branded generics dominate the pharmaceuticals market, constituting nearly 70 to 80 per cent of the market. Exports from Indian pharmaceutical industries comprise mainly of generic drugs and accounted for nearly $15 billion in the FY 2012-2013 as per the data available from a strategy paper from the Commerce Ministry of India. The Indian pharmaceutical market size is expected to grow to US$ 100 billion by 2025, driven by increasing consumer spending, rapid urbanisation, and rising healthcare insurance, among others.

Moving forward, better growth in domestic sales would depend on the ability of companies to align their product portfolio towards chronic therapies for diseases such as cardiovascular, anti-diabetes, anti-depressants and anti-cancers that are on the rise. Overall, revenues of Indian Pharma Industry are expected to expand at a CAGR of 12.1% during 2012-20 and reach $45 bn.[103] The Indian pharmaceutical industry spends, on an average, about 6-8% of their sales on R&D, compared to 15-20% by companies in the developed world. Going ahead, an improvement in medical infrastructure and increase in the

[103] Make in India Website

penetration of health insurance will pave way for the growth of drugs and pharmaceuticals sector in the country. Indian pharma companies have increased their R&D expenses to build pipeline of niche drugs which will in turn help the pharma sector companies to optimize growth.

8.16 Handicrafts and Handloom Industry

The handicrafts sector is important for the Indian economy as it is one of the largest employment generators and accounts for a significant share in the country's exports. Handicraft exports from India increased by 11.07 per cent year-on-year during April 2016-March 2017 to US$ 3.66 billion. During this period, the exports of various segments registered positive growth like Shawls and Artwares (26.79 per cent), Hand printed Textiles & Scarves (25.96 per cent), Artmetal wares (19.04 per cent), Agarbatis and attars (6.76 per cent) and Embroidered & Crochetted goods (5.85 per cent). The export of handloom products from India stood at US$ 360.02 million in FY2015-16. The US was the major importer of Indian handloom products, with estimated purchases of US$ 106.13 million, followed by the UK and UAE at US$ 22.42 million and US$ 19.42 million, respectively. Italy, Germany, France, Spain, Japan, Netherlands, and Australia were some other export destinations.

Research in the sector is conducted by independent and government bodies to provide suggestions for the overall development of the sector. For e.g. The Report of the working Group on Handlooms was prepared by the Ministry of commerce, Government of India. It suggested that less capital and labor intensive type of handloom industry is most suitable to India. Similarly Indian Institute of Handloom technology at Guwahati was also proposed to be established along with the strengthening of existing infrastructure in other IIHTs (Indian Institutes of Handloom Technology) and weavers' service centers. The Weavers' service centers and Indian Institutes of Handloom Technology (IIHT) constitute Research and development wings in the office of the development commissioner for Handlooms 24 weavers' service centers. The 4 Indian Institutes of Handloom Technology have empowered the handloom industry by providing technically trained manpower, development of new designs, improvement in weaving and processing techniques, up gradation of skill etc, in all over the country.

8.17 Biotechnology

The Biotechnology sector in India has played a pivotal role in enhancing the country's global profile and has a share of nearly 2% in the global biotech industry. India is among the top 12 biotech destinations in the world, ranks third in the Asia-Pacific region and has emerged as a leading destination for clinical trials, contract research and manufacturing activities owing to the growth in the bio-services sector. With numerous comparative advantages in terms of research and development (R&D) facilities, knowledge, skills, and cost effectiveness, the biotechnology industry in India has immense potential to emerge as a global key player. In recognition of the need for training and education for generating interdisciplinary human resource relevant to biotechnology, the Government of India and UNESCO took a joint

decision and established the Regional Centre for research training and education in biotechnology.

8.18 Chemicals and Petrochemicals

The chemical industry is a key constituent of Indian economy, accounting 2.11% of the gross domestic product (GDP).[104] The estimated size of Indian chemicals market is USD 144 bn with total production accounting to 21.2 million tonnes during 2014-15. Thereby, the Chemicals sector is most diversified, covering more than 70,000 commercial products. India's growing per capita consumption and demand for agriculture-related chemicals offer immense scope of growth for the sector in the coming times.

The overall R&D impact on Indian chemical industry is non-uniform across its subsectors on account of system heterogeneities, varied scales of operation, uneven responses to globalization challenges and wide variation in human skills and innovative capabilities.[105] In order to remain complacent with the global benchmarks there's an urgent need to increase spending in the research and development of the sector. On the UIL front, even though 2500^{+} projects have been funded by the government in Indian academic institutions with more than Rs. 100 corers funding during 2000-10, they have very little industrial relevance except the IIT's in which certain degree of success has been achieved in making some of their projects industry driven.

8.19 Electronics

Over the years, electronic sector has emerged as one of the important growth drivers of the Indian economy. Under the electronic systems, around 10% growth rate was registered in the period 2011-15 and 100% FDI allowed under the automatic route in the Electronics Systems Design & Manufacturing sector. Going ahead, strong design and R&D capabilities in auto electronics and industrial electronics will contribute towards the future growth and development of the sector in the coming times. Intellectual Property Rights (IPR) is the key determinant of progress in R & D and innovation in the electronics sector. The government of India has thereby amended relevant IPR – related acts (like Copyright Act, Trademark Act, and New Designs Act) from time to time to help spruce up innovation and new technologies in the sector.

8.20 Engineering

The Engineering sector plays a vital role for the development of other industrial sectors of the economy. During 2014-15, this sector remained the largest contributor to exports (25.1% of total). The key sectors driving demand for the engineering goods include

[104] Indraja Jaiswal, "Make in India" initiative provides the impetus for chemical industry, Nov 2016
[105] Article titled Ímpact of R&D on Chemical Industry', Indian National Academy of Engineering

infrastructure, power, mining, refinery and steel, among others. India has a considerable advantage in some of the engineering sub sectors in terms of manufacturing costs, market knowledge, technology and creativity. Going forward, spending on engineering services is projected to increase to US$ 1.1 trillion by 2020.[106] The rapid growth in the market for products and services coupled with a large pool of engineers and data scientists makes India the destination for the global corporations to off-shore their Engineering Research and Design (ER&D) needs. India is currently home to over 600 ER&D companies, and over 400 global ER&D organizations. More than 200,000 engineers are employed by service providers and engineering firms.[107]The market for Engineering R&D (ER&D) companies in India is mainly structured across pure play PES companies.

8.21 Gems and Jewellery

The Gems and Jewellery sector plays a pivotal role in the Indian economy, contributing around 6-7% of the country's GDP. It is one of the fastest growing sectors, it is extremely labour intensive and export oriented. The Government of India has, therefore, declared the sector as a focus area for export promotion. The Government has recently undertaken various measures to promote investments and to upgrade technology and skills to promote 'Brand India' in the international market. India exports 95 per cent of the world's diamonds, as per statistics from the Gems and Jewellery Export promotion Council (GJEPC).

Despite being a thrust area for Government, Gems and Jewellery (G&J) exports declined in 2015-16 to the lowest in six years, due to a global economic slowdown which reduced the demand for luxury goods. According to Gems & Jewellery Export Promotion Council (GJEPC), India's net G&J export is around $32 billion (Rs 2.1 lakh crore), as compared to $36.2 bn in the previous year. Product design innovation initiatives in developing newer designs, new products and also new methods for developing new designs and product development are required. It may be raw material procurement, variety of jewellery design and product related research and development. It also covers the new techniques employed in product design.[108]

8.22 Leather and Leather Products

The leather industry has a place of prominence in the Indian economy due to substantial export earnings and growth, besides the fact that it employs 2.5 million people. India ranks fifth in the list of world's largest exporter of leather goods and accessories. Today, around 50% of India's leather business comes from international trade. The growth in demand for leather is mainly driven by the fashion industry, especially footwear. However, 2015-16 saw a considerable drop of 10.11% in leather exports to $5.92 bn from $6.58 bn from a year ago period. India also missed its export target of $6.25 bn in leather and leather products. The exports volume was hit by several factors such as slowdown in China, weakening demand in

[106]Ministry of Commerce document on 'Frequently Asked Questions on Free Trade Agreements- Engineering Sector', July 2015
[107]Article titled 'India destination of choice for engineering R&D: NASSCOM, Business Line, October 2014
[108]GJEPC Website, September 2016

euro zone, currency fluctuations, hike in duty tariff etc. India exports nearly 60% of its leather goods to the U.S., Germany, the U.K., Italy, France, HongKong and Spain.[109] R&D, technology and innovation development has been stagnant in India over the years. This is primarily because most of the firms in this sector are either small or medium enterprises having very little risk appetite and not inclined towards investing in newer technologies. There is very limited collaboration with industry and hence the research & development is not reaching the masses. Further, MSME's which constitute majority of leather & footwear industries in India have not been able to utilize the benefits of R&D efforts of Central Leather Research Institute (CLRI).

8.23 Oil and Gas

The oil and gas sector is one of the eight core industries in India and plays a major role in influencing decision making for all the other important sections of the economy. Government is aiming to bring down oil imports by 10% over the next 6 years by raising domestic output, conserving fuel and shifting to alternate sources like natural gas. India spent $112.7 billion (Rs 7.62 lakh crore) on import of 189.4 million tons of crude oil in 2014-15 fiscal year. Currently India imports nearly 75% of its oil requirements.

The Government of India has initiated several reforms in the oil and gas sector to make the environment conducive for oil and gas players. Some of these measures include Cabinet approval of the Hydrocarbon Exploration and Licensing Policy (HELP). Another important development in the sector is marketing including pricing freedom given to the gas produced from High Pressure High Temperature, Deepwater and Ultra Deepwater areas. Cabinet also approved a policy for grant of extension to the Production Sharing Contracts for small and medium sized discovered fields. All of these measures are expected to boost investments in the sector, going forward. Although guidelines from the department of public enterprises stipulate R&D expenditure of at least 1% of net profit for Maharatna and Navratna PSEs and 0.5% for mini-Ratnas and others, the actual spending by some PSEs, has been much higher.[110]

8.24 Iron and Steel

India is the world's third-largest producer of crude steel (up from eighth in 2003). India's crude steel capacity reached 109.85 Million Tonnes (MT) in 2014-15, a growth of 7.4%. Total finished steel production for sale increased by 5.1% to 92.16 MT in 2014-15. Consumption of total finished steel increased from 3.9 per cent to 76.99 MT in 2014-15.The steel sector in India contributes nearly 2% of the country's gross domestic product (GDP) and employs over 600,000 people. The per capita consumption of total finished steel in the country has risen from 51 Kg in 2009-10 to about 59 Kg in 2014-15.

[109] Article titled 'Leather exports fall below $6 bn mark', The Hindu, April 2016
[110] Article titled 'Aggressive on R&D', Financial Express, August 2015

Going forward, the Government of India is aiming to scale up steel production in the country to 300 MT by 2025 from 81 MT in 2013-14.[111] The Ministry of Steel has announced to invest in modernization and expansion of steel plants of Steel Authority of India Limited (SAIL) and Rashtriya Ispat Nigam Limited (RINL) in various states to enhance the crude steel production capacity in the current phase from 12.8 MTPA to 21.4 MTPA and from 3.0 MTPA to 6.3 MTPA respectively. Indian Companies plan to invest around Rs 2.94 trillion over the next decade to increase the country's steel capacity. The R & D efforts by the Indian steel companies out of their own corpus have mainly concentrated on improving internal processes related to saving costs and improving efficiency. Process improvements such as beneficiation and pelletization of iron ore have received good response in the industry. Adoption of continuous casting together with thin slab casting as well as dedicated technologies for harnessing the waste heat are drawing attention of the steel companies. These have led to improved productivity and energy efficiency in the Indian steel industries. However, there are certain constraints in raw material quality, particularly high Alumina in Indian iron ore and high ash in Indian coal, which adversely affect the techno economic performance of the whole industry. To address these constraints and also to sustain the projected high growth rate, there is an urgent need for concerted R&D and technology intervention in the iron and steel sector.

8.25 Mining

Mining sector is one of the core sectors of economy. It provides basic raw materials to many important industries. India is also the third largest coal producer, third largest steel producer, fourth largest Iron-ore producer globally and has the fifth largest Bauxite reserves in the world. With barely 20% of reserves mined, India presents a major opportunity for investors.[112] Mining sector (including fuel, atomic, major and minor minerals) contributed about 2.4% of GDP in 2014-15 as per the data released by Central Statistical Organization under Ministry of Statistics & Programme implementation.[113] The Government of India is focused on accelerating mineral exploration activity in the country through the National Mineral Exploration Policy (NMEP). The policy aims at making available geo-scientific data of world standards in the public domain, envisaging involvement of the private sector in carrying out quality research in the area of mineral exploration, while aiming for the creation of a dedicated geo-science database.[114]

8.26 Minerals

India has vast mineral potential with mining leases granted for longer durations of 20 to 30 years. India produces 88 minerals– 4 fuel-related minerals, 10 metallic minerals, 50 non-metallic minerals and 24 minor mineral. The mineral production witnessed 5% growth from INR 448407 crore in year 2012-14 to INR 470725 crore in Year 2014-16.[115] The Mining and

[111] India Brand Equity Foundation
[112] Report on 'Mining Sector- Achievements Report', Ministry of Mines, December 2016.
[113] Make in India Website
[114] Make in India Website
[115] Report on 'Mining Sector- Achievements Report', Ministry of Mines, December 2016

Mineral Statistics Division of Indian Bureau of Mines, functions as the nodal agency for statistics on mineral sector. India is also the third largest coal producer, third largest steel producer, fourth largest Iron-ore producer globally and has the fifth largest Bauxite reserves in the world. With barely 20% of reserves mined, India presents a major opportunity for investors. [116]

8.27 Sports Goods

India's sports goods industry is nearly a century old and has flourished, driven by a skilled workforce. Being labour-intensive in nature, the industry provides employment to more than 500,000 people. India's sporting goods are popular around the world and have made a mark in the global sports goods market. The domestic industry exports nearly 60% of its total output.[117]

The Ministry of Finance, after a series of meetings and discussions with different agencies including Reserve Bank of India (RBI), had decided that sports infrastructure will be included under the Harmonized Master List of Infrastructure Subsectors. It "includes the provision of Sports Stadia and Infrastructure for Academies for Training / Research in Sports and Sports-related activities".[118] This inclusion would encourage private investment in a public good which has socio-economic externalities in a country with young population. It will also bolster investment in sports infrastructure sector which will contribute to the economy and help in promotion of health and fitness of the people of this country and also provide employment opportunities in new and exciting sectors.

Services

8.28 Tourism

The Indian tourism and hospitality industry has emerged as one of the key drivers of growth among the service sector in India. The sector's total contribution to GDP is expected to grow to US$ 280.5 billion by 2026. India has moved up by 12 positions from 52nd rank in 2015 to 40th rank in 2017 in Travel & Tourism Competitiveness Index. As per the Ministry of Tourism, foreign tourists' arrival (FTAs) on e-tourist visa increased to 48.3 per cent year-on-year in December 2017. In 2017, a total of 16.97 lakh foreign tourists arrived on e-Tourist Visa as compared to 10.80 lakh in 2016, registering a growth of 57.2%.

There are very few institutions conducting research to facilitate the tourism sector in India. The ministry of tourism conducts numerous research work to analyze how tourism in India can be promoted. However, at state level there is an urgent need to promote tourism in India by building centers of excellence to conduct research and development activities.

[116] ibid
[117] India Brand Equity Foundation
[118] PIB, Ministry of Youth Affairs and Sports, September 2016.

8.29 Information Technology and IT Enabled Services (ITeS)

India is the topmost off shoring destination for IT – BPM companies across the world. Social, Mobility, Analytics and Cloud (SMAC) are collectively expected to offer a US$ 1 trillion opportunity. Cloud represents the largest opportunity under SMAC, increasing at a CAGR of approximately 30% to around US$ 650-700 billion by 2020. The social media is the second most lucrative segment for IT firms, offering a US$ 250 billion market opportunity by 2020. The Indian e-commerce segment is US$ 12 billion in size and is witnessing strong growth and thereby offers another attractive avenue for IT companies to develop products and services to cater to the high growth consumer segment.

Government of India is aimed at building a national resource for advancing the quality and quantity of R&D in Information and Communications Technologies and Electronics (IT). It also aims to focus on its applications at a steadily growing number of academic and research institutions; while strengthening academic culture of IT based problem solving and societal development.

8.30 Finance

India has a diversified financial sector undergoing rapid expansion, both in terms of strong growth of existing financial services in firms and new entities entering the market. The sector comprises commercial banks, insurance companies, non-banking financial companies, co-operatives, pension funds, mutual funds and other smaller financial entities. However, the financial sector in India is predominantly a banking sector with commercial banks accounting for more than 64% of the total assets held by the financial system. [119] As the industries providing financial services continue to offer homogeneous products and services, it is necessary to use research, product development and technology to create a distinct differentiation in product offerings. To achieve this, it will be necessary to create a unit whose efforts are focused specifically on aligning and matching products with consumer needs and using research and product development to deliver these products and services.[120]

Infrastructure

8.31 Power

India's renewable energy sector has been ranked third in the Renewable Energy Country Attractiveness Index (RECAI) with China at second and the US on top. Under the stewardship of Hon'ble Prime Minister Shri Narendra Modi, India has a target of 175 Gigawatt of installed capacity by 2022. India's total installed renewable energy capacity stands at close to 28GW which is nearly 22% of the proposed target. The overall investment to achieve the target would be around Rs 6 lakh crore (US$89.88 billion) at the rate of Rs 6 crore per MW at the present cost. India has attracted Rs 90,841 crore (around $14 billion) over the last 3

[119] India Brand Equity foundation
[120] An article by Saleema Barclay, Product Management Professional.

financial years in renewable energy investments, that is, between FY2013–14 and FY2015–16.

The Ministry of Non-Conventional Energy Sources has been supporting R&D for technology and manpower development in Renewable Energy. Present emphasis is on reduction in cost and increase in efficiency. For sustained development of this sector, efforts are being made so that Renewable Energy is driven to a large extent by the market and the consumer.

