MODELLING AND MEASURING THE CAPABILITY OF INTELLECTUAL PROPERTY CREATION IN INDIAN HIGHER EDUCATION INSTITUTES

Ph.D. THESIS

by

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INDIAN INSTITUTE OF TECHNOLOGY ROORKEE
ROORKEE - 247 667 (INDIA)
JANUARY, 2019

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A THESIS

Submitted in partial fulfilment of the requirements for the award of the degree

of

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in

MANAGEMENT STUDIES

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INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the thesis entitled "**MODELLING AND MEASURING THE CAPABILITY OF INTELLECTUAL PROPERTY CREATION IN INDIAN HIGHER EDUCATION INSTITUTES",** in partial fulfillment of the requirements for the award of the Degree of Doctor of Philosophy and submitted in the Department of Management Studies of the Indian Institute of Technology Roorkee, Roorkee is an authentic record of my own work carried out during a period from December, 2014 to January, 2019 under the supervision of Dr. Rajat Agrawal, Associate Professor, Department of Management Studies, Indian Institute of Technology Roorkee, Roorkee.

The matter presented in this thesis has not been submitted by me for the award of any other degree of this or any other institute.

(ANKUR KASHYAP)

This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

(Rajat Agrawal)
Supervisor

The Ph. D. Viva-Voce Examination of Mr. Ankur Kashyap, Research Scholar, has been held on 18th June 2019.

Chairperson, SRC **Signature of External Examiner**

This is to certify that the student has made all the corrections in the thesis.

Signature of Supervisor **Head of the Department**
Dated:18.06.2019

ABSTRACT

The importance of Intellectual Property (IP) creation, protection, and commercialization requires no introduction. In the knowledge economy society, creation of new knowledge and its proper commercialization will help a nation to progress on the economic ladder. Higher education institutions (HEIs) are increasingly expected not only to conduct education and research, but also to play an active role in the economic, social and cultural development of their regions. Therefore, HEIs around the world are moldings themselves into these new expectations. Some of the European, American and even Asian countries have developed a good enabling environment to leverage the strength of their HEIs for IP creation and its monetization.

The importance of HEIs regarding IPR in economic growth has not been well-established in existing literature. There is lack of consensus among the researchers about the role of HEIs in economic development with reference to IPR creation. The disagreement among the research studies aimed at identifying universally accepted common factor on IP creation capability. There are no studies in developing nations which empirically test the traditional academic motivations (i.e., eponymy, prizes and publication) for patenting. There is a need of identifying the role of non-monetary rewards in academic IP creation for formulating effective incentive policy.

The IP creation in Indian HEIs is very low. At the same time there are no measurement criteria available to measure there IP creation potential. Therefore, it is important to study IP creation potential/capability of HEIs to enhance their indirect contribution in economic activity.

No suitable empirical scale is developed for different geographical and disciplinary settings especially in Indian context. The majority of academic literature focused on the IP creation in academic institutes is from developed countries and the applicability of the findings of such research to Indian scenario is limited.

Studies do not suggest any empirical model that relates critical factors of Intellectual Property creation capability (IPCC). There are no studies which identify the dimensions of IP creation capability in knowledge-based environment especially in higher education. Researchers acknowledged that patenting by Indian academic institutions is in a nascent stage and requires further strengthening. There is a need to formulate policies & strategies for enhancing academic patenting in Indian Universities. Studies related to IPR in India do not give importance to IP

creation capacity. For enhancing activities related to academic patenting strategies are to be formulated.

Based on the existing knowledge gaps, the study maps the economic contribution of HEIs in global perspective, identifies critical factors for IP creation, and proposes a structured model for IPCC with respect to Indian conditions. Because of the complexity of the research problem, pragmatic research approach is used to carry out this research.

This research study approached the idea of triangulation to achieve the research objectives and to increase the validity of the findings. We have applied three types of triangulations i). data triangulation i.e. use of variety of data sources; ii). methodological triangulation i.e. use of multiple methods to study a research problem; and iii). theory triangulation i.e. the use of multiple perspectives to interpret the results.

Based on the suitability, the different research tools are applied for achieving specific research objectives. Like secondary data analysis is used for mapping the economic contribution of HEIs with respect to IP. Interpretive Structural Modeling is applied on the qualitative data gathered through expert elicitation for identifying and finding inter-relationship between the enablers and barriers of IP creation in Indian HEIs. This is followed by MICMAC analysis to propose a four layered ISM model. Factor analysis followed by SEM to prepare a scale for measuring IPCC and testing. Soft System Methodology (SSM) suitable for assessment of complex administrative system with diverse alternatives is applied to propose strategies for enhancing IP creation in Indian HEIs.

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(Ankur Kashyap)

LIST OF PUBLICATIONS

Refereed Journals:

1. **Kashyap, A.**, Agrawal, R., & Ghosh, P. K. (2018), "Examining higher educational institutes for better growth of national economy through structured innovation", ***International Journal of Innovation in Education***, Vol 5(1), 61-78, EBSCO Indexed.
2. **Kashyap, A.**, Ghosh, P. K ., & Agrawal, R. (2018), " Intellectual Property: Country-wise trends of contributors and indicators in the knowledge economy ", ***International Journal of Intellectual Property Management***, (under press), Scopus Indexed.
3. **Kashyap, A.**, Agrawal, R., "Intellectual Property Creation in Higher Education: Conceptualization, Scale Development and Empirical Validation using PLS-SEM", ***Journal of Intellectual Capital***, (Under review), Emerald Publishers. Scopus Indexed.
4. Agrawal, R., **Kashyap, A.** (2017), "Role Change: Finding New Supplier of Knowledge", ***Indian Management by AIMA***, Vol 56(12), 85-90.
5. Ghosh, P. K., **Kashyap, A.** & Agrawal, R. (2016), "Mapping the position of higher educational institutes in national economic advancement: a comparative analysis", ***International Journal of Technological Learning, Innovation and Development***, Vol 8(3), 283-302, Scopus Indexed.
6. Ghosh, P. K., Agrawal, R**. & Kashyap, A. (**2016**)**, "A Model for Innovation at Higher Education Institution for Nation Building", ***University News***, Vol 54(5), 164-166, Association of Indian Universities, New Delhi.

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1. **Kashyap, A.**, Agrawal, R., (2018) "***Barriers in the development of HEIs as a supplier in knowledge supply chain***" ; International Conference on Business, Economics and Sustainable Development (ICBESD 2018) , organized by TERI University, New Delhi, during February 22-23, 2018.
2. **Kashyap, A.**, Agrawal, R., (2018) "***IP generation in SME Sector: Finding new Role for Institutes of Higher Education***" National Conference on Intellectual Property and Entrepreneurship (NCIPE-2018), organized by IPR Chair, Department of Management Studies, IIT Roorkee, on March 19 2018.
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4. **Kashyap, A.**, Raghuvanshi, J., Agarwal, R. (2015) "***Facet of Indian Traditional Knowledge: Capturing the trends of Geographical Indications''***; International conference on Research and Business Sustainability (ICRBS-2015), Organized by DoMS IIT Roorkee and Sheffield Business School, Sheffield Hallam University, UK, Greater Noida campus, December 4-6, 2015.

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CHAPTER-1
INTRODUCTION

1.1 Preview

This chapter gives the background of the study. An overview of various issues related to the broad area of research study is given in brief. The chapter gives an introduction of Indian education system along with the status of the numbers of HEIs and their growth trend in recent past. Current scenario of IP statistics is also discussed. Organization of the complete thesis is given in the last section of the chapter.

1.2 Background of the study

The importance of Intellectual Property (IP) creation, protection, and commercialization require no introduction. In the knowledge economy society, creation of new knowledge and its proper commercialization will help a Nation to progress on the economic ladder. In Indian scenario also the role and importance of IP in industries specially in agriculture is also increasing (Menon, Jha, & Jain, 2015). Higher Education Institutes (HEIs) which are primarily responsible for development of human resources by providing education and conducting research are now responsible for cultural, societal, and economic development in more direct manner (Mansfield, 1991; Rosenberg & Nelson, 1994). Although innovations are driven by business goals of industry specially in software firms (Kumar & Mishra, 2005) but universities are also an important source of technical change and innovation (Freeman, 1995; Nelson & Rosenberg, 1993) as well as establishing startups (Gregorio & Shane, 2003). Therefore world over HEIs are adopting themselves into these new expectations. Some of the European, American and even Asian countries are able to develop a good enabling environment to leverage the strength of their HEIs for IP creation and its monetization. Keeping in view the changing role of higher education around the world, it is high time to review HEIs in India with respect to IP creation.

1.3 Overview of Indian educational system

In 1992, the World Conference on Higher Education defined higher education as: "all types of studies, training or training for research at the post-secondary level, provided by universities or other educational establishments that are approved as institutions of higher education by the competent state authorities." India has one of the largest educational systems to cater the needs of the 1.3 billion population. The Indian education system is broadly divided into elementary education, secondary education and higher education. Higher education is either three years or

of four years duration. Which can be extended for specialization and doctorate work. But the education system in India is either known as "10 + 2 + 3" or "10+2+4" system.

Figure 1.1 shows the education system of India.

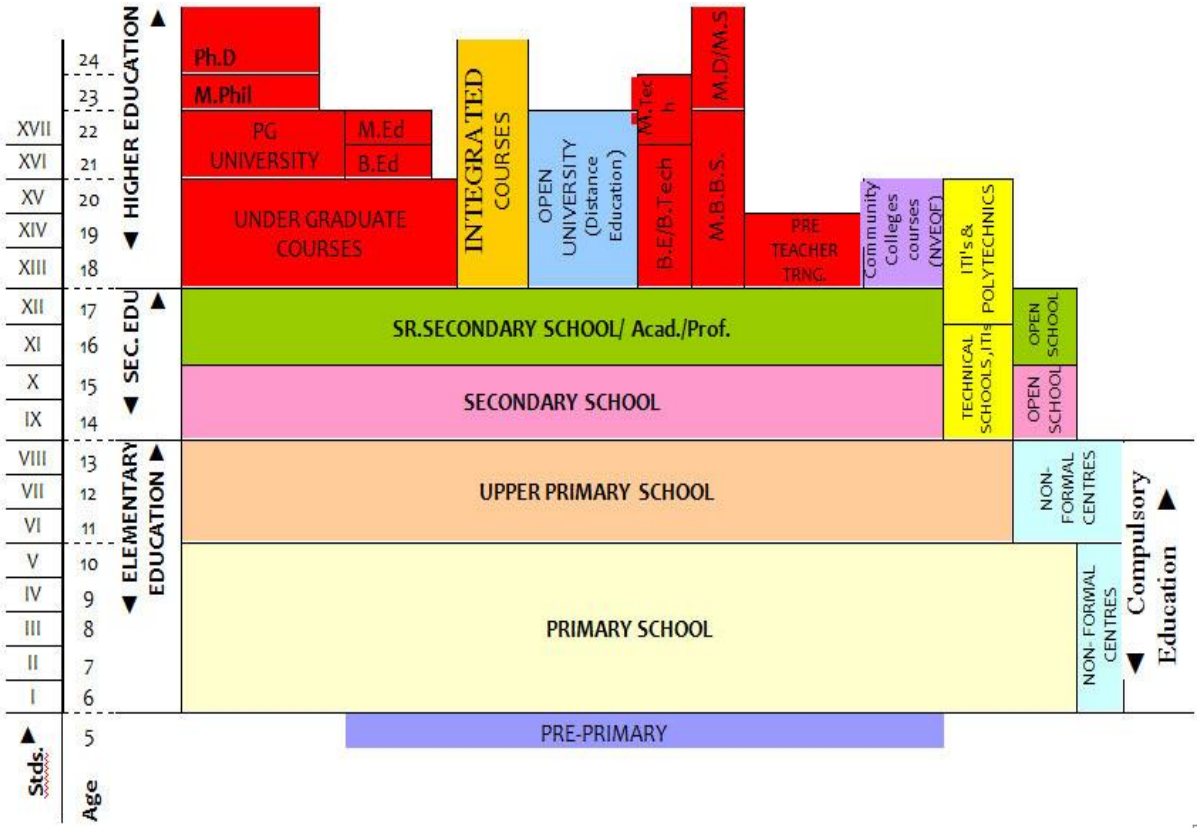

Figure 1.1: Education system in Indian scenario (Source: UGC)

In India, Higher Education and Research Bill, 2011 define higher educational institution "as an institution of learning including a university, an institution deemed to be university, a college, an institute, an institution of national importance declared as such by an Act of Parliament, or a constituent unit of such institution, a polytechnic or other institutions in vocational education, which is imparting by means of conducting regular classes or through distance education systems, higher education or research therein". This bill also describe higher education "as such education, imparted by means of conducting regular classes or through distance education systems, beyond twelve years of schooling leading to the award of a degree or diploma; and includes research associated with such education".

The journey of seventy years (1957-2017) of Indian higher education system is continuously in transition state. Student strength has shown a healthy growth rate in Indian HEIs in last few decades. Under this approach expansion of higher education is done through establishment of new universities and encouraging student enrolment. In 2017, there were 757 Universities

which mainly includes: Central University, State universities, Institute of National Importance, Institute under State Legislature Act, State Private University, Deemed University-Government, Deemed University-Government Aided and Deemed University-Private.

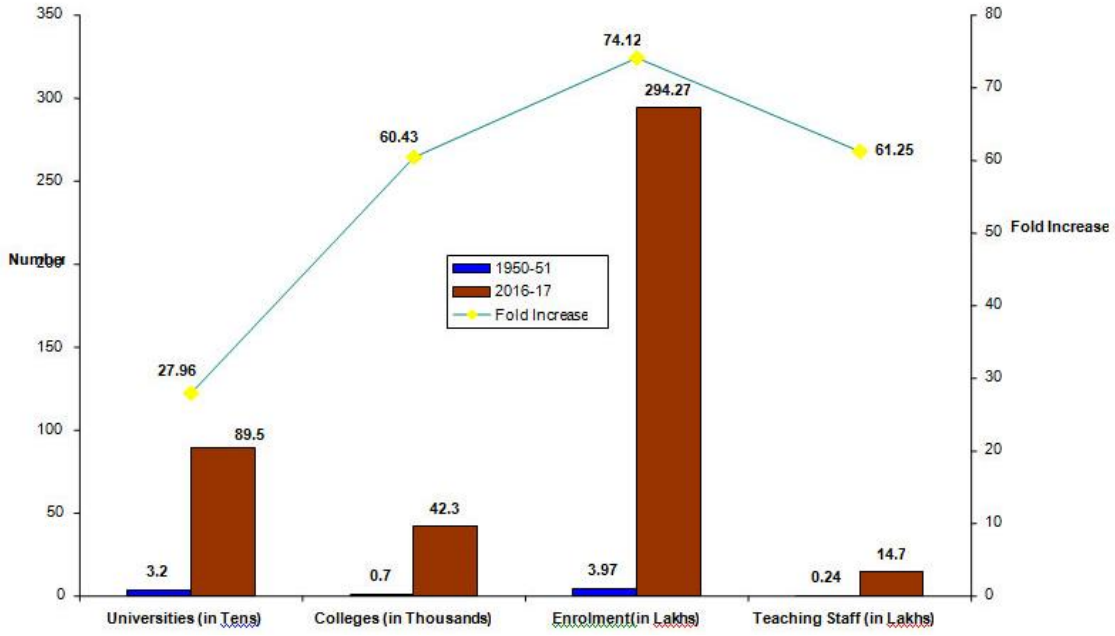

Figure 1.2: Growth of Higher Education: 1950-51 to 2016-17. (Source: UGC website)

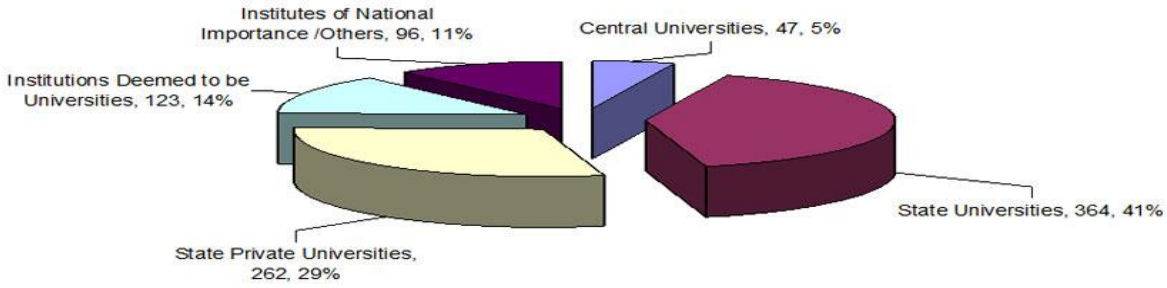

Figure 1.3: Statistics of HEIs in India (Source: UGC)

When India became independent in 1947, there were 19 universities and some hundred colleges. In 2014, British council report indicated low rate of enrolment in higher education at only 18% compared to 26% in China But, in the same report BC expects that by the year 2020, the Indian higher education system will be transformed tremendously due to the economic and demographic changes corresponding to rapid growth in the size of its middle class (British Council, 2014). Today India has the largest system of higher education in the world in terms of

number of institutions. The latest figure of HEIs in India (UGC, 2018) is as given in Table 1.1. But, in the pursuit of acquiring this position, the quality was compromised (Agarwal, 2006; Senthilkumar & Arulraj, 2011). According to (OECD economic survey, 2014) the spending on secondary education has increased but the educational quality of universities is very poor. The current status for the year 2018 is shown in Table 1.1

Table 1.1: Status of HEIs in India

No. of Universities	**Total No.**
State Universities	378
Deemed to be Universities	123
Central Universities	47
Private Universities	289
Total	**837**

1.3.1 Development of HEI in India

After independence, education was considered an important aspect for overall progress of the country and various policies that were framed time to time played a vital role in it. Policies that shaped the higher education in India can be categorized from three broad documental evidences.

1. National Educational Policies (NEP 1968; NEP 1986 and NEP1992)
2. Science and Technological policies (STP1968; STP 1983; STP 2003 and STIP 2013)
3. Five year plans (FYP I to XII)

Some of the mile stone in the history of higher education are listed in Table 1.2.

Table 1.2: Important Events in the Indian Higher education history

Year	**Activity**
1817	First college- "Hindu College, Calcutta" was established for higher education
1857	Calcutta, Madras and Bombay universities were established
1857	The Acts of Incorporation of the Universities mentioned the degrees by name that the university might confer.
1860	Indian Universities (Degrees) Act empowered the universities to confer such diplomas or degrees as had been or might be approved by the bylaws or regulations
1909	The Indian Institute of Science, Bengaluru was founded
1950	First Indian Institute of Technology was established at Kharagpur
1958	Indian Institute of Technology , Bombay was established at Powai

1956	Delhi, Banaras, Aligarh and Vishwabharti universities were established
1960-61	The duration of degree courses was increased to three from two years
1961	IITs were declared "Institutions of National Importance" by Institutes of Technology Act, 1961
1961	First Indian Institute of Management at Calcutta was established
1969-70	College science Improvement Programme (COSIP) started to improve the teaching in physical, biological, mathematical sciences and later on humanities
1972	Department of Special assistance (DSA) started for selected departments as supporting programmes for "Centre of Advance Studies" to strengthen research in India
2001	University of Roorkee made into IIT
2007	The National Institutes of Technology, Science Education and Research Act, 2007 declare India's National Institutes of Technology as Institutes of National Importance.
2008	Conversion of BHU into IIT.
2018	Selected (3 private and 3 government) educational Institutes declared as "Institutions of Eminence" for converting them into world class teaching and research institutes.

1.4 Intellectual Property in Higher Education

The trend for universities to apply for and own patents has been increasing in the developed countries for some decades. There are several reasons for the rise in the number of university-owned IP: changes in knowledge production increasing the capacity of university researchers to produce patentable inventions and scientific publications (Azagra-Caro, Archontakis, & Yegros-Yegros, 2007; Baldini, 2006; Breschi, Lissoni, & Montobbio, 2008; Meyer, Du Plessis, Tukeva, & Utecht, 2005), access to industry knowledge, practical experience and the possibilities for its application (Arvanitis et al., 2005), and changes in societal demand and funding conditions. These reasons have been the motivation for regulatory changes in some countries to allow universities to own patents (Baldini, 2006, 2009) and in universities to share royalties with academic inventors and departments (Baldini, 2010) or to accommodate IPR sharing with partners (Okamuro & Nishimura, 2012).

Sun & Baez (2009) note emerging IP-related issues in higher education, including ownership rights pertaining to online courses and licensing of university marks (e.g., athletics logos).The

authors also identify the significance of university IP policy, noting that IP policies in higher education certainly affect the academic core.

HEIs can dictate the terms of rights for faculty and students (through employment contracts and policies related to academic programs). Other important academic institutes related IP topics include the ownership of faculty-created classroom materials (Blanchard, 2010), and the fair use of protected properties, such as text books, as part of educational activity. Institutions of higher education, as well as the faculty, staff, and administrators who work within those institutions, are surrounded by IP usage and ownership issues. While the overarching IP forms are the same (e.g., copyright, trademarks, and patents), there are specific provisions, applications, and impacts that are unique. For instance, in USA the Bayh-Dole Act, and its transformative effect on university patenting and technology transfer activity, is a critical component of the higher education IP discussion. Another contemporary IP issue in higher education surrounds the question of who owns the copyright on content created for online course offerings. Two topics appear regularly in the literature regarding IP in higher education: (1) copyright and the related work-for-hire and fair-use provisions, and (2) patenting or licensing related to research discovery commercialization. While copyright and patenting topics are not the only IP issues relevant to higher education. Sun & Baez (2009) note that trademark protection, is sought by many institutions.

Apart from the broad review of IP issues, review of the literature from the prospective of creation and commercialization of IP has also been done. The literature review revealed that IP creation need a culture of innovation and environment which is favorable for bringing IP to the commercialized world either through technology transfer or through academic start-up.

The organizational arrangements, installed by knowledge-generating institutions with respect to IP creation and related activities, undoubtedly affect the extent to which different actors are willing to engage in patenting activity (Debackere & Veugelers, 2005). At the same time, Owen-Smith & Powell, (2001) suggest that the decision to disclose a new finding depends upon the patent benefits, framed by the costs of interacting with the university administrators: inconvenient or frustrating interactions may lead to failure to disclose.

1.4.1 Intellectual Property Statistics of India

National Institutional Ranking Framework (NIRF), an initiative of Indian government, has been commissioning ranking of Indian universities for the past three years (2016,2017 & 2018). The NIRF ranking for the year 2018 bears the parameters- “Teaching, Learning and Resources,” “Research and Professional Practices,” “Graduation Outcomes,” “Outreach and Inclusivity,”

and “Perception”. Based on the ranking of 2018, the publication and patent details of Indian higher educational institutes for the years 2014, 2015 and 2016 are given in Table 1.3. It contains data on myriad IP assets- number of publications (Web of Science and Scopus), number of citations, citations in highly cited papers, number of patents granted & published and the earnings from the patents. The selection of HEIs is on the basis of NIRF ranking (with reference to RPC score) of top 50 institutes. This table gives a clear view of IP and its related aspects in Indian HEIs.