With a view to achieve this goal, the Ministry has evolved a policy for supporting research and development with close involvement of the industrial sector. It is hoped that there will be increased interaction and close co-operation between research and teaching institutions of the country - which are reservoirs of knowledge and experience. The Indian industries have the requisite entrepreneurship and market-orientation.[121]

8.32 Real Estate

The strength of the Indian economy and favorable demographics, coupled with the introduction of several growth oriented reforms, are aiding the real estate sector to attract higher investments. Indian real estate has attracted institutional investments (excluding bank credit to commercial real estate) of over US$ 10.7 billion, since the beginning of 2016, which is more than half of the total investments witnessed since 2013. The year 2017 is on its course to witness the highest annual investment in Indian realty in the past decade, with about US$5 billion worth of funds already been invested between January and June 2017. The share of real estate sector which includes ownership of dwellings accounted for 7.7 per cent in India's overall GVA in 2015-16.[122] The National Real Estate Development Council strives to be the collective force influencing and shaping the real estate industry. It seeks to be the leading advocate of developing standards for efficient, effective, and ethical real estate business practices, valued by all stakeholders of real estate sector and viewed as crucial to their success. NAREDCO works to create and sustain an environment conducive to the growth of real estate industry in India, partnering industry and government alike through advisory and consultative processes.[123]

8.33 Sectoral University Industry Linkages Scores

The sectoral[124] scores of UILs reveal that sectors such as IT & ITeS, Tourism and Textile have observed an average UIL score of more than 17. The agro and food processing registered a score of 15, agriculture and allied activities-14.1, drugs and pharmaceuticals- 13.8, automobile and auto components- 12.8, engineering- 11.5, power- 11.3, cement- 10.7 and

[121] R&D Focus Areas,MNRE Website

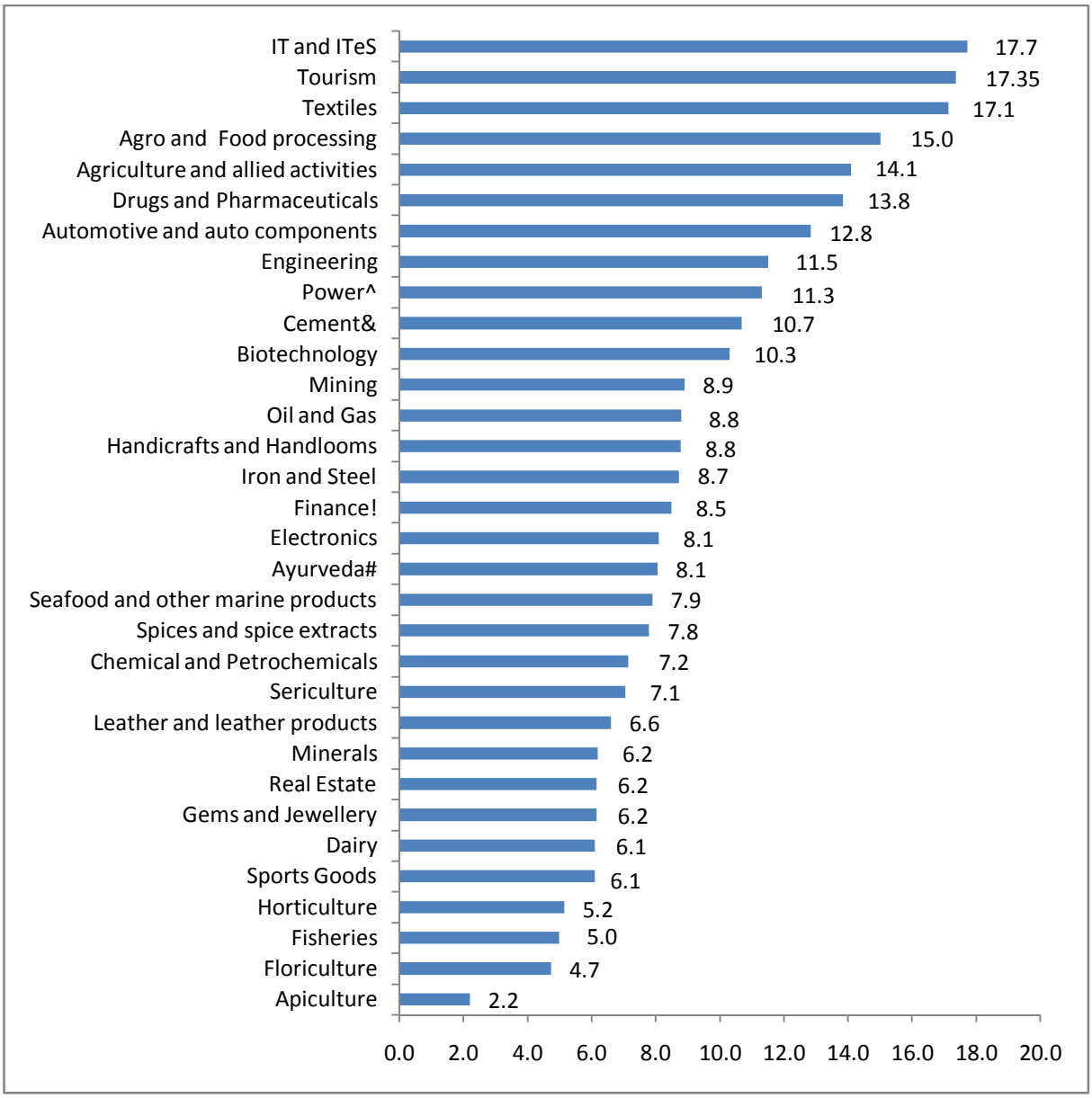
[122] Economic Survey 2017-2018.

[123] National Real Estate Development Council

[124] The sectoral scores have been arrived by first taking out the average UIL scores of sectors in each of the states and then summing up with their frequencies (their existence in the number of states). This is undertaken because few sectors were existing in only 1 or 2 states, so we considered frequencies to arrive at total score of each sector.

biotechnology- 10.3. The mining sector registered a score of 8.9, oil and gas- 8.8, handicrafts & handlooms- 8.8, iron and steel- 8.7, finance- 8.5, electronics- 8.1, ayurveda- 8.1, seafood and other marine products- 7.9, spices and spice extracts- 7.8, chemical and petrochemicals- 7.2, sericulture- 7.1, leather and leather products- 6.6, minerals- 6.2, real estate- 6.2, gems and jewellery- 6.2, dairy- 6.1 and sports goods- 6.1. The horticulture registered a score of 5.2, fisheries- 5, floriculture- 4.7 and apiculture- 2.2.

Graph 17: Sectoral University Industry Linkages Scores



Source: PHD Research Bureau, compiled from the study on Framework for University-Industry Linkages in Research, Note: * includes tea, bamboo, rubber, coir, fertilizers and forest based products, ^includes hydroelectric power, [&]includes limestone, [#]includes medicinal plants and Herbal Medical Industry, [!]includes banking and financial services.

8.34 Sectoral Complementarities Score of the University Industry Linkages

The level of University-Industry linkages for all the 32 sectors identified in the Indian economy have been found out on the basis of complementarity score that exists between the industry and the university. Complementarities in the study mean that if the research in university is useful in the states and vice-versa and if the existing industry is also facilitated by research institutes, centres for excellence and incubation centres; then complementarities exist between the university and the industry.

The average UIL score of all the 32 sectors identified has come out to be 9.2 which has been calculated taking the average of University-Industry complementarities scores of all the sectors. The all India score thus, shows moderate complementarities between university and industry.

The Tourism, Textiles, IT and ITeS industries with a complementarity score of '1' indicate very strong complementarities between the universities and these industries. The industries such as agro and food processing, Agriculture and allied activities, Power, Automobiles and auto components, Cement, Drugs and Pharmaceuticals, Engineering and Biotechnology with a complementarity score of '2' indicate strong complementarities between the universities and these industries. The industries such as Handicrafts and Handlooms, Sericulture, Mining, Iron and Steel, Leather and leather products, Minerals, Oil and Gas, Ayurveda, Chemical and Petrochemicals, Finance, Gems and Jewellery, Horticulture, Real Estate, Electronics, Seafood and other marine products, Spices and spice extracts, Sports Goods and Dairy with a complementarity score of '3' indicate moderate complementarities between the universities and these industries. The industries such as Floriculture, Fisheries and Apiculture with a complementarity score of '4' indicate weak complementarities between the universities and these industries.

Table 27: Sectoral Complementarity Score of the University Industry Linkages

S. No.	Sector/Industry	UIL Score	University-Industry Complementarity Score
1	Agriculture and allied activities*	14.1	2
2	Agro and Food processing	15	2
3	Tourism	17.35	1
4	Textiles	17.1	1
5	IT and ITeS	17.7	1
6	Power^	11.3	2
7	Automotive and auto components	12.8	2
8	Cement&	10.7	2
9	Drugs and Pharmaceuticals	13.8	2

10	Handicrafts and Handlooms	8.8	3
11	Engineering	11.5	2
12	Sericulture	7.1	3
13	Mining	8.9	3
14	Floriculture	4.7	4
15	Iron and Steel	8.7	3
16	Leather and leather products	6.6	3
17	Minerals	6.2	3
18	Oil and Gas	8.8	3
19	Ayurveda[#]	8.1	3
20	Biotechnology	10.3	2
21	Chemical and Petrochemicals	7.2	3
22	Finance[!]	8.5	3
23	Fisheries	5	4
24	Gems and Jewellery	6.2	3
25	Horticulture	5.2	3
26	Real Estate	6.2	3
27	Apiculture	2.2	4
28	Electronics	8.1	3
29	Seafood and other marine products	7.9	3
30	Spices and spice extracts	7.8	3
31	Sports Goods	6.1	3
32	Dairy	6.1	3
	Average Score of all the sectors	**9.2**	

Source: PHD Research Bureau, compiled from the study on Framework for University-Industry Linkages in Research, Note: * includes tea, bamboo, rubber, coir, fertilizers and forest based products, ^includes hydroelectric power, [&]includes limestone, [#]includes medicinal plants and Herbal Medical Industry, [!]includes banking and financial services,'1' stands for very strong complementarity between the University and the Industry and has been assigned to a value having UIL score which is 16 or more than 16, '2'stands for strong complementarity between the University and the Industry and has been assigned to a value having UIL score which is 5 or more than 11but less than 15, '3' stands for moderate complementarity between the University and the Industry and has been assigned to a value having UIL score which is 6 or more than 6 but less than 10, '4' here stands for stands for weak complementarity between the University and the Industry and has been assigned to a value having UIL score which is less than 5.


8.35 UIL Score of the top 10 sectors of the Indian Economy

So, out of all the 32 sectors identified, we have identified the top 10 sectors of Indian economy which are majorly present in almost all the states. The industries such as tourism, textile, IT and ITeS have very strong complementarities. The sectors such as Agriculture and Allied Activities, Agro & Food Processing, Power, Automobile and Automobile Components, Cement, Drugs and Pharmaceuticals have strong UILs whereas Handicrafts and Handloom has moderate linkages.

Table 28: UIL Score of the top 10 sectors of the Indian Economy (Brief Summary)

S. No.	Sector with UIL Score	Description about the Sector	Suggestions with Complementarity Score
1.	**Agriculture and Allied Activities*** **(14.1)**	Agriculture and Allied Activities Sector is prominent in the 11 states of Andhra Pradesh, Arunachal Pradesh, Kerala, Mizoram, Nagaland, Sikkim, West Bengal, Assam, Tripura, Punjab and Jharkhand.	The complementarity score in Agriculture and Allied Activities Sector is 2 indicating strong complementarities between the universities and the industries. So, the UIL in this sector needs to be strengthened.
2.	**Agro & Food Processing** **(15)**	Agro & Food Processing Sector is prominent in 10 states of Andhra Pradesh, Assam, Gujarat, Himachal Pradesh, Manipur, Uttarakhand, Bihar, Chhattisgarh, Goa, Haryana, Punjab, Tripura, Uttar Pradesh and Delhi.	The complementarity score in Agro & Food Processing Sector is 2 indicating strong complementarities between the universities and the industries.
3.	**Tourism** **(17.35)**	Tourism Sector is prominent in 13 states of Goa, Arunachal Pradesh, Himachal Pradesh, Jammu & Kashmir, Madhya Pradesh, Manipur, Meghalaya, Odisha, Rajasthan, Uttarakhand, Telangana, Bihar and Delhi.	The complementarity score in Tourism Sector is 1 indicating very strong complementarities between the universities and the industries. Therefore, the government should focus on strengthening the University Industry Linkages further in Tourism Sector.
4.	**Textiles** **(17.1)**	Textiles Sector is prominent in 12 states of Maharashtra, Arunachal Pradesh, Gujarat, Karnataka, Madhya Pradesh,	The complementarity score in Textiles Sector is 1 indicating very strong complementarities between

		Rajasthan, Telangana, Haryana, Bihar, Punjab, Tamil Nadu and Andhra Pradesh.	the universities and the industries.
5.	**Information Technology and IT Enabled Services (17.7)**	Information Technology and IT Enabled Services Sector is prominent in 11 states of Tamil Nadu, Delhi, Uttar Pradesh, Uttarakhand , Haryana, Bihar, Telangana, Rajasthan, Odisha, Karnataka and Andhra Pradesh.	The complementarity score in Information Technology and IT Enabled Services Sector is 1 indicating very strong complementarities between the universities and the industries.
6.	**Power^ (11.3)**	Power Sector is prominent in 7 states of Arunachal Pradesh, Meghalaya, Nagaland, Himachal Pradesh, Mizoram, Uttarakhand and Sikkim.	The complementarity score in Power Sector is 2 indicating strong complementarities between the universities and the industries. So, there is a need to strengthen UIL in this sector.
7.	**Automobile and Automobile Components (12.8)**	Automobile and Automobile Components Sector is prominent in 7 states of Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Haryana, Punjab and Tamil Nadu.	The complementarity score in Automobile and Automobile Components Sector is 2 indicating strong complementarities between the universities and the industries.
8.	**Cement& (10.7)**	Cement Sector is prominent in 7 states of Himachal Pradesh, Jharkhand, Madhya Pradesh, Rajasthan, Chhattisgarh, Tamil Nadu and Assam.	The complementarity score in Cement Sector is 2 indicating strong complementarities between the universities and the industries. So, the universities and industries in this sector need to collaborate and improve the R&D acitivities thereby improving the University Industry Linkages.
9.	**Drugs and Pharmaceuticals (13.8)**	Drugs and Pharmaceuticals Sector is prominent in 7 states of Goa, Maharashtra, Himachal Pradesh, Madhya Pradesh, Sikkim, Telangana and Andhra Pradesh.	The complementarity score in Drugs and Pharmaceuticals Sector is 2 indicating strong complementarities between the universities and the industries.


10.	**Handicrafts and Handloom (8.8)**	Handicrafts and Handloom Sector is prominent in 6 states of Jammu & Kashmir, Manipur, Meghalaya, Nagaland, Odisha and Tripura.	The complementarity score in Handicrafts and Handloom Industry Sector is 3 indicating moderate complementarities between the universities and the industries. Therefore, the government should focus on research centres with state of the art infrastructure in order to conduct research to provide support to the industrial clusters in this sector and vice versa so that UIL can be strengthened in this sector.

Source: PHD Research Bureau, compiled from the study on Framework for University-Industry Linkages in Research, Note: * Includes tea, bamboo, rubber, coir, fertilizers and forest based products, ^includes hydroelectric power, &includes limestone.

Table 29: Matrix of Sectoral University Industry Linkages Scores

S.No	State	Agriculture and allied activities*	Agro and Food processing	Tourism	Textiles	IT and ITeS	Power^	Automotive and auto components	Cement&	Drugs & Pharmaceuticals	Handicrafts and Handlooms	Engineering	Sericulture	Mining	Floriculture	Iron and Steel	Leather and leather products	Minerals	Oil and Gas	Ayurveda#	Biotechnology	Chemical and Petrochemicals	Finance!	Fisheries	Gems and Jewellery	Horticulture	Real Estate	Apiculture	Electronics	Seafood and other marine products	Spices and spice extracts	Sports Goods	Dairy
1	Karnataka				5.1	7.1		8.5				9.4									8.9												
2	Kerala	7.9																		7.1										6.9	6.8		
3	Gujarat		7.2		7.1							7.4										6			5.8								
4	Maharashtra				7			5.9		7.1									6.9				5.3										
5	Uttar Pradesh		6.8			6.8											5.2											7.1				5.1
6	Tamil Nadu				6.1	6.1		7.6	4.5			6.4																					
7	Delhi		4.9	4.5		7																	7.7				6.2						
8	Telangana			5.2	2.6	9.2				8.7								4.7															
9	Odisha			7.1		8					4			6.4		4.7																	
10	Andhra Pradesh		4.9		7.1	5.5				8.3							3.7																
11	Punjab	4.5	7.9		6.8			4.9																								5.1	
12	Himachal Pradesh		2.8	6.5			6.5		5.8	6.7																							
13	Uttarakhand		8.3	4.3		7.5	4.7					3.2																					
14	Haryana		8.8		2.6	5.1		8.7																			2.1						
15	Rajasthan			6	7.5	7.6			2.6																2.5								
16	West Bengal	2.4														7.5	1.9				7.7	4.3											
17	Chhattisgarh		3.9						3.3					3.6		5				6.5													
18	Madhya Pradesh			4.9	4.5			2.3	4.4	5.7																							
19	Jharkhand	3						3	2.8			6.1		6.4																			
20	Bihar		4.5	2.8	1.9	4													5.8													
21	Goa		2.6	1.6						5.7				3.1										5.1								
22	Tripura	4.0	1.9								4																						
23	Sikkim	3.1					4.7			5.7					2.2					1.6													
24	Jammu & Kashmir			6.3							2.3		3.3		1.6											3.2							
25	Meghalaya			2.3			5.7				3		2.3													3.1							
26	Assam	1.9	4.2						2.4				1.6						4.7														
27	Arunachal Pradesh	1.8		3.1	3.2		1.4											2.8															
28	Mizoram	1.6					3.9						1.6											0.9									
29	Nagaland	0.8					3.3				2.6				1.4													1.2					
30	Manipur		1.4	2							0.8		1.5					2.1															
	Average	3.1	5.0	4.4	5.1	6.7	4.3	5.8	3.7	6.8	2.8	6.5	2.1	4.9	1.7	5.7	3.6	3.2	5.8	5.1	8.3	5.2	6.5	3.0	4.2	3.2	4.2	1.2	7.1	6.9	6.8	5.1	5.1

Source: PHD Research Bureau, compiled from the study on Framework for University-Industry Linkages in Research, Note: * includes tea, bamboo, rubber, coir, fertilizers and forest based products, ^includes hydroelectric power, &include limestone, # includes medicinal plants and herbal medical industries, ! includes banking and financial servic

Chapter 9

Action Plan to improve University Industry Linkages in States

In the previous chapters 7 and 8, an analysis of university industry linkages in states and across the sectors has been conducted of which few states have a very strong university industry linkage namely Karnataka and Kerala followed by states having a strong UIL namely Gujarat, Maharashtra, Uttar Pradesh, Tamil Nadu, Delhi and Telangana, followed by states having moderate UIL such as West Bengal, Chhattisgarh, Madhya Pradesh, Jharkhand, Bihar, Goa Assam, Jammu & Kashmir. Further states with a weak UIL are Arunachal Pradesh, Mizoram, Nagaland and Manipur.