Table 1.3: IP details of HEIs (Source: Compiled from various annual reports of Intellectual Property India, submission reports of institutions to MHRD)

Ranking	Institute name	Publication details (for calendar year 2014,2015,2016)				Patent details (for calendar year 2014,2015,2016)		
		Source of data	Publication	Citation	Top 25% highly cited paper	No. Of patent granted	No. Of patent published	Earnings from patents (Rs)
1.	Indian Institute of Science	Web of Science	7237	38203	2584	92	277	11701309.00
		Scopus	7734	41945	2233			
2.	Indian Institute of Technology Bombay	Web of Science	5836	27457	1932	86	369	66200000.00
		Scopus	6618	31337	1882			
3.	Indian Institute of Technology Madras	Web of Science	5253	20390	1639	54	395	65531734.00
		Scopus	5852	24096	1511			
4.	Indian Institute of Technology Delhi	Web of Science	5496	26219	1936	39	156	3571000.00
		Scopus	5792	28677	1794			
5.	Indian Institute of Technology Kharagpur	Web of Science	6214	28167	2286	11	131	4995889.00
		Scopus	6420	31553	1905			
6.	Indian Institute of Technology Kanpur	Web of Science	4079	18082	1366	29	203	8144839.00
		Scopus	4286	20495	1229			
7.	Indian Institute of Technology Roorkee	Web of Science	4459	22822	1631	0	2	0.00
		Scopus	4903	26914	1477			
8.	Anna	Web of	4475	15144	1243	12	39	0.00

	University	Science						
		Scopus	7251	19931	1130			
9.	University of Delhi	Web of Science	5205	28338	1602	6	33	0.00
		Scopus	5630	32122	1365			
10.	Jadavpur University	Web of Science	4497	17999	1397	8	8	2128000.00
		Scopus	4950	21153	1356			
11.	Indian Institute of Technology Guwahati	Web of Science	3270	15568	1073	0	1	0.00
		Scopus	3401	17065	983			
12.	Banaras Hindu University	Web of Science	4326	22978	1371	1	6	0.00
		Scopus	4306	22658	1018			
13.	Calcutta University	Web of Science	3126	12326	873	31	103	12754088.00
		Scopus	3392	13911	717			
14.	Indian Institute of Technology (Banaras Hindu University) Varanasi	Web of Science	1714	7742	536	0	10	0.00
		Scopus	4310	22659	1018			
15.	Institute of Chemical Technology	Web of Science	1211	8294	417	116	35	31505000.00
		Scopus	1290	8873	414			
16.	Vellore Institute of Technology	Web of Science	4289	13564	1167	0	4	0.00
		Scopus	7720	20083	1401			
17.	University of Hyderabad	Web of Science	2354	10507	704	2	8	0.00
		Scopus	2560	12458	649			
18.	Panjab University	Web of Science	3045	20877	1116	2	33	26151.00
		Scopus	3252	23949	999			
19.	Indian Institute of Technology (Indian School of Mines) Dhanbad	Web of Science	2281	9616	851	0	14	0.00
		Scopus	2674	11364	788			
20.	Manipal Academy of Higher Education	Web of Science	3240	7141	797	11	27	396065.00
		Scopus	4226	10594	440			
21.	Savitribai	Web of	2092	11957	580	0	14	16000

	Phule Pune University	Science						00.00
		Scopus	2304	16678	545			
22.	Amrita Vishwa Vidyapeetham	Web of Science	2358	6355	541	4	72	368423980.00
		Scopus	3361	9259	698			
23.	Jawaharlal Nehru University	Web of Science	2248	9934	668	6	14	0.0
		Scopus	2478	11531	575			
24.	National Institute of Technology Rourkela	Web of Science	2267	9164	751	0	3	0.00
		Scopus	2490	11136	753			
25.	Bharathiar University	Web of Science	1607	8604	524	0	1	200000.00
		Scopus	2250	10090	516			
26.	Aligarh Muslim University	Web of Science	2469	12432	773	0	2	5277370.00
		Scopus	2905	14600	739			
27.	Indian Institute of Science Education & Research Kolkata	Web of Science	887	9061	317	0	0	0.00
		Scopus	1045	11201	336			
28.	Birla Institute of Technology & Science	Web of Science	2183	8424	575	0	10	101000.00
		Scopus	2322	10176	622			
29.	Indian Institute of Engineering Science and Technology, Shibpur	Web of Science	1635	5023	488	0	4	0.00
		Scopus	1744	6037	433			
30.	Indian Institute of Technology Hyderabad	Web of Science	1201	4789	381	1	32	0.00
		Scopus	1219	5625	364			
31.	Thapar Institute of Engineering and Technology	Web of Science	1802	6327	600	1	11	279000000.00
		Scopus	1880	7636	479			
32.	Shanmugha Arts Science Technology & Research Academy	Web of Science	1404	6677	409	0	17	0.00
		Scopus	2961	9434	465			
33.	National	Web of	1633	6360	533	0	0	0.00

	Institute of Technology Tiruchirappalli	Science						
		Scopus	1778	7538	449			
34.	University of Madras	Web of Science	1188	6082	357	3	10	0.00
		Scopus	1494	6650	328			
35.	Jamia Millia Islamia	Web of Science	1572	6668	495	0	18	0.00
		Scopus	1698	8045	477			
36.	Indian Institute of Science Education & Research Pune	Web of Science	922	8255	368	0	0	0.00
		Scopus	876	8146	308			
37.	Jamia Hamdard	Web of Science	1004	4910	335	2	12	3266750.00
		Scopus	1148	10461	315			
38.	Guru Nanak Dev University	Web of Science	1494	7174	465	0	3	0.00
		Scopus	1460	7484	382			
39.	Tezpur University	Web of Science	1134	6292	374	0	3	0.00
		Scopus	1177	6959	346			
40.	Amity University	Web of Science	1737	3337	385	1	283	8000000.00
		Scopus	2613	6496	570			
41.	King George`s Medical University	Web of Science	960	5400	270	0	11	0.00
		Scopus	1345	7324	179			
42.	National Institute of Technology Surathkal	Web of Science	1399	3452	324	0	7	0.00
		Scopus	1470	4186	311			
43.	Birla Institute of Technology, Ranchi	Web of Science	1187	3249	312	2	16	0.00
		Scopus	1707	4603	335			
44.	Sathyabama Institute of Science and Technology	Web of Science	1337	1358	155	3	7	2700000.00
		Scopus	3821	4288	360			
45.	Bharath Institute of Higher Education & Research	Web of Science	630	947	79	0	111	8242000.00
		Scopus	2818	16568	151			
46.	Bharathidasa	Web of	1101	5427	345	0	1	0.00

	n University	Science						
		Scopus	1318	5912	307			
47.	SRM Institute of Science and Technology	Web of Science	1616	5831	474	0	15	0.00
		Scopus	3854	8241	482			
48.	Indian Institute of Technology Bhubaneswar	Web of Science	757	4169	263	0	6	0.00
		Scopus	766	3847	223			
49.	Madurai Kamraj University	Web of Science	838	6514	263	0	0	10000 0.00
		Scopus	1127	7309	274			
50.	Visva Bharati	Web of Science	1117	9984	426	0	6	0.00
		Scopus	1106	7961	318			

It is clearly analyzed from Table 1.3 that there are only few institutions which are actively involved in IP creation activities and generating patents out of their research work. It is evident from the table that major contribution in the field of IP is coming from old IITs in India while other institutions have very minimal contribution. This is the situation of top 50 institutions in India. If we scan the complete list of institutions, situation looks very miserable. New IITs are fast understanding the importance of conversion of their research into patent but they will take time to reach to a respectable number. Private HEIs in India do not have such research infrastructure that could deliver IP, but some institutes like Amity University are leading the private institutes in patent filing. There is a huge gap in the standard of various types of HEIs in India, some are producing excellent results (academics, research, innovation, entrepreneurship) whereas some are struggling to survive and their existence is not sure in long time horizon.

1.5 Problem Statement

As discussed in the previous section, there is a substantial growth in the number of HEIs in India but the quality of research output is not good. Because of which the innovation is not happening in higher education. The IP creation in Indian HEIs is also very low. Most of the studies related to IP creation, technology transfer and IP protection in India are silent about enabling factors of IP creation. There are some studies which are done in different parts of the world but India being a very promising developing nation needs to have a detailed framework of IP creation at HEI. At the same time there are no measurement criteria available to measure

there IP creation potential. Therefore, it is important to study IP creation potential/capability of HEIs to enhance their direct and indirect contribution in economic development of the country.

1.6 Research Objectives

To address the above problem statement, this study has undertaken four research objectives. These research objectives are:

Objective 1: To compare and contrast role of HEIs in economic development of India vis-à-vis some other nations with reference to Intellectual property rights.

Objective 2: To identify enablers and barriers for IP creation and its commercialization in Indian HEIs.

Objective 3: To prepare a scale for measuring the IP creation capability in Indian HEIs.

Objective 4: To propose strategies for enhancing IP creation in Indian HEIs.

1.7 Scope of research

This research is focused on measuring the role of factors that are responsible for the development of IP in higher educational institutes. The scale for IP creation capability in HEIs developed in this study provides practitioners with a reliable and valid analytical tool for the measurement of faculty's perceptions about IP. This can be used as a diagnostic tool that allows various educational institutes to identify and solve problems that occur in the process of IP creation. Based upon the feedback from the study, the authorities can reframe their management strategies and tactics to redesign the innovation & IP creation delivery system.

1.8 Organization of the thesis

The organization of the research work is covered in seven chapters. A brief idea of all chapters is given as follows,

Chapter 1: Introduction

This chapter provides an introductory background for this research work including the overview of the Indian education system and current IP statistics of some of the leading HEIs. The later part of the chapter gives details of the problem statement, scope of the research work and chapter wise organization of the thesis.

Chapter 2: Literature Review

The second chapter of the thesis provides the extensive literature review in the field of IP creation and its relation with technological advancement/progress in HEIs in India.

This chapter also covers the general overview of IP rights in India and global scenario. In addition, it provides an overview of higher education institutes in India, literature review IP creation and technological advancement/progress to both Indian and global scenario. A bibliographic classification of existing literature in the field of study is also presented. At the end, gaps from the literature are presented.

Chapter 3: Research Methodology

This chapter presents the conceptual framework proposed for enhancing the IP creation and explore its relationship with technological advancement in HEIs in India. The elements of the framework are also discussed. The research methodology includes research design, sample design, data collection method, scale development, pilot testing, data collection and analysis process and an overview of proposed statistical techniques used in this research work.

Chapter 4: Role of academically generated IP in economic development

This study examines the role of Higher Educational Institutes (HEI) in national economic development, from various angles and aspects with a specific focus on university-based research in different nations worldwide. The discussion is complemented by an in-depth study of the available data on Research and Development (R&D) for various countries. This research is done on gathered evidence from existing data from the World Bank, UNESCO and other such sources.

Chapter 5: Identifying and prioritizing the factors of IP Creation Capability

This objective of this chapter is to identify and prioritize various factors and enablers of IP creation capability in Indian HEIs. The study is divided into two sections. In first section various factors are identified which are responsible for IP creation in Indian HEIs. In second section these factors are prioritized using an Interpretive Structural Modeling (ISM), which highlights the mutual influences among the factors of IP creation.

Chapter 6: Analysis and results

This chapter presents the application part of statistical techniques to analyse the data. Hypothesis testing is conducted and tested. This chapter also presents the findings of literature review to identify the IP capability factors with reference to HEIs in India. The identification of

factors will help in developing a framework for enhancing the IP creation in HEIs. Further a scale is developed for measuring IP creation capability of an institution.

Chapter 7: Enhancing IPCC in HEIs: Forming Strategies

This chapter suggests the various strategies for HEIs and policy makers for enhancing the IP creation in the field of higher education. For this purpose, CATWOE technique is used.

Chapter 8: Conclusion, Limitations and Future Scope

This chapter provides a comprehensive overview of the research and the major findings along with the contribution of the study in the existing set of literature. In addition, this chapter also provide the managerial implication of the study. The last section of the chapter highlights the limitations of the study followed by the future scope in the study.

CHAPTER-2
LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of literature on the issues related to IP creation capability in HEIs and various methodologies that are applied in the present study. This section of thesis gives a comprehensive literature on Intellectual property rights, critical factors for IP creation in HEIs, the research approach, and avenues for future research. This review will also provide a robust groundwork for conducting the present study and other areas that need to be explored.

This section of the study deals with the systematic review of the IP Literature to gain an understanding into how IP research has been conducted in the higher education context. The systematic review approach was chosen because it is an established scientific tool designed to assist in appraising, summarizing, and communicating the results and implications of large and complex data sets (Walker, 2007).

2.2 Definitions of terms

2.2.1 Definition of intellectual property (IP)

In a broader term intellectual property are the legal rights arising due to some intellectual creation in the industrial, scientific, literary and artistic fields. These rights are given to protect the intellectual creation that may be embodied in a physical object but not the object itself. In general intellectual property encompasses all the ownership rights related to patent, trademark, copyright and trade secret. In a case processing, Supreme Court of India has defined a patentable invention as "anything under the sun that is made by man" (Bhandari, 2005).

According to (Hughes, 1988) "A universal definition of intellectual property might begin by identifying it as nonphysical property which stems from, is identified as, and whose value is based upon some idea or ideas."

2.2.2 Types of intellectual property

In July 14, 1967, the World Intellectual Property Organization (WIPO) in the Article 2(viii) stated "intellectual property shall includes rights relating to:

- literary, artistic and scientific works,
- performances of performing artists, phonograms and broadcasts,

- inventions in all fields of human endeavor,
- scientific discoveries,
- industrial designs,
- trademarks, service marks and commercial names and designations,
- protection against unfair competition,

and all other rights resulting from intellectual activity in the industrial, scientific, literary or artistic fields." According to WIPO, IP can be classified into two broad categories, as given in Table 2.1.

Table 2.1: Classification of Intellectual Property Rights

	Category	**Types**
Intellectual Property	Industrial	Patents
		Trademark
		Industrial Design
		Utility Model
		Trade secrets
		Geographical Indication
	Literary	Copyrights

2.2.3 Patent

As defined by WIPO, "a patent is a document which describes an invention and creates a legal situation in which the invention can normally only be exploited with the authorization of the owner of the patent. A patent is an exclusive right granted for an invention – a product or process that provides a new way of doing something, or that offers a new technical solution to a problem". A patent according to United Nation's Charter is "A statutory privilege granted by the government to the inventor for a fixed term of years, to exclude others from manufacturing,

using or selling a patented product or utilizing a patented process".

Patent is a territorial right which is given to inventor by the state government for any invention that is considered to be novel, usefulness and involves an inventive step (Martinez-Ruiz & Aluja-Banet, 2009). The patent rights are given in lieu of detailed public disclosure of the invention. But if the product or technology is already in the public domain in form of publication, claimed before in any specification, it loses its novelty and hence cannot be granted patent. Any new manufacturing, process, item, chemical composition that has some new useful properties or and any other useful advancement are eligible for obtaining a patent.

A patent is like any other property which could be assigned, licensed, or charged by way of mortgage (Blackburn, 2003). As the patents are territorial rights which mean an applicant have to apply for patent separately in different countries. The practice of applying, requirements and the extent of the exclusive rights may differ from country to country as per the law of land and international treaty signed by the country.

"The patenting activity in a country also determines its level of national innovation capacity" (Furman, Porter, & Stern, 2002). In addition, "the use of technology for introducing innovation leads to enhancement of the importance and oddity measurements of a new product or service. New product oddity and weightiness are needed to be upgraded to make the new item advantageous, so that the item can develop its identity and consumer loyalty, both of which add to new product performance" (Kim, Im, & Slater, 2013). Patent application is the outcome of research work carried out in a country. Patent activity is also related to the field of one's specialization. For example, in certain fields patenting is not the preferred means of intellectual property protection. In computer sciences, by way of example, it is much more common to copyright than to patent research in the area of software. In other fields with a strong emphasis on applied research, such as engineering, it is fairly common to apply for patents for intellectual property protection (Stephan et al., 2007). Further, Patents granted found to be a better proxy for measuring innovations also (Burhan, Singh, & Jain, 2017)

This research has taken account of academic patents only. An academic patent is defined "as such when at least one university professor appears among its inventors, irrespective of ownership" (Lissoni & Montobbio, 2015).

2.2.4 Trademark

Trademarks are signs or symbols that are used for distinguishing the product or service offered

by the company from its competitors. A formal definition given by WIPO is “A trademark is a sign that individualizes the goods of a given enterprise and distinguishes them from the goods of its competitors”.

A trademark may consist of a single word or group of words, pattern, slogans, sign etc i.e anything that fulfills two main criteria of distinctiveness and non-deceptiveness (Landes & Posner, 1987). It should also neither be generic nor merely descriptive of the goods or services they represent.

Higher the number of trademark applications, higher is the business activities of that country. It indicates the entrepreneurship level as new enterprises usually apply for new trademarks. According to Millot (2009) “trademark data convey information on two key (overlapping) aspects of innovation which is not well covered by traditional indicators: marketing innovation and innovation in the service sectors”. United Nations Educational & The Commonwealth Education Media Centre for Asia (2015) defined trademarks as “A trademark is a recognizable symbol, sign, expression, design or the like which is used to identify and differentiate one product or service emanating from a particular source against one emanating from another source. The association of a trademark with an entity may take many forms, and could be visible on packaging, labels, advertisements, all company merchandise, etc.”

2.2.5 Industrial design

WIPO defined industrial design as “An industrial design refers to the ornamental or aesthetic aspects of an article. A design may consist of three-dimensional features, such as the shape or surface of an article, or two-dimensional features, such as patterns, lines or color”. Industrial design is different from trademark as it is concern with appearance of the product which must not necessarily be distinctive. But in case of trademarks they need to be distinctive. Industrial design differs substantially from patent since the former is confined to the appearance of the product and does not consider technical or functional aspect of it. Whereas the patent right is given on the basis of the inventiveness of the functionality of product or process.

By obtaining an industrial right, the owner of the design has the right against its unauthorized copying or imitation by others. It may be said that any person having industrial design protection for its article could prevent competitors from manufacturing and bringing items to market having same design which is the copy of the original patented industrial design.

The industrial design find their utility commercially, as they are used to protect the aesthetic

appearance of the object which makes object appealing and attractive, giving advantages over competitors as facilitating its marketing and commercialization.

2.2.6 Utility model

An alternate path to protect patent and industrial design is the utility model, which is particularly helpful in protecting the inventions of incremental nature that have lower level of inventiveness. According to WIPO these are sometimes referred to as "short-term patents" that are considered particularly suited for protecting inventions that make small improvements to, and adaptations of, existing products or that have a short commercial life. Many countries across the world have established a system either as a part of their patent law or a *sui-generis* (independent) system by enabling the right holders to commercialize the products of such innovations at an early stage of technological development. In India utility model are not granted.

2.2.7 Geographical Indication

"A geographical indication is a sign used on goods that have a specific geographical origin and possess qualities or a reputation due to that place of origin" (WIPO). Under this category usually agricultural products could be placed as they are grown in that particular place aided by the soil and climate of that place. The special product of any region that is being made in that area for long also comes under this category. Few examples are (origin is Kashmir), Havana cigars, Tuscany olive oil, Darjeeling tea, Allahabadi amrood, Bordeaux wine, Banarasi sari etc.

United Nations Educational & The Commonwealth Education Media Centre for Asia (2015) has defined geographical indication (GI) "as a sign that is used on goods and denotes the geographical origin of the said good. The qualities of that product, or the reputation and characteristics that it enjoys are attributable to the place of origin of the product, and are represented by the GI". A trademark is different from geographical indication in the sense that trademark is a sign used by a company for its goods and services preventing others from using it, whereas a geographical indication guarantees to consumers that a product is from the area and it allows permission to all inhabitants to use right.

2.2.8 Trade secrets

"Trade secrets are basically refer to information, be it a formula, a program, a method, a pattern, a process or anything of the like. The rationale of keeping the same a 'secret' is to have a competitive economic advantage over one's competitors in one's trade" (United Nations Educational & The Commonwealth Education Media Centre for Asia., 2015). The finest

examples are of the variety of beverages prevalent in market. Every brand has its own secret recipe.

2.2.9 Copyright laws

It grants authors, artists and other creators protection for their literary and artistic creations, generally referred to as "works". According to United Nations Educational & The Commonwealth Education Media Centre for Asia (2015) "Copyright, as the name suggests, is a kind of right that protects the 'expressions' of some ideas, but not the idea itself. Expressions include literary works, artistic works and dramatic works.

2.3 Intellectual Property Creation capability (IPCC)

Before discussing IPCC, it is important to discuss the role of innovation in driving economic growth. It's implied that the future strength of any economy lays on its capacity to innovate. The way to growth and development has dependably been innovation which deals with creating new from old. It may have heard that procedure portrayed as "creative destruction". This phrase was developed by Joseph Schumpeter a Harvard economist. He contended that financial action and business are an indispensable and in fact, important piece of development. Profitable assets are diverted into giving new merchandise and ventures that have higher incentive than the old.

Research studies related to various forms of IP creation capabilities in different fields are available - knowledge creation capability for business firms (Wang, Su, & Yang, 2011); appropriation capabilities of patent protection in R&D firms (Reitzig & Puranam, 2009); R & D capability creation for IT companies, (Breznitz, 2005) ,creation capability for spin-out of universities (Lockett & Wright, 2005) etc. Table 2.2 shows the related studies along with their details.

Table 2.2 IP Creation Capability

S.No.	Author & year	Country	Methodology	Capability for creation	Result
1	A. Lockett, M. Wright (2005)	United Kingdom	Questionnaire	Creation of spin-out companies	Expenditure on intellectual property protection, the business development capabilities of technology transfer offices and the royalty regime of the university, technology transfer officers in spinning-out companies increases,

					but the university's stock of technology to commercialize remain unaffected.
2	Dong Wang, Zhongfeng Su, Dongtao Yang, (2011)	China	Questionnaire & face-to-face interview of 212 firms	Knowledge creation capability	Organizational culture & collectivism (cooperation in and as a group) increases power distance (inequalities in the distribution of power and authority) and uncertainty avoidance decreases
3	Dan Breznitz (2005).	Taiwan	582 interviews conducted with founders and executives of IT companies, top civil servants of industrial agencies	R & D capability creation in IT industry	Explored the capabilities and limits of the Taiwanese state in achieving sustained industrial growth in two key sectors of the IT industry, software and IC design.
4	Markus Reitzig and Phanish Puranam (2009)	UK	Survey and patent (application) data of 30 R&D intensive firms that operated globally across eight different primary industries.	Appropriation capabilities of patent protection	Intermediate levels of functional specialization in IP generation, protection, and usage activities outperforms very high or very low levels of functional specialization; there is an inverted U-shaped relationship between functional specialization and patent grant success.
5	So Young Kim and Eungdo Kim (2018)	Korea	Survey and multiple regression models	Intellectual property management capability	New ICT companies need to construct technological innovation networks using multiple external sources to enhance their IP management capability.

Expanding the arena of the series, we have modelled the Intellectual Property creation capability for Indian Higher Educational Institutions. To generate IP capital, HEIs require a nurturing environment. The different factors on which IP creation depend are infrastructure, IP related policy, human resource, personal benefits, incentives and motivation provided to faculty

members, incubation center, TTO etc. These parameters could be clubbed altogether to form IPCC which would represent the efficiency of HEIs to produce IP capital. Studies have shown that no one model fit for all as different factors are prominent in different geographical region. To understand the relationship between different components, this work developed an IP creation capability scale. Since patent is considered to be one of the most valued intellectual property (Burhan et al., 2017) and driving as well as promoting innovation (Goel & Göktepe-Hultén, 2018); (Zobel et al., 2016), the present study has considered patenting as major component of IP creation capability

2.4 Factors of IP Creation Capability

In the present study, an in-depth literature review gives an overview of various factors that are critical for the creation of IP in higher education academic setup. An extensive review of literature has been carried out to gain insights of factors responsible for patent creation. In recent years there are numbers of studies conducted in various part of the world that deals with the enablers and barriers of IP creation in Universities.

2.4.1 Availability of IP policies

The motive of universities for applying for patents is altogether different from the purpose with which the firms and small companies applied for patents. The main aim of universities is to gain licensing fees from applying patents, whereas, the firms mostly apply to block their competitors (Theresa Veer & Jell, 2012).Thus, policies regarding IP generation should be conducive to the creativity at universities. IPR legislative at national and university level leads to the creation of more spinoffs (Fini, Fu, Mathisen, Rasmussen, & Wright, 2017). Similarly Breznitz (2005), stresses the need to restructure Research-Institute based industrial technology policy, when the research institutes extended their interactions with private IT industries. The availability of policy saves a person a lot of hassles. In the case of university startups or university patent, the clear cut policies of HEIs eliminate the conflict between students and universities regarding profit sharing issues.

Baldini et al., (2006) found that the legislative and organizational changes are essential for the creation of conditions that induce effective commercialization of research results through patents. Their finding further stated that the adoption of university level patent regulations almost triples the rate of patenting activities. This might be the reason that the larger universities patent more because of the presence of internal IPR regulations there. The role and function of the policies, especially on science and technology, plays an important role in IPR

for individual countries. That's why it is the current trending issue among countries (Geuna et al., 2011).

2.4.2 Awareness about IP filing processes

IP generation is also depend on the awareness level of the researchers of the university (Baldini, 2009). The basic concept of intellectual property is not known to the faculty members and other research stakeholders. In a study performed by Ama & Fombad (2011), it was found that the level of patent awareness and intellectual property awareness in the country was generally low (67%), while 69% of the researchers did not understand what the patent system was. The most pressing challenge highlighted by researchers for inability to apply for patent was unawareness of conventions/laws governing patent practices. Conducting orientation programme could bring the awareness level of the researches at HEIs (Ama & Fombad, 2011).

2.4.3 Industry Academia collaboration

This is a crucial factor since education 3.0 & Science 2.0 will have to serve Industry 4.0. Advanced automation, robotics, artificial intelligence and big data as four major drivers of modern industry require new knowledge from academia (Mashelkar, 2019) for efficient functioning. Lam (2011) describes four types of scientists' orientations categories regarding university–industry links Type I 'pure traditional'—academia and industry should be distinct and pursue success strictly in academic arena; Type II 'pragmatic traditional'—academia and industry should be distinct, but also recognizes need to collaborate for pragmatic reasons; Type III 'hybrid'—the fundamental importance of science–business collaboration for scientific advancement, but also recognizes need to maintain boundary and Type IV 'entrepreneurial'—the fundamental importance of science–business collaboration for knowledge application/exploitation . The need of the hour is to select the link as per the requirement of HEIs. There are studies conducted in various countries which favors the industry academia collaboration for better research output and patents as well (Balconi, Breschi, & Lissoni, 2004); (Gulbrandsen & Smeby, 2005). The networking among the industry and university is a regular phenomenon in most of the developed countries (Grandi & Grimaldi, 2005); (Göktepe-Hulten & Mahagaonkar, 2010). Even the industries are keen on keeping interaction with universities. In a study by Belderbos et al., (2014), it was found that from the three different types of co-patenting partners: intra-industry partners, inter-industry partners, and universities; co-patenting with universities is positively related to market value for the industries.

2.4.4 Technology Transfer Office (TTO)

The role of the TTO is to facilitate commercial knowledge transfers through the licensing to industry of inventions or other forms of intellectual property resulting from university research (Siegel et al., 2004). TTOs usually have three tasks: they serve as a service center for scientists as well as for (local) industries, facilitate, promote, and support university–industry cooperation, and spread information on issues related to technology transfer within the university and patent application procedures (Backs, Günther, & Stummer, 2018). The research work shows that scientific quality, existence of technology transfer office, and socioeconomic environments have positive effect on the patent applications (Calderón-Martínez & García-Quevedo, 2013). Besides other factors as presence of qualified teachers, the presence of TTOs and technology parks are also advocated by Closs et al., (2012), TTOs/TLOs may have a critical role to play in inducing scientists who have had no previous involvement in patenting, to engage in such activity (Moutinho, et al., 2007). Lars Bengtsson (2014) study shows that university owned systems favour the business model of patenting and licensing while university inventor systems favour the business model of spinoffs. This study provides support for the effect of a strengthening of the TTO organization in relation to a change from a university-inventor to university own-ership system. On the contrary, according to Belitski, Aginskaja, & Marozau (2018), TTOs have become neither facilitators nor promoters of knowledge transfer and knowledge spillover from universities. Usually these types of conclusions are drawn based on the competency of the TTO staff. Even when there are organizational structures supporting technology transfer and/or patenting, most researchers perceive these as being underfunded and understaffed and refer to the lack of qualifications and competences of their staff and, particularly, to their poor marketing, technical and negotiation skills (Moutinho, et al., 2007). Evidence from a new inventors' survey indicates that one third of patent applications are incentivized by current royalty sharing arrangements, one third would be incentivized by higher royalty shares, and that the remaining one third is totally insensitive to royalty sharing (Arqué-Castells et al., 2015). It all depends on the ability of TTO Most TTOs lack the resources and competencies necessary to search a wide range of laboratories and research groups for commercially viable technologies. Thus, institutional success at patenting depends in part on faculty perceptions of the benefits of patenting, the quality of the TTO, and the institution as a collective enterprise (Owen-Smith & Powell, 2001).

2.4.5 Government schemes

The government instruments schemes should be structured in order (1) to provide resources for use in commercialization projects either directly or through the development of professional expertise in the university sector, (2) to encourage innovation in program design by encouraging institutions to attempt new initiatives or by encouraging the broader adoption of good practice, and (3) to create networks between commercializing organizations. Government support is as crucial as other discussed critical factors, for the IP creation capability in any organization (Rasmussen, 2008) especially in education institutions (Blind, Filipovic, & Lazina, 2017). This factor is more relevant in countries like India where most of the research activities are driven by government financial aids and schemes. Baldini (2009), shows that obstacles to university patenting activity have four dimensions: lack of support mechanisms (including insufficient reward for researchers, lack of a TTO, lack of funds to cover patenting costs), commercialization problems, too heavy teaching and administrative duties, and personal/cultural problems (related to the scarce knowledge of institutional-level patent regulations and to the "open science" mentality of the university. Among them, however, only the lack of support by the university administration reduces the patent counts of the institutes. This support could be in the form of schemes formulated for IPR. There are challenges related to goal formulation and assessment of the results from the commercialization of research, as the impacts of such a complex array of initiatives are extremely difficult to measure (Rasmussen, 2008).

2.4.6 Carrier Advancement Schemes (CAS)/ Promotion

Scientific articles in top journals, being cited, participating in or even prestigious being invited in top international conferences, teaching skills and receiving grants are always considered as academic merits and improve the chances of academic promotion and reputation (Mahagaonkar, et al., 2010). Peer recognition of a scholar as the 'intellectual proprietor' of the knowledge he has produced increases his reputation within the community. In turn, scientific reputation translates into increased wages, more prestigious positions and other non-monetary rewards. Such a reputation-based system has two important implications on the distribution of incentives during researchers' careers. First of all, the individual returns on research activities are generally not immediate and are spread over the remaining professional cycle of the individual (Carayol, 2007). The mid-career promotion system is considered as a consistent screening process since the share of promoted permanent faculty and researchers favour both publication and patent count always (Carayol et al., 2004).

2.4.7 Monetary incentive

Various studies suggested a positive relationship between the monetary incentives and the research output (Friedman & Silberman, 2003). The monetary incentives could be in the form of infringe benefits or could be hike in salary and related allowances (Veer & Jell, 2012) and are very effective in short-term time horizon .The patent system uses private economic incentives to promote innovation, but academic institutions are charitable organizations intended to promote the public good. Thus, there are vast differences in their incentives schemes. Christopher et al., (2017) demonstrates that patent incentives may have encouraged academic institutions to invest in patentable innovation. It may also be important to consider pecuniary rewards, such as the university's royalty and equity distribution formula. Adjusting this formula in favor of the scientists could elicit more faculty involvement in University Industry Technology Transfer (UITT) (Siegel et al., 2004). According to Schankerman (2003), the response to incentives is much stronger (and more significant) in private universities than in public ones. In private universities, the incentive effect is strong enough to produce a Laffer effect, where raising the inventor's royalty share would increase the license revenue actually retained by the university. The interplay between economic and psychological factors plays an important role for scientists' transition from academia to entrepreneurship (Goethner, et al., 2012).

2.4.8 Prestige as incentive

Lam (2011), defined the three concepts of 'gold' (financial rewards), 'ribbon' (reputational/career rewards) and 'puzzle' (intrinsic satisfaction) to examine the extrinsic and intrinsic aspects of scientists' motivation for pursuing commercial activities. Not only "gold" but "ribbon" could also as prime motivator for faculties in HEIs to obtain patent (Baldini, 2005); (Lam, 2011); (Göktepe-Hulten & Mahagaonkar, 2010); (Sauermann & Cohen, 2010). In other words the prestige associated with patent could also persuade researcher to disclose their research. Among these measures, publishing the inventors' names on the website of the university as a means to increase the inventors' reputation was the most common. A few universities also honor academic inventors during public events or reduce their teaching load (Backs, Günther, & Stummer, 2018). There are studies that show the preference given to non-monetary rewards over monetary ones. Baldini et al. (2017), found that the professors get involved in patenting activities to enhance their prestige and reputation and to look for new stimuli for their research.

2.4.9 Research facilities

A study by Gholami et al. (2013), claimed research quality and timeliness as the strongest domain elements. It points out indirectly towards the research facilities. The better the research facilities, the better would be the research quality. There are evidences that the physical work environment also have impact on the services provided by the service organizations like education sector (Ahmed & Agarwal, 2018).

2.4.10 Subscription of journals/ Patent database

This research infrastructure is closely associated with the subscription of academic journals and provides future direction and communicates current trends in research necessary for IP generation (Belderbos et al., 2014). The large repository of patent database and journals would certainly be helpful in keeping trend with time. Upgraded library and e-library are always beneficial for research works.

2.4.11 Funding (Public & private)

Lots of financial resources are required for acquiring advance and modern research facility at HEI. The challenge for HEIs is to manage a more complex portfolio of aim funding; to differentiate themselves in an increasingly competitive environment; and to protect and maintain academic quality and their ability to deliver over the long term (Qamar, 2019). At present Indian higher education system is showing the signs of breaking mainly under the pressure of enhanced access and reduced finances (Nigavekar, 2019). The funding either from public or private sources are very crucial for research facility and in turn to IP creation (J. M. Azagra-Caro, Carayol, & Llerena, 2006). There is a significant relationship between industry funding and research performance: professors with industrial funding describe their research as applied to a greater extent, they collaborate more with other researchers both in academia and in industry, and they report more scientific publications as well as more frequent entrepreneurial results (Gulbrandsen et al., 2005). Belitski et al. (2018), demonstrates that direct industrial funding is the most efficient route of research commercialization by scientists as compared to disclosure, marketing and adaptation of technology via TTOs. But, the research results of Caro (2014), somewhat differ in one of his studies that the expenditure made on Research & Development of university didn't increase the number of patents applied. For Public Research Organizations (PROs), more was the money spent; more was the number of patents applied which indicates that the University patent ownership activity is dependent on business funding, while PRO patent ownership is not.

2.4.12 Technology Incubator

Technology incubators at HEIs are responsible for nurturing academic entrepreneurship and provide support to new firms which are owned by institute (Kumar & Umesh, 2004). Most of the incubates are based on technology and hence they promote patenting activities at HEIs (Rubin, Aas, & Stead, 2015; Thursby & Kemp, 2002). The start-up ecosystem in higher institutes and universities also helps in IP generation. This aspect is also justified as the innovative startups runs longer than non-innovative start-ups (Colombelli, Krafft, & Vivarelli, 2016). The start-up is an important enabler of IP, but the students are not interested in entrepreneurship. According to Danish Agency for Science, Technology and Innovation Bredgade analysis (IDCK Analysis, 2016) for India, the reasons for low entrepreneurial interest are i) The students are under the pressure of securing jobs with the fixed monthly salary, ii) Due to repayment of student loans and receding job opportunities, they don't want to go for risky entrepreneurial ventures, iii) High collateral demands before starting innovative projects , iv) Redundancy of soft money in Indian start-up ecosystem and v) Fear of failure is higher in India. Such negative mindset about start-ups acts as a barrier in IP creation as well. Academic spin-offs are directly tied to universities, research centers, research parks, and incubators that act as wombs in which new spin-off firms are gestated, supporting and providing physical and also reputational resources and legitimacy to the spin-offs.

Research on spin-off firms has generated substantial interest in academia for a number of possible reasons. For public policy makers, there is an interest in economic renewal, growth and employment. For universities, spin-offs are a vehicle for the productive and commercial exploitation of the innovations generated and a possible source of revenue (Ferreira et al., 2017). Academic entrepreneurs willing to start up a new company should therefore devote attention to the technology side, as well as to organizational factors like choosing team members embodying different characteristics and being able to play different roles corresponding to different functions and different requirements of new ventures (Grandi & Grimaldi, 2004). Spin-offs refer to the formation of a new firm from an existing organization, an enterprise or a university or research center (Ferreira et al., 2017).

2.4.13 Education/Training

The research and training is another important factor. Not only the training of students, but the training of TTO staff was suggested by Lockett & Wright (2005) and recommended the recruitment of only those employee that have commercial skills. Training and education imparts innovative attitude to researchers. Well trained and innovative faculty enables as well

as support the managerial innovation in the university (Fernando, 2016). Managerial innovation is measured by the extent to which administrators support innovative ideas and practices is also positively related to skill of human resources of the academic institution (Fernando, 2013). Support in the early stage by the parent organization can facilitate the process of commercialization and that supported spinoffs expect to generate first revenues earlier than not-supported counterparts (Slavtchev & Göktepe-Hultén, 2016; Wright et al., 2017).

2.4.14 Work Load (teaching & administrative)

Organizational work culture also plays a critical role in knowledge creation capabilities (Wang et al., 2011; Henschke, 2014). The faculty members at HEIs have to perform academic related activities and administrative work also. Both these activities require great amount of time and efforts. Studies have shown that the research efficiency of faculty members had decreased who perform more activities related to administrative work (Ama & Fombad, 2011; Baldini, Grimaldi, & Sobrero, 2007). A balance work load is what is required for promoting research and IP creation. In another study by Baldini (2009), the hypothesis "Universities with heavier teaching and administrative duties generate fewer patents" was not supported in his experiment.

2.4.15 Salary

According to Knut Blind et al., (2018) and Manes Rossi et al., (2018), in universities and industries, especially knowledge based entities, the research output by human capital be rewarded by linking the employee's salary to research results. Such inducement coupling income would help nurture the feeling of attachment towards the organization. Other critical factors which are related to the work environment are the remuneration provided by the institute (Edvinsson & Sullivan, 1996). Salary either directly or indirectly is determined by publications and the extent to which researchers acquire external funding. In addition to career concerns and salary, researchers have the possibility to earn a bonus. This bonus is related to the knowledge transfer of universities and can take different forms. It can include honoraria for books or lectures, income from consulting assignments, or income from patents. Out of a broad range of means to transfer knowledge and technology, consulting is a frequent practice and the bonus associated with consulting seems to be less risky than the potential income from patenting (Sellenthin, 2009).

2.4.16 Autonomy

Universities, like other types of organizations, have unique histories, differing capabilities and resources, and evolve different types of organizational structures. Bercovitz & Feldmann

(2006), examines the influences of university organizational structure on technology transfer performance and found the structure with multiple decentralized technology transfer units and limited central control more producing. Typically, academic researchers are concerned with radically new problems, with the aim of either creating new products or demonstrating that new unexpected applications can be realized also by resorting to known technologies or by creatively recombining existing concepts. But for that research autonomy is required that is closely related to IP creation in HEIs (Azoulay, Ding, & Stuart, 2007). Unconstrained by the pressure of market demands, they enjoy a much broader freedom to set their own research agenda than their industrial counterparts (Balconi & Laboranti, 2006).

2.4.17 Geographical location

Proximity to developed areas like near capital region and industrial area are related to innovation and intellectual property creation. There are studies conducted which suggested a positive relationship between geographical location and IP creation activities (Maietta, 2015). Dholakia (2003), studied the trends in regional disparity in India's economic and human development and the direction of their causality. A similar study is also conducted by Saksena & Deb (2016), focusing the regional development and human development based on geographic regions. There is high educational inequality for the major Indian states regarding the rural and urban region (Agrawal,2014). Baldini et al., 2006 found that the patenting activities of universities are more where there is a high level of industrial development. In a study conducted by Friedman & Silberman (2003), they strongly supported the factor- "location of the university in a region with a concentration of high technology firms".

Table 2.3: Summary of literature review of critical factors for IPCC

S.no	Critical factors	References
1	Availability of IP policy	(Baldini, Grimaldi, & Sobrero, 2006), (Geuna & Rossi , 2011)
	Awareness about IP filing process	(Baldini, 2009), (Ama & Fombad, 2011)
	Industry academia collaboration	(Balconi et al., 2004), (Gulbrandsen & Smeby, 2005), (Grandi & Grimaldi, 2005),
	TTO	(Berco et al., 2001), (Siegel, Waldman, Atwater, & Link, 2004), (Belitski, Aginskaja, & Marozau, 2018), (Backs, Günther, & Stummer, 2018), (Moutinho, et al.,

		2007)
	Government Schemes	(Rasmussen, 2008), (K Blind et al., 2017)
2	Promotion/CAS (Carrier Advancement Scheme)	(Göktepe-Hulten et al., 2010), (Moutinho, et al., 2007), (Blind, Pohlisch, & Zi, 2018)
	Monetary	(Veer & Jell, 2012), (Lach & Schankerman, 2008), (Lam, 2011), (Stephan, Gurmu, Sumell, & Black, 2007), (Goethner et al., 2012). (Sauermann & Cohen, 2010), (Friedman & Silberman, 2003)
	Prestige	(Baldini, 2005), (Lam, 2011), (Göktepe-Hulten & Mahagaonkar, 2010), (Sauermann & Cohen, 2010)
3	Research facilities	(Owen-Smith, et al., 2001), (Baldini, 2011). (Carayol, 2007), (Agrawal & Henderson, 2002), (Zi & Blind, 2015)
	Subscription of Journals/Patent database	(Belderbos et al., 2014), (Balconi & Laboranti, 2006), (Goel & Göktepe-Hultén, 2013)
	Funding (Public & Private)	(J. M. Azagra-Caro et al., 2006), (Carayol & Matt, 2004), (Elfenbein, 2007), (Carayol, 2007), (Landry, Amara, & Saïhi, 2007), (Barrio Castro & García, 2009)
	Technology Incubator	(Baldini, et al., 2007), (Friedman, et al., 2003), (Thursby & Kemp, 2002), (Rubin et al., 2015), (Fini, Grimaldi, & Sobrero, 2009),
	Education/Training	(Baldini, et al., 2007), (García et al., 2001), (Kolympiris & Klein, 2017), (Zucker, Darby & Brewer, 1998), (Sellenthin, 2009), (D'este & Perkmann, 2011), (Gonzales-Brambila & Veloso, 2007), (Meyer, 2006),
4	Work Load (teaching & administrative)	(Ama & Fombad, 2011), (Baldini et al., 2007)
	Salary	(Baldini et al., 2007) , (Edvinsson & Sullivan, 1996)
	Autonomy	(Baldini, et al., 2014), (Azoulay et al., 2007)
	Geographical location	(Carayol, et al., 2004), (Gulbrandsen, et al., 2005), (Friedman & Silberman, 2003), (Fuentes & Dutrénit, 2016), (Maietta, 2015), (Srinivasan, et al., 2013)

2.5 Studies of IP practices

According to the India Economic Survey 2017, India's spending on R&D in terms of percentage of GDP has been stagnant at 0.6 to 0.7 per cent in the last two decades - much lower than the major nations such as the US (2.8%), China (2.1%), Israel (4.3%) and Korea (4.2%).India topped the list with regard to the government's participation in R&D but hit the bottom in terms of participation of institutions of higher education. The share of institutions of higher education in R&D in the other countries varied from 7% in China to 40 % in Canada, as compared to India's mere 4%. What conditions are responsible for this poor position of India? The answer lies in the fact, as cited by (Jameel, 2018), Chief Executive Officer of DBT India Alliance ,that as compared to a state university in US that gets only about 25% of its funds from the State; the rest are raised through fees, endowments and consultancy; in India very little comes from sources other than the government.

To overcome this situation and increase the research database, HEIs should be creative and innovative in Intellectual Property creation to become financially strong. Innovation is seen as difficult, expensive, and protracted process. But, new lessons about how to make it easier for individuals, organizations, and networks to stimulate and embrace innovation on a grand scale will certainly make the difference (Rao & Sutton, 2008). As there's much variability within age groups of students from pre graduate to doctorate level and their requirements, care should be taken in selecting the learning and experimentation proposal wisely as no one model will suit for such a span of life years (Hoyte & Sutton, 2016).

The pattern of teaching in Indian universities is primarily based on theoretical concepts, far from imparting practical knowledge. This might be the reason that India stands firmly in publishing scientific papers worldwide despite poor student to teacher ratio, provision of contractual appointments and scarcity of dedicated faculty.

IP literature provides findings of many studies on different issues and for different parts of world. It has been tried to incorporate as many studies as possible that are based on surveys. Survey methodology is popular among researchers for the reasons i) the results of the surveys are quantified therefore, statistical techniques could be applied easily, ii) Statistically the results derived from small samples could be extended to larger areas, thus, allowing for wide

coverage, iii) it is a fast and straightforward method, easy to conduct and iv) various characteristics of an issue could be gathered.

Several authors have reported the important contribution of universities related to IP. The topic of IP and HEIs has been investigated from different perspectives using different theoretical and methodological approaches. The summaries of relevant studies covering various IP practices are given in Table 2.4 on next page. Almost all the studies are empirical in nature. These studies are further classified on the bases of their type i.e studies conducted on patents; intellectual capital; spin-off; technology transfer and some general studies in HEIs related to IP. Most of the studies are based on the patents and from western or European countries. The second largest studies are on technology transfer through research institutes or HEIs covering the commercial aspect of intellectual property. Entrepreneurship or spin-off related studies present in the extant literature are also given in the Table 2. 4

Table 2.4: Summary of literature review of IP practices in HEIs.

S.No	Type of Study	Variables of the Study	Country	Reference	Sample	Method	Findings
1	**Based on Patent**	Effect of network between university and company on patent cooperation network strategy and IP management capability	Korea	(S. Kim & Kim, 2018)	300 respondents from industries	Regression analysis	Explored a new way to disclose intellectual capital (IC) in universities through their websites
2		University patenting and royalty	Italy	(Baldini, 2010)	University Patents	Regression Analysis	Licensing strategies that directly engage the inventor increase the likelihood and degree of commercialization success.
3		Online intellectual capital disclosure by universities	Italy	(Manes Rossi, Nicolò, & Tartaglia Polcini, 2018)	Italian public universities	Content Analysis	Explored a new way to disclose intellectual capital (IC) in universities through their websites.
4		Factors of academic patenting, obstacles to patent production, & Students' participation	Mexico	(Pérez & Osuna, 2015)	Institutional patents database and 33 unstructured open ended interviews	Regression analysis (Probit method)	Collaboration and participants' variety is a major factor for patenting propensity.
5		University patent ranking, size of a university with the quality of its	Worldwide	(Fisch et al., 2015)	300 universities	econometric analysis	Provided patent ranking system and an analysis of the determinants of university patenting

		publications					
6		Patenting activities of scientists, expectations of scientists and disclosure behaviours	Germany	(Göktepe-Hulten & Mahagaonkar, 2010)	2,500 scientists from 67 institutes	Regression Analysis	Scientists' involvement in inventing and patenting activities are related to gaining reputation and visibility than financial expectations.
7		Patenting and technology transfer		(Owen-Smith & Powell, 2001)	Data from two universities	Regression Analysis	Faculty who wish to patent may be discouraged by their surrounding environment and high costs of pursuing protection through a technology transfer office
8		Patents as proxy for measuring innovations	India	(Burhan et al., 2017)	43 Public funded research organizations	Binomial Regression Analysis	Patent filing behaviour varies with experience
9		Patents and academic research	Europe	(Van Zeebroeck, van Pottelsberghe de la Potterie, & Guellec, 2008)	Literature	Systematic Review	Academic patenting has only limited effects on the direction, pace and quality of research
10		Quality of university patenting	European regions	(Acosta, Coronado, & Martínez, 2012)	4580 European university-owned patents	Multilevel framework analysis	The size of a university does not influence the quality of university patents.
11		Royalty sharing and invention in universities	Portugal , Spain	(Arqué-Castells, Cartaxo, García-Quevedo, & Godinho, 2016)	15 Portuguese and 39 Spanish	Regression analysis	The incentive effects documented by the inventors' survey fail to translate into increased patenting or

					universities		licensing income
12		Knowledge transfer and university patents	Mexico	(Calderón-Martínez & García-Quevedo, 2013)	80 Mexican universities	Econometric analysis	Universities' size and scientific quality, the existence of a technology transfer office, and the socioeconomic environment have positive effect on the applications for patents
13		Faculty problems and their impact on university patenting activity	Italy	(Baldini, 2009)	PATUNIT database (1965-2002), survey	Principal component analysis	Universities which give higher support to patenting activity generate more patents.
14		Motives, barriers of publishing, standardization and patenting for scientists	Germany	(Knut Blind, Pohlisch, & Zi, 2018)	129 scientists	Exploratory factor analysis	Patenting is driven by commercialization motives,and standardization is mainly fostered by intrinsic motivation.
15		Effect of royalties' incentive in patenting activities	Italy	(Baldini, 2010)	Patent records	Auto regression model	Both the royalties shared with the inventors and their departments are associated with greater patenting activity.
16		Effects of technology commercialization on researcher practice and productivity in public versus private universities	U.S.	(Powers & Campbell, 2011)	345 patents in industry and 60 U.S. universities	Regression Analysis	Exclusive licensing may have a dampening affect on innovation diffusion.