Across the various sectors identified, few of them have a very strong university-industry linkage such as electronics and biotechnology, followed by many sectors having a strong UIL such as agro and food processing, ayurveda, sports goods, dairy, textiles, chemical and petrochemicals, iron and steel, oil and gas, automotive and auto components, engineering, finance, IT and ITes, spices and spice extracts, drugs and pharmaceuticals, seafood and other marine products.

Sectors such as fisheries, agriculture and allied activities, horticulture, minerals, leather and leather products, cement, gems and jewellery, real estate, power, tourism and mining have a moderate UIL and very few sectors such as apiculture, floriculture, sericulture and handicrafts & handlooms sector have a weak university industry linkage.

After the analysis of sectors and states, an action plan for states is suggested in order to strengthen UILs in states which would lead to strengthening of university-industry linkages at the all-India level. Thus, to give the pinpoint suggestions for states, an analysis of incubation centres, centres of excellence and industrial clusters was done.

To conduct the analysis and provide suggestions, we have identified various industrial clusters in the states and have mapped the availability of centres of excellence, research centres with respect to those industrial clusters. An attempt has been made to find out the gaps in the industrial clusters and availability of centres of excellence in the same state. Accordingly, various suggestions for the state have been provided which will help strengthen the university-industry linkages in research in the respective state in the coming times.

Table 30: Steps to be taken

S. No.	State	Industry Cluster(s)	University	Incubation Centre(s)	Suggestions
1.	Karnataka Score in UIL: 7.8	The state has good chunk of industrial clusters. The total industrial clusters are at around 95 in the areas of agriculture implements, auto components, food processing, packaging, garments, leather, arecanut, printing, jaggery, textiles, foundry, rice mills, plastics, hosiery, and footwear among others.	The state is very good in the university education and research facilities and the state has top colleges in the areas of information technology, engineering, fashion technology, pharmaceuticals sector, management colleges, and institutes among others. The state has renowned institutes such as International Institute of Information Technology, Manipal Institute of Technology, National Institute of Fashion Technology, Indian Institute of Science, Christ University.	The state has a vast variety of incubation centres in the areas of IT, textiles, food processing, data analytics, automotive design, building technology, mobile applications, software, E-commerce, artificial intelligence hardware, sector agnostic E-marketing, electronics & IT, energy conversation, embedded systems, machine learning, healthcare, technology among others.	The state is very strong in university industry linkages and almost all industrial clusters are facilitated by incubation centers, research institutes, centers of excellence. Majorly dominant industries are food processing, garments, hosiery, printing, agriculture implements, and rice mills. Going ahead, the state needs to focus on building industrial clusters related to pharmaceuticals sector and research centers, centres of excellence related to machine tools, biotechnology, agriculture implements, food processing among others.

S. No.	State	Industry Cluster(s)	University	Incubation Centre(s)	Suggestions
2.	**Kerala Score in UIL: 7.3**	The state has good amount of industrial clusters. The total industrial clusters are at around 100 in the areas of diamond jewellery, rubber, coir, coconut oil, wood furniture, gold & silver jewellery, food processing, bricks, powerloom textiles, general engineering, ayurvedic & unani, readymade garments, footwear, plastics, among others.	The state has top colleges such as National Institute of Technology, Indian Institute of Science Education & Research, Indian Institute of Space Science & Technology, Kerala college of Agriculture, Indian Institute of Rubber and Indian Institute of Spices Research among others. The state has universities in the areas of rubber, coir, space technology, science, agriculture, ayurveda, marine, spices.	The state has huge chunk of incubation centres related to rural, green, information technology, IT products, SAAS, electronics, agriculture engineering, nano-tech, biotechnology, E-learning, bio informatics, social entrepreneurship, medical devices, biomaterials, healthcare among others.	The state has a very strong university industry linkage. The state has established industrial clusters in rubber, engineering equipment, food processing among others. The state is dominant in ayurveda therefore, the state should focus on developing incubation centres related to it in order to support the industrial clusters. The research activity is being conducted by various universities for sectors such as rubber, coir, spices. The state needs to focus on developing research centers, center of excellence related to various industries such as jewellery, wood furniture, plastics, footwear, food processing, coconut oil, bricks among others in order to improve the quality of existing industries.

S. No.	State	Industry Cluster(s)	University	Incubation Centre(s)	Suggestions
3.	**Gujarat Score in UIL: 6.7**	The state has good amount of industrial clusters. The state has around more than 100 industrial clusters. The industrial clusters are in the areas of pharmaceuticals, engineering, ceramics, fisheries, diamond jewellery, non - ceramic bricks, readymade garments, plastics, wood furniture, foundry, fish processing, power, surgical instruments, and agriculture among others.	The state has universities in the areas of food processing technology & bio energy, diamond & gems testing, chemicals, petrochemicals, engineering, technology. The state has top colleges namely Indian Institute of Technology, Indian Institute of Management, College of Agriculture & Engineering, Indian Diamond Institute.	The state has a wide variety of incubation centres. The incubation centers are in the areas of Information and Communication Technology, food processing, clean technologies, technology& innovation, comcubator, pharmaceutical, healthcare, education, transport, agritech, energy, hardware & manufacturing, energy & allied areas, E-commerce among others.	The state has large number of industrial clusters and a strong UIL. The state should focus on developing industrial clusters related to textiles, chemicals and petrochemicals. The state has universities conducting research in the areas of diamond jewellery, food processing. Therefore, the state needs to focus on developing research centres related to ship breaking, fish processing, foundry, marbles, and ceramics.

S. No.	State	Industry Cluster(s)	University	Incubation Centre(s)	Suggestions
4.	**Maharashtra Score in UIL: 6.4**	The state has at around 98 industrial clusters. The state has industrial clusters in the areas of textiles, electronics, food processing, leather, hosiery, machine tools, readymade garments, rubber, sea food, food processing, plastics, foundry, pharmaceuticals, floriculture, power loom, general engineering among others.	The state has top universities namely, Indian Institute of Quantitative Finance, The Institute of Pharmaceutical Education & Research, Dr. DY Patil School of Engineering, Indian Institute of Technology. The state also has various management colleges namely, IES Management College of Research & Centre, Lala Lajpat Rai Institute of Management among others. The state has universities, colleges in the areas of science, technology, designing, event management, research & entrepreneurship.	The state has many incubation centres in the areas of agnostic, NASSCOM 10000 Start Ups, IT and enabled technologies, Biotechnology, Ayurveda, Biomedicine, renewable energy, environment, project managements, data centers, education, agro & food processing technology, Cyber Security, textile and software among others.	The state has strong university industrial linkage and has industrial clusters related to almost all sectors. The state has various universities, colleges conducting research in the sectors of finance, fashion designing, pharmaceuticals, petroleum. The state should focus on developing research centres, centre of excellence related to sectors such as oil & gas, auto components, sea food, food processing, rubber, plastics, and floriculture among others.

S. No.	State	Industry Cluster(s)	University	Incubation Centre(s)	Suggestions
5.	**Uttar Pradesh Score in UIL: 6.2**	The state has approximately 150 industrial clusters. The industrial clusters are in the areas of rice mills, leather, stone, food processing, silk, foundry, textiles mustard oil, readymade garments, wood products, mechanical engineering, powerloom textiles, pharmaceuticals, defence related textiles, agriculture implements, wood craft, footwear among others.	The state has various universities related to leather, agriculture, engineering, food processing, plastics, technology, various management and designing colleges. The state has various top colleges namely, Indian Institute of Technology Kanpur and Varanasi, Government Leather Institute, University Department of Food Process Engineering, Indian Grassland and Fodder Research Institute among others.	The state has wide variety of incubation centres related to textile, apparel, diary, solar, technology, electrical vehicles, pharmaceuticals, agriculture, IT, biomedical engineering, healthcare, handicraft, sports goods, leather, agnostic, mechanical and electronics.	The state is strong in university industry linkages. The state has many industrial clusters. There are many universities, colleges, research institutes providing support to the industrial clusters such as agriculture, plastics, leather, IT. The state should focus on developing research centres, related to sectors such as food processing, wood products. The state should also focus on strengthening the plastics and dairy industry, as colleges related to these sectors are present in the state.


S. No.	State	Industry Cluster(s)	University	Incubation Centre(s)	Suggestions
6.	**Tamil Nadu Score in UIL: 6.1**	The state has a wide variety of industrial clusters. The industrial clusters are around 100. The state has various industrial clusters related to auto components, pharmaceuticals, engineering, rubber, rice mills, leather, textiles, readymade garments, coir, dyeing, and agriculture implements among others.	The state has top colleges namely, Madras Institute of Technology, SRM Institute of Science and Technology, Coimbatore Institute of Technology. The state has universities related to textiles, technology, science, engineering.	The state has incubation centres in the areas of biotech, information communication and technology, electronics, IT, medical devices, computer science, aeronautical engineering, agro, bio and food technologies, herbal products, manufacturing, bioinformatics, exploitive micro-biology, healthcare, waste management, bio waste, civil engineering, renewable energy among others.	The state is strong in university industry linkages. The state has many universities providing research support to sectors such as technology, textiles, engineering, and science. The state needs to focus on developing research centres, and centre of excellence for sectors such as rice mills, coir, and machine tools, among others. The state should also focus on strengthening university industry linkages in pharmaceuticals as the state has many universities, colleges related to pharmacy.

S. No.	State	Industry Cluster(s)	University	Incubation Centre(s)	Suggestions
7.	**Delhi** **Score in UIL: 6.1**	The state has many industrial clusters in the areas of rubber, readymade garments, electronics, engineering, home furnishing, light engineering, footwear, printing, auto components, food processing among others. The state has at around 20 industrial clusters.	The state has top universities, colleges, namely University of Delhi, Indian Institute of Technology, Indian School of Business & Finance, Indian Agricultural Statistics Research Institute. The state has many management colleges, tourism & travel management institutes, real estate among others.	The state has many incubation centre related to nanomaterials & composite technologies, electronics & ICT, E-waste, embedded systems, mobile computing, web technology, digital image processing, power systems, food & dairy products, bioinformatics, agriculture & allied sectors.	The state has many industrial clusters related to almost all sectors. The state has many universities, colleges related to technology, agriculture, real estate, managements, tourism and other courses. The state should focus on developing more industrial clusters related to pharmaceuticals in order to strengthen university industry linkages.

S. No.	State	Industry Cluster(s)	University	Incubation Centre(s)	Suggestions
8.	**Telangana Score in UIL: 6.1**	There are very few industrial clusters present in the state. The state has industrial cluster related to automotive & engineering and agri seeds.	The state has many universities in the areas of technology, pharmaceutical, tourism & hospitality, fashion technology. The state has top colleges, universities namely International Institute of Information technology, SRR College of Pharmaceutical Sciences, CMR Engineering College, National Institute of Agricultural Extension Management among others.	The state has wide variety of industrial clusters in the areas of agriculture, embedded systems, VLSI Designs, computer vision, natural languages, speech recognition, Agnostic, T and enabled technologies, pharmaceuticals, biotechnology, renewable energy, eco friendly products.	The state has a strong university industry linkage. The state has many universities, colleges conducting research in sectors such as technology, pharmaceutical among others. The state should focus on developing more industries related to sectors namely, agriculture, pharmaceuticals, minerals, textiles, biotechnology, and renewable energy as there are many incubation centres available.

S. No.	State	Industry Cluster(s)	University	Incubation Centre(s)	Suggestions
9.	**Odisha Score in UIL: 6**	The state has at around 70 industrial clusters in the state. The industrial clusters present in the state are in the areas of engineering & fabrication, cashew, food processing, spices, rice mills, turmeric processing, powerloom textiles, plastics, foundry, pharmaceuticals, maize processing, terracotta among others.	The state has many universities, colleges related to engineering, technology, science, tourism among others. The state also has many management colleges. The top colleges in the states are National Institute of Science and Technology, Indira Gandhi Institute of Technology, NIIS Institute of Information Science and Management among others.	The state has many incubation centres in the areas of Biotech, Internet Startup, Engineering Industry, Functional food, Bioinformatics, Agri-tech & information technology, electronics & engineering products, among others.	The state is strong in university industry linkage. The state has many industrial clusters and universities, colleges conducting research in the areas of tourism, management, technology, engineering, handicrafts. The state should focus on developing incubation centres, centres of excellence, research institutes, in the areas of textiles, mining, plastics, rice mills iron and steel in order to strengthen these industries.


S. No.	State	Industry Cluster(s)	University	Incubation Centre(s)	Suggestions
10.	**Andhra Pradesh Score in UIL: 5.9**	The state has at around 85 industrial clusters. The state has industrial clusters in the areas of general engineering, coir, fibre glass, plastics, readymade garments, pharmaceuticals, foundry, textiles, rice mills, auto components, food processing, fruit processing and agri seed producers among others.	The state has many universities, colleges in the areas of engineering, food processing, pharmaceuticals, information technology, textiles. The top colleges in the state are Andhra University College Of Engineering For Women, Gandhi Institute of Technology and Management, Indian Institute of Information Technology, Government Institute of Textile Technology, College of Food Science and Technology among others.	The state has very few incubation centres in the areas of agri business incubator, life science.	The state has a strong university industry linkage. The state has wide variety of industrial clusters related to almost all sectors. The state has many universities, colleges also but it should focus on developing more incubation centres in order to support the R&D activities in the state. The sectors to be focused upon are granite, leather, information technology, fiber, coir, plastics.

S. No.	State	Industry Cluster(s)	University	Incubation Centre(s)	Suggestions
11.	**Punjab Score in UIL: 5.8**	The state has at around 80 industrial clusters. The state has clusters in the areas of agricultural implements, hi-tech metal, hosiery, re-rolling, footwear, foundry, auto components, tractor parts, general engineering, textiles, wood products, knitwear, and food products among others.	The state has many universities, colleges in the areas of agriculture, engineering, aeronautics, fashion technology, textiles, and technology among others. The state also has top universities, colleges namely, University of Technology, Punjab Agricultural University, Northern Indian Textile Research Association, Punjab Aircraft Maintenance Engineering College, Punjab State Aeronautical Engineering College among others.	The state has very limited incubation centres in the areas of mechanical, IT, biotechnology, electronics.	The state has a strong university industry linkage. The state has good amount of universities, colleges supporting the industrial clusters. Therefore the state should focus on developing research centre in the sector of sports goods. The state should also focus on developing the aeronautical industry as it has huge potential for growth.

S. No.	State	Industry Cluster(s)	University	Incubation Centre(s)	Suggestions
12.	**Himachal Pradesh Score in UIL: 5.7**	The state has at around 10 industrial clusters. The industrial clusters are in the areas of garments, food processing, stone crushing, light engineering, wood sawn, pharmaceuticals, and furniture among others.	The state has good amount of universities, college in the areas of technology, management, engineering, pharmaceuticals. The state has some of the top colleges namely National Institute of Technology, Jaypee University of Information Technology, Himachal Pradesh Agricultural University, Himachal Institute of Pharmaceutical Education & Research among others.	The state has only one incubation centre- National Small Industries Corporation Limited.	The state has a strong university industry linkage. The state has universities also. The state needs to focus on developing universities, colleges, research centres in the sectors of food processing, stone, crushing, wood furniture. The state also needs to focus on developing more incubation centres. The state also needs to focus on developing research training and vocational institutes, in order to develop the tourism.

S. No.	State	Industry Cluster(s)	University	Incubation Centre(s)	Suggestions
13.	**Uttarakhand Score in UIL: 5.6**	There are very few industrial clusters in the state. The state has industrial clusters in the areas of pharmaceuticals, survey instruments, rice mills, textiles.	The state has many renowned universities, colleges in the areas of hydropower technology, agriculture, and technology. The state has some of the top colleges namely, JB Institute of Technology, Indian institute of Technology, University of Petroleum and Energy Studies. There are some management institutes also.	There are many incubation centres in the state related to innovation and entrepreneurship, information & communication technology, bio technology, manufacturing & engineering, micro & nano electronics, water, sanitation, housing urban & rural, renewable energy among others.	The university industry linkage in the state is strong. The state has good amount of universities related to many sectors. The state should focus on developing more industrial clusters. The state has huge potential in pharmaceuticals, textiles, IT & ITeS. Therefore, the state needs to focus on developing research centres, centre of excellence which will provide support to these industrial clusters.

S. No.	State	Industry Cluster(s)	University	Incubation Centre(s)	Suggestions
14.	**Haryana Score in UIL: 5.5**	The state has around 55 industrial clusters. The state has industrial clusters in the areas of auto components, foundry, light engineering, stone crushing, electronics, footwear, leather products, readymade garments, pharmaceuticals, agricultural implements, textiles engineering, wood furniture, chemicals among others.	The state many renowned universities, colleges in the areas of engineering, automotive, agricultural engineering, technology. Some of the top universities in the state are International Center for Automotive Technology, KIIT College of Engineering, Technological Institute of Textiles & Sciences, College of Agricultural Engineering & Technology among others.	The state has very few incubation centres in the areas of dairy technology, internet & mobile, technology.	The state has a strong university industry linkage. The state has many universities supporting through research to the industrial clusters. The state needs to focus on developing more incubation centres. The state also needs to focus on developing more industrial clusters related to engineering, real estate, food processing among others.