17		Changes in academic institutions patent policy and their patent acquisition strategy	United States	(Ryan Jr & Frye, 2017)	HEIs	Spline regression modeling	Change in patent policies is necessary to incentivize university to research and patentable technology.
18		Scientist expectation, academic entrepreneurial intentions & attitudes	Germany	(Goethner, Obschonka, Silbereisen, & Cantner, 2012)	Survey data on 496 scientists	Theory of planned behavior	Fostering scientists' entrepreneurial mindsets and networks is important.
19		Organizational change and institutionalization of university patenting activity	Italy	(Baldini, Fini and Grimaldi, 2014)	Patent policies issued between 1993-2009 in Italian universities	Document Analysis	Suggests that universities first dealt with legislative changes on IPRs by enacting isomorphic behaviours, then by creating a community of practices, and finally by leveraging on such community to influence government reforms on IP-related matters.
20		Patent and research exemptions	Botswana	Ana & Fombad, 2011	366 researchers from universities and research organisations	Regression Analysis	Less number of researchers were aware that they could conduct their researches or experiments on patented inventions without infringing on the rights of patentee to their inventions by invoking research exemptions, only a few know the procedure for

							invoking research exemption.
21		Patents and publications	World wide	Azaulay et al. (2007)	3862 academic life scientists	Discreet time hazard rate model and logistic models	Patents are preceeded by publications.
22		Patentng and publishing	Europe	Nicolas Carayol, Mireille Matt,2004	80 labs of awell-ranked European research university	Regression Analysis	Highly publishing labs also patent.
23		Motivation behind academic scientists to engage with industry	U.K.	D'este, P., & Perkmann, M. (2011).	4337 Research holders record from 1999-2003	Regression Analysis	Academics engage with industry to further their research rather than to commercialize their knowledge
24		IP and self assessment by universities	India	G. Gargate, K.S. Momaya ,2018	6 case studies with 46 top executive respondents	Case study	Introduces 5 stage IPM model with a total of 6 processes.
25		Intrinsic and Extrinsic motivations of inventors	Japan	(Owan & Nagaoka, 2011)	5,091 Japanese inventors	Empirical analysis	Firms having many employee-inventors with strong intrinsic motivation are less likely to adopt revenue-based compensation policy for inventors
26		Examining university policies with respect to corporate	United States	(Fine & Ottavio Castagnera, 2003)	241 randomly selected university employment policy of	Regression analysis	Patent and invention policies are more prevalent at public than private institutions.

					HEIs		
27	**Based on Intellectual Capital**	Studying IP management	Spain	(Lorduy, Ramírez, & Rojas, 2007)	Projects in public HEIs	Regression analysis	The intellectual assets are specific to each organization, so there is no homogeneous model of intellectual capital measurement in universities
28		Evaluating third mission of university	Italy	(Di Berardino & Corsi, 2017)	71 universities	Empirical analysis	Positive role of structural capital and relational capital in the development of third mission.
29		Studying relationship between intellectual capital disclosure & efficiency	United Kingdom	(Bezhani, 2010), (Bloom et al., 2014)	Annual reports of 30 UK Universities	Questionnaire based content analysis	Voluntary IC disclosure is the best option.
30		Exploring the relationship between intellectual capital and universities performance	Columbia	(Cricelli, Greco, Grimaldi, & Llanes Dueñas, 2017)	Internal stakeholders of public universities	Cluster analysis	IC should be strategically placed for better research results.
31	**Based on Spin-off**	Knowledge base and spin-off research	World wide	(Ferreira, Reis, Paula, & Pinto, 2017)	Literature	Bibliometric analysis	Differentiated between academic entrepreneurship and corporate spin off.
32		Early stage support of University spin-offs by the parent	Italy, Norway, and the	(Fini, Fu, Mathisen, & Rasmussen, 2015)	World Bank Database	Binomial regression analyses	Support at nascent stage of spin-offs assists in acquiring external capital.

		organization	UK				
33		Research spin-offs and the speed of commercialization	Germany	(Slavtchev & Göktepe-Hultén, 2016)	78 research institutes	Multivariate regression techniques	Support of spin offs in the early stage by the parent organization can speed up commercialization.
34		Entrepreneurial orientation scale for universities	Canada	(Todorovic, McNaughton, & Guild, 2011)	Faculty from four universities	Regression analysis	A new Entrepreneurial Orientation (EO) scale was developed.
35		Ecosystem for student start-ups	different countries	(Wright, Siegel, & Mustar, 2017)	-	Framework	A framework developed for incubators.
36		IP and investment from venture capitals for spin offs	Seoul, Korea	(Cho & Sohn, 2017)	21 University Business Incubator Centers	Weibull AFT model	Derived strategies for USOs to increase their stabilization speed
37		IP generation and its commercialization	Developing countries	(Gargate & Momaya, 2018)	Various organizations	Case study approach	Development of an IPM model
38	**Based on Technology Transfer**	Determinants of the university technology transfer	21 European countries	(Munari, Rasmussen, Toschi, & Villani, 2016)	Survey of 125 university TTO managers	Regression analyses	U-shaped relationship found between the use of centralized gap-funding instruments and the country's implementation of TT practices.
39		Academic Researchers and Transfer	Brazil	(Closs, Ferreira, Brasil, Sampaio, & Perin, 2013)	Personal interviews from four	Content Analysis	Provided motivational factors for technology transfer.

		Technology			universities		
40		Organizational Factors that Affect the University-Industry Technology Transfer Processes	Brazil	(Closs et al., 2012)	Single University	Content analysis	Provide organizational factors and hindrances that affect the university-industry technology transfer (UITT) processes of a private university
41		Measuring the performance of university technology transfer	Dutch	(Vinig & Lips, 2015)	16 university data	Meta data approach	Potential for technology transfer considered for evaluating technology transfer performance of universities.
42		Forming strategies for TTO	Europe	(Secundo, De Beer, Schutte, & Passiante, 2017)	TTO offices of 18 universities	Survey Study	Increased access to and utilization of IC leads to increased efficiency of university technology transfer
43		Comparison of University Ownership Technology Transfer with University Inventor Technology Transfer Systems	Scandinavian countries	(Bengtsson, 2014)	Research universities	Study of policies	University owned Systems favour the business model of patenting and licensing while university inventor system favour the business model of spin-offs.
44		Rights and responsibilities	Finland	(Kauppinen, 2013)	6 research universities	Case study	Economic arrangements of universities to promote

		during the commercialization of research results and patent policies					globalization of knowledge capitalism.
45		TTO and university patenting	Sweden, Germany	(Mark O Sellanther, 2007)	801 university professors	Regression Analysis	Researchers that have received support from the public infrastructure and have wide experience are more likely to apply for patents.
46	**Knowledge Management**	Organizational culture and knowledge creation capability	China	(D. Wang et al., 2011)	212 firms	Regression analysis	Organizational culture with the characteristics of high collectivism, low power distance, and low uncertainty avoidance contributed to knowledge creation capability.
47		Knowledge management in universities	UK	(Cranfield & Taylor, 2008)	Data from 7 HEIs	Qualitative analysis	Correct culture needs to be cultivated to implement KM within any organization

2.6 Research Gap

Detailed literature examination leads the researchers to the gaps prevailing in the existing literature which motivated them to conduct their study. Going through the literature, it was found that most of the intellectual research has European (Bisogno et al., 2018), Italian (Secundo et al., 2018); (Rossi et al., 2018); (Sangiorgi & Siboni, 2017), Republic of Columbia (Cricelli et al., 2017), Kazakhistan (Sultanova et al., 2018) or Spain (Yolanda & Silvia, 2014) context. The outcomes of these may not be safely extended to other countries as each country has its distinct characteristics. It is not a good idea to generalize findings of developed countries to developing countries without validation of research in these countries (Rettab, Brik, & Mellahi, 2009). Thus, this review indicated the need to focus on checking the reliability and validity of the outcomes from developed countries as well as to generalize the results in other geographic areas with reference to knowledge oriented sectors (Arqué-Castells, Cartaxo, García-Quevedo, & Godinho, 2015). Therefore, for India, a separate study was needed that suits its atmosphere and the academic conditions in HEIs.

The first objective of this work is to compare and contrast role of HEIs in economic development of India with other nations with reference to intellectual Property Rights. There is no direct study related to the significance of academically generated IP of India and its comparison with the top rated countries. Although the data is available for different countries, including India, but it is in scattered form. The compilation of figures from different databases of World Bank, WIPO, OECD, UNESCO Institute of Statistics, EU and others provide a clear picture of the role of IPR in nation's economic progression. It also determines the position of Indian HEIs on global basis.

There are studies conducted on the issues related to academic patenting but still some potential issues have been left untapped .Many studies are conducted on commercialization of IP through academic setup but very few deals with the IP creation capability. There is also a scarcity of studies which identifies critical factors which are responsible for IP creation (Mehralian, Rasekh, Akhavan, & Ghatari, 2013). Beside a few studies that were conducted on the factors of IP creation in the field of HEIs, no researcher has tried to identify, classified and find relationship among the enablers and barriers of IP creation capability in higher education. Due to above mentioned issues this empirical study was conducted which could reduce existing research gaps prevailing the field of IP research. Thus, one of the objectives of this research work is to identify the enablers and barriers for IP creation in Indian HEIs.

Although majority of IP related research is focused on western countries no instrument had been developed yet to measure the IP creation capability of HEIs. Considering the paucity of measuring scale, this study comes up with one such scale that is suitable for HEIs of under developed nations. Since IP generation in Indian HEIs is very low, it requires specific measures to improve the situation (Sharma & Jain, 2014) but any strategic framework for enhancing IPCC in HEIs is unavailable. This research work generates a scale for measuring IPCC fulfilling the objective of this research.

Most of the studies done on university patenting and entrepreneurship used qualitative methods like case studies are only about 39 % relied on econometric analysis based on quantitative data (Rothaermel, Agung, & Jiang, 2007). To bridge this gap the present study used the mixed methodology to explore the research objectives.

Summarizing the other gaps from literature review, the list is as follows,

- There is a need of identifying the role of non-monetary rewards in academic IP creation for formulating effective incentive policy.
- There are no studies that identify the dimensions of IP creation capability in knowledge-based environment especially in higher education.
- It is important to understand the variations across universities and to assess how much and why, technology licensing offices (TLOs) are tied to university patenting & commercial behavior.
- There are no studies in India which empirically test the traditional academic motivations (i.e., eponymy, prizes and publication) for patenting.
- No empirical scale is developed that is suitable for different geographical and disciplinary settings especially in Indian context.
- Patenting by Indian academic institutions is in a nascent stage and requires further incentives. There is a need to formulate policies & strategies for enhancing academic patenting in Indian Universities.

2.7 Conclusion

This chapter has reviewed different aspects related to IP, which are relevant for this research. This section gives the basic understanding of the various types of IP along-with the extensive literature review of the studies of IP practices which helps us to identify the research gaps. This chapter also discusses about the concept of IPCC its potential constructs and various critical factors which are responsible for the IP creation in HEIs.

CHAPTER-3
RESEARCH METHODOLOGY

3.1 Introduction

"Research is a systematic inquiry aimed at providing information to solve problems" (Donald & Pamela, 2003), which requires a set of expertise as well as systematic activities (Bell & Bryman, 2007) to create fresh knowledge on a specific subject matter (Saunders, et al., 2009). The systematic and scientific research is reflected in its methodology. Research is the study of the research problem with a scientific view discussing the steps taken and the logic used behind them (Kothari, 2004).

Research is complementary to the methodology that is used for deriving useful results out of it. There are alternative approaches to form a methodology. They may consist of various options, phases, techniques or scientific tools .The methodology approaches could overlap as the entities used to form a methodology could be present in more than one method. The selection of methods used depends upon the type of problem to be solved or according to the objective of the research. The suitable options are to be compared and tested before finalizing the methodology.

As the reason behind the use of any method for research should justify the generation of optimum results (Sekaran, 2003), this chapter deals with the exploration of theoretical stand of the researcher and present support f or the choice of methodology used in this research. It may be said that the aim of this section of thesis is to explain the research methods used to respond to the research questions and accomplish the research objective prospective.

This chapter explains the methodology adopted for achieving the objectives of the study and details of the sampling, data collection methods, scaling techniques, hypothesis testing and analysis procedures used in different stages of the research. Since the study was conducted using a mixed approach, this chapter also provides details of both qualitative as well as quantitative research approaches. Based on the literature and inputs of FGDs, a conceptual frame work of the study is also provided.

3.2 Research Objectives

This study primarily deals with intellectual property in higher academic institutions. To study the phenomenon of IP creation and the paradigm shift in Indian education four objectives are formulated based on the detailed literature review of the subject matter. The research objectives, questions and hypotheses have been discussed as follows:

Objective 1: To compare and contrast role of HEIs in economic development of India vis-à-vis some other nations with reference to Intellectual property rights.

The aim of this objective is to find the role of HEIs in economic development of the country with reference to academic ally generated intellectual property. By following secondary analysis of existing data related to economy and various indicators of intellectual property.

Objective 2: To identify enablers and barriers for IP creation and its commercialization in Indian HEIs.

The aim of this objective is to explore the various aspects and dimensions of IP creation with reference to HEIs. This objective has been achieved by identifying the critical factors of IP creation present in the Indian higher educational institutes.

Objective 3: To prepare a scale for measuring the IP creation capability in Indian HEIs.

This objective deals with the measurement of IP creation capability in Indian HEIs. A scale has been developed, tested and validated using SEM.

Objective 4: To propose strategies for enhancing IP creation in Indian HEIs.

The purpose of this objective is to formulate strategies and recommendation for HEIs to improve and increase the IP creation by using the findings and results of the previous three objectives of the study.

3.3 Research Questions

The research questions are formulated to solve the research problem. This is a step by step approach to achieve the research objectives. Four research questions are built against each research objectives, which are listed as:

Research Question 1: a) Does the contribution of academic generated intellectual property in national economy is significant or not? and b) what is the position of Indian HEIs on the global picture.

Research Question 2: a) What are the various factors of intellectual property creation capability? and b) what is the interrelationship among them?

Research Question 3: How these identified factors influence the IP creation capability in Indian HEIs.

Research Question 4: What the different measures through which the IPCC could be enhanced?

3.4 Hypothesis Formulation

Research hypothesis is formulated to achieve the research objectives. Based on the research problem, objectives, literature review and expert consultation, the following hypotheses have been formulated for this study are given below. Detailed theoretical description of hypothesis formulation is given in Chapter 6.

H1. The Construct Policy & Strategic Support (PSS) has significant effect on IP creation capability (IPCC).

H2. Incentives (IN) has a relationship with IPCC and it mediates the relationship between PSS and IPCC

H3. Research Infrastructure (RI) competence has relationship with IP creation capability (IPCC).

H4. Work Environment and Culture (WEC) have significant relationship with IP creation capability (IPCC).

3.5 Research Approach

A study could apply broadly three types of research approaches viz qualitative; quantitative and mixed or pragmatic approach (William, 2003; William G Zikmund, Babin, Carr, & Griffin, 2013). Considering the little amount of work available in the field of IP creation in HEIs it is requiring some qualitative inputs and at the same time developing a scale for IPCC requires quantitative data. Therefore, the present research uses mixed method approach where both qualitative and quantitative approaches are used to enrich the research methodology. The broad flow of research approaches, as used in the present study is presented in Figure 3.1.

3.5.1 Pragmatic approach or mixed approach

This type of approach involves the use of methodology that is most compatible to the research work without caring for specific approaches. Johnson & Onwuegbuzie (2004) define it as, "the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language in a single study and thus grant themselves the freedom to use any of the methods, techniques and procedures typically associated with quantitative or qualitative research". A broad view of mixed approach is given in Figure 3.1.

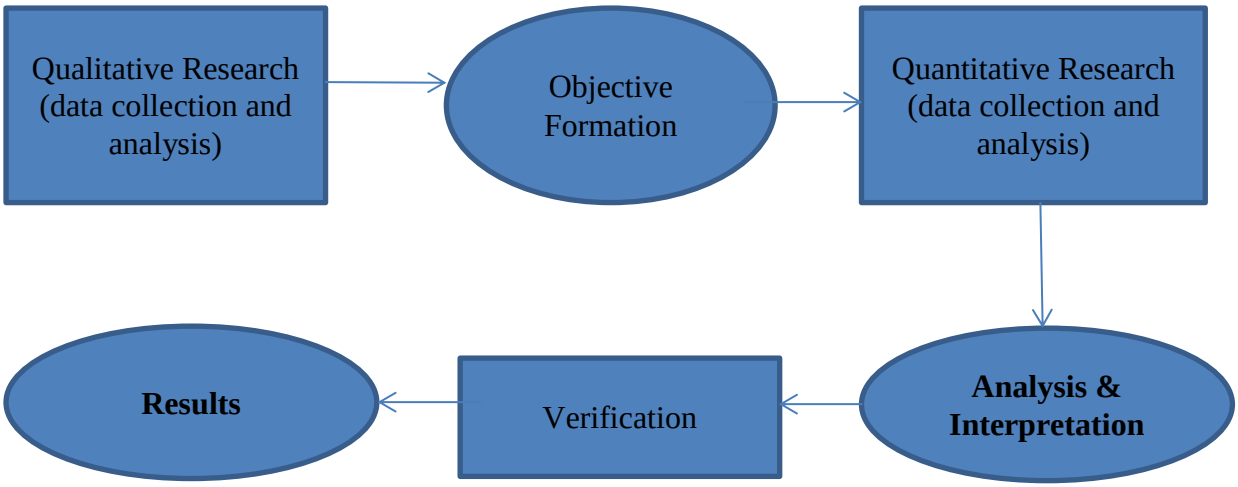

Figure 3.1: Mixed Research Approach

As the qualitative approach is inductive in nature and widely used by humanities and social science disciplines as political science, social work, and education (Domun & Talwar, 2016). The approach is based on collecting of data from various sources and inducing a pattern out of the results (Alasuutari, 2010). This approach is often known as bottom-up approach where specific outcome is maintained first and later moved to the general statements. Both these types have certain unique characteristics and importance for conducting research (Strauss & Corbin, 1994).

Some researchers use qualitative and quantitative methods in supplementary or complementary form, but this study supported an interplay between both types. Qualitative directed the quantitative approach and the quantitative provides feedback that is used to strengthen qualitative approach again. Thus, forming an unending loop. Both approaches contribute accordingly in processing the data/information. Qualitative data forms the basic objectives. On validation quantitative analysis is used to enhance the research process. In this research, both, qualitative and quantitative research approaches are followed by using mixed method of research.

The reason behind using the pragmatic approach is that "it encompasses the application of induction (or discovery of patterns), deduction (testing of theories and hypotheses), and abduction (uncovering and relying on the best of a set of explanations for understanding one's results). Mixed method approach reduces the drawback and utilizes the advantages of both qualitative & quantitative research methods, while conducting a particular study or a longitudinal program of inquiry" (Johnson & Onwuegbuzie, 2004).

Since we are following the mixed approach and using more than one method it becomes necessary to use triangulation. Researchers frequently used triangulation with mixed approach. This research study approached the idea of triangulation (Bell & Bryman, 2007; Collis et al., 2003) to achieve the research objectives and to increase the validity of the findings. Three types of triangulations have been applied in the study i). data triangulation i.e. use of variety of data sources; ii). methodological triangulation i.e. use of multiple methods to study a research problem; and iii). theory triangulation i.e. the use of multiple perspectives to interpret the results.

3.6 Research Design

Research design is the outline plot for any research that contains systematic method and procedures to achieve the research objective (Zikmund, et al., 2009; William, et al., 2013). Research design involves arranging or settling on the structure and technique of examination, keeping in mind the end goal of the study to acquire answers of certain research questions under investigation. "A research design is the logical sequence that connects the empirical data to the study's initial research questions and ultimately its conclusions" (Yin, 1994) . Based on the mixed method research approach research design is chosen. Malhotra & Dash (2010) categorizes research design into exploratory, descriptive and casual research. To answer the research questions of the present study, application of exploratory, descriptive and causal kinds of study is needed. Exploratory research includes a thorough study of literature of IPR, innovation capability in HEIs, and interview with various experts from both industry and academia. For achieving first and second objective of study i.e. to compare and contrast role of HEIs in economic development of India vis-à-vis some other nations with reference to Intellectual property rights and to identify the enablers and barriers for IP creation and its commercialization in Indian HEIs respectively, exploratory research design was applied.

Furthermore, to complete the present study a cross sectional descriptive research design was followed. Multiple cross sectional research design is applied where the data is collected from various respondents for a single time only. Reason for adopting the multiple cross sectional research design was the low cost of application. Data was collected from different sample of respondents in various phases of scale development process.

In short, a blend of all three research design exploratory, descriptive and causal was adopted for the present study. With the application of both quantitative and qualitative methodologies the problem, nature of problem, variable and the relationship between these two variables were

identified. The main benefit of adopting a mixed research design is that it offers better, holistic and a structured preview of the research problem. According to Sarshar, & Newton (2002), these three designs are complement to each other in nature and support each other in attaining the objectives of the research.

3.6.1 Methodology for Qualitative Study

3.6.1.1 Data collection

For achieving the objective of identifying the critical factors for IP creation and its commercialization in Indian HEIs, focus group discussions and in-depth interviews were done. For collection of data, experts for both industry and academics were considered for FGDs. Three focus group discussions were conducted at different time from June 2015 to March 2016, involving total of thirty six experts. The details of FGDs are presented in Table 3.1. After the FGD a report consist of themes note, hunches, interpretations, and ideas was created moreover comparing and contrasting results by categories of individual focus groups also followed. A semi-structured approach was adopted for conducting FDGs. The advantage of this approach is that it helps in attaining internal validity by ensuring the responses received equal attention across all the participants (Weller & Romney, 1988). Along with these two methods, public documents, historical items, websites and social media were also followed. The main outcome of a qualitative research is to gain an initial insight and understanding of a problem (Malhotra & Dash, 2010) . A test was conducted to find the face validity of the questionnaire. Pilot test on faculty members of HEIs and data triangulation on the participant response was followed.

Table 3.1: Participants of Focus Group Discussion

Participants	FGD-1	FGD-2	FGD-3
Senior level faculty member/administrator from central government funded technical institutes	5	2	4
Senior level faculty member /administrator from Central Universities	2	4	2
Senior level faculty member /administrator from State Universities	2	2	3
Senior level faculty member /administrator either from Private Universities or Private Colleges	1	2	2
Industry personnel at managerial level	2	2	1

Since the first part of the study deals with the objective of identifying the critical factors present in HEIs which are responsible for IP creation in purview of Indian condition; the faculty

members at senior level are taken as the sample unit along with the industrial representation in research work for tapping the commercializing aspects also. Faculty members active in teaching and research basically in the area of innovation and innovation, IP management were selected as the respondent base and industry personnel were selected on basis of their involvement with academic institutions.

Since sampling is done to represent the total population with less efforts due to the smaller size of the sample as compared to population (Saunders, Lewis, & Thornhill, 2007), hence it is important to carefully perform it. Because the study followed both qualitative & quantitative approach, according to Marshall (1996) and Sbaraini et al., (2011) it is suggested to apply purposive or judgmental sampling for the first stage of the study and convenience sampling to be applied for the second stage (quantitative) of the study.

3.6.1.2 Reliability and validity

For qualitative phase of this study reliability and validity were tested as it is necessary to maintain the integrity of research (Golafshani, 2003; Kirk, Miller, & Miller, 1986). Reliability and validity are particularly important for the qualitative research (Miles and Huberman, 1994). Reliability deals with examining both the process and the product of the research for consistency and repeatability i.e obtaining same results while repeating of experiment. The researcher used data triangulation for reliability & validity. According to Flick (2014), "focus groups as a stand-alone method can be combined with other methods, allowing for the adoption of a strong triangulation approach". In this case interviews with senior level faculty members are used to validate the results of first phase of study. External validity regarding generalization is tested through data triangulation (Yin, 1994). External validity shows the extent of representing the results with the study undertaken. In this work, the generalizability was better as FGDs & interviews were conducted with the faculty members having good amount of experience. Moreover the FGD transcripts/reports were circulated among the respective group for verification before data analysis (Miles, Huberman, Huberman, & Huberman, 1994; Yin, 1994) to improve construct validity and improving its authenticity.

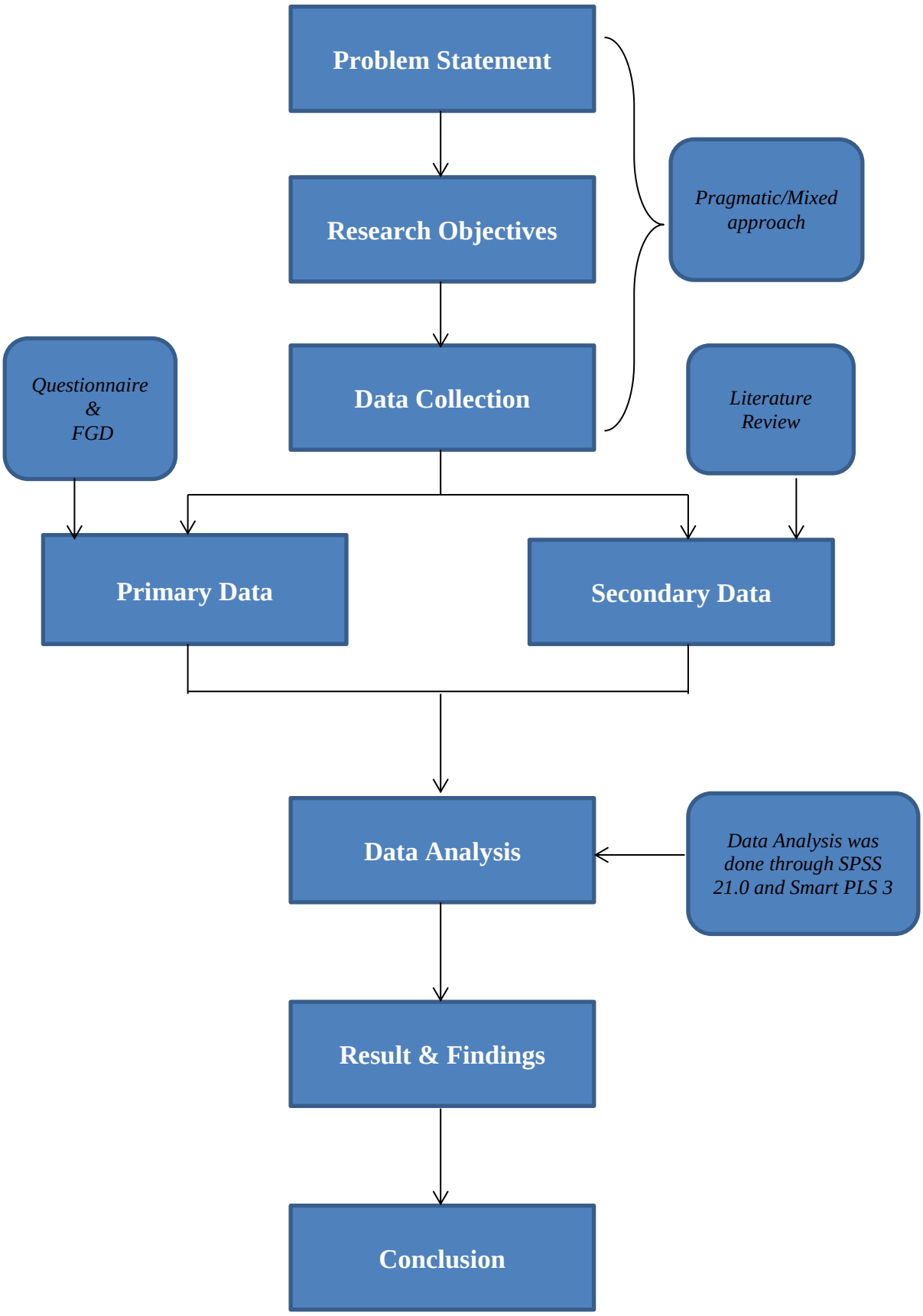

Figure 3.2: Flow chart of research methodology

3.6.2 Methodology for Quantitative study

3.6.2.1 Sample design

It is important for selection of appropriate sample for gathering the necessary data through questionnaire (Churchill, 1979). Therefore the next task in the research is to follow the correct sampling methods for deciding the sample which would be the correct representation of the target population. This step will decide the quality of research output hence suitable technique will be selected among the various present (Zikmund & Babin, 2007). Based on the factor of probability two most common types of sampling are "non-probability sampling" and "probability sampling".

This study followed a systematic approach (Malhotra & Dash, 2010) to design the sample. According to which the first step if to identify the target population from which appropriate sampling frame is chosen, after which sampling technique is decided according to the required research objective. Deciding of the sample size is the concluding stage of the sample design exercise.

3.6.2.2 Target Population

The target population is the total group of individuals from which the sample might be drawn (Malhotra & Dash, 2010). We have used the population with following specification for conducting the present research:

- Members of the target population- Faculty members
- Sampling units- Higher Educational Institutes
- Duration- March, 2017- February, 2018
- Extent- North Indian region

3.6.2.3 Sampling Frame

"A sampling frame is a representation of the elements of the target population. It consists of a list or set of directions for identifying the target population (Malhotra & Dash, 2010)". Researchers of this study have considered the sampling frame on the basis of TEQIP Scheme. Respondents of the study were the faculty members of various HEIs across the India. The selection criterion was the presence of Technical Education Quality Improvement Programme (TEQIP) at the Institute. TEQIP is being implemented as a World Bank assisted project to improve the quality of technical education system in India.

3.6.2.4 Sampling Method

For the reason that the study was based on a larger population which was assumed to be infinite, we have not followed the probabilistic sampling in deciding the sample. Instead, it was justified to follow judgmental non-probabilistic sampling for filling the questionnaire. Therefore, it becomes necessary to form some conditions to pick the sample for the study, which would be similar to the target population. The responses of only selected faculty members were taken who satisfied all the conditions of the judgmental process. These conditions were:

- Experience of more than five years with at least two years in the present institute.
- Only engineering & basic sciences faculty were considered.
- Faculty member has published at least two research papers in International Journal.

3.6.2.5 Sample Size

For the studies, like this one, where they are assuming their population to be infinite, it becomes very difficult to decide upon the adequacy of the sample size. The adequate sample size depends on various issues like type of research, tools and methodology adopted, number of constructs, limitation of researcher and less finance (Kumar & Phrommathed, 2005). Since the study has done structured modelling through PLS, which has the advantage of using less number of respondents (Wetzels, Odekerken-Schröder, & Oppen, 2009). Considering these recommendations the study has taken sample size of 543 respondents. The description of sample is given in Table 3.2. In general, the accuracy and stability of SEM results decline with decreasing sample size as well as with increasing number of variables (Beran & Violato, 2010).

Table 3.2 Description of respondents for quantitative study

S.no.	Type of Institute	Sample Size	Percentage
1	Central Government funded technical institutes	229	42.17%
2	Central Universities	196	36.10%
3	State Universities	118	21.73%
	Total	543	100.00%

3.6.2.6 Scale development

For developing a scale for this study, quantitative methodology was adopted in which the data was collected from 543 respondents using a structured questionnaire. "Scaling involves creating a continuum upon which measured objects are located" (Malhotra & Dash, 2010). To develop a multi-dimensional scale this study followed the well-established process given by (Churchill, 1979).

In general, there are two scaling techniques- comparative scales and non-comparative scales. To achieve the objective of this study, data was collected through structured questionnaire in two stage i.e., scale refinement and scale validation stage of scale development process. Initially, for pilot test and exploratory factor analysis, a 64 items questionnaire was applied. In next stage, for first order confirmatory analysis, data was collected with the help of 44 item questionnaire. All items were scored with the help of 5-point Likert scale.

3.6.2.7 Data Collection

In the present study, we collected data from faculty members of HEIs where TEQIP scheme is running. The data was collected through structured questionnaire. The main reason for the adoption of structured questionnaire was the even nature of results. This makes analysis and interpretation is comparatively easier. In the present study, a structured questionnaire has been administered to the respondents personally and through e-mail. A paper based approach is used for collecting data face to face from respondents, whereas e-mail was used for collecting responses electronically. Following steps were followed to collect data electronically.

1. Questionnaires were sent through e-mail along with cover letter. Cover letter contained introduction of researcher, purpose of the research, and significance of the study.
2. Three reminders were sent after 15 days to the people who had not answered requesting them to fill the response form.
3. The same process was adopted once again to get more response.

3.7 Review of research methodologies

Various studies on IP applied different tools and methods. This research has applied diverse types of research tools, according to their suitability, to achieve the research objectives of the study. A brief descriptions of which are given below:

3.7.1 Interpretive Structural Modeling (ISM)

This tool finds its use for better understanding of the multifaceted structures consisting of various entities. John Warfield in 1973 has come up with this unique technique which is capable for easy representation of different processes in any system, with the help of graphics and graphs. These graphs shows the strength and route of prevailing relationship in the system (Sage, 1977).

Direction as well as the position of these multifaceted related connections can be find with the use of ISM (Attri, Grover, Dev, & Kumar, 2013). This tool has been broadly utilized in management studies to understand flow of any system and to recognize exactly the connections and relationship among different barriers and enablers of the system (Diabat, Kannan, & Mathiyazhagan, 2014). Steps that are followed to perform ISM methodology is defined in the various literature of Mathiyazhagan et al. (2013) and Thakkar, Kanda, & Deshmukh (2008).

The ISM arrange various directly and indirectly related factors that influence the framework, under observation, in a complete systematic model (Mathiyazhagan et al., 2013). The excellence of the ISM is that it depicts the structure of a difficult issue using diagram and words. The ISM can be applied to any setup to know the relationship among its different components (Thakkar et al., 2008).

3.7.2 Factor analysis (Exploratory and confirmatory factor analysis)

Factor analysis is a statistical technique that has been applied to assessed interrelationship between observed and latent variables. This is mainly a data reduction tool, to extract the number of factors (Malhotra & Dash, 2010). This technique assessed the co variation among the observed set of variables which collect their information. This technique has been developed by Charles Edward Spearman to use in the field of psychometrics. Since then this technique has been widely applied in various areas like behavioral studies, social sciences, operations management, marketing, environment performance measurement and other fields

those are engaged in huge quantitative data. Factor analysis can be classified in two categories: exploratory factor analysis and confirmatory factor analysis.

3.7.3 Structural Equation Modeling

Structural Equation Modeling is an extension of other multivariate tools, particularly, factor analysis and multiple regression analysis. According to Hair et al., (1987) "SEM is a multivariate technique combining aspects of multiple regression and factor analysis to estimate a series of inter-correlated dependent relationships simultaneously". The growing complexity of the research problems in the behavioral and management sciences and the development of various softwares have raised the significance as well as application of SEM (Hoyle, 1995; Kline, 2015; Patra, Ray, & Padhy, 2017; Raykov & Marcoulides, 2012).

3.7.4 Soft system methodology

SSM is a method to handle complex situations in where there is a feeling that "something needs to be done about this". These situations should be referred to as "problematical" rather than "problem situations" (Checkland & Poulter, 2006). It generates knowledge and understanding of real social systems that it assumes exist in the world by breaking them down into constituent parts and then studying these simple elements in terms of cause and effect and hence useful in management research (Baxter & Sommerville, 2011; Mingers & White, 2010). The systemic thinking when taken to its practical conclusion from a critical perspective offers to action research a somewhat unique liberating praxis (Flood, 2010).

3.8 Chapter Summary

This chapter presents the research objectives on which the study is conducted. Explanation for using mixed research approach for achieving the research objectives is also written in detail. The mixed method of research chosen for the design of this study was an appropriate decision as the newness and complexity of the problem could not be addressed by one research method alone. Section 3.6 of the chapter deals with the research design followed for both qualitative

and quantitative study. Details about the methodology for conducting various FGDs are also given. This was trailed by the description of data collection technique applied by the researcher along with the description of sample unit & size taken on for developing IPCC scale.

CHAPTER-4
ROLE OF ACADEMICALLY GENERATED INTELLECTUAL PROPERTY IN ECONOMIC DEVELOPMENT

4.1 Introduction

This chapter deals with the objective of comparing and contrasting role of HEIs in economic development of India vis-à-vis some other nations with reference to Intellectual property rights. This chapter explores the complex relationship of HEIs with national growth on eight different factors which include patent filing, student enrolment in higher education, Institute ranking, government funding, high-technology exports, scientific and technical publications, researcher employment, and interaction with industry. The study is performed for the top fifteen countries of the world based on their Gross Domestic Product in the year 2013.

4.2 Background

It has been observed in many instances that education and more specifically higher level education has a vital role to play in supporting sustainable development (Isaksson, Johnson, & Garvare, 2009). Imparting education and contributing to scientific knowledge and intellectual capital has always been the primary focus for HEI, but in present scenario; due to a drastic change in the foreground of the economic pattern the repercussions of work done by HEI has large and far reaching. Every region has different competitiveness which depends on different supporting environment present related to different industries performing in that region (Huggins, Izushi, Prokop, & Thompson, 2014). Such encouraging environment consist of research institutions, business and producer service providers, information and communication technologies (ICT) infrastructure, as well as institutes of higher education (Johnston, 2007; Rodrigues, 2011; Tether & Tajar, 2008). There are many factors which are working on several levels in big economic machinery; many of these factors have direct or indirect relationship with institutions of higher education.

There are quite a number of research studies which have recognized contributions that institutes of higher education make to economic development of a country in term of wide range of societal, political and cultural aspects but only few studies are dedicated to measure other specific economic indicators (Thanki, 1999). Every country in the world is in the process of achieving high economic growth and development through various policies and strategies. While we discuss about this phenomenon, it is necessary to mention that there is a significant difference between economic growth and economic development. Economic growth is related

to numeric values of national income, GDP, per capita income, etc. such as if GDP of a country raises it is referred to as economic growth. Then again monetary advancement incorporates the upward development of the whole social framework. Social frameworks incorporate non-monetary components, for example, education and human development infrastructure, class segmentation, the division of authority, and general organizations and social states of mind. To get a broader view, this study concentrates on economic development in which HEI is contributing directly or indirectly through research and intellectual property.

Besides, as learning turns into an undeniably imperative element of territorial advancement and improvement course, the part of HEI has go to the fore of provincial advancement and economic advancement approach (Audretsch & Fritsch, 2002). The technology exchange and commercialization of HEI produced knowledge is taking a more grounded part inside of government strategy at various levels (Abreu, Grinevich, Hughes, & Kitson, 2009). Numerous government and their offices are concentrating their thoughtfulness regarding the part of HEI's knowledge commercialization in creating inventive, practical and prosperous economies. In financial terms, locales may fluctuate in their "reliance" on colleges and universities as a generator of both revenue generation and innovation (Farid et al., 2015). Studies revealed that business lacks innovations in achieving its objectives in many sectors including information technology area also (Pandya & Anand, 2008). In strategy terms, there is a hidden presumption that the knowledge created by HEI can be exploited most excellently if can be circulated to industries (regional and national) and adjacent entities through proper connections (Smith, 2007). In general, the information and knowledge base of an economy can be characterized as the ability and limit to build and innovate new thoughts, routes to produce new products or services and to convert these into economic progression by expanding the worth of a territorial economy and the related creation of prosperity (Afzal & Lawrey, 2012).

4.2.1 HEIs and economic development

It is very difficult to measure the contribution of HEI in the economy of a country. There are many factors responsible for this, firstly most of the impact of HEI are indirect in nature be it research or human resources development. Secondly the effect of HEI on economies takes much more time and results are seen in the long run. As in case of research performed at the HEI time difference between performance of research and when its benefits become apparent can be considerable and unpredictable. Thirdly, these institutions do not work in isolation; there is a complex network involved through which HEI make its delivery of national growth and it's difficult to understand (Plewa, Galán-Muros, & Davey, 2014). Due to recent development of

internet and telecommunication, online higher education also plays an important role in emerging economies (Wali, 2010).

Goddard & Chatterton (1999) shows a value-adding prospective of HEI in its adjoining region. It indicates a clear contribution of universities and colleges by enhancing the skills, innovation and cultural dimensions of the community.

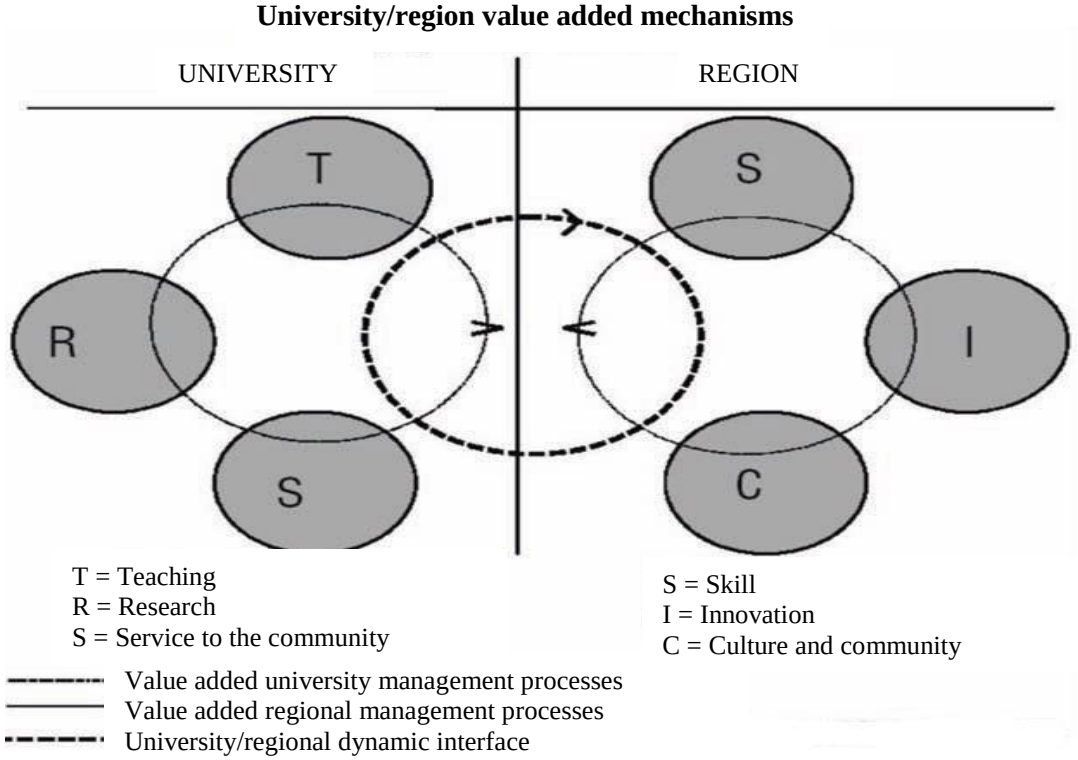

Figure 4.1: Interaction and interrelation between HEI and region. Source: Goddard and Chatterton (1999)

The function and position of HEI are becoming more significant and crucial in the new knowledge and innovation based economic environments. Until few years back higher education in most of the developing and emerging nations has been primarily funded by government for meeting a specific need of skilled human resource. But now a new role of building capacity in research and industrial development is being carried out by HEI (Marmolejo & Puukka, 2006). But, there are also some significant limitations on the influence of economic thinking. Outcomes of policy debates and reforms of HE finance have often been determined by non-economic factors and issues, as well as the economic concepts (Woodhall, 2006).

4.2.2 Strategic planning and financial support for higher education

The philosophy, strategy and funds are interwoven in a thread. One of the tools used to implementing the strategies developed by a nation is the funds allocated for the purpose. In other words, both of these terms are complement to each other. As evident from the literature, many nations' strategic moves have stalled by the lack of funds.

As given by Wikipedia, the EU adopted various educational policies and programmes from time to time-the first been "COMETT", then "Youth for Europe" programme, followed by "Erasmus" programme-under which more than 3,000,000 students have taken part in inter-university exchange and mobility over the last 20 years , "Bologna" programme - whose purpose is to create a European higher education area by harmonizing academic degree structures and standards as well as academic quality assurance standards throughout EU Member States and in other European countries and the Education and Training 2020 programme (ET2020).

A research report for British Council by the Economist Intelligence Unit, 2013 indicates that for Asian countries and especially the south Asian countries, which also includes India, much of the work lies with education stakeholders in articulating the economic argument for more funding to flow into the sector, and for greater urgency on institutional reform.

From a territorial approach point of view, despite the fact that HEI have a part to play in fortifying private segment demand for knowledge, much of the time this view is fundamentally constrained given their own boundless arrangement of exercises. Just a modest number of universities and colleges can be relied upon which can play a major and decisive role in the innovation capabilities and knowledge economies of their nation (Jacob, Lundqvist, & Hellsmark, 2003). The extending part of HEI whereby governments keep on heaping new duties and exercises onto them which can be many a time leave them with less flexibility to do other jobs (Nedeva & Boden, 2006).

Some of the major challenges in implementing the higher education policy are bureaucratic inertia, competing interests, resistance from different sections, lacking of transparency of governance and politicalisation of higher academic posts.

4.3 Methodology

For this study, the GDP is taken as the parameter for the national economic development and the analysis is performed for the top fifteen countries of the world based on their Gross Domestic Product in the year 2013.

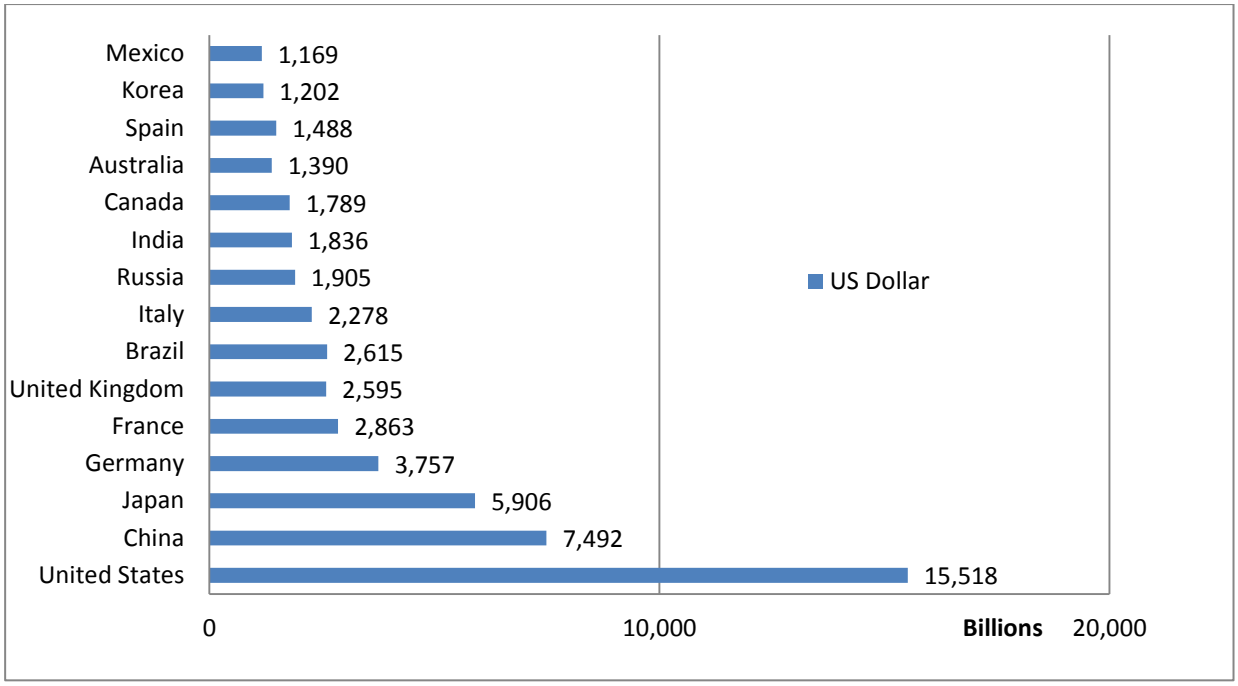

Figure 4.2: Comparison of Gross Domestic Product of countries for the year 2013. Generated data from source: World Bank

In this ranking, United States stood at number one position with annual gross domestic production of 16,768,100 million US dollars and Mexico on 15th position with GDP of 1,260,915 million US dollars. As these fifteen countries represent all the different continents of the world except for Africa we consider to carry out the comparative analysis based on this group which could bring out a balance picture of the whole world with less distortion. Among these countries five are from Asia (India, China, Japan, Russia & Japan) and five are from Europe (France, Italy, Germany, United Kingdom & Spain). The other three are American countries (USA, Canada, Mexico & Brazil) and Australia is the single entity from its respective continent.

4.4 Decision determinants in mapping the position of HEIs

Most of the required data for analysis is downloadable from UNESCO Institute for Statistics & World Bank database. This includes data on: Patent applications, GDP, Student enrolment for tertiary education, Research and development (R&D),Scientific and technical journal articles, Expenditures for R&D, High-technology exports, Charges for the use of intellectual property, Trademark applications filed and many others. We also have added data on Research and Development (available from the OECD) and data on European countries (available from EU).

4.4.1 Number of patent applications

The primary aim of first objective is to know the role of IPR in country's economic progression, if any, and one of the direct ways is to compare the number of patent applications

filed in the office of registrar with the GDP. The comparison is carried on the data of thirteen years from year 2000 to 2013. The data for domestic patent applications (both resident & non-resident) is drawn from WIPO and the data of GDP (constant 2010) is taken from World Bank. Both these sources are reliable enough to carry on the further analysis. Figures 4.3 (a-o) shows the status of fifteen countries through graph plot of number of patent applications on y axis (primary) and GDP on secondary y axis, whereas the year on horizontal x axis.