S. No.	State	Industry Cluster(s)	University	Incubation Centre(s)	Suggestions
15.	**Rajasthan Score in UIL: 5.2**	The state has approximately 75 industrial clusters. The state has industrial clusters in the areas of leather, agricultural implements, food processing, foundry, mechanical engineering, readymade garments, re-rolling, wires & cables, auto components, chemicals, oil mils, powerloom textiles, footwear among others.	The state has top colleges, universities namely Indian Institute of Information technology, Indian Institute of Gems and Jewellery. The state has good amount of hospitality and management colleges also.	The state has very less incubation centres in the areas of agnostic and embedded systems & VLSI.	The state is strong in university industry linkages. The state should focus on developing incubation or research centres in the areas of textiles, tourism, gems & jewellery, as they have huge potential in the state. The state should also focus on developing on research institutes, centre of excellence related to food processing, in order to boost the sector.


S. No.	State	Industry Cluster(s)	University	Incubation Centre(s)	Suggestions
16.	**West Bengal Score in UIL: 4.7**	The state has at around 70 industrial clusters. The state has a wide variety of industrial clusters in the areas of hosiery, mechanical engineering, food processing, leather products, gold & silver jewellery, tea processing, foundry, silk printing, readymade garments, powerloom textiles, among others.	The state has many universities in the areas of agriculture, genetic engineering, leather technology, engineering, science and technology. The state has many top management colleges namely Indian Institute of Management, Army Institute of Management. The state also has renowned institutes such as Darjeeling Tea Research and Management Association, Institute of Genetic Engineering among others.	The state has very few incubation centres in the areas of innovation, technology incubation and entrepreneurship, start ups warehouse, green technology among others.	The state has moderate university industry linkage. The state has many universities supporting the various industrial clusters in the state. The state has very limited incubation centres therefore more focus should be on developing the incubation centres. The state should also focus on developing more research centres, centre of excellence in order to support silk, biotechnology, chemicals & petrochemicals, hand tools, silvery jewellery, rubber industrial clusters.

S. No.	State	Industry Cluster(s)	University	Incubation Centre(s)	Suggestions
17.	**Chhattisgarh Score in UIL: 4.5**	The state has very few industrial clusters at around 10. The state has industrial clusters in the areas of bricks, rice mills, re-rolling, fabrication, general engineering, agricultural implements, foundry, footwear.	The state has many universities, colleges in the areas of technology, engineering, ayurveda, management, agriculture. Some of the renowned colleges, universities in the state are National institute of Technology, Chhattisgarh Ayurved Medical College, Indira Gandhi Krishi Vishwavidyalaya.	The state has very limited incubation centres in the areas of information technology and start up.	The state has a moderate university industry linkage. The state has many universities, colleges related to the various industrial clusters in the state. The state should focus on developing more incubation centres in order to support the industrial clusters. The state should focus on developing industries related to herbal medicines, mining. The state should also focus on developing research institutes, centre of excellence in order to support industrial clusters such as, footwear, garments, bricks, rice among others.

S. No.	State	Industry Cluster(s)	University	Incubation Centre(s)	Suggestions
18.	**Madhya Pradesh Score in UIL: 4.3**	The state has at around 60 industrial clusters. The state has a wide variety of industrial clusters in the areas of silk handloom, garments, textiles, agricultural implements, footwear, mini cement plants, auto components, powerloom textiles, foundry, pharmaceuticals, and food processing, leather products among others.	The state has universities, colleges in the areas of technology & science, fashion technology, pharmaceutical, tourism, and management among others. Some of the top colleges in the state are Maulana Azad National Institute of Technology, Indian Institute of Science Education and Research, Central Institute of Agricultural Engineering, International Institute of Fashion Technology.	The state has only one incubation centre related to ITES & products.	The state has a moderate university industry linkage. The state has limited incubation centres therefore the state should focus on developing more incubation centres in order to support the existing industrial clusters. The state should also focus on developing centre of excellence, research centres in order to support the various industrial clusters such as rice, silk, plastics, auto components among others.

S. No.	State	Industry Cluster(s)	University	Incubation Centre(s)	Suggestions
19.	**Jharkhand Score in UIL: 4.2**	The state has approximately 20 industrial clusters. The state has industrial clusters in the areas of brass & bronze utensils, auto components, engineering, refractory, wood products, mini cements plants, garments, food processing.	The state has many universities, colleges in the areas of mining, technology, agriculture, civil engineering among others. The state has various top colleges such as Birla Institute of Technology, Indian Institute of Agricultural Biotechnology, Institute of Mining and Mine Surveying.	The state has only one incubation centre in the area of mechanical.	The state has a moderate university industry linkage. The state needs to focus on developing more incubation centres. The state should also focus on developing industry clusters related to mining, fertilizers, cements among others. The state should also focus on developing research centres, colleges in the areas of engineering, auto components, brass & bronze utensils in order to support these existing industrial clusters.

S. No.	State	Industry Cluster(s)	University	Incubation Centre(s)	Suggestions
20.	**Bihar Score in UIL: 3.8**	The state has at around 40 industrial clusters. The state has industrial clusters in the areas of food processing, rice mills, mustard oil, garments, brass utensils, herbal & aromatics plants, leather footwear, chemical cluster, agricultural implements, bee keeping among others.	The state has renowned universities namely, Bihar Institute of Silk and Textiles, National Institute of Technology, Bihar Agriculture University. The state has universities in the areas of tourism, management, fashion technology,.	The state has very few incubation centres in the areas of industrial, entrepreneurship association and business.	The state has a moderate university industry linkage. The state should focus on developing more incubation centres supporting the existing industrial clusters and universities. The state should focus on developing industrial clusters related to oil & gas, IT& ITeS. The state should focus on developing research institutes in order to support industrial clusters namely rice, leather, herbal & aromatic plants, bee keeping among others.

S. No.	State	Industry Cluster(s)	University	Incubation Centre(s)	Suggestions
21.	**Goa Score in UIL: 3.6**	The state has very few industrial clusters in the areas of food processing, pharmaceuticals, gold & silver jewellery, and cashew.	The state has many renowned universities in the areas of tourism, agriculture, engineering, pharmaceuticals. The state also has many management and maritime study institutes. Some of the top colleges in the state are Goa College of Engineering, Institute of Maritime Studies, Goa College of Architecture, Goa Institute of Management.	The state has very less incubation centres in the areas of information & communication technology, food processing and clean technologies.	The state has a moderate university industry linkage. The state has many universities supporting the industrial clusters. The state should focus on developing more incubation centres and industrial clusters related to fishing, mining among others. The state should also focus on developing research centres and industries related to cashew, tourism, food processing.


S. No.	State	Industry Cluster(s)	University	Incubation Centre(s)	Suggestions
22.	**Tripura Score in UIL: 3.5**	The state has very few industrial clusters in the areas of hosiery, rice mills, bricks, agarbatti sticks, and paper bags.	The state has many universities in the areas of agriculture, technology, bamboo & cane, rubber, engineering, handicrafts. The state also has management colleges. Some of the top colleges in state are College of Agriculture, National Institute of Technology, Department of B.Voc Rubber Technology, Bamboo & Cane Development Institute among others.	The state has only one incubation centre in the area of small industries corporation cum training centre.	The state has a moderate university industry linkage. The state has very few industrial clusters and incubation centres. The state has universities related to almost all sectors. The state should focus on developing industrial clusters in the sectors of food processing, bamboo, rubber, handicrafts & handlooms among others.


S. No.	State	Industry Cluster(s)	University	Incubation Centre(s)	Suggestions
23.	**Sikkim Score in UIL: 3.4**	The state has very few industrial clusters in the areas of cane & bamboo, woodwork & lacquerware, embroidery, miniature painting and painted woodwork.	The state has many universities, colleges in the areas of floriculture, ayurveda, tea, pharmaceuticals, technology. Some of the renowned university in the state are Himalayan Pharmacy Institute, Darjeeling Tea Research & Management Association, National Institute of Technology Sikkim, Regional Ayurveda research Institute among others.	The state has only one incubation centre in the area of entrepreneur activity.	The state has a moderate university industry linkage. The state has universities related to major sectors. The state should focus on developing more incubation centres and industrial clusters in the sectors of pharmaceuticals, floriculture, ayurveda, hydropower among others.


S. No.	State	Industry Cluster(s)	University	Incubation Centre(s)	Suggestions
24.	**Jammu & Kashmir Score in UIL: 3.3**	The state has at around 10 industrial clusters. The state has industrial clusters in the areas of rice mills, cricket bats, mustard oil, wood products, oil mills, steel re-rolling, garments, utensils, wood furniture, agro based and cement.	The state has many universities in the areas of agriculture, sericulture, engineering, handicrafts. The state has renowned universities, colleges such as Central Sericulture Research & Training Institute, National Institute of Technology, Craft Development Institute, University of Agricultural Sciences and Technology.	The state has very few incubation centres in the areas of biotechnology, engineering (electronics, robotics, e-commerce, business development.	The state has a moderate university industry linkage. The state has many universities related to all the sectors. The state should focus on developing more incubation centres. The state should also focus on developing sericulture, floriculture, horticulture handicrafts & handlooms clusters. The state should also focus on developing more research institutes related to rice mills, agro based, wood products among others.

S. No.	State	Industry Cluster(s)	University	Incubation Centre(s)	Suggestions
25.	**Meghalaya Score in UIL: 3.2**	The state has very few industrial clusters in the areas of footwear, cashew and black smith.	The state has many renowned universities namely, Indian Council of Agricultural, National Institute of Technology, Regional Institute of Science, National Institute of Fashion Technology. The state has many other universities in the areas of engineering, agriculture.	The state has only one incubation centre in the area of information technology.	The state has a moderate university industry linkage. The state has very few industrial clusters and incubation centre thus, the state should focus on developing more of clusters and centres in the areas of tourism, handicrafts & handloom, horticulture, sericulture among others. The state should also focus on developing research centres for cashew, footwear industry.

S. No.	State	Industry Cluster(s)	University	Incubation Centre(s)	Suggestions
26.	**Assam Score in UIL: 3**	The state has approximately 10 industrial clusters. The state has industrial clusters in the areas of food processing, garments, rice mills, brass utensils, jute, tea, cane, bamboo, terracotta, pottery among others.	The state has many universities in the areas of management, agriculture, tea, engineering, sericulture, technology. Some of the renowned universities, colleges in the states are College of Sericulture, Tea Research Institute, Central Institute of Technology, NEF College of Management & Technology, Assam Agricultural University among others.	The state has very few incubation centres in the areas of IT, healthcare, renewable energy, and mechanical.	The state has a moderate university industry linkage. The state has a good chunk of universities, colleges related to major sectors. The state should focus on developing industrial clusters in the areas of oil & gas, limestone, cements, sericulture. The state should also focus on developing centre of excellence, research centres related to food processing, rice, pottery, terracotta, tourism as they are the growing sectors.

S. No.	State	Industry Cluster(s)	University	Incubation Centre(s)	Suggestions
27.	**Arunachal Pradesh Score in UIL: 2.4**	The state has only one industrial cluster related to food processing.	The state has many universities in the areas of technology, power, tourism, textiles, leather and IT among others. Some of the renowned universities in the state are National Institute of Technology, Himalayan University.	The state has only one incubation centre related to business.	The university industry linkage in the state is weak. The state has only one industrial cluster and incubation centre. The state has many universities related to major sectors. There is a need for this state to focus on developing more industrial clusters and incubation centres related to textiles, power, tourism, minerals, forest and agriculture among others.

S. No.	State	Industry Cluster(s)	University	Incubation Centre(s)	Suggestions
28.	**Mizoram Score in UIL: 2**	The state has only two industrial clusters in the areas of cane, bamboo and wood carving.	The state has many universities, colleges in the areas of bamboo, engineering, technology, agriculture, fisheries. The state has renowned universities namely Bamboo& Cane Development Institute, College of Fisheries, Mizoram School of Engineering & Technology among others.	The state has only one incubation centre related to apparel manufacturing.	The state has a weak university industry linkage. The state should focus on developing more incubation centres. The state should also focus on developing industrial clusters related to fisheries, food processing, agriculture, handicrafts & handlooms, horticulture, tourism and engineering among others. The state should also focus on developing a research centre related to wood products.

S. No.	State	Industry Cluster(s)	University	Incubation Centre(s)	Suggestions
29.	**Nagaland Score in UIL: 1.8**	The state has estimated around 7 industrial clusters. The state has industrial clusters in the areas of food processing, steel fabrication, tea processing, bee keeping, honey processing.	The state has renowned universities, colleges namely Nagaland University, National Institute of Technology, Department of Horticulture, Nagaland Development Bamboo Agency. The areas of the universities, colleges are handicrafts, hydropower, bamboo, sericulture, apiculture, floriculture among others.	The state has only one incubation centre related to business.	The state has a weak university industry linkage. The state should focus on developing more incubation centres. The state should focus on developing industrial clusters in the areas of handicrafts, hydropower, apiculture, floriculture and bamboo. The state should also focus on developing research centres related to various industrial clusters such as bee keeping, honey processing among others.

S. No.	State	Industry Cluster(s)	University	Incubation Centre(s)	Suggestions
30.	**Manipur Score in UIL: 1.5**	The state has approximately 7 industrial clusters. The state has industrial clusters in the areas of jewellery, food processing, rice mills, garments, forest based furniture, iron & steel fabrication.	The state has universities, colleges in the areas of agro & food processing, handicrafts, tourism, sericulture and minerals among others. Some of the renowned university, colleges in the state are Central Agricultural University, Manipur Institute of Technology, Regional Institute of Medical Sciences.	The state has only one incubation centre in the area of entrepreneurship.	The state has a weak university industry linkage. The state has many universities, colleges related to different sectors. The state should also focus on developing incubation centres related to medicinal equipments. The state should also focus on developing industrial clusters and research centres related to sericulture, handicrafts & handlooms.

In a nutshell, the states with strong complementarities of universities and industries are found having strong in establishing university – industry linkage. There are a few states in which the universities and industries are of similar nature and they facilitate each other. For example, automobile is facilitated by centre of excellence, universities and incubation centers. On the same lines, if specialized institutions are majorly of the engineering background, then the concentration of engineering clusters are also found in the peripheries.

However, in most of the states a mismatch has been observed as the nature of universities, centre of excellence and incubation centers is different from the existing industrial clusters. State-wise specific suggestions were given. Where industries and incubation centers are present but universities are not functional, the government should focus on opening more universities which will conduct research for those industries. The suggestions made are in order to strengthen the university-industry linkages for the effective utilization of research activities undertaken by the industrial firms in the state.


Chapter 10

Employment Generation and UILs

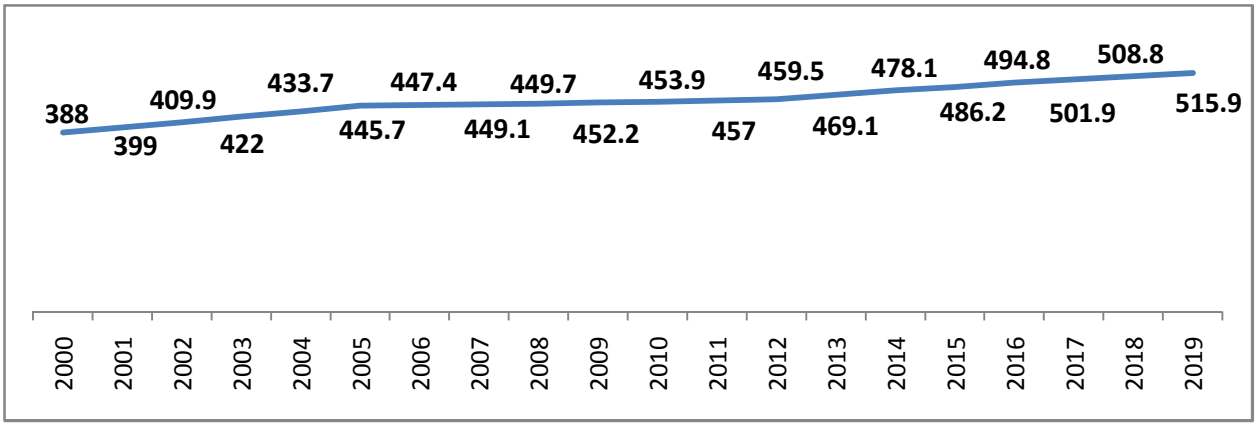
10.1 Employment Scenario in India

India has experienced rapid economic growth, urbanization and structural shifts in the economy in the past few years. One of the sharpest driving forces through which economic growth translates into prosperity for the population is the number of people employed in that particular country. In a developing economy, growth of employment with rising productivity provides various mechanisms to the poor people to participate in the growth process and improve their standard of living. From a long term perspective, high economic growth contributing to the development of the nation should be accompanied by quality employment opportunities. Thus, attaining economic growth with equity and alleviating poverty from the economy can be somehow achieved through generating employment opportunities.

India's experience of rapid economic growth has led to structural shifts in the economy and contributing to an increase in the level of education and rapid urbanization. Quality employment generation is an even more powerful tool for a nation like India as it is projected to be the largest young population nation in the world by the year 2020. In response to this statement, the Government of India has taken various initiatives to boost the employment generation opportunities for the youth of the nation. 'Start-up India', 'Make in India' and 'Skill India' are some of the schemes introduced by the government to unleash the entrepreneurial skills of the youth and provide them a platform from being a job seeker to job creator.

Given that one of the greatest challenges in India is the lack of skilled workforce, thus it is important to analyze the current scenario of employment in our country. Historically speaking, the structural increase in employment in India has been very slow. But it seems to have accelerated a bit since 2000s. Figure 1 depicts the number of people employed in India.

Graph 18: Employment in India **(in million)**



Source: PHD Research Bureau, data compiled from International Labour Organisation (ILO)

The total employment in India increased from 388 million in 2000 to 501 million in 2017 and is estimated to reach at 515 million by the year 2019. From a longer term perspective, the employment generation opportunities for men have grown faster as compared to that of women. In this regard, male employment grew from 279.7 million in 2000 to 379.5 million in 2017 while female employment grew from 108.3 million in 2000 to mere 122.4 million in 2017.