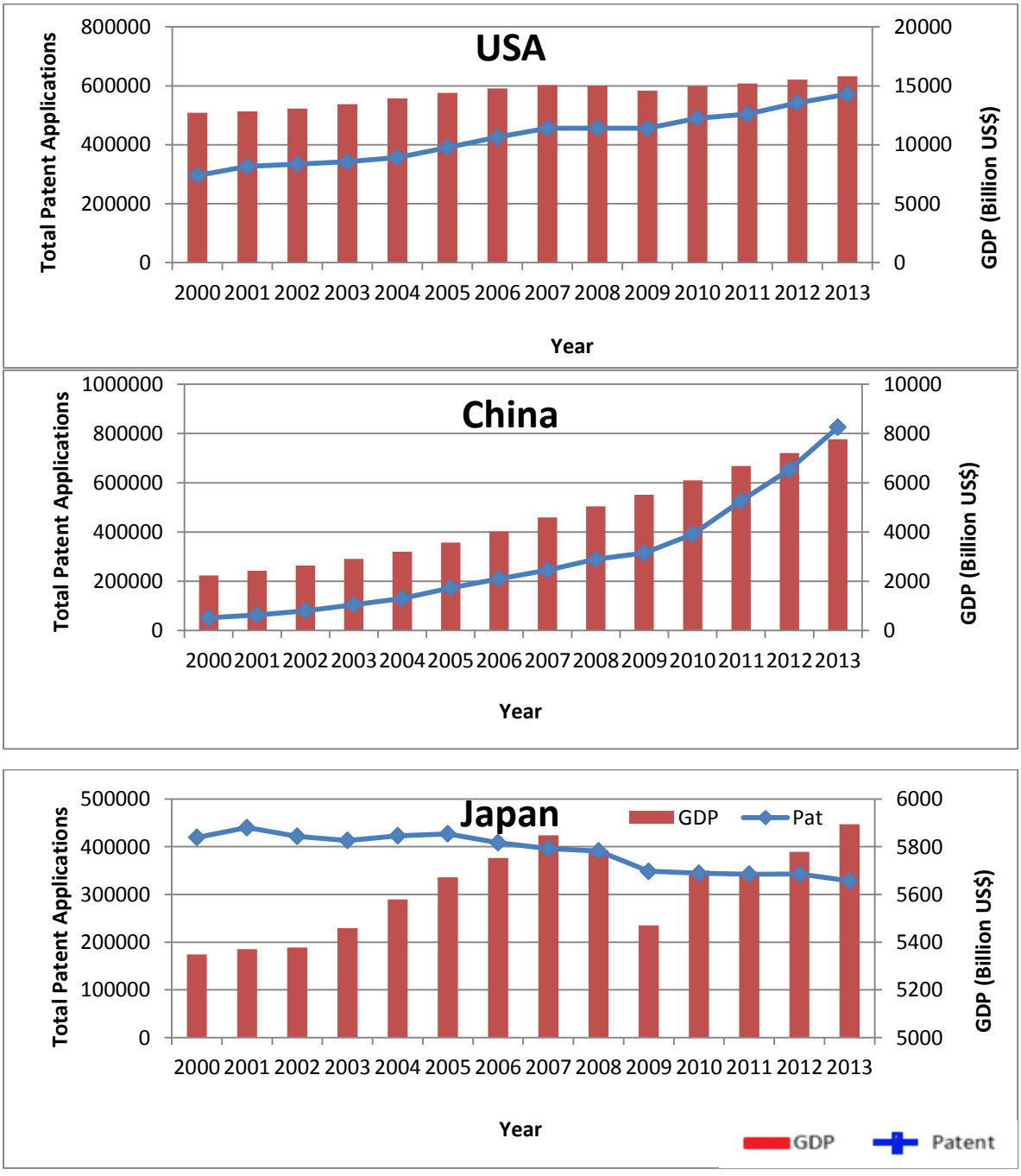

Figure 4.3(a,b,c): Patent applications Vs GDP

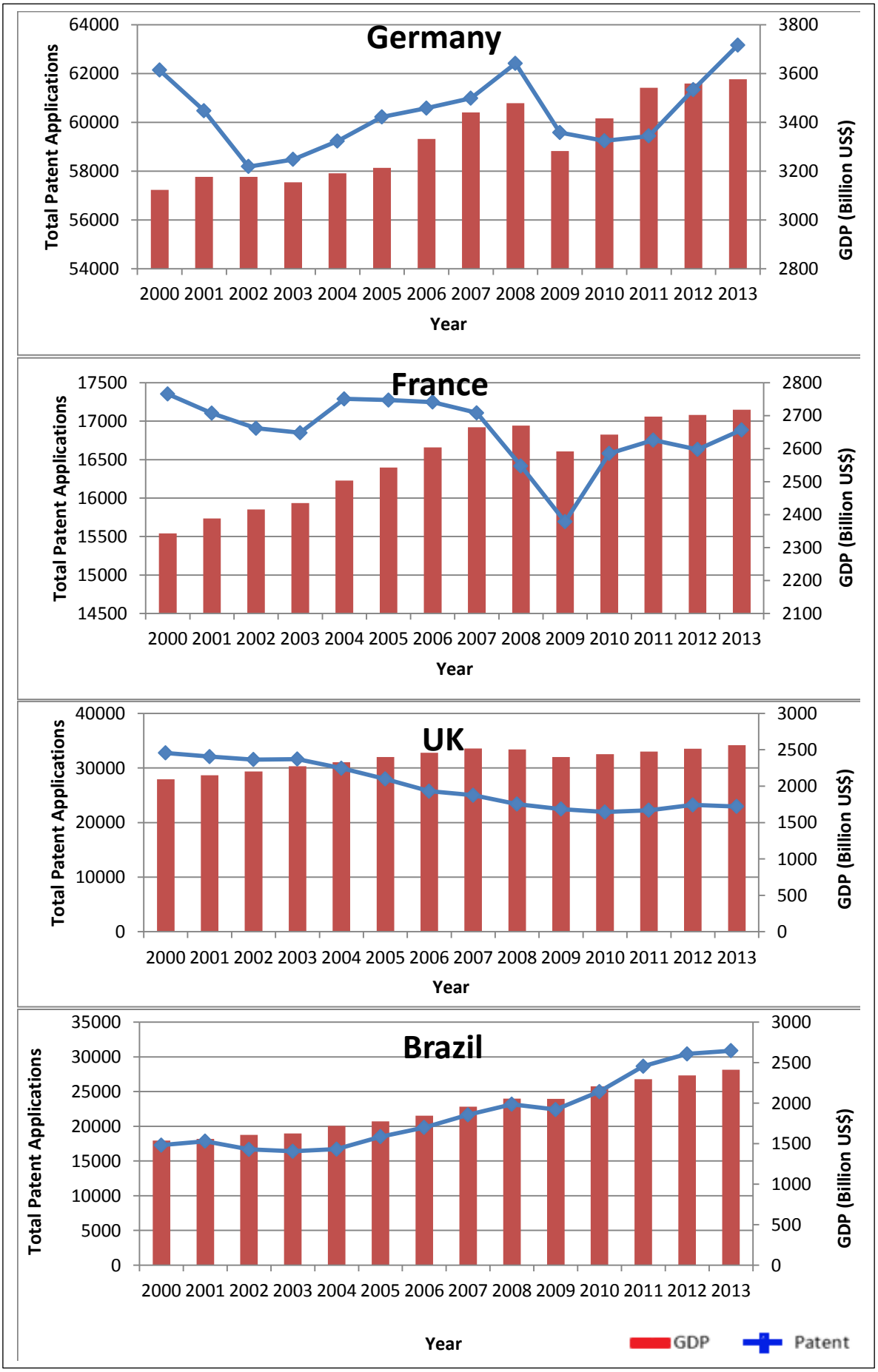

Figure 4.3 (d,e,f,g): Patent applications Vs GDP

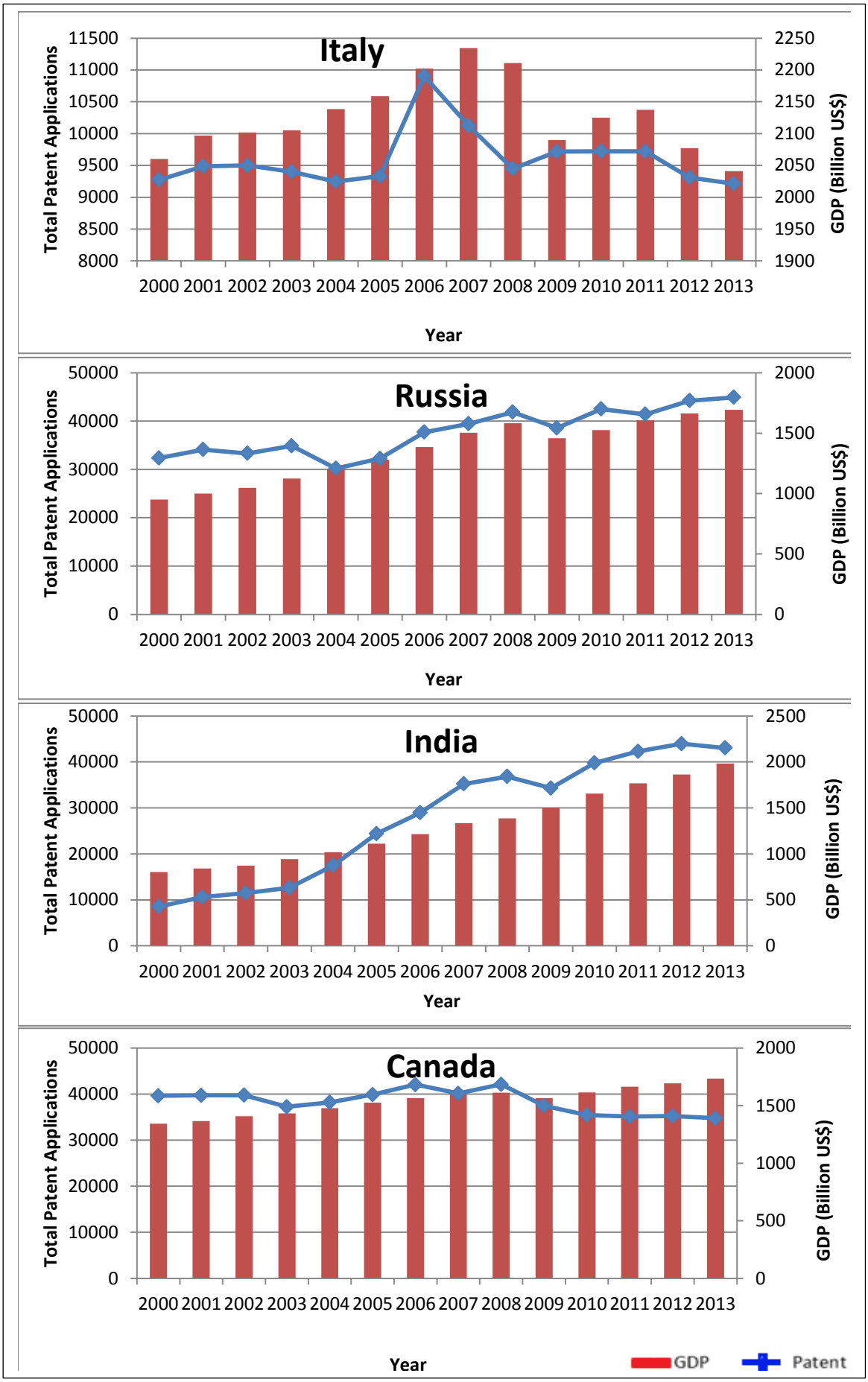

Figure 4.3 (h,i,j,k,): Patent applications Vs GDP

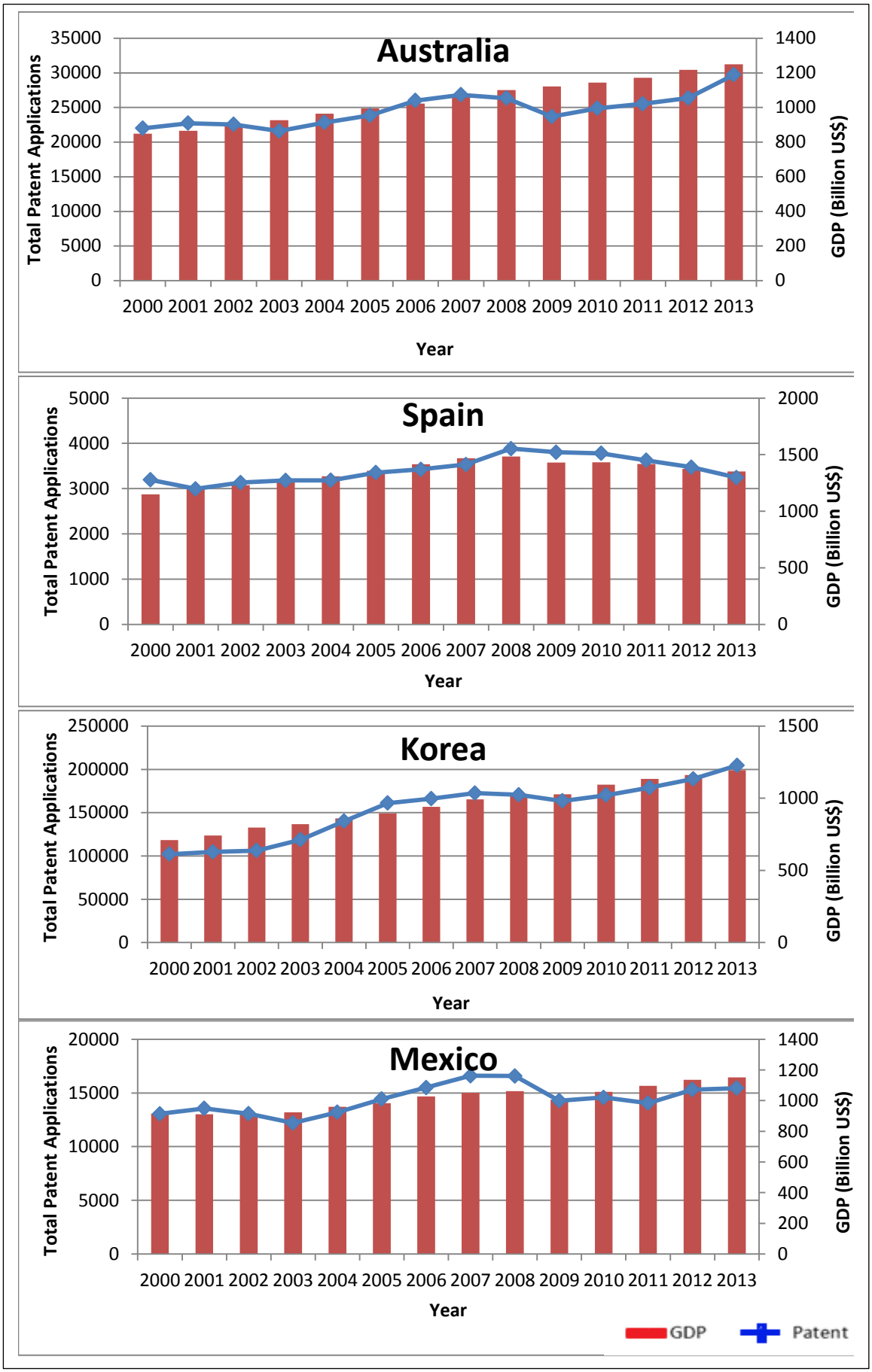

Figure 4.3 (l,m,n,o): Patent applications Vs GDP

Figure 4.3 (a-c) gives the snapshot of the patent applications that are filled by USA, China and Japan in their domestic patent office. These are the top three economies in term of numbers and two among three comes in developed category. In case of USA the growth of patent applications is constant and steady which shows their indulgence in patenting for long period and it is one of the mature player in terms of patent numbers. China on the other hand shows a steep growth in patent applications. This increase of number also reflects in their economy also. It is the classic example where the positive correlation exists between economy and patents and is clearly visible in figure. Japan is slightly less active in patenting in the first decade of the century. They are also not able to convert their intellectual property into commercial gains as well as in the economy. Their economic growth is also constant and shows a huge depreciation from year 2009 onwards and they are still in the process of economic recovery.

Figure 4.3 (d-g) contains the patenting trends of Germany, France, UK and Brazil. Three out of four countries are classified under high income countries and are well developed research infrastructure. This is visible in the patenting applications also. Germany is considered to be very innovative economy producing advance technology. The patenting worm of Germany leads the economic growth as visible from year 2002 to year 2008 both are complimenting each other in term of their upward trend. France and UK are also showing the same trend in their economy and patents. Brazil although a developing economy has shown a remarkable growth in patenting and may because of which it lead to economic prosperity. Its patent applications in year 2000 were around fifteen thousand but by the end of year 2013 it jumped to more than twenty five thousand, their GDP also cross two thousand billion US dollar mark in year 2013.

Figure 4.3 (h-k) shows the trends of Italy, Russia, India and Canada. Italy also shows positive correlation between patents and GDP. The growth in GDP from year 2000 to year 2006 is led by patent and as their patenting activity showed down their GDP also suffered a loss and ended to close to two thousand billions US dollar in year 2013. Russian and Canadian economies are grown with a constant steady rate as well as their patents also shown a steady growth. But in case of Canada from year 2008 the patents are going down but their GDP has grown, this suggests that their economy is not lead by innovation and may be some other reasons were responsible for their economic growth. In case of India, considering its size of economy the number of patents in year 2000 were less than ten thousand. The number patent applications are on constant increase except in year 2009 where it dipped marginally but regained quickly in next year. Their economy is also synchronized with the patenting activities.

The fourth part of Figure 4.3 (l-o) deals with Australian, Spanish, Korean and Mexican economic development with patent activities. All these are developed economies except for Mexico. Graph movement suggests that one of the important enabler of their economic growth is patent. In the figure their GDP bars are in align with their patent application worm. Where Spain GDP is on downward as their patent application but rest of the countries in the figure has shown upward movement in GDP and patent applications. The trend of these countries also showed a correlation between patents and GDP. This relationship is more prominent in the case of Korea which is the home of most of the electronic product manufacturing giant like Samsung, LG, Hyundai etc.

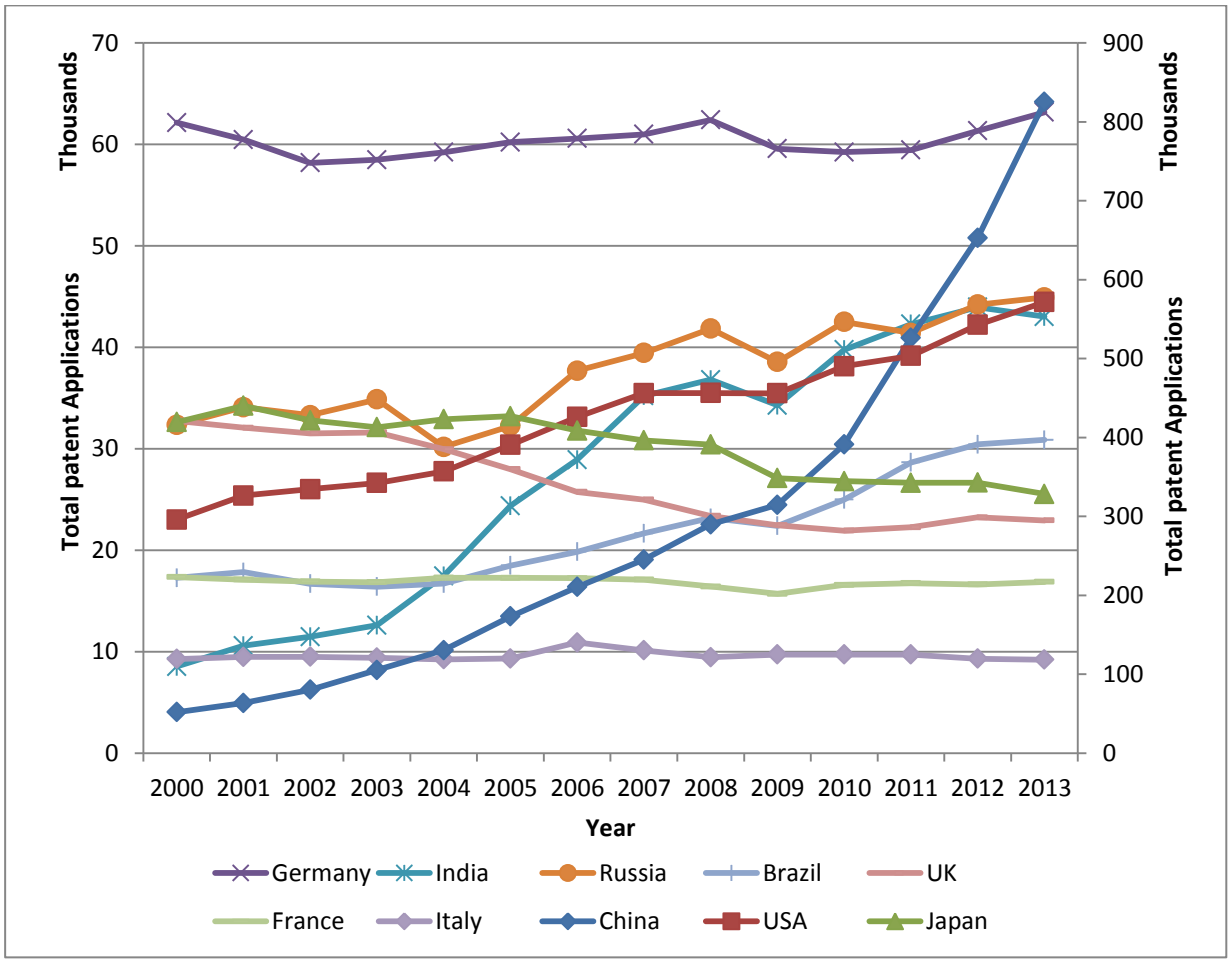

Figure 4.4: Patenting Trends around the globe

The Figure 4.4 shows the number of patent applications of selected ten countries, which are filed in their respective domestic patent office from year 2000 to 2013. There is large variation of patent applications in selected countries and hence to make the graph clear the figure is showing patent applications data of China, USA, and Japan on secondary vertical 'y' axis. On

comparing the total number of patent applications of top ten economies across the globe an upward trend was found. All the countries are engaged in patenting activities and they are continuously protecting their innovation. This trend is due to the belief that for taking commercial benefit from the research and development it is necessary to protect the outcome with IP tool like patent. Due to which intellectual property has become an important driver in economic activity across the world. Various developed countries like US, UK, Japan etc were in this practice of patenting from long duration. But developing countries like China begun patenting late but catch developed countries around 2010 and is now leader in applying for patent rights.

4.4.2 Student enrolment in higher education

Any country's educational and training system is the key in determining its success in tapping the global resources (Said, Ahmad, Mustaffa, & Abd Ghani, 2015). It is very important for education institutes to provide such skilled human resource that can exploit the global opportunities into its local production system (Morgan, 2002). In emerging countries like India one way of embedding local talent with multinational industries, which generally uses advanced and sophisticated technology for its production process, is through imparting education at the mass level and ensuring high number of student enrollment in the universities (G. Wang, Wu, & Han, 2015).

For this, the educational system has to regularity changed itself according to the changing times to compete with the universal changes worldwide. Over the course of the last two decades, many countries have moved from previously elite systems to massification. Trow (2007) describes higher education system growth as following three phases – elite, mass and universal access phases – based on the proportion of the relevant age group enrolled in higher education institutions. In this classification, when a country's enrolment ratio for higher education (gross enrolment ratio, GER) is below 15% of the relevant age group it comes under the elite phase. The massification phase is when the GER is between 15% and 50% and when GER is above 50% it comes under universalization phase. Most developed nations come under the phase of universalization.

From year 2000 to 2012 enrolment in higher education has gone up because of increasing demand of the society and economy for specialized human resources and apparent importance of higher education in consequent life opportunities. Another factor is increased school participation rate in developing countries.