Changes in the employment status of an economy are linked to the process of structural transformation, with a shift in the resources from low-productive to high-productive sectors. In India, this transformation has not taken place to the same extent as the agriculture sector; still it employed 214.5 million of the population in the year 2017 in comparison to the services and industry sector which employed 168 million and 125.2 million of the population. Thus, in India, a large share of the population is still dependent on agriculture for employment.

In this context, the focus of the government is to increase the level of employment in the industry and services sector of the economy. The aim of Government in India's 'Make in India campaign' is to make India a manufacturing hub and create employment for 100 million job seekers by the year 2022 in the manufacturing sector.

Major employment generation schemes introduced by the government are Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), PRIME Minister Employment Generation Programme (PMEGP), Swaranajayanti Gram Swarozgar Yojna (SGSY) and Swarna Jayanti Shahari Yojna (SJSRY). Besides these schemes there are some other schemes of the Centre/State governments from which 1.5 percent households have been benefitted.

In addition to this, various announcements have been made by the government in the Union Budget 2018-19 in order to improve the status of employment in the country. The proposal to set up state-of-the-art testing facilities in all the forty two Mega Food Parks and exports of agri-commodities will be liberalized to realize the agri-exports potential which is as high as US $ 100 billion as against the current exports of US $ 30 billion and is likely to create immense employment opportunities for the individuals. The budget provision of Rs 48,000 crore under Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) has been increased to Rs 55,000 crore in 2018-19 which is expected to facilitate employment generation in the rural areas. At the all India level, 21.9% households were found to have benefitted from MGNREGA.

A sum of Rs 3,794 crore to Micro small and medium enterprises (MSMEs) will be provided for giving credit support, capital and interest subsidy and for innovations as MSME is a major driver for employment generation in India. Target for lending under Micro Units Development and Refinance Agency Limited (MUDRA) for the year 2018-19 will be increased to Rs 3 lakh crore which is a major driver for employment creation as more than 60 million micro units support over 100 million people for their jobs and livelihood.


Indian government has taken various major initiatives to improve the living standards of its people by providing employment opportunities to them through various schemes. But the picture as a whole depicts that these schemes and initiatives taken up by the government are not enough for an ever growing young population in the economy. At this juncture, strengthening the University-Industry linkage is important to make the population capable of doing a job in the industry and other related segments.

10.2 Hypothesis

At this backdrop, it becomes essential to know the drivers of employment creation. As University Industry Linkages (UILs) are important for the promotion of employment opportunities in the economy, it is interesting to know about how the linkages between University and Industry are becoming fruitful for the generation of employment in the economy.

The empirical explanation to test the efficacy of the University-Industry linkage in generating employment in the country is presented in this part of the chapter. Here the following hypothesis is intende to be tested

- ***Industry consultation in setting of pedagogy, Working on gaining patents, Regular interaction with industry, Student's internship, Providing specific solutions to industry and links with industry influences the level of placement in a university***

This hypothesis has been verified empirically based on the methodology and data used.

10.3 Data Collection

Primary data has been taken into consideration to perform the analysis of various indicators on the level of placement in a university in Indian states. Primary data comprise of in-depth conversation with the universities covering various states and union territories of India.

10.4 Data Variables

1. **Industry consultation in setting up of pedagogy**
   While setting up their course structure, the universities consult the industries with a subsequent emphasis on industry consulting issues. The main aim to consult the industries is to develop proficiencies in a range of skills required to work in an industry as it helps to enhance placement and career opportunities in the industrial sector.


2. **Working on gaining patents**
   Trade off between providing new ideas and information by the universities to the industries are promoted to commercialize university research and foster economic growth. Lock up of inventions by the universities and industries results in academic discoveries and benefits the stakeholders of the industries.

3. **Regular interaction with industry**
   Through interacting with industries in various activities, the universities can gain knowledge on the current technologies being used in the industries and thus, adapt their curriculum to meet the needs of the industry. They can further receive assistance from the industries to design their research projects.

4. **Student's Internship in industry**
   An experience of internship in an industry is the key to placement from a university. An internship provides an exposure to the real world problems and issues that can not be gained from textbooks. It further eases the transition from being a student to entering the workforce.

5. **Providing specific solutions to the industry**
   Providing specific solutions to the industry by the universities is an important component that influences the level of placement in a university. Academic institutions have a unique capability to transfer their knowledge to the industries to make them move forward by guiding them on various issues.

6. **Links with industry**
   The linkage projects schemes between industries and universities by taking up joint research activities, signing of long term MOUs with the industries, continuous participation of universities in live projects of the industries help to deepen the collaboration between industries and universities.

10.5 Research Methodology

According to the hypothesis stated in the chapter, the study intends to look at the impact of the above mentioned indicators on the level of placement in a university. Effects of industry consultation in setting up of pedagogy, working on gaining patents, regular interaction with industry, student's internship, providing specific solutions to industry and links with industry on the level of placement of the universities will be analyzed based on the estimation of an econometric model. Here, there is a need to estimate a university-industry linkage equation. Following is the methodology for constructing the equation on university-industry linkage.


10.5.1 Model

Consider the following multiple regression equation[125] in which placement level has been treated as a dependent variable.

$$Y = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 \quad \ldots\ldots (1)$$

Where,

Y = Placement
X_1 = Industry consultation in setting up of pedagogy
X_2 = Working on gaining patents
X_3 = Regular interactions with industry
X_4 = Student's Internship
X_5 = Providing specific solutions to industry
X_6 = Links with industry
β_o = Constant or intercept
β_1 = Slope (Beta coefficient) for X_1
β_2 = Slope (Beta coefficient) for X_2
β_3 = Slope (Beta coefficient) for X_3
β_4 = Slope (Beta coefficient) for X_4
β_5 = Slope (Beta coefficient) for X_5
β_6 = Slope (Beta coefficient) for X_6

Multiple regression equation was run using the OLS method.

10.6 Empirical Results

Table 31 shows the results of the regression equation.

Table 31: Dependent Variable: Placement level

INDEPENDENT VARIABLE	OLS RESULTS
Constant	-4.427** (1.348)
Industry consultation in setting up of pedagogy	0.424** (0.106)
Working on gaining patents	0.474** (0.104)
Regular interaction with industry	0.269** (0.062)
Student's internship	0.046 (0.033)
Providing specific solutions to industry	0.104 (0.085)

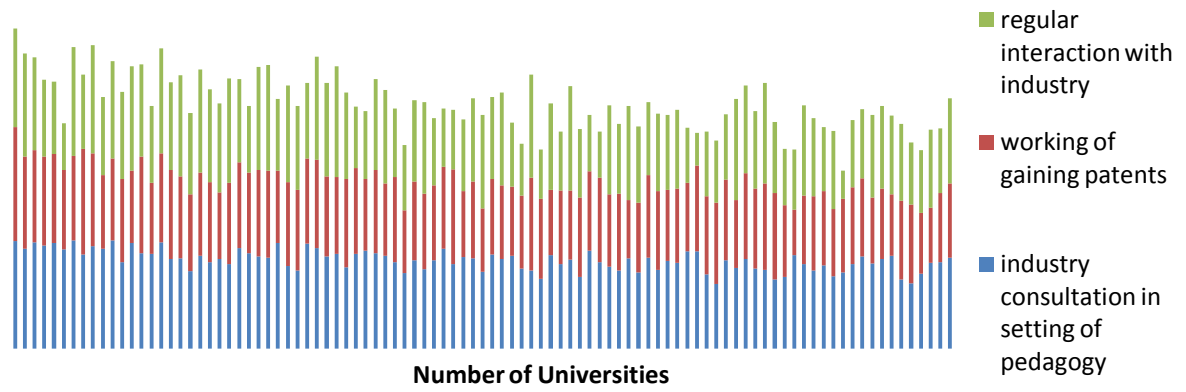
[125] Multiple regression is a statistical technique to understand the relationship between one dependent variable and several independent variables.

Links with industry	0.226 (0.119)
Observations	97
R^2	0.51

Standard errors in parentheses
** significant at 5%

The results indicate that industry consultation in setting up of pedagogy, working on gaining patents and regular interaction with industry have a positive and significant impact on the placement level of a university. Interaction and collaboration of universities with the industries is important for the skill development of students, adoption of knowledge by the industries and promotion of entrepreneurial skills.

Graph 19: Scenario of the variables significantly influencing placement level



Source: PHD Research Bureau, data compiled from the study on Framework for University Industry Linkages in Research

The interdependence between universities and industries enable both the entities to sustain growth in their areas. Graph 19 shows the scenario of the positive and significant variables influencing the placement level of the universities. Apart from these variables, student's internship, providing specific solutions to the industry and links with the industry are the variables that have a positive impact on the level of placement from a university.

Thus, the hypothesis that industry consultation in setting up of pedagogy, working on gaining patents, regular interaction with industry, student's internship, providing specific solutions to industry and links with industry are able to influence the level of placement in a university with the first three variables having both positive and significant impact.

In a nutshell, interaction of industries with the universities is important to have a significant impact on the placement level of a university. A link between Industries and Universities is really important in order to increase the opportunities for the young professionals. Firms and universities are increasingly finding it mutually beneficial to collaborate with each other. Going ahead, it is believed that interaction and collaboration of universities with the industries is important for the skill development of students, adoption of knowledge by the industries and promotion of entrepreneurial skills.

Chapter 11

Role of intermediaries and Technology Transfer Organizations in UILs

There is no denying of the fact that collaboration between universities and industries are essential to fuel the innovation ecosystem that will propel growth and development in the country. The facilitation of such interactions often requires certain stakeholders such as the intermediaries and technology transfer organizations that can facilitate UILs in the countries.

11.1 Role of Intermediaries

Intermediaries play an important role in fostering collaborations between universities and industries through mediation as well as getting embedded in the projects. Moss (2009) defines the basic function of intermediaries as the collective pursuit of public, common or individual interests and that a defining asset of intermediaries is their ability to reap collective benefits.

There are four types of these intermediaries which are listed below[126]: -

- **General purpose intermediary** of which the university is the leading example, producing and disseminating the different forms of knowledge (Yusuf, 2008 pp. 1170).

- **Specialized intermediary**- These are the ones which seek out, help codify via patenting and also help tin transfering knowledge to commercial users. For instance, the university Technology Licensing / Transfer office (TLO or TTO).

- **Financial intermediary-** These include venture capitalists or an angel investor supplies risk capital. Most of the time, such a provider brings additional tacit knowledge in the form of contacts, managerial know-how, troubleshooting skills or risk assessment skills which can assist start-ups (Yusuf, 2008 pp. 1170).

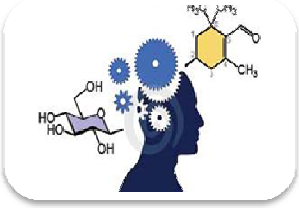
- **Institutional intermediary**- It is often a public agency that offers incentives to encourage knowledge transfer and a variety of services to facilitate interaction among researchers and firms (Yusuf, 2008 pp. 1170).

The intermediaries play a major role in creating a platform for the universities and industries to collaborate on research based activities along with scope for training, internship and subsequent employment opportunities. This is because the universities and industries both have divergent ways of functioning due to which collaborations are not easily formed. In such a situation it becomes imperative to have an intermediary which understands the

[126] Yusuf, 2008 pp. 1170, Special Issue on the role of intermediaries in university – industry collaborations, Research Policy Journal

concerns of both the parties and creates an interface between the universities and industries to collaborate on points of mutual interest.

General Purpose Intermediaries



Specialized Intermediaries

Financial Intermediaries

Institutional Intermediaries

For example, a university say XYZ wants to train its professors on the 'Recent aspects and developments in GST', in terms of practical knowledge. It approached a Chamber of Commerce, say ABC to organize a programme on the same by getting industry practitioners to talk about it since the Chambers are well connected with the industry. ABC thus provided a platform to the XYZ where in, it invited industry leaders to educate the faculty of XYZ on the captioned topic. This would have been time-consuming and tedious task. With the help of an intermediary ie ABC, XYZ was able to get the best trainer and provide training at a lower cost (actual as well as opportunity cost) in conducting the same activity.

The intermediaries range from NGOs to private bodies including consultancies, public institutions, think-tanks as well as autonomous institutions such as Chambers of Commerce, Associations, Forums and Consortiums. These organizations work in different sectors at different levels to interact with all stakeholders in accordance with their entities and can provide meaningful collaborations between the universities and industries. These collaborations can be for knowledge transfer, providing technical and manpower assistance or financial assistance.

11.1.1 Facilitation to Industries

Intermediaries can play a major role in facilitating the industries to collaborate with universities for research as well as other activities such as employment, short term projects, among others.

- **Identification of universities**- The identification of universities is a major task. This is because though there are many universities but finding the right university in terms

of geographical proximity, adequate and qualified faculty and bright students (in case of internships and short term projects) is a daunting task which the industries may not be able to do on their own. In such a case, the Intermediaries can help the industries identify universities for collaborations.

- **Communicating the objectivity of collaboration effectively**- As the mindset of the universities and industries is different, the intermediaries can communicate the objectivity of collaboration to the universities effectively. This is because the industries may define the objectivity in a very technical manner which the universities may comprehend in different way. But the intermediaries can translate them into a less technical manner which is easier for the universities to understand. Thus the complexities are reduced.

- **Monitoring the progress**- The intermediaries in some cases can also monitor the progress of the project, if agreed by both the parties. They can also push for achieving the results as per the terms of reference, if decided in the beginning of the collaboration.

- **Provide Human resource**- The intermediaries can serve as an important source of human resource as they can easily coordinate with the universities and enunciate the requirements of the industry. This is a good source if the industries are looking for employees at the freshers level.

Chart 20 : Facilitation by intermediaries to industries

Source: PHD Research Bureau

11.1.2 Facilitation to universities

Intermediaries can play a major role in facilitating the universities to collaborate with industries for research as well as other activities such as for placement of students, internships, short term projects, among others.

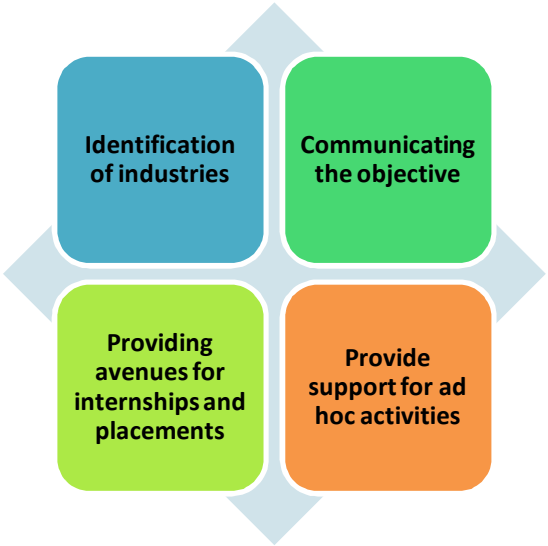
- **Identification of industries-** The intermediaries can facilitate the universities to identify the industries as they have the expertise in this area. They also have connections and knowledge of activities of the industries which can help the universities to identify industries which will be the best fit.

- **Communicating the objectivity of collaboration effectively**- The intermediaries would be able to clearly define the objectivity of collaboration to the industries as they are also aware of the requirements of the industries. Thus, the activity becomes less time consuming for the university than the time they would have taken otherwise.

- **Providing avenues for internships and placements-** The intermediaries can provide collaborative opportunities for universities for internship as well as placement of students in industries. For instance, if a university approaches an association for internship of their students, then the Association can take forward the proposal to its industry members who may be looking for interns and employees.

- **Provide support for ad hoc activities-** The intermediaries can provide ad-hoc support in terms of organizing training for faculty, short projects for students and lectures for students by arranging Guest Lecturers from industries.

Chart 21: Facilitation by intermediaries to universities



Source: PHD Research Bureau

11.2 Role of Technology Transfer Offices

According to Correa and Zuñiga 2013, the creation of technology transfer offices (TTO) in universities has become a widespread institutional mechanism to assist researchers in patenting their findings and obtaining license fees and royalties. According to OECD, TTO in the university or research centre or an institute is an office which has tasks such as

identification and management of academic intellectual property (IP), IP protection, IP commercialization and license contracts (OECD 2011). Besides these, the other major tasks are creation and management of spin-off organizations and maintaining close contact with partners.

The technology transfer offices act as a bridge between the researchers and academic management. They are also identified as an extended arm of industries with respect to solving their technical problems. The three basic forms of TTOs are as under[127]-

1. **Department type TTO**- the Department type model involves TTO acting as a department in the organization. In this model, technology managers and researchers can be closer to each other in time and in localization too.
2. **Internal Department**- the TTO can work as an Internal Department of the university. This is a cost effective measure as it does not involve much of fixed costs.
3. **Independent organization**- the university can hire an independent organization to act as a TTO. The TTO functions on its own and has the advantage of know-how and high effectiveness.

11.2.1 Status of TTOs in different countries

Various countries have adopted the model of Technology Transfer Office. Some of them are as under[128]-

Table 32: Status of TTOs in select countries

S.No.	Country	Status of TTOs
1	UK	Most of the Universities in UK run department-type organizations. Their tasks include connecting with administration, contacting and connecting with new partnerships.
2	Japan	As a result of the implementation of policy of promoting TLOs to activate technology transfers under the TLO Act, the TT offices can be operated with the provision of opportunity for Universities to finance the two-third of the costs of the offices in the first five years.
3	China	The Chinese universities run TTOs in the wholly owned model with external services providing. The private firms are active costumers of them. The most common services are business planning, incubation and spin-off management consultancy.
4	Australia	The Public Research Organizations organized TTOs by the 'Wholly owned subsidiary' model and they can finance their operations without involvement of other financial resources.
5	India	The organization of TTOs is not in formal frameworks. Most universities have established some offices, but they have to use their own resources for implementation of tasks.

[127] Bucsai, Role of Technology Transfer Offices in University-Industry Interactions, Lengyel I. – Vas Zs. (eds) 2013: Regional Growth, Development and Competitiveness. pp. 204-214
[128] ibid

11.2.2 Facilitation to industry

- **Identification of universities for collaboration-** the industries may have specific requirements in their day to day activities for which they may want to connect with universities which have dedicated TTO to connect with and collaborate. The TTO have expertise in understanding the requirements of industry and consequently, the collaborations can be taken further.

- **Connecting with relevant universities-** the Technology Transfer Office helps the industries to identify the level of research being undertaken by the university and provides avenues for collaboration as the industry stakeholders can see live projects.

11.2.3 Facilitation to Universities

- **Making universities more readily accessible-** The TTOs help in making the universities more readily accessible as the industry can see their products through their brochures/ catalogues.

- **Creating a vibrant culture of innovation-** The TTOs facilitate in industry collaborations thereby, providing motivation to the faculty for taking up more research activities.

- **Developing a sustainable model of attracting funds-** Though many universities undertake research, but they are unable to commercialise most of them due to funding problems. If the universities have their technology transfer offices, in most cases, these offices have their separate financing avenues through industry partnerships which maintain the cashflow. Hence, a sustainable model of funds is created which fosters greater research.

  However, it is to be observed that the TTOs cannot become "money-makers" overnight. The universities will have to allocate funds for several years before they can begin to generate their own revenues and potentially contribute to the university's own income[129].

11.3 Suggestions for harnessing the potential of intermediaries

- The universities must engage with intermediaries by signing more MoUs with the basic theme of connecting with the industries.

[129] Technology transfer, Intellectual property and effective university-industry partnerships: The Experience of China, India, Japan, Phillipines, the Republic of Korea, Singapore and Thailand, WIPO

- The universities must collaborate with intermediaries to conduct more programmes, symposiums, seminars and conferences with the intermediaries such that the intermediaries invite industry stakeholders which would help the universities also to connect with them.

- The universities must also set up Technology Transfer Office that can manage their IPR and at the same time connect with industries for possible collaborations.

- Many TTOs, over the years, develop good rapport with industries which keeps momentum of work smooth. Hence, developing a TTO helps in networking and also accumulating over the years a database of agreements which are used as the basis for drafting and negotiating new agreements. This helps in speeding up processes which is otherwise believed to be a major bottleneck in collaborations.

In a nutshell, the intermediaries play an important role in acting as a bridge between the universities and industries. They can act as a source of fostering new relations between the universities and industries and can also strengthen the existing relations through their expertise. Thus, if the universities and industries are willing to collaborate but are unsuccessful in negotiating a favourable deal, they can approach an intermediary, which can provide its know-how in forging successful partnerships. The Technology Transfer Office can also facilitate in fostering university-industry collaborations as they serve as a face of the universities. The TTO helps in identifying innovative products developed by the universities for the industry. The functions[1] of all TTOs are not identical. In some cases, they only deal with the management of Intellectual Property Rights. In other cases, TTOs also market their technologies and search for companies that would sponsor university projects. It is widely recognized that having a TTO as a central body to handle all issues relating to the transfer of technology is that it makes possible to professionalize technology transfer activities and enhance the bargaining power of the universities. It would be practically next to impossible for individual researchers to deal with all the necessary work. Hence, the universities must utilise the resources of TTO (if it exists in their campuses) or develop TTOs to collaborate with more and more industries.

[1] ibid

Chapter 12

Conclusions and Suggestions

University Industry linkages (UILs) primarily involve Industries and Universities coming together to collaborate in various areas that would lead to growth and socio-economic development in an economy**.** Linkages between universities and industries are increasingly important in various spheres of economy such as skill development, innovations and technology transfer, promotion of entrepreneurship and start-ups, among others. When universities and industries work together, the different skill sets and experience amalgamate to produce research which pushes frontiers of knowledge and becomes a powerful engine for accelerating innovative solutions and economic growth in the long run. There are various benefits availed by both universities and industries. The industries gain access to research being produced by universities and build a good reputation through innovative solutions developed in collaboration. The universities on the other hand also gain equally in terms of resources, exposure to real time solutions and strengthening their brand name through collaboration with industries focused on innovation.

However, India is at a very nascent stage when it comes to University-Industry Linkages. There are very few opportunities for interdisciplinary working, because of a weak innovation ecosystem in academia and low industry-university collaborations. The country witnesses several issues and there are few gaps in terms of policies and on ground reality of university-industry relations. India does not have legislation in place to facilitate University-Industry Linkages in Research. The Protection and Utilization of Public-Funded Intellectual Property (PUPFIP) Bill which was prepared on the lines of the Bayh Dole Act has been withdrawn from the parliament. Further, an institutionalized framework for industry-academia connect is absent in the country. There is an urgent need to develop a comprehensive framework where the universities must establish centers of learning which could serve as the base for promotion of entrepreneurship and the start-up ecosystem.

With the strong macroeconomic fundamentals coupled with effective policy measures of the government, India is expected to grow at a higher trajectory in the coming times. To reach a high level, it is essential to develop leadership in innovation, science and technology to compete in this global knowledge economy. Hence, it becomes imperative to develop strong UILs in the country to accelerate innovations in various spheres which will contribute to the growth of all sectors of the economy. Growth of research and development through successful collaboration between universities and industries more often leads to development of new products/ solutions which promote economic growth in the long run.

There is a rich literature related to university- industry linkages in research in various countries as entailed in the study. These studies have facilitated to have an idea of trend in university industry linkages, their implications and causes, among others. With regard to the Indian economy, there are a few studies that have been conducted by International Institutes. The objectives of these studies were to explore the level of Industry -university linkages. Inferences were made in generic terms at all India level; not state specific level.

Hence, the present study has been conducted with the objective of assessing the current state of university-industry linkages and giving suitable recommendations. The specific objectives of the study were- 1. To analyse the growing sectors of the Indian economy (top 10 sectors were selected) with respect to capacity building, research and development activity, innovation, employment generation in the economy; 2. To analyse the university-industry linkages with respect to employment generation in the economy; 3. To analyse the issues and challenges to university-industry linkages; 4. To assess and formulate various case studies with regard to university-industry linkages; 5. To study the international scenario (four countries viz. USA, Germany, Japan and China) of university-industry linkages and draw suggestions for India; 6. To draw conclusions on the above and suggestions for increased efficacy of university-industry linkages.

The main objective of the study has been to entail suggestions to enhance the growth and competitiveness of the growth oriented and promising sectors not only at the aggregate level but also with state specific suggestions which will be useful to enhance the growth and competitiveness of our industry sector. This will help Make in India programme of the Government to provide fruitful results as well as create synergies between Industry and Academia to create more and more employment opportunities in the economy.

International Scenario of UILs

One of the objectives of the study was to understand the international scenario of UILs to draw suggestions for India. The UIL Models of USA, Germany, Japan, China, United Kingdom and Australia were studied to have an understanding of industry-academia collaborations. The analysis of the international scenario revealed that the Bayh Dole Act of United States has been a very successful model of collaboration between the industry and academia. It has been adopted by many countries and has given fruitful results. The Bayh Dole Act of United States suggests that title to innovations developed under federally funded programs can be retained by them. The innovators are given non-exclusive license to practice the patent throughout the world. Further, the universities have to give preference to small businesses at the time of licensing.

In Germany, there is legislation similar to Bayh Dole Act of USA called the Inventors' Law. According to Inventors' Law, an employee must give his or her employer, written notice of a technical invention. The employer can claim rights to the invention or leave these rights with the employee. If the invention leads to revenues and the employer has made a claim to the invention, the employer must remunerate the employee in accordance with a legal framework.

The Japanese Bayh-Dole Act permits universities and research institutions to retain ownership of intellectual property rights arising from government contracted research and developments under the condition that universities and research institutions must report an invention to the government without delay after disclosure from researchers. The royalty fee has to be given to the government. Further, they must grant a license to a third party if

they have not exploited the subject matter for a reasonable period of time without any excuse, and the government makes clear a reason that the exploitation of the subject matter is necessary for public interest. There is no requirement of compensation for inventors.

In China, the relationship between Universities and Industries is driven largely by government policy. China passed the Scientific and Technological Progress Law in 2007, which upgraded the provisions of the Regulations pertaining to intellectual property ownership to the level of national law. The law sub-divides intellectual property rights into four items, namely, computer software copyrights, exclusive rights to layout-design of integrated circuits, invention patents and new variety right of plant. Utility model patents and design patents as well as other intellectual property are excluded from the scope of intellectual property defined in the law.

Case studies of global arena

The analysis of UILs through select case studies in the global arena revealed that the universities and Industries entering into strategic alliances and collaborations across the world have managed to sustain long lasting relationships without government interventions in most cases. These entities have strived to foster long term collaborations by identifying the objectives and adopting a win-win approach. It is suggested that the universities and Industries should enter into partnership with some kind of complementary relationship so as to harness each other's potential and contribute to the growth of research and development of the country, going forward.

Indian scenario of UILs

India is at a very nascent stage when it comes to University-Industry Linkages. There are very few opportunities for interdisciplinary working, because of a weak innovation ecosystem in academia and low industry-university collaborations. There are few gaps in terms of policies and on ground reality of university-industry relations. There is an urgent need to develop a comprehensive framework where the universities must establish centers of learning which could serve as the base for promotion of entrepreneurship and the start-up ecosystem.

At this juncture, it is worthwhile to mention that the Bayh Dole Act has been the best model so far for strengthening University-Industry Linkages in research and development. This is evident from the huge success in United States after which majority of the world economies adopted the captioned legislation. But, there are a few challenges for India to adopt this legislation. There is a growing concern that the Protection and Utilization of Public Funded Intellectual Property (PFIP) is hastily drafted without a full impact assessment of grass-root realities and complexities of the Indian scenario and lack of transparency and receiving inputs from some of the important organizations, lack of specific clauses are some of the


other concerns. Further, lack of resources and poor infrastructure is a major constraint which needs to be addressed.

Case studies of UILs in India

Despite the prevalence of a weak ecosystem for the universities and Industries to collaborate in India, there have been many successful partnerships and collaborations between the universities and Industries in the area of research and development. These strategic collaborations/ partnerships/ agreements entail that the linkages should be mutually beneficial for both the universities and the industries. The industry should gain from the research developed while the universities/institutes should get funds, knowledge-sharing and exposure of the industry amongst others. One of the case studies reflects that there is a need for constant interaction of industries not just with faculty but also with students. Further, the industries must also influence the curriculum being taught in the universities so as to ensure that the students are taught both practical and theoretical aspects of a concept that would make them industry ready.

Identification of growing sectors of Indian economy

One of the objectives of the study has been to identify top 10 sectors of the Indian economy for capacity building, research and development activity and innovation. In order to fulfil this objective, firstly, the top 5 sectors of each state have been identified which has been followed by frequency analysis wherein the sectors of all the states have been compiled to arrive at 32 major sectors of the country. Further, on the basis of frequency analysis of the top 5 sectors of each state, the top 10 sectors of the country have been identified out of the list of all the 32 sectors where the sectors occurring with higher frequency have been selected. These top scoring sectors of the Indian economy are IT and ITeS, agriculture and allied activities, agro and food processing, tourism, textiles, power, automotive and auto components, cement, drugs and pharmaceuticals and engineering.

The average UIL score of all the identified 32 sectors has come out to be 9.2 which has been calculated taking the average of University-Industry complementarities scores all the sectors. The all India score thus, shows moderate complementarities between university and industry.

The top scoring sectors are IT & ITeS- 17.7, Tourism - 17.35, Textiles- 17.1, Agro and Food Processing with a score of 15, agriculture and allied activities had a UIL Score of 14.1, Drugs and Pharmaceuticals- 13.8, Automobiles and Auto components- 12.8, Engineering -11.5, Power- 11.3, Cement- 10.7.

The scores of other sectors are Biotechnology has a UIL score of 10.3, Mining- 8.9, Oil and Gas- 8.8, Handicrafts and Handlooms 8.8, Iron & Steel- 8.7, Finance-8.5, Electronics- 8.1, Ayurveda- 8.1, Seafood and other marine products- 7.9, Spices and Spice Extracts- 7.8, Chemicals and Petrochemicals- 7.2, Sericulture- 7.1, Leather & Leather Products-6.6,

Minerals- 6.2, Real Estate-6.2, Gems & Jewellery- 6.2, Dairy- 6.1, Sports Goods- 6.1, Horticulture- 5.2, Fisheries- 5, Floriculture- 4.7, Apiculture- 2.2.

It has been recommended that the state must incentivize universities and industries to create more linkages in sectors such as gems and jewellery, leather and leather products and handicrafts and handlooms to develop strong linkages between universities and industries which will create innovative products and revolutionize these sectors. These sectors are major employment generating sectors which need to be emphasized for the overall development of the economy.

University Industry Linkages in States

The study has analysed the UILs in all states with respect to the top five sectors of each state on ten parameters such as availability of universities in the vicinity of the industry, level of interaction of industry with universities in terms of continuity and frequency. Also, the UILs were assessed on the basis of support in providing quality solutions, MoUs/ collaboration between the industries and universities, patents gained by the industry in last five years, continuity of research activities, interaction with students and frequency of interaction with the students. Accordingly, two structured questionnaires (each for university and industry) were prepared and disseminated. A total of 241 responses from Universities and 840 responses from industry were received which have been put together and the states are ranked according to the UILs prevalent in each of them.

Though University – Industry Linkage were considered moderate in India with a score of 4.7 points out of 10 but surprisingly lot of disparities have been observed among the States. Some States are good in University – Industry Linkages and others are found to have moderate or weak University – Industry Linkages. On the basis of analysis of States, it has been observed that University – Industry Linkages are the strongest in the State of Karnataka with a score of 7.8 points out of 10 and Kerala with a score of 7.3 while the linkages are weak in the State of Manipur with the score of 1.5 points out of 10.

The state of Karnataka has the highest score of 7.8 out of 10 with the state scoring exceedingly well in the parameter on interaction with research institutes. All the major industries of the State including engineering, biotechnology, automotive and auto components, IT & IT enabled services and textiles industries have strong University – Industry Linkages. Further, the state witnesses continuous interaction between the universities and Industries which is highly appreciable.

The state of Kerala also has very strong university-industry linkages as the state scores 7.3 out of 10 which is commendable. Industries in the State such as rubber, ayurveda, seafood and other marine products, spice and coir industries have received quality solutions from research institutes for their production process in the last one year. Further, rubber and ayurveda industries have gained patents during the last 5 years through collaboration with the universities in the State. The industry in the state also has continuous interaction with


students as the business firms generally on an average give internship opportunities to two students in their firms in a year. Seafood and other marine products industry has provided maximum number of internship opportunities to the students followed by spice, rubber, ayurveda and coir industries in the State.

Many states have strong University-Industry linkages. These include Gujarat (6.7 score), Maharashtra (6.4 score), Uttar Pradesh (6.2 score), Tamil Nadu (6.1 score), Delhi (6.1 score), Telangana (6.1 score), Odisha (6 score), Andhra Pradesh (5.9 score), Punjab (5.8 score), Himachal Pradesh (5.7 score), Uttarakhand (5.6 score), Haryana (5.5 score), Rajasthan (5.2 score). The states of West Bengal (4.7 score), Chhattisgarh (4.5 score), Madhya Pradesh (4.3 score), Jharkhand (4.2 score), Bihar (3.8 score), Goa (3.6 score), Tripura (3.5 score), Sikkim (3.4 score), Jammu & Kashmir (3.3 score), Meghalaya (3.2 score) and Assam (3 score) have moderate linkages in research and development which needs to be strengthened in the coming times. On the other hand, only the North-Eastern States such as Arunachal Pradesh (2.4 score), Mizoram (2 score), Nagaland (1.8 score) and Manipur (1.5 score) are the states with weak linkages between the universities and industry.

Few recommendations for the states

On the basis of our analysis of the prevalence of incubation centres, centres of excellence and industrial clusters, following are the recommendations for the states-

Karnataka- The state needs to focus on building industrial clusters related to pharmaceuticals sector and research centers, centres of excellence related to machine tools, agriculture implements and food processing, among others.

Kerala- The state needs to focus on developing research centers, center of excellence related to various industries such as jewellery, wood furniture, plastics, footwear, food processing, coconut oil, bricks among others to improve and collaborate the R&D activities in order to improve the quality of existing industries.

Gujarat- The state has universities conducting research in the areas of diamond jewellery, food processing etc. Therefore, the state needs to focus on developing research centres related to ship breaking, fish processing, foundry, marbles, ceramics etc.

Maharashtra- The state should focus on developing research institutes, colleges, centre of excellence related to sectors such as oil & gas, auto components, sea food, food processing, rubber, plastics, and floriculture, among others.

Uttar Pradesh- The state should focus on developing research centers related to sectors such as food processing, wood products etc. The state should also focus on strengthening the plastics and dairy industry as colleges related to these sectors present in the state.

Tamil Nadu- The state needs to focus on developing research institutes and centre of excellence for sectors such as rice mills, coir, and machine tools, among others.


Delhi- The state should focus on developing more industrial clusters related to pharmaceuticals among others.

Telangana- The state should focus on developing more industries related to sectors namely, agriculture, pharmaceuticals, minerals, textiles and renewable energy as there are many incubation centres available.

Odisha- The state should focus on developing incubation centres, research institutes, centres of excellence, in the areas of iron and steel, mining, plastics, rice mills, textiles in order to strengthen these industries.

Andhra Pradesh- The state should focus on developing more incubation centres for sectors such as granite, leather, information technology, fiber, coir, plastics etc.

Punjab- The state of Punjab houses various colleges in Aeronautics which can be tapped in for supporting aeronautical industry. Thus, there is a huge scope of setting up industrial clusters relating to aeronautics in the state.

Himachal Pradesh- The state needs to focus on developing research centers in the sectors of food processing, stone, crushing, wood furniture, etc. The state also needs to focus on developing research centres, centre of excellence in order to boost tourism.

Uttarakhand- The state should focus on developing more industrial clusters as it has good number of universities. The state has huge potential in pharmaceuticals, textiles, IT & ITeS which need to be tapped by providing research support to these clusters.

Haryana- The state government should focus on developing more industrial clusters related to engineering, real estate, food processing among others.

Rajasthan- The state of Rajasthan should focus on developing incubation or research centres in the areas of textiles, tourism, gems & jewellery, as they have huge potential in the state. The state should also focus on developing research institutes, centers of excellence related to food processing, in order to boost the sector.

West Bengal- The state should focus on developing the incubation centres. The state should also focus on developing more research institutes, centre of excellence in order to support silk, biotechnology, chemicals & petrochemicals, hand tools, silvery jewellery and rubber industrial clusters of the state.