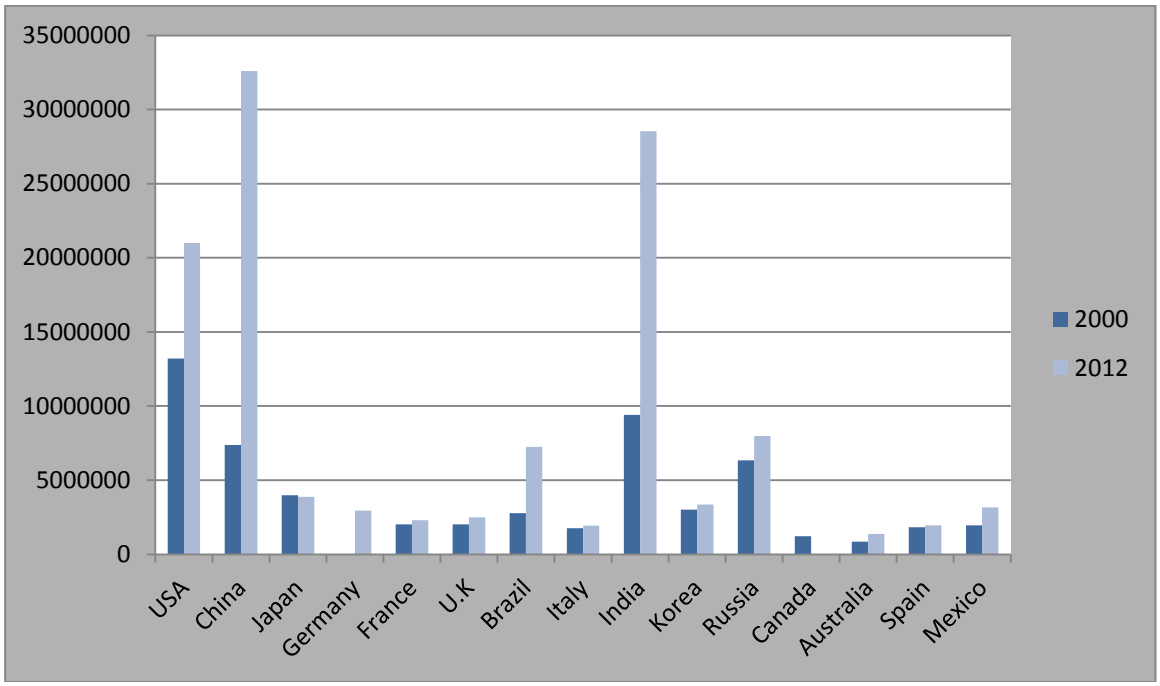

Figure 4.5: Comparison for the Students Enrolment in tertiary education. Generated data from source: UNESCO Institute for Statistics.

Number of student enrollments in tertiary education grown explosively in China and India. In China enrollment figures increased by a compound annual growth rate of 13.19% succeeded by India with a rate of 9.69% and Brazil with 8.3%. USA increases with a moderate rate of around 3.94% while Japan being the only country where number of enrolments have decreased (Figure 4.5).

To accommodate increasing number of students, the expansion of higher education system is compulsory. Thus, leading to establishment of new universities, recruitment of more faculty members and enhancement of the share of private education entities.

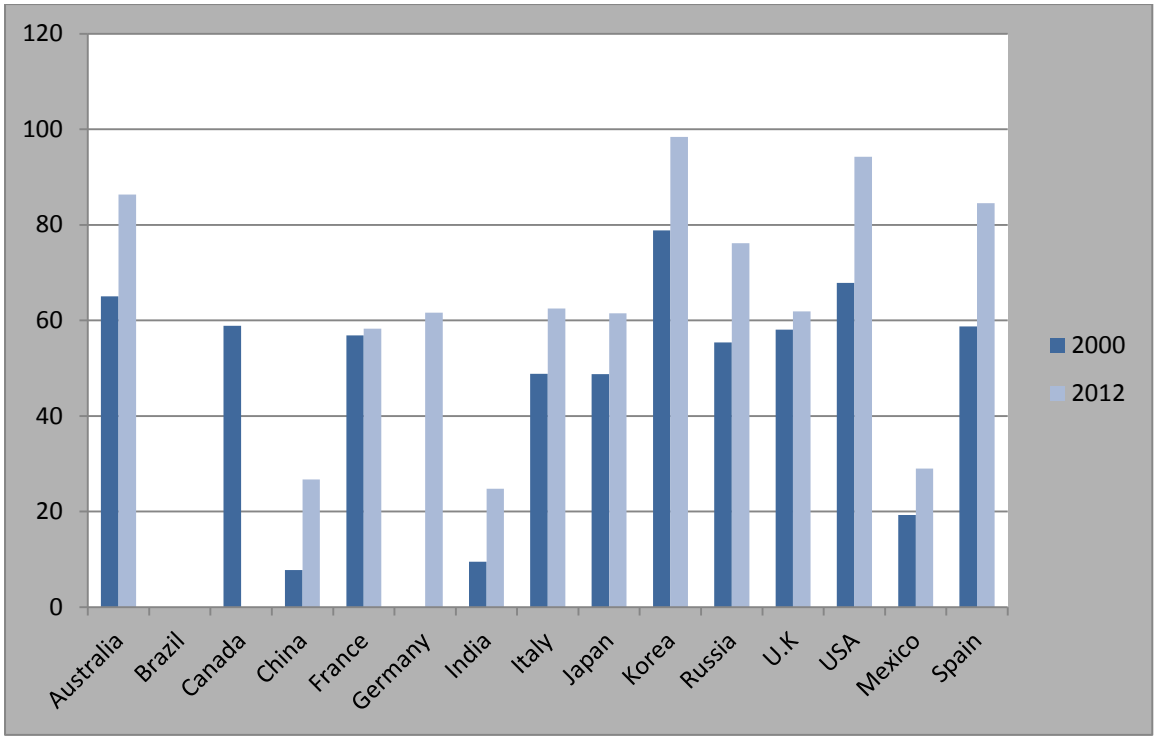

Figure 4.6: Gross student enrolment ratio in tertiary education. Generated data from source: UNESCO Institute for Statistics.

But when we talk about Gross enrolments ratio in tertiary education USA holds first position with 94% and India is at last position with 15%. China which was behind India in year 2000 with 7% GER has improved to 27% in year 2012 (Figure 4.6). Data for Brazil, Canada and Germany was insufficient to compare the present situation. The United Nations Educational, Scientific and Cultural Organization (UNESCO), explain 'Gross Enrollment Ratio' as the total enrollment within a country "in a specific level of education, regardless of age, expressed as a percentage of the population in the official age group corresponding to this level of education."

Due to enrolments growth HEI tends to become more diverse, resulting in new instructional challenges for faculty members, at a time when some of these instructors are coming under intensified pressure to undertake research. From the point of view of numerous legislatures, growing graduate education has an appealing advantage. Numerous governments see HEI as core of research activities that will yield constructive monetary profit to the nation. HEI research is normally done at the graduate, master and doctoral level. Henceforth, extending higher education is seen as a method for expanding the financial aggressiveness of the nation.

According to Holland, Liadze, Rienzo, & Wilkinson (2013), individuals with a university degree tend to have a significantly higher wage rate than those without and graduates, on average, are paid 70-180 per cent more than workers without formal educational qualifications.

4.4.3 Ranking of higher educational institutes

Other figure which shows the excellence of education in different countries is world university rankings. Many agencies generate ranking for HEI from various countries around the globe based on specific performance indicators which are grouped into various areas like teaching, research, citations, industry income etc. We have taken ranking from QS (*Quacquarelli Symonds*, a British company specialized in education and study abroad*) a*nd Times Higher Education agencies and counted the number of universities of specific country which comes under first two hundred positions. India which is representing high number of enrolments in tertiary education has zero university within top 200 universities. Even china which has highest number of students at tertiary level has got only seven universities in university rankings. Developed countries like USA, UK, and Germany are having most number of universities that got placed in top 200 QS world university ranking (Figure 4.7).

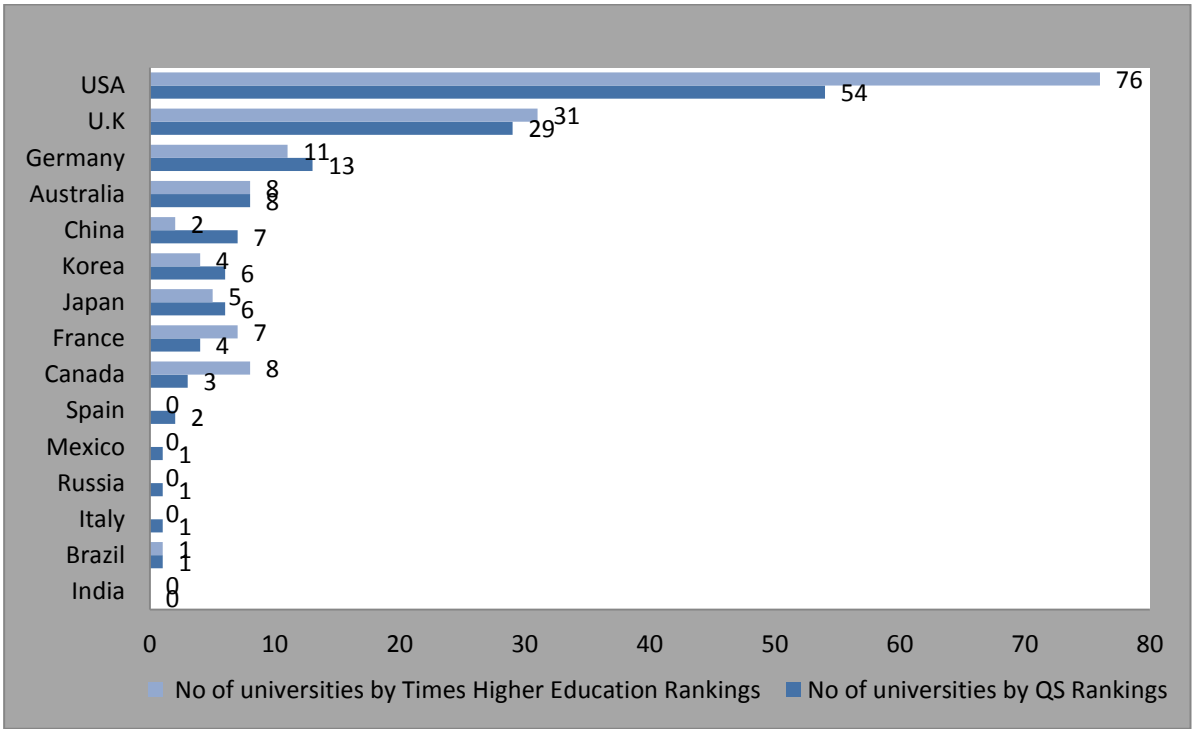

Figure 4.7: University rankings for the year 2012. Generated data from source: http://timeshighereducation.co.uk

4.4.4 Government funding

The expenditure made by the government on the education system of the country is the measure of its readiness to change and invest in new resources necessary for obtaining better results in R&D (Nicolov, 2013).

The growth in student at higher level of education is not matching to economic development in developing country like India is due to poor expansion of facilities like number of faculties,

instructors, laboratory instruments etc. Developing countries has finding it hard to keep pace with increased number of enrolments and there is pressure on increasing university budgets. The situation gets clear if we study data related to expenditure done by government on one tertiary student. China is spending around 22 thousand US dollars per tertiary student in year 2011 followed by France which is around 13 thousand US dollars (Figure4.8).

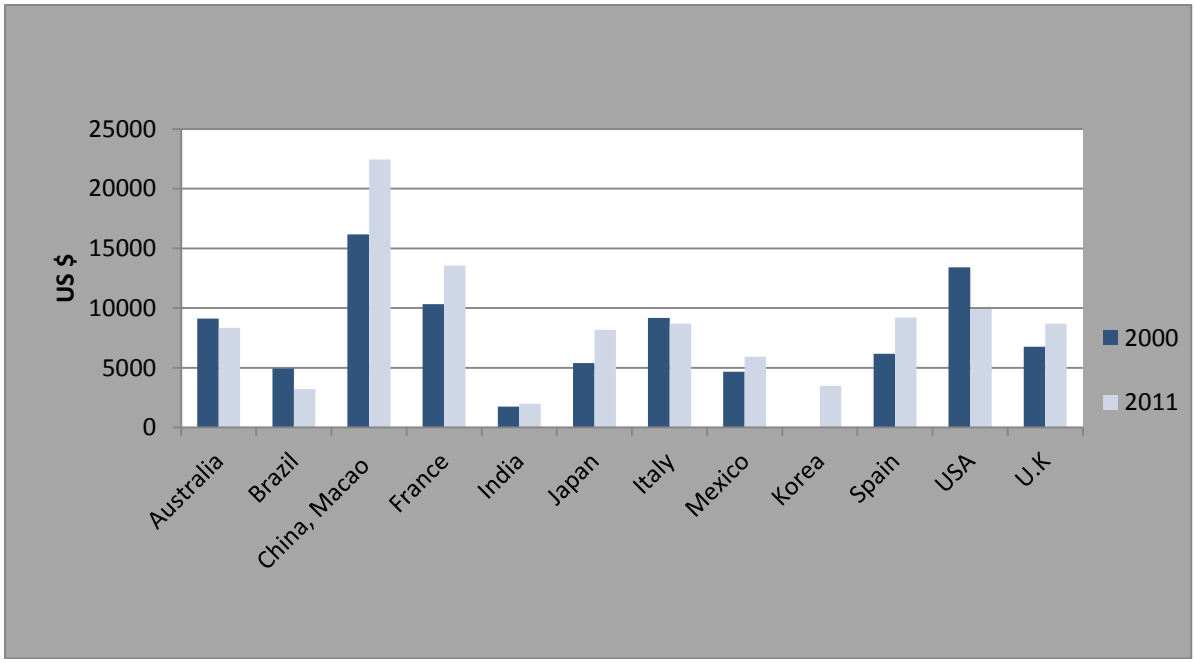

Figure 4.8: Comparison of Expenditure incurred by Government on a tertiary student. Generated from source: UNESCO Institute for Statistics

Average total (current, capital and transfers) general government expenditure per student in tertiary education is expressed in purchasing power parity (PPP) dollars at constant prices of year 2011. This expenditure measures the importance given to higher education in the government spending. USA as in case of GER has reduced its expenditure on tertiary student from US $ 13419 in year 2001 to US $9932 in year 2010 which is high when compared to India where it is around 2000 US dollars. The governments in developing countries are more focused on tertiary education as they think that development of higher education will lead to more growth and development as in most of developed countries. Similarly India is spending around 4% of its government expenditure on tertiary education which is almost equal to Japan's expenditure, but less than China's who spend more than 5% of total expenditure on tertiary education (Figure 4.9).

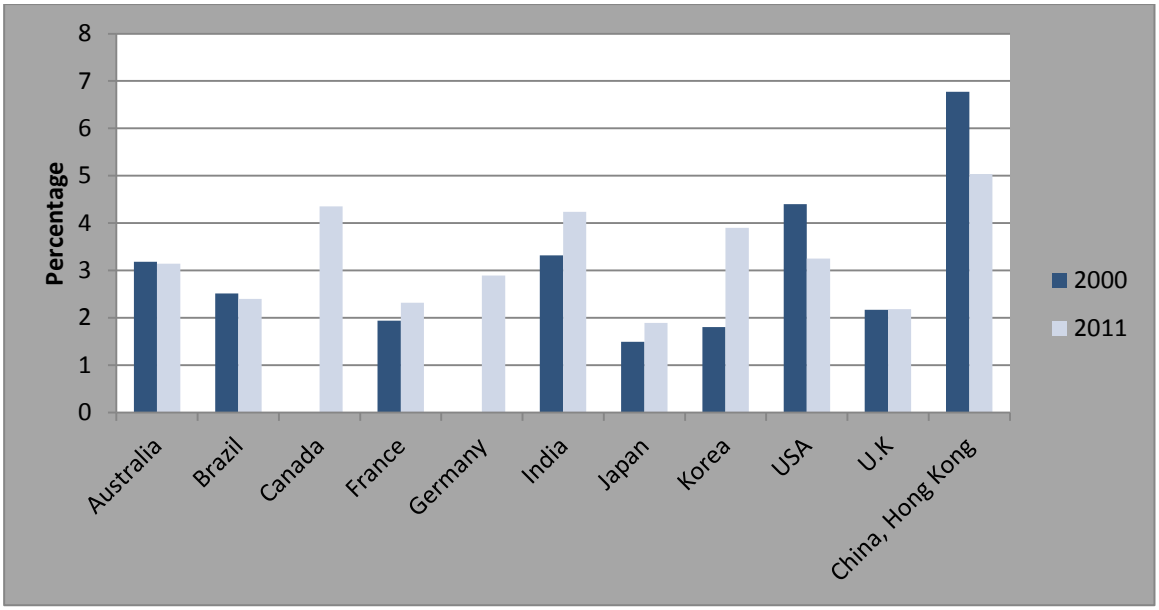

Figure 4.9: Comparison of the share of expenditure incurred on tertiary education from total government expenditures. Generated data from source: UNESCO Institute for Statistics.

4.4.5 Export of high technological products

Technology and technological advances are key components of innovation and economic growth in high-income economies. The knowledge development abilities of economies are progressively more connected with their framework of innovation, both national and local, with HEI considered an element of these frameworks together with close by firms, R&D research facilities and training organizations, and so forth (Cooke, 2005).

Technology has been the real force behind rising standards of living, a role that has grown over the last century given the global trend toward knowledge-based economies. The most dynamic economic sectors in the global marketplace are those that are technology-intensive, and they depend on the capacity to generate, adapt and utilize knowledge as the foundation of productivity growth. This is equally true for the services sector as it is for manufacturing (Grossman & Helpman, 1994; Lichtenberg, 1992; Romer, 1990; Trajtenberg, 1990).

One of the indicators which can reflect the extent of research in growth and development of a country is export of high-technology products. These products require high R&D intensity and come under field of aerospace, computers, pharmaceuticals, scientific instruments, and electrical machinery. The arrangement of HEI inside local innovation frameworks can be imagined as that of ‘knowledge transceivers’, getting knowledge from worldwide sources and transmitting it to more neighboring entities (Cooke, 2005). As the part of HEI in supporting knowledge & information groups and molding innovation societies has been identified and

accepted far and wide, provincial commitments and innovation capacity have ended up as center subjects in HEI mission statements (Smith, 2007).

The triple helix model formalizes this part and perspectives sight institutions of higher education as progressively "entrepreneurial" or "generative" organizations where the overflow of knowledge is the after effect of vital inside redesign encouraging the advancement of infrastructure, like incubator or knowledge parks and additionally human resource improvement initiatives (Etzkowitz & Zhou, 2007). Districts blessed with a more of high-tech firms are likely to be benefitted by HEI's knowledge (Audretsch, Lehmann, & Warning, 2005), with there being a huge relationship between the concentration of high-tech commercial ventures and HEI research in high-innovation fields inside of a vicinity (Culkin & Mallick, 2011).

Figure 4.10 draws a picture of how exports of technology products had taken place from year 2000 to 2012. Exports from China touches 500 billion $ US mark in 2012 from 41.74 billion dollars in span of twelve years depicting high growth rate. Technological Exports in USA had increased since year 2000 to year 2008; from there onwards it continuously declined and in year 2012 it reached below the figures of year 2000. India and Korea had also shown a remarkable progress in this sector of export (Figure4.14).

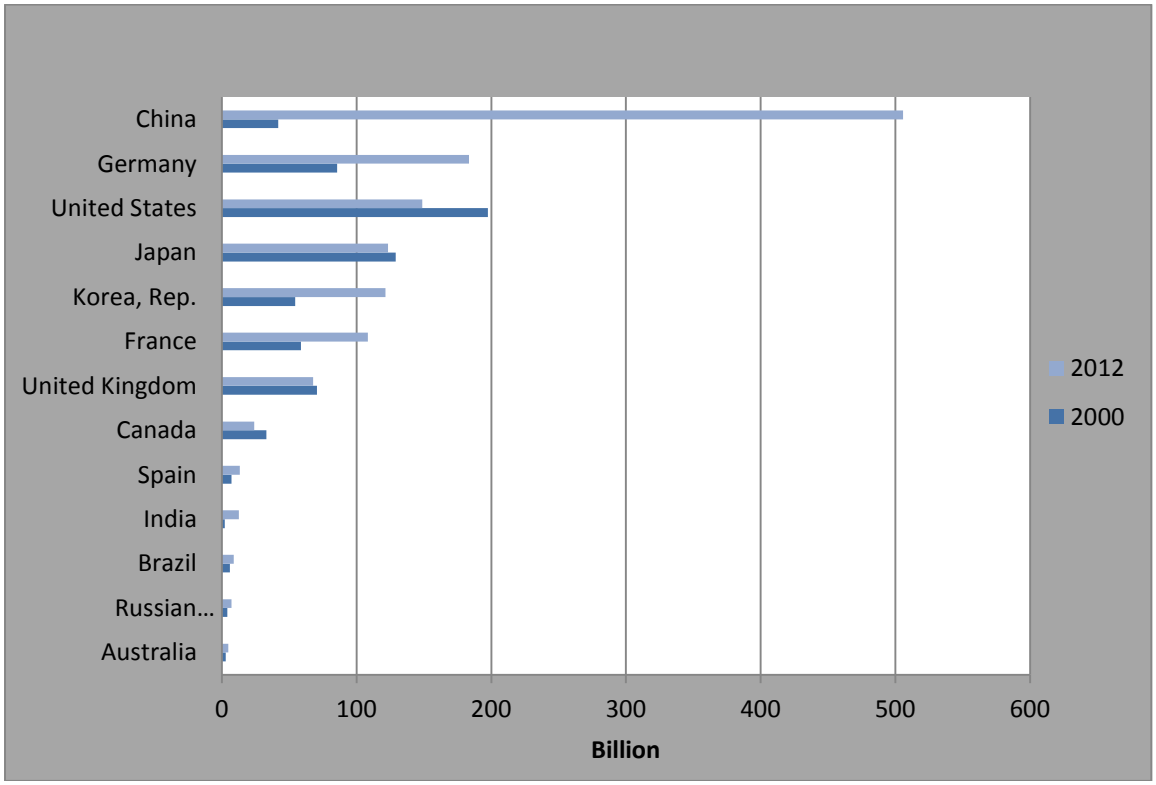

Figure 4.10: Value of high technology goods export by countries in current US dollars. Generated data from source: World Bank.

4.4.6 Research publications

Research publication is a primary instrument to present the findings of any research, contributing to scientific development of the world. It is the best way to share the knowledge and plays an important role in networking by creating lines of communication among scholars working in similar areas of inquiry. Faculties and instructors through this shared knowledge maximize the effect of their delivery by updating current findings in their respective fields (Gopinathan & Lee, 2011). Among the intellectual community publications are seen as a scale of measuring the research quality of individual researchers, institutions and national research system as a whole. A country's scientific development can be traced through the analysis of scientific affiliations with its institutions of higher education and research institutions. Publications act as base for development of new technology, product, process or patent which carries a commercial value supporting economic enhancement.

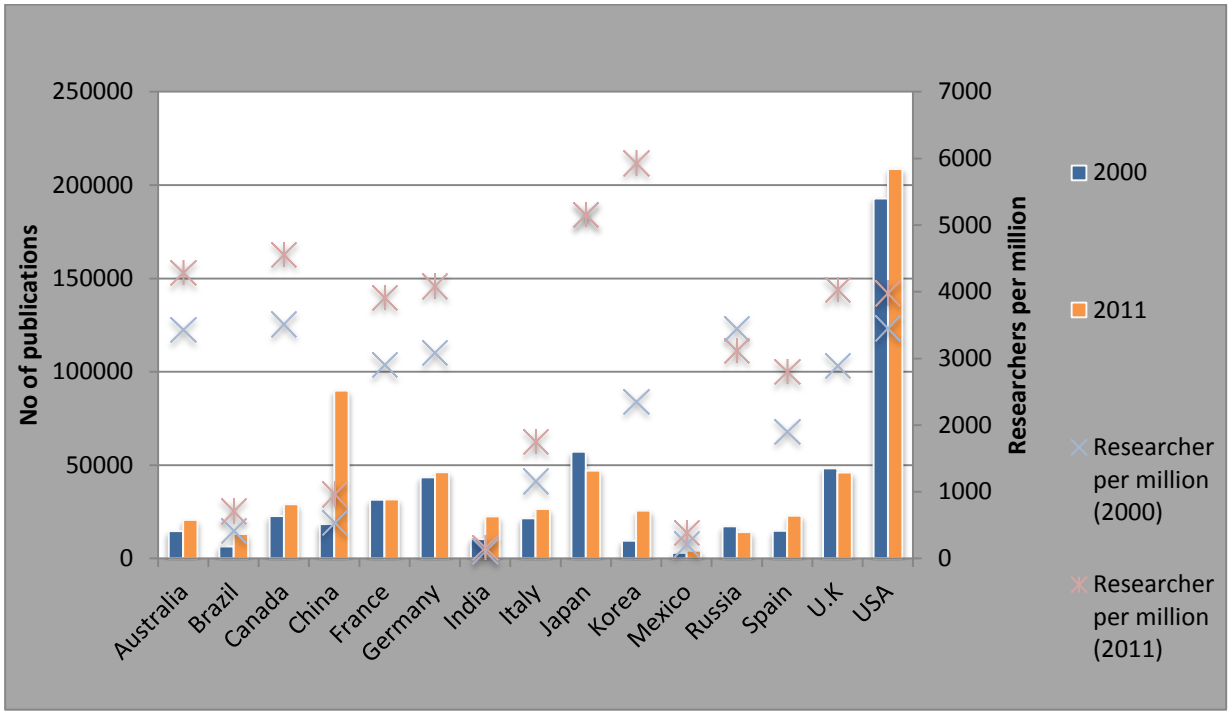

Figure 4.11: Progress status of publications and number of researchers per million for the year 2000 & 2011. Generated data from source: UNESCO Institute for Statistics and World Bank.

Figure 4.11 shows the position of countries related to publications. Research publications shows number of scientific and engineering articles published in the field of physics, biology, chemistry, mathematics, clinical medicine, biomedical research, engineering and technology, and earth and space sciences. United State has published highest number of articles but China has achieved highest growth rate and enhanced the publishing from 18500 articles in year 2000 to 90000 in the year 2011. Compound annual growth rate of publications of China is 15.47%,

which is highest in the world followed by India with 7.38%. Although USA has achieved first position in number of publications but number of publications from last 11 years has increased with Compounded Average Growth Rate (CAGR) of 0.72% which is negligible when compared to other developing countries like China and India.

It is also important to analyze the number of researchers who eventually present number of publications. Figure 4.11 shows the number of researchers per million employed in the country. Researchers in R&D are professionals engaged in the conception or creation of new knowledge, products, processes, methods, or systems and in the management of the projects concerned. Postgraduate PhD students engaged in R&D are also included in the data shown in Figure 4.11. Korea has the highest number of researchers in per millions of people which is around 6000 and India at the lowest with around 160 in the year 2011. This shows the intensity of employment in research domain in two different countries. Developed countries like Australia, Germany, U.K. and USA are around 4000 mark. Korea which has shown a remarkable expansion in its economy and industrial growth can be associated with the popularity of research as a profession among the people.

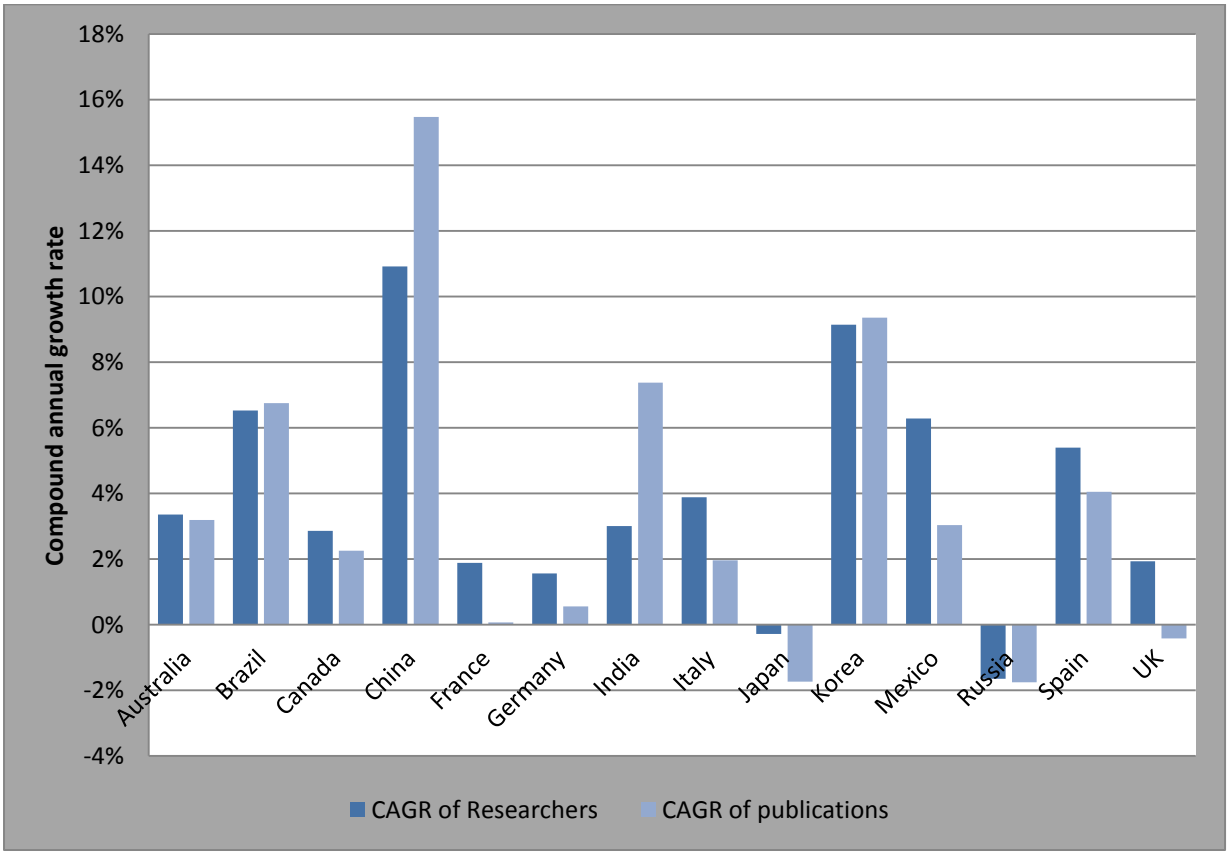

Figure 4.12: Comparison of growth rate of researchers with publications. Generated from source: UNESCO Institute for Statistics

Compound annual growth rate of researchers in Korea from year 2000 to 2011 has also shown significant increase of 9.14% which is marginally short of China's 10.92% (Figure 4.12). If the effectiveness of researchers are judged by number of publication then India has done fairly good in a decade so since its rate of increase in the number of researcher is 3.01% which delivers more than double i.e.7.38% growth rate of publications. China which has observed CAGR of 10.92% in number of researchers only delivered a growth rate of 15.47% for publications.

4.4.7 Employment rate of researchers

To achieve this high volume of technical product development and production a country will need large number of human resource from the field of technical research and development. This human resource mainly includes technicians and researchers. Figure 4.13 & Figure 4.14 show percentage of professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems, as well as in the management of research projects, broken down by the sectors they are employed in (business enterprise, government and higher education organizations) in years 2000 and 2011. Maximum numbers of researchers are employed with business sectors in majority of countries like China, USA, Japan, Korea, and Mexico. Korea has the highest percentage (77%) of total researchers in country employed in business organizations, followed by Japan with 75% and China on third position with 62%. But countries like Australia, Brazil, India, Russia, U.K and U.S.A have more percent of researchers in sector other than business. Hence it would be safe to assume that major contribution in research work in these countries comes from researchers either from education sector or government sector.

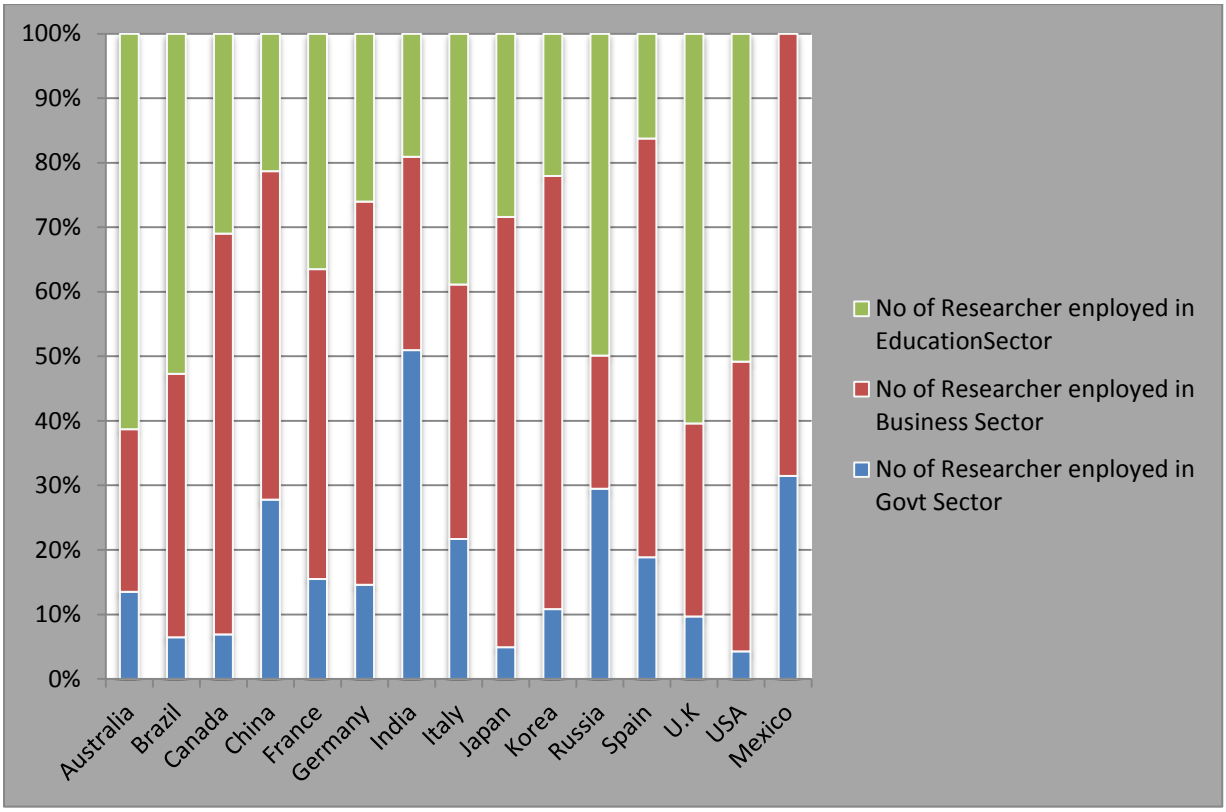

Figure 4.13: Percentage of researchers employed in different sectors of economy in the year 2000. Generated data from source: UNESCO Institute for Statistics.

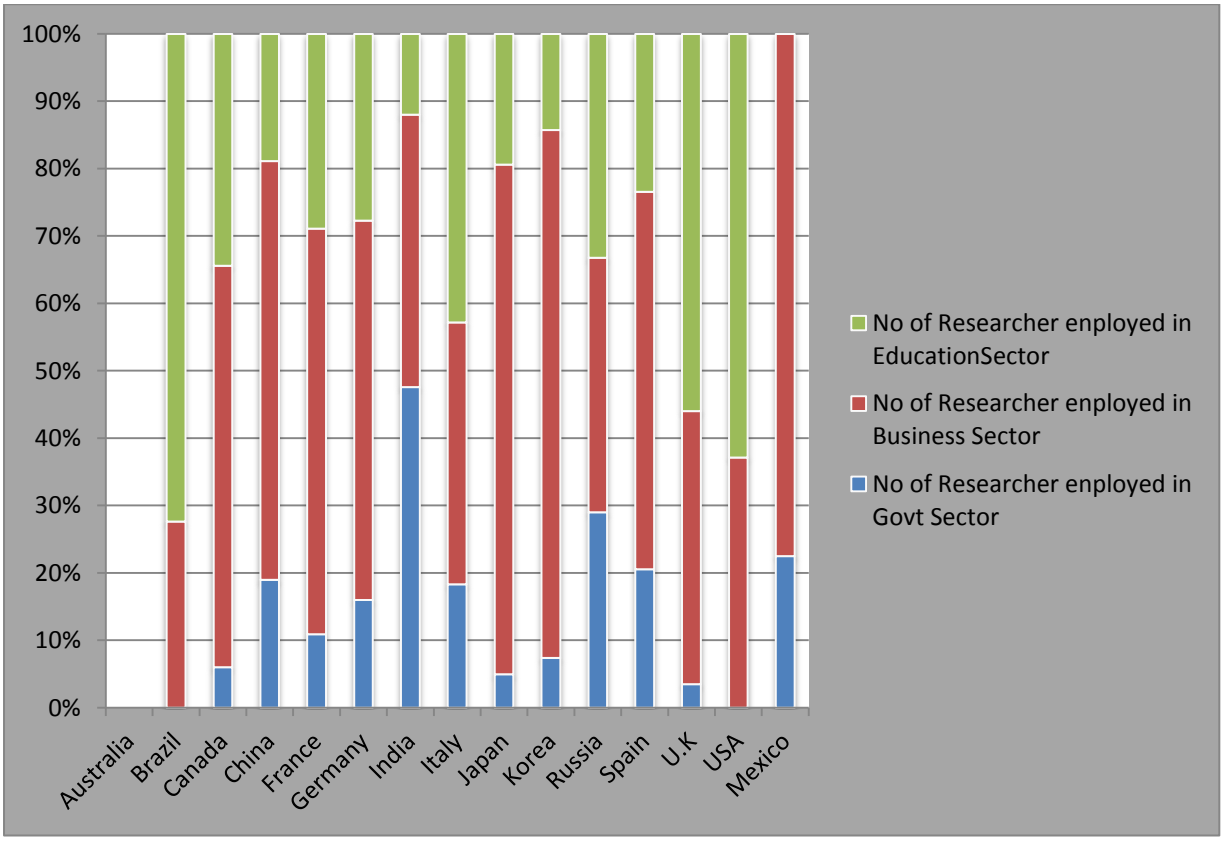

Figure 4.14: Percentage of researchers employed in different sectors of economy in year 2011 or latest. Generated data from source: UNESCO Institute for Statistics.

Taking the case of China whose export of high technology products has grown at a maximum rate since year 2000 has also increased the number of researchers in business sector from 51% to 62% from year 2000 to 2011 respectively. Germany who is on second position in export of technological goods; decreased its business researchers from 60% to 56% in business sector and marginally increased employment of researchers in academic sector from 26% to 28% since year 2000 to 2011.

USA, UK, Italy, Brazil, Russia have more researchers employed in education sector as compared to any other sector in year 2011 or latest; with 68% in Brazil, 60% in USA, 48% in U.K, 41% in Italy, 36% in Russia. This shows that most of the technology is developed and contributed in national economy through academic sector researches. India being the only country where highest number of research force is employed in government sector (51% in year 2000 and 46% in year 2010) but the trend changed slowly showing slight increases of business employed researchers from 30% in year 2000 to 39% in year 2010.

4.4.8 Interaction of industry with academia

Economic experts from the field of economics always consider industry-academic interaction as an important factor in economic development of any country. World has now moved to knowledge economy and economies are steadily becoming interrelated in this changed situation. The quality of commodities of incomprehensible financial quality is knowledge based (Lazzeretti & Tavoletti, 2005). Knowledge and information sharing, technology transfer and exchange of experience and innovation between academic institutes and industries are the need of the hour for growth in this present scenario. The HEI/SME (Small and Medium Enterprises) engagement provide a supportive environment where both the parties can share their knowledge and experiences, search for support and advice and can therefore give support to the business development process (Isaksson et al., 2009).

Figure 4.15 shows the status of cooperation of industry with universities and other higher educational institutes around the globe. The percentage of firms which collaborate with academia is highest in Germany; 17.1% followed by Japan, France and Korea subsequently.

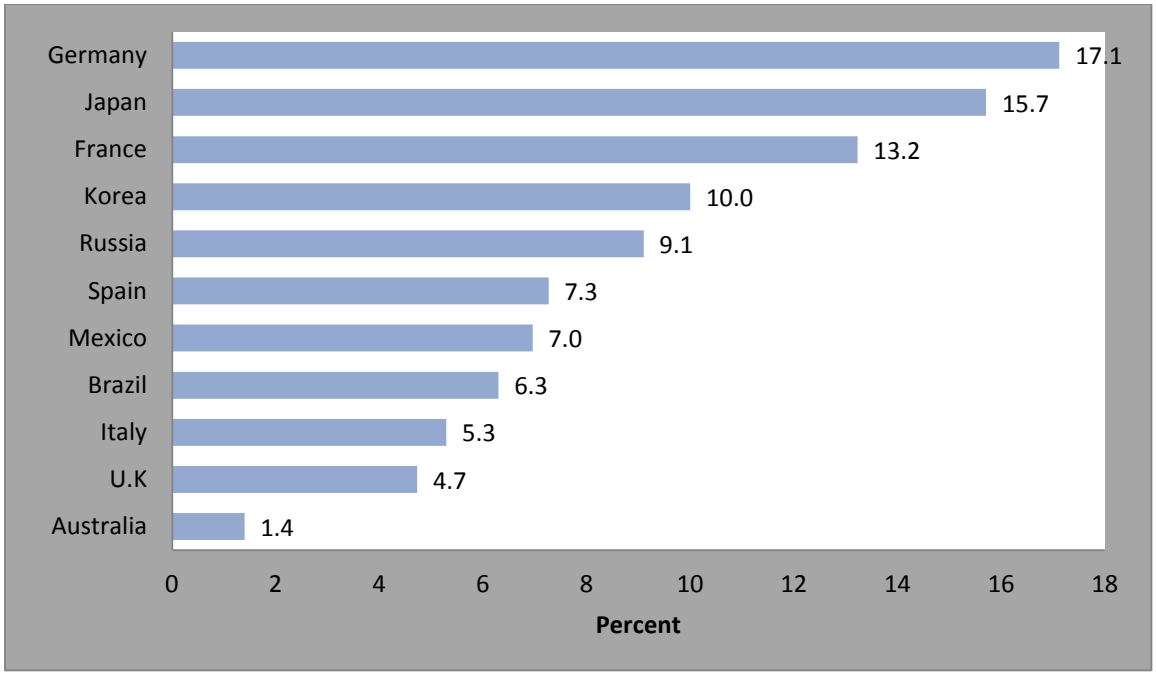

Figure 4.15: Percentage of manufacturing firms that has cooperated with universities or other higher education institutions in year 2011. Generated data from source: World Bank

It is important to point out that top four countries in the figure are known for their excellence in technological products and manufacturing processes. Germany specializes in developing and manufacturing complex industrial goods, primarily capital goods and innovative production technologies. Among the six producers of VW, Audi, BMW, Daimler, Porsche (VW) and Opel (General Motors) Germany, alongside Japan, China and the USA are one of the largest car producers. On the other hand many manufacturing philosophies like lean manufacturing, kaizen etc are developed in Japan since the country has few natural resources and manufacturing is one of its strength. Japan also leads the world in robotics which is considered to be a promising field for future economic growth. The discussion is not completed until we talk about Korea which is the place of major manufacturing giants like LG, Hyundai and Samsung.

The administrative system of HEI is also failed to market their services and their expertise in respective subject matter (Saad, Guermat, & Brodie, 2014). In a study by Dadameah et al.,(2011), it was found that British universities are more focused on gaining academic recognition and little effort is done for collaboration with small scale industries in their region. Most of the Small or Medium Enterprises (SMEs) do not have enough information regarding whom to contact for to begin an association or corporation that may help with their specific necessities and they also do not have knowledge about different academic courses offered at HEI (Dadameah & Costello, 2011).

4.5 Discussion

In spite of confinements and constraints, it is for the most part recognized that HEI can serve as wellsprings of information and knowledge for industry, and that approach activities intended to construct new specialties of knowledge and grow more successful machinery for exchanging HEI based information to neighboring accomplices can possibly support national innovation and economic progress (Benneworth & Charles, 2005). HEI have generally give know-how (aptitudes and capacity) and know why (general standards and rules), however the attention on commercializing information, providing consultancy, going into mutual associations and technology transfer all shows expanding role of academic institutions (Lockett, Wright, & Franklin, 2015). The equilibrium in making and diffusing information represents a developing 'third mission' of HEI where new duties to administration complement existing educating and research undertaking (Etzkowitz & Zhou, 2007). Be that as it may, there is critical level headed discussion encompassing the degree to which HEI ought to concentrate on knowledge creation or knowledge dissemination. Researchers, for example, Johnston (2007) contend that institutes of higher education should concentrate on building R&D capacity, that is knowledge creation, in the event if they need to expand knowledge commercialization, while others contend that cultivating more viable method for knowledge exchange that is knowledge dispersion is more essential (Stoneman & Diederen, 1994).

This study has yielded mixed evidence on the education–growth relationship in the context of 15 countries. Every country has to find its own mix of factors for national development. This document tried to provide further data and ideas relevant to various situations related to higher education prevailing in different countries.

There is a belief of various experts that higher education based research leads to economic development. This is somewhat true as historic data from various developed nations confirms this philosophy. There is considerable evidence that countries which spend more on development of higher education based research they get benefitted from the investment financially, but this linkage can be very complicated.

In this anticipation various developing nations are expanding their base of higher education and doing so in very quick time; they have compromised with the quality which can be observed in Asian continent as well. In many countries most researches are not done at universities but through private sector enterprises.

Another barrier which is present in developing countries is the employability of researchers at doctorate level in private industrial sector, whereas in most of the developed countries fairly large number of researchers is employed with different business sectors.

Countries like Germany, France, and Japan are benefitted with academic research because they are able to develop an environment in their HEI which favors industry interaction. In countries like India where majority of researchers are employed with government institutions; it becomes very difficult to obtain benefits for industrial sector from their research. A huge effort and energy is required to churn the bureaucratic machinery for developing a good and fruitful collaboration with industry which can respond to market demand quickly.

On analyzing the scores of decision determinants, the attributes associated with the higher education could be assessed to a certain limit only. Out of eight determinants taken in this study, six determinants show USA and China (being the highest GDP) in the first five highest ranking ratings. In this sense, the results could support that the HEIs which are actively involved in IP generation, help in their national economic development. This trend is shown by most of the countries we selected for the study. Thus, on our comparison maps, we clearly see that,

- The distribution of determinants among the countries is very mixed.
- The weightage of the dimensions of the pattern followed are different from one country to another.

The results support the idea that the higher education is one of the factors that help in national economic development. The study tries to ascertain the widely speculated notion – 'HEI contributes to the GDP of a country'. Most of the countries have upward trend in IP generation but few counties do not show a clear and consistent relationship. There is considerable evidence that countries which spend more on development of higher education based research they get benefitted from the investment financially, but this linkage can be very complicated.

CHAPTER-5
MODELLING THE FACTORS OF IP CREATION CAPABILITY

5.1 Introduction

This objective of this chapter is to identify and prioritize various factors and enablers of IP creation in Indian HEIs. The study is divided into two sections. In first section various factors are identified which are responsible for IP creation in Indian HEIs. In second section these factors are prioritized using an Interpretive Structural Modeling, which highlights the mutual influences among the factors of IP creation.

The methodology to achieve this objective starts with an extensive literature review of IP creation related issues that are observed in academics. The source of literature covers books, journals, the internet, and reports. Based on this literature review all the factors are summarized in Table 5.1. In order to identify the appropriate factors of IP creation a systematic procedure was adopted and carried out in phased a manner. Firstly extensive literature review using appropriate key words was conducted from various journal databases which includes Science Direct, Emerald, Scopus, Web of Science and EBSCO. The studies which are considered for the literature review were conducted in foreign countries and hence they lack the Indian scenario in general. To include the Indian conditions and to make the study more relevant inputs from Indian HEIs and Industry were also taken for identifying & prioritizing the factors. Chapter 2 of the thesis presents the findings of extant literature review for the critical factors of IP creation capability. Using ISM technique the identified factors are modelled so that priorities for IP creation capabilities can be assigned.

5.2 Critical factors of IP creation

Through extant review of literature, the interrelationships among the 14 identified customer experience factors (See Chapter 2) have been acknowledged. However a short description of these factors and there interrelationships among the factors are given in Table 5.1.

Table 5.1: Summary of factors for IP creation

S.No	Factor	Short Description	References
1.	Availability of IP policy (F1)	The policy document gives the clear guidelines and procedure for executing various activities related to generation of academic IP.	(Baldini et al., 2006), (Geuna & Rossi, 2011)
2.	Technology Transfer Office (F2)	University technology transfer offices (TTOs) are responsible for technology transfer and other aspects of the commercialization of research that takes place in a university. TTOs engage in a variety of commercial activities that are meant to facilitate the process of bringing research developments to market, often acting as a channel between academia and industry and in the process act as enabler for patenting.	(Berco et al., 2001), (Siegel et al., 2004), (Belitski et al., 2018), (Backs et al., 2018)
3.	Government Schemes (F3)	This factor encircles the various schemes and incentives that are provided by the Government of India in form of scholarship or prize is also motivating for academic patenting.	(Rasmussen, 2008), (K Blind et al., 2017)
4.	Industry academia collaboration (F4)	University-industry collaboration can expand the relevance of research carried out in public institutions, foster the commercialization of public R&D outcomes, and increase the patenting activity in HEIs.	(Balconi et al., 2004), (Gulbrandsen & Smeby, 2005), (Grandi