Chhattisgarh- The state should focus on developing industries related to herbal medicines, mining etc. The state should also focus on developing research institutes in order to support these industrial clusters namely, footwear, garments, bricks, rice among others.

Madhya Pradesh- The state of Madhya Pradesh lacks incubation centres which should be developed to support its growing industrial clusters. The state should also focus on developing center of excellence, research institutes in order to support the various industrial clusters such as rice, silk, plastics and auto components, among others.

Jharkhand- The state government of Jharkhand should focus on developing industry clusters related to mining, fertilizers, and cements among others. The state should also focus on developing research institutes, colleges in the areas of engineering, auto components, brass & bronze utensils in order to support these existing industrial clusters.

Bihar- The state of Bihar should focus on developing industrial clusters related to oil & gas, IT& ITeS. Further, the state should focus on developing centre of excellence, research center in order to support industrial clusters namely rice, leather, herbal & aromatic plants, bee keeping among others.

Goa- The state government of Goa should focus on developing more incubation centres and industrial clusters related to fishing, mining among others. The state should also focus on developing research institutes and industries related to cashew, tourism as well as food processing.

Tripura- Tripura should focus on developing industrial clusters in the sectors of food processing, bamboo, rubber, handicrafts & handlooms, among others.

Sikkim- The state of Sikkim should focus on developing more incubation centres and industrial clusters in the sectors of pharmaceuticals, floriculture, ayurveda, hydropower among others.

Jammu & Kashmir- Jammu and Kashmir should focus on developing more incubation centres along with a focus on developing sericulture, floriculture, horticulture handicrafts & handlooms clusters. The state should also focus on developing more research institutes related to rice mills, agro based, wood products among others.

Meghalaya- The state government of Meghalaya should focus on developing more of clusters and centres in the areas of tourism, handicrafts & handloom, horticulture, sericulture, among others. The state should also focus on developing centre of excellence, research institutes for cashew and footwear industry.

Assam- The state government of Assam should focus on developing industrial clusters in the areas of oil & gas, limestone, cements, sericulture etc. The state should also focus on developing centre of excellence, research institutes in the food processing, rice, pottery, terracotta, tourism etc. as they are the growing sectors of the state.

Arunachal Pradesh- In the state of Arunachal Pradesh, there is a need for states to focus on developing more industrial clusters related to textiles, power, tourism, minerals, forest and agriculture among others.


Mizoram- The state of Mizoram should focus on developing more industrial clusters related to fisheries, food processing, agriculture, handicrafts & handlooms, horticulture, tourism and engineering among others. The state should also focus on developing centre of excellence related to wood products.

Nagaland- Nagaland should focus on developing more incubation centres. The state should focus on developing industrial clusters in the areas of handicrafts, hydropower, apiculture, floriculture and bamboo. The state should also focus on developing research institutes related to various industrial clusters such as bee keeping, honey processing among others.

Manipur- The state government of Manipur should focus on developing incubation centres related to medicinal equipments. The state should also focus on developing industrial clusters as well as research institutes related to sericulture, handicrafts & handlooms.

University- Industry Linkages in employment generation

To analyse the UILs with respect to employment generation, data variables such as Industry consultation in setting of pedagogy, Working on gaining patents, Regular interaction with industry, Student's internship, providing specific solutions to industry and links with industry were analysed to know if these influence the level of placement in universities. Multiple regression equation by running the OLS method was used.

The results indicated that industry consultation in setting up of pedagogy, working on gaining patents and regular interaction with industry had a positive and significant impact on the placement level of a university. Interaction and collaboration of universities with the industries is important for the skill development of students, adoption of knowledge by the industries and promotion of entrepreneurial skills. Interaction of industries with the universities is important to have a significant impact on the placement level of a university. A link between Industries and Universities is really important in order to increase the opportunities for the young professionals. Firms and universities are increasingly finding it mutually beneficial to collaborate with each other. Thus, it has been found that industry consultation in setting pedagogy, gaining patents and regular interactions with industry have significant impact on placement level. Hence the universities must ensure more collaboration with industries particularly in pedagogy and gaining patents which will facilitate higher employment level of students.

Issues and challenges to UILs in India

Linkages between universities and Industries are increasingly important for various spheres of economy such as skill development, innovations and technology transfer, promotion of entrepreneurship and start-ups, among others. The issues and challenges to university-industry linkages in research in India were analysed. The lack of industry, R&D orientation has limited the links between industries and universities over the years. There are several issues when it comes to technology transfer, for instance lack of applicability of research at the institutional level, no transfer of technology mechanism from universities to industries,

inadequate funds, and less focus of university researchers on publishing their research papers/articles in journals etc. Above all, India lacks an enabling policy environment for a strong focus on R&D area when it comes to university-industry linkages.

It is recommended that the government must put in place a legislation which entails strong IPR Laws. There should be more programmes to promote entrepreneurship in the country which will create synergies for greater industry-academia collaborations. Further, the government must also encourage greater mobility of university faculty and professionals from industry.

12.1 Suggestive model for India on lines of Bayh Dole Act

University Industry Linkages (UILs) in research has been a topic of discussion worldwide. While various countries have adopted models to overcome the challenge of this 'interaction lag', India still has no widely accepted model to be followed.

Certainly, the collaboration, throughout the globe, is quite restricted. This just exhibits the difficulty of the problem. This is due to the fact that academia -industry collaboration is not something that can be well explained with some stipulated laws or by establishing a static model because it evolves progressively, keeping pace with the continuous changes in the academic and industrial domains.[130]

The most commonly adopted Bayh-Dole Act fundamentally changed the global system of University Industry Linkages. However, in the case of India, the current status of the act stands withdrawn under the Parliament of India. This creates a need to develop an integrated model of University-Industry Interface for strengthening research in India.

The Protection and Utilization of Public Funded Intellectual Property (PFIP) Bill, 2008 seeks to provide incentives for creating and commercializing intellectual property from public funded research. The Bill was introduced in the Rajya Sabha on December 15, 2008. The objective of the bill is to ensure that benefits of public funded research reaches the public, creates an environment in which wealth can be generated from the University system and forges closer academia-industry partnerships[131].

12.1.1 Need for an Integrated Model of University Industry Interface for Strengthening Research in India

In the present scenario, India needs to adopt a model wherein the concentration of clusters must be facilitated by state of the art centre for excellence incubation centers supporting updated research. Thereby, the concept of Universities working in isolation needs to be

[130] R.B.Dasher, "Joint Lecture Meeting Promotion of Technological Innovation and Fostering of Venture Companies Through Industry Academia-Government Collaboration", Journal of Industry-Academia Government Collaboration, Vol.1, No.4 pp. 1-25, 2005

[131] Satyanarayana, Intellectual Property Rights Unit, The Indian Public Funded IP Bill : Are we ready?, Indian Council of Medical Research, Indian J Med Res 128, December 2008, pp 682-685

eradicated by bringing forward a more collaborative framework of both universities and industries working together in strong alliance.

Therefore, within the academic institution, research and interface centers are to be constructed that would function with a degree of autonomy with paramount industrial partnership and government aid. A good example of university - industry interface centre is Bureau of Industrial Consultancy Services (BICS) of JNTU (Jawaharlal Nehru Technological University), Hyderabad that functions as the university's interface with industry.

The need of the hour is to develop the unique culmination of domestic and international perspective amongst future managers of India. The present generation should be well versed with Industry demands at present and how it will be generated in future, how government of India is working for betterment of Industry and education sector for higher and sustainable growth of India through its structural reforms.

The factor endowment theory can be highly relevant in Indian context, if the major stakeholders' (the corporate, government and professional education) objectives and outcomes are not designed in silo but in unification. Whether it is of economics, finance, human resources or marketing, the curriculum and perception towards education need to be modified towards more research based driven by students, not by faculty members (majorly done for personal monetary benefit or institutional branding).

The government initiative of Skill India cannot be achieved until or unless there is research oriented education in India, not by faculty but by students under guidance of faculty and mentorship of Industry personnel taking into consideration government policies. Also, management bodies need to consider government policy measures for enhancement of higher education not as mandatory requirement but as accelerator for achieving higher growth trajectory. The assessment parameter of written exam with higher weightage of theory than practical education leads to escalation of training cost for corporate players', reduction in monetary benefits to all stakeholders, lower salary to students and lower efficiency of employees.

It is suggested that all students of technical and managerial programs should have at least one industrial training of at least two months duration. It is also recommended that the permanent faculty members should spend two months with the industry. This would give them exposure to industry which they can elaborate in their classrooms which will make their teachings based on practical approach and application of theory. At the same time, the faculty may be able to help industry solve their problems through their breadth of knowledge and experience.

12.1.2 Key observations and recommendations for the Bill

There are certain observations in the Bill which need to be addressed. Some of them are as under-

1. The Bill requires the scientist who creates an intellectual property to immediately inform the research institution. The institution shall disclose this information to the government within 60 days.

2. The scientist shall be paid a minimum of 30% of net royalties received from the public funded intellectual property.

3. Failure of the scientist to intimate the institution and of the institution to inform the government carries penalties, which include fines and recovery of the grant funds.

4. The Bill aims to incentivize innovation by sharing at least 30% of the royalty with the scientist.

5. The Bill requires the scientists as well as the institution to inform the government about an Intellectual Property (IP) and list the countries in which it wants to retain the title. The title in all other countries will vest in the government. **Recommendation**- It is not possible to intimate the government of the intention to retain the title to the publically funded intellectual property prior to that time as the IP is created only after the patent is granted. Thus, this needs to be altered in the Bill.

6. The Bill penalizes scientists who publicly disclose IP without a 30 day notice, and institutions that fail to protect IP if there is commercial potential.
   Recommendation- It is recommended that there should be an alteration in this mandate. There should no penalty on publicly disclosing IP without 30 day notice.

7. One of the objectives of the Bill is to make the institution self sufficient by incentivizing commercialization of IP.
   Recommendation- incentives should be provided not just for commercialization of research but also for intellectual research for socio-economic development of the economy.

8. The statement of objects and reasons of the Bill notes that the bill seeks to encourage innovation in MSMEs and promote collaborations between government, private enterprises and non-government organizations.
   Recommendation- the Bill should ensure that Universities should give preference to MSMEs at the time of licensing.

The Protection and Utilization of Public Funded Intellectual Property Bill, 2008 was initiated with the objective to develop a framework for protecting and utilizing intellectual property in order to incentivize creativity and innovation; to encourage commercialization of intellectual property; to ensure access to innovations for all stakeholders and to minimize dependence of universities on funding from the government by encouraging promotion of self reliance through income from intellectual property. The Bill prohibits scientists from


public disclosure of any intellectual property without a 30 day notice to the institution or the government which needs to be reviewed. This provision can be made only for inventions as is done in the United States and not on intellectual property as intellectual property is a broad term. Further, the bill seeks to fullfill two objectives which are poles apart. One object is to protect and utilize IP by incentivizing innovation and the other objective is to promote self reliance through income from IP so as to reduce dependence on government funding. If the focus is on commercially viable projects, then the intellectual research which is essential for socio-economic development of the nation will take a backseat. Further, the government funding would not be there in research which will further fuel research only for commercial purposes which is not entirely in the interests of growth of the country. Thus, the objectivity needs to be reviewed, going forward.

In a nutshell, there is no denying that the UILs are essential for scaling up technological development and spurring innovations in the economy. It is evident from the analysis of select countries that concerted efforts with effective policy regime and strong coordination between the industry and university can strengthen UILs which leads to socio-economic development in an economy. The analysis of the case study also reiterates this fact. However, as far as India is concerned, the UILs continue to remain weak due to structural issues and challenges in implementing legislation similar to the Bayh Dole Act which has turned around the innovation landscape. To understand the Indian perspective, the present study is conducted with an effort to know the linkages in all 30 states with its top five sectors on ten defined parameters. The University – Industry Linkages differ from state to state with many states having moderate to weak linkages. Thus, there is an urgent need to re-draft and re-introduce The Protection and Utilization of Public-Funded Intellectual Property Bill, 2008 which will enable increased focus on R&D activities and greater interest from the private sector to enhance the increased University-Industry Linkages in Research. India needs to adopt a model wherein the concentration of clusters must be facilitated by state of the art universities with centre for excellence, incubation centres supporting up to date research. Going ahead, it is essential that the universities and industry should together take concerted efforts to strengthen the university-industry linkages in the country. The government must also ensure full support to both the stakeholders which would facilitate in accelerating innovations in the country thereby, making us globally competitive and a strong economic power in the coming times.

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Annexure 1

University Industry Linkages in Research: Questionnaire for Industries

General Information

1. **Name of the Company**
2. **State** 3. **City**

Q1. Is there any university[132] in your area to facilitate you in R&D activity? Yes No

Q2. Have you interacted with university for R&D activity of your firm? Yes No

Q3. Have you ever interacted with university in the last 3 months for R&D activity of your firm? Yes No

Q4. How many times have you interacted with university in the past one year?

a) 4 times
b) 3 times
c) 2 times
d) Once

Q5. Has the university provided you any solutions in your production processes in the last one year? Yes No

Q6. Have you signed any MOU or agreement for research with the university? Yes No

Q7. Have you gained any patent during the last 5 years with the help of universities? Yes No

Q8. Is there any ongoing research activity being conducted with university for improvement in your production process/unit? Yes No

Q9. Are students coming frequently from universities in your plant for internship? Yes No

Q10. How many students were there during their last one year?

a) 5 and above
b) 4 students
c) 3 students
d) 2 students
e) 1 student

[132] **University** includes all universities, colleges, research institutes as well as IITs, IIMs, IIS

Annexure 2

University Industry Linkages in Research: Questionnaire for Industries

Details of the respondent

Name	
Designation	
Company Name	
Address	
Telephone No.	
Email Id	

Details of the Industry

Year of Establishment	
Number of employee as on today	
Number of trainees as on today	
Connected university for finding new talent	

Q1. Type of partnership between university and industry

Placement	
Internship	
Training	
Innovations in bringing out new product	
Research & Development	
Conferences/seminars	
Guest Lecture	
Any other(s)	

Q2. Is there a dedicated person who is connected to the University?

a) Yes	
b) No	

Q3. How often do you interact with representatives from University?

Daily	
Weekly	
Bi-weekly	
Monthly	
Bi-monthly	
Once a quarter	
Once in 6 months	
Once a year	
Never	

Q4. How often do you interact/ collaborate with University for research?

Daily	
Weekly	
Bi-weekly	


Monthly	
Bi-monthly	
Once a quarter	
Once in 6 months	
Once a year	
As and when need arises	
Never	

Q5. How many Universities are associated with your organization for purely research & development?

Q6. What type of research/s is/are undertaken in your Indusrty?

Scientific research	
Social research	
Economic research	
Medical Research	
Any other(s)	

Q7. Has your Organization developed any product with the help of linkages with university in research?

Q8. In your opinion, how is the present environment of University-Industry linkages in India?

Very Good	Good	Average	Bad	Very Bad
☐	☐	☐	☐	☐

Q9. In your opinion, how is the present environment on University-Industry linkages in with respect to your university?

Very Good	Good	Average	Bad	Very Bad
☐	☐	☐	☐	☐

Q10. What factors support university-industry partnerships in your state?

Strong government support	
Regular interface with industry	
Dedicated person appointed to liaison with universities	
Industries approaching the universities by themselves	
Any other(s)	

Q11. What factors have supported university-industry partnerships in your Organization?


Strong government support	
Regular interface with industry	
Dedicated person appointed to liaison with universities	
Industries approaching the universities by themselves	
Any other(s)	

Q12. What are the challenges that prevent stronger university-industry partnerships in the India?

Q13. What are the challenges that prevent stronger university-industry partnerships in your Industry?

Q14.What are the various ways in which industry-university linkages can be improved in Research?

Q15. What are potential opportunities for future university-industry partnerships in India?

Q16. According to you what are the future prospect of Research in India?

Q17. What is the proportion of R&D you are importing and what are you doing in terms of R&D in India?

Q18. What are your expectation from the Universities for R&D?

Q19. Is your company/industry satisfied with the incentives being provided by the Government. Do you think Government should provide additional incentives?What are your expectations from the Government to strengthen University-Industry Linkages in India?

Q20. Which Universities/R&D Institutes have you associated with for R&D in last 25 years?

Q21.Do you have your own in-house R&D unit?

Q22. Where are you spending your CSR funds...in which sectors?

Q23. Do you have any additional comments not covered by the previous questions?

Annexure 3

University Industry Linkages in Research: Questionnaire for Universities

General Information

1. **Name of the Company**
2. **State**
3. **City**

Q1. Is your research institute linked with any specific industry to provide R&D activity?
- a) Yes
- b) No

Q2. How many times do you interact with industries in a year?
- a) Once a year
- b) 2 times
- c) 3 times
- d) 4 times a year
- e) Never

Q3. Is the industry benefiting from the research facilitation of providing specific solution to the industry?
- a) Yes
- b) No

Q4. Has the industry signed any formal agreement or MOU with your institute for facilities in R&D?
- a) Yes
- b) No

Q5. Is the industry benefited from any patent or innovations from your research institute?
- a) Yes
- b) No

Q6.How many students from your research institute do internship with industry in a year?
- a) 100% of students
- b) 75% of students
- c) 50% of students
- d) 25% of students

Q7. Do you receive queries from industry for specific solutions for their production/business process?
- a) Yes
- b) No

Q8. How many queries on an average come in a year from the industry for facilitation in issues related to production process?
- a) 4 times
- b) 3 times
- c) 2 times
- d) Once a year
- e) Never

Q9. Have you organized a joint programme/ round table with the industry in the last three months?
- a) Yes
- b) No

Q10. How many programme have you conducted in collaboration in last one year with the industry?
- a) 4 programmes a year
- b) 3 programmes a year
- c) 2 programmes a year
- d) programmes a year
- e) Never

Annexure 4

University Industry Linkages in Research: Questionnaire for Universities

Details of the respondent

Name	
Designation	
University	
Address	
Telephone No.	
Email Id	

Details of the University

Year of Establishment	
Type of University	Central ☐ State ☐ Deemed ☐ Private ☐
Total Number of Students	
Total Number of Students in Science Section	
Number of Patents/ Copyrights of the University	
Number of inventions/ innovations in last 5 years	

Q1. Type of partnership between university and industry

Placement	
Internship	
Training	
Innovations in bringing out new product	
Research & Development	
Any other(s)	

Q2. Is there a dedicated Industry Linkages Cell in your University?

c) Yes	
d) No	

Q3. How often do you interact with representatives from industry?

Daily	
Weekly	
Bi-weekly	
Monthly	
Bi-monthly	
Once a quarter	
Once in 6 months	
Once a year	
Never	

Q4. How often do you interact/ collaborate with industry for research?

Daily	
Weekly	

Bi-weekly	
Monthly	
Bi-monthly	
Once a quarter	
Once in 6 months	
Once a year	
As and when need arises	
Never	

Q5. How many industries are associated with your university for purely research & development?

0-10	
10-20	
20-30	
30-40	
40-50	
More than 50	

Q6. What type of research/s is/are undertaken in your university?

Scientific research	
Social research	
Economic research	
Medical Research	
Any other(s)	

Q7. Which types of firms are generally associated with you for R&D?

a) Automobiles	
b) Automobiles Components	
c) Aviation	
d) Biotechnology	
e) Chemicals	
f) Construction	
g) Defence manufacturing	
h) Electrical	
i) Electronics	
j) Food Processing	
k) Gems & Jewellery	
l) IT & ITeS	
m) Infrastructure firms	
n) Leather	
o) Mining	
p) Oil & Gas	
q) Pharmaceuticals	
r) Textiles	
s) Thermal Power	
t) Space	


Q8. In your opinion, how is the present environment of University-Industry linkages in India?

Very Good	Good	Average	Bad	Very Bad
☐	☐	☐	☐	☐

Q9. In your opinion, how is the present environment on University-Industry linkages in with respect to your university?

Very Good	Good	Average	Bad	Very Bad
☐	☐	☐	☐	☐

Q10. What factors support university-industry partnerships in your state?

Strong government support	
Regular interface with industry	
Dedicated person appointed to liaison with universities	
Industries approaching the universities by themselves	
Any other(s)	

Q11. What factors have supported university-industry partnerships in your University?

Strong government support	
Regular interface with industry	
Dedicated person appointed to liaison with universities	
Industries approaching the universities by themselves	
Any other(s)	

Q12. What are the challenges that prevent stronger university-industry partnerships in the India?

Q13. What are the challenges that prevent stronger university-industry partnerships in your University?

Q14. What are potential opportunities for future university-industry partnerships in India?

Q15. What are your expectations from the industry and from the Government to strengthen UILs?

Q.16. What is your strength area in terms of R&D?

Q.17. Which are the industries/sectors you would like to collaborate with?

Q18. Do you have any additional comments not covered by the previous questions?

Annexure 5

Government of India
Department of Scientific & Industrial Research

Minutes of the First meeting
of Project Guidance cum Review Committee (PGRC) for the study on "Framework of Industry-University Linkage in Research" being conducted by PHD Chamber of Commerce and Industry, New Delhi under the DSIR-A2K+ studies programme

Date: 23rdSeptember, 2016 - 3:00 PM
Venue: Mohta Room, PHD House, Augest Kranthi Road, New Delhi

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1. The above meeting to review the progress of the study on "Framework of Industry-University Linkage in Research" was held on 23rd September, 2016 at Mohta Room, PHD House, Augest Kranthi Road, New Delhi. The list of participants is given in Annexure–I.

2. Shri. Ashwani Gupta, Head A2K+ (Studies), DSIR in his opening remarks welcomed everyone present on behalf of DSIR and mentioned that the study was approved when Dr. Jyoti Bhat was in charge after whose retirement he's taken over. The study was sanctioned in December 2015 with a total cost of Rs. 12.75 lakh out of which Rs. 4.5lakh have already been sanctioned. He suggested that the presentation may focus on the objectives and the scope and highlight the outcome along with major findings. He suggested that the comparison of 4 countries namely China, Japan, US and Germany and the models of these countries should be compared to see what we can learn and how we can strengthen our own industry institute network. Since strong technology transfer cells in the institutions are missing in India. He further mentioned that the prime focus of universities is to do research without bothering about the commercialization of research activities and rightly so, because the stress is on new knowledge generation. The technology transfer wings in universities must focus on translational research and see how the research output can be applied for benefit of society and people, since these days the governments focus is on Make in India and start-ups.Then he asked the Chairman to give his remarks.

3. The Chairman welcomed the members. He said that a report of this kind should focus all three stakeholders; namely people who produce the knowledge, people who use the knowledge and the government who focuses on policy.

4. Dr. S.P. Sharma, Project Investigator of the study briefed about the aim and objectives of the Research Bureau in PHDCCI and the importance of the study. He said that the project is in its 10thmonth and the first copy of the draft report has been prepared. He defined university industry linkages (UIL) and stated that UIL is the strongest in USA and is in its early stage of development in Europe and Asia. He mentioned that 31 Indian universities are among the 980 universities around the world ranked by TIMES higher Education World universities ranking 2016-17 which marks 3.1 % of total sample. He then mentioned that a

stronger collaboration between industry and university needs to be created for the benefit of industry, economy and society. He addressed the existing gaps in UIL's.

5. He next discussed the top ten objectives of this study along with the approach and methodology. Emphasis was laid on the survey across 6 regions in India wherein it was noticed that while the central region has the lowest UIL linkage the linkage in North East and south is fairly good.

6. During the discussion, the following suggestions/recommendations were made by the Committee:

i. The committee suggested that the study should focus on the key areas to strengthen University-Industry linkages; identify and suggest specific do-ables for key institutions/ organizations/ departments to strengthen the University-Industry linkages.

ii. The secondary data used by the report should be more analytical and interpretive. Data can be ascertained from DAC website and other authentic websites of International organizations.

iii. The study should be supported by the specific case studies. The case studies can be selected from the best practices adopted by Universities, Industries and the Government to strengthen the UILs.

iv. The questionnaire of the study should also include more specific result seeking questions so that expectations of the Industry from the University and that of the University from the Industry are clearly described.

v. The report should identify the expectations of the industry as well as the university which should be gathered through updating the questionnaire and these expectations should be mapped with the timeframe the industry and university expects in order for execution.

vi. To adopt the best practices of University-Industry linkages in 4 countries namely China, Japan, US and Germany and inferences in terms of best practices adopted by them should be taken from the same to prepare a model for University-Industry linkages.

vii. As mentioned in the Terms of Reference, the study should identify top 10 sectors for capacity building, research and development activity and innovation. Firstly the top 5 sectors of each state must be identified, following which 10 sectors of the country may be identified based on the higher frequency sectors selected for the state.

viii. The incubation centers of the Universities should be approached to know about the development in University-Industry linkages to prepare specific

suggestions for the study for the promotion of Research and development activity in the economy.

ix. Institutional data is very important to study University-Industry linkages in research. So, IPR (Intellectual Property Rights) data, data from IIM's, NIPER, Indian Patent Office and data from specific Universities researching on agriculture, industry as well as technology to be taken.

x. The policy initiatives that the industry and university would want government to make/initiate must emerge.

xi. A meeting between PHD Chamber of Commerce and Industry and Department of Scientific and Industrial Research (DSIR) should be conducted to finalize, review the questionnaire and future plan of the study.

xii. The final draft of the report should be ready by the first week of December in order to produce the final report by December 2016.

7. To sum up, the committee suggested PHD Chamber to also implement the suggestions to make the report more result oriented, more specific and recommend do-ables for the specific institutions/ organizations/ departments.

8. The meeting concluded with a vote of thanks to the Chairman and the members of the Committee.

Participants in 1st TAC meeting

1. Prof. Suneet Tuli, Ex-Dean, Research & Development, IIT- Delhi
2. Shri Ashwani Gupta, Head A2K+ (Studies), DSIR, New Delhi
3. Dr. R.S.Rathore, Director (NSQF), Industry Institute Partnership, AICTE, New Delhi
4. Dr. Meenakshi Sharma, Scientist-E, Indian Council of Medical Research, New Delhi,
5. Mr. D.C. Joshi, Chief Business Development, National Research Development Cooperation,
6. Dr. Meenakshi Singh, Senior Principal Secretary CSIR, New Delhi
7. Dr.Ramesh Golla, Scientist-C, DSIR, New Delhi
8. Dr. S.P. Sharma, Chief Economist & Director-Research, PHD Chamber, New Delhi
9. Ms. Rashmi Singh, Associate Economist PHD Research Bureau, New Delhi
10. Ms. Surbhi Sharma, Sr. Research Officer, PHD Research Bureau, New Delhi
11. Ms. Mahima Kaushal Research Associate, PHD Research Bureau, New Delhi
12. Ms. Shefali Malik Consultant, PHD Research Bureau, New Delhi


Annexure 6

Government of India
Department of Scientific & Industrial Research

Minutes of the Second Meeting
Project Guidance cum Review Committee (PGRC) for the study on "Framework of Industry-University Linkage in Research" being conducted by PHD Chamber of Commerce and Industry, New Delhi under the DSIR-A2K+studies programme

Tuesday, 12th December 2017, 3.00 p.m., PHD House, New Delhi
Venue : PHD House, August Kranti Road, New Delhi

The second meeting of the Project guidance cum Review Committee (PGRC) to review the progress of the study on "Framework of Industry-University Linkage in Research" was held on Tuesday, 12th December 2017 at 3.00 p.m. at PHD House, New Delhi. The record of attendance in annexed.

Shri Ashwani Gupta, Head A2K+(Studies), DSIR in his opening remarks welcomed everyone present on behalf of DSIR and introduced the members of the PGRC for the study. He suggested that the report should be submitted by mid-January so that the committee can review it and the Study can be completed in time. He then asked the Chairman of PGRC to give his remarks.

Prof. Suneet Tuli, Ex-Dean, Research & Development, IIT-Delhi, suggested that Dr. S P Sharma should present the progress made in the study and subsequently the members can give the suggestions on the same.

Dr. S P Sharma, Chief Economist, PHD Chamber made a presentation, where he spoke about the work conducted under the study. Dr. S P Sharma highlighted the University Industrial Linkages (UIL) in Research and the benefits that accrue to the universities and industry. He highlighted that there are a number of studies conducted on the captioned topics but the study being conducted by PHD Chamber would cover the status of university-industry linkages in the Indian States as well as analyse the sectors in which these linkages are taking place, which has not been convered by any other study uptil now. He highlighted the Research methodology which was followed in the study. The state analysis reflected that the level of University – Industry Linkages differs from State to State. Though University – Industry Linkage are considered moderate in India with a score of 4.7 points out of 10 but surprisingly, lot of disparities have been observed among the States. On the basis of analysis of States, it has been observed that University-Industry Linkages are very strong in the States of Karnataka and Kerala with a score of 7.8 and 7.3 points out of 10 respectively and weak in Arunachal Pradesh, Mizoram, Nagaland and Manipur. Rest of the States is in the category of moderate and strong University – Industry Linkages. He further highlighted

the level of UILs between university and industry on complementary basis and said that the all-India score shows moderate complementarities exist between university and industry.

Further, Dr. Sharma highlighted the identification of top 10 sectors based on the survey analysis. He also stressed on the action/steps to be taken by each of the states for enhancing UILs. He highlighted the UILs with respect to employment generation in the economy. The presentation also covered the global scenario of UILs with specific case studies and the impact of models of select counties. He also highlighted the issues and challenges to UILs in India and why India lags behind. Dr. S P Sharma informed the members of PGRC that the study also presents few case studies of UILs in India. The presentation ended with conclusions of the study.

The Committee appreciated the work undertaken by PHDCCI. Following suggestions/recommendations were made by the Committee:

1. To clearly state the basis of arriving at state level ranking in the study.
2. The research methodology adopted in the study needs to clearly defined mentioning the statistical tools and sampling techniques used.
3. Employment generation potential should be adequately covered in the study.
4. Discrepancies, given below observed in the report needs to be removed.

4.1 In report, at some places 30 states are mentioned and in some places 29 states are mentioned.

4.2 There is a typo error in the report on sample size of universities and industry and the number of responses received.

4.3 The report mentions universities at some places and research institutes at other places. This needs to be streamlined throughout the report.

5. UIL score in the bio-technology sector should be clearly explained (on how it is derived)
6. It was advised that graphs may be include the study, wherever feasible.
7. It was advised to make very pinpointed recommendations. Recommendations should be made objective wise.
8. It was also suggested to cover role for the intermediaries and technology transfer organizations, as to how they can enhance UILs in our country. A model / policy may be proposed for the same.
9. It needs to be mentioned in the report as to how BayhDole Act can be implemented in India. Further, a model has to be suggested for India.
10. Kay learnings from case studies should form part of recommendations too.

11. The limitations of the study should be included in the report.

12. It was recommended that role played by research councils should be presented in the report

13. PHDCCI will provide raw data to DSIR

14. Committee suggested release of second instalment of the payment for the study.

15. Prof. Tuli gave the concluding remarks and summarized the steps PHD Chamber should take to improve the report:

15.1 For the analysis of data, giving different weightages to parameters may be considered.

15.2 Local linkages as well as local relevance of industries should be there.

15.3 In the conclusion section of the report, specific recommendations for each state.

15.4 Matrix of national UILs should be given with the Indian map depicting the relevant information.

The meeting concluded with a vote of thanks by Dr. Ashwani Gupta and he suggested that the report should be finalised by mid-January.

Participants in 2nd PGRC meeting

1. Dr. Ashwani Gupta, Head A2K+ (Studies), DSIR, New Delhi
2. Dr. R.S.Rathore, Director (NSQF), Industry Institute Partnership, AICTE, New Delhi
3. Dr. Meenakshi Singh, Senior Principal Secretary CSIR, New Delhi
4. Sh. Venkata Subramanian, Scientist, Mission Directorate, CSIR,
5. Dr. A.K. Vasisht, Asst. Director General (PIM), Indian Council of Agriculture Research
6. Dr.H.Purushotham, CMD, National Research Development Corporation
7. Dr. Rajesh Kumar, Scientist, Access to Knowledge for Technology Development Programme, Department of Scientific & Industrial Research
8. Dr. S.P. Sharma, Chief Economist, PHD Chamber, New Delhi
9. Ms. Megha Kaul, Associate Economist PHD Research Bureau, New Delhi
10. Mr. Agraja Pratap, Deputy Secretary, PHD Chamber, New Delhi
11. Ms. Areesha, Research Associate, PHD Research Bureau, New Delhi
12. Ms. Abha Chauhan, Research Associate, PHD Research Bureau, New Delhi
13. Ms. Aakriti Batra, Research Associate, PHD Research Bureau, New Delhi


DSIR PROFILE

The Department of Scientific and Industrial Research (DSIR) is a part of the Ministry of Science and Technology, which was announced through a Presidential Notification, dated January 4, 1985 (74/2/1/8 Cab.) contained in the 164th Amendment of the Government of India (Allocation of Business) Rules, 1961. The Department of Scientific and Industrial Research (DSIR) has a mandate to carry out the activities relating to indigenous technology promotion, development, utilization and transfer.

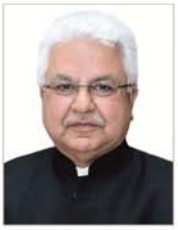
The primary endeavor of DSIR is to promote R&D by the industries, support a larger cross section of small and medium industrial units to develop state-of-the art globally competitive technologies of high commercial potential, catalyze faster commercialization of lab-scale R&D, enhance the share of technology intensive exports in overall exports, strengthen industrial consultancy & technology management capabilities and establish user friendly information network to facilitate scientific and industrial research in the country. It also provides a link between scientific laboratories and industrial establishments for transfer of technologies through National Research Development Corporation (NRDC) and facilitates investment in R&D through Central Electronics Limited (CEL).

NATIONAL APEX CHAMBER

PRESIDIUM, PHDCCI

Dr D K Aggarwal
President, PHDCCI

Sanjay Aggarwal
Sr. Vice President, PHDCCI



Pradeep Multani
Vice President, PHDCCI

Dr Mahesh Y Reddy
Secretary General, PHDCCI

About Us

PHD Chamber of Commerce & Industry, a leading Industry Chamber of India, ever since its inception in 1905, has been an active participant in the India Growth Story through its Advocacy Role for the Policy Makers and Regulators of the Country. Regular interactions, Seminars, Conference and Conclaves allow healthy and constructive discussions between the Government, Industry and International Agencies bringing out the Vitals for Growth. As a true representative of the Industry with a large membership base of 1,30,000 direct and indirect members, PHD Chamber has forged ahead leveraging its legacy with the Industry knowledge across sectors (58 Industry verticals being covered through Expert Committees), a deep understanding of the Economy at large and the populace at the micro level.

At the National level, the PHD Chamber is well represented in 16 States with its own offices and MOUs with eleven Partner Chambers in different States.

At the Global level we have been working with the Concerned Ministries, Embassies and High Commissions to bring in the International Best Practices and Business Opportunity.

PHD Chamber has special focus on the following thrust areas:

- **Economic & Business Policy Advocacy**
- **Industry**
- **Infrastructure**
- **Housing**
- **Health**
- **Education & Skill Development**
- **Agriculture & Agri-business**
- **ICT**
- **International Trade**

"Towards Inclusive & Prosperous New India"

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PHD Chamber of Commerce and Industry

PHD Research Bureau

PHD Research Bureau; the research arm of the PHD Chamber of Commerce and Industry was established in 2010 with the objective to review the economic situation and policy developments at sub-national, national and international levels and comment on them in order to update the members from time to time, to present suitable memoranda to the government as and when required, to prepare State Profiles and to conduct thematic research studies on various socio-economic and business developments.

The Research Bureau has been instrumental in forecasting various lead economic indicators national and sub-national. Many of its research reports have been widely covered by media and leading newspapers. The Research Bureau has undertaken various policy studies for Government of India and State Governments.

Research Activities	Comments on Economic Developments	Newsletters	Consultancy
• Research Studies	• Macro Economy	• Economic Affairs Newsletter (EAC)	• Trade & Investment Facilitation Services (TIFS)
• State Profiles	• States Development	• Global Economic Monitor (GEM)	
• Impact Assessments	• Infrastructure	• Trade & Investment Facilitation Services (TIF)	
• Thematic Research Reports	• Foreign exchange market	• State Development Monitor (SDM)	
• Releases on Economic Development	• Global Economy & International Trade	• Forex and FEMA Newsletter	

Notes

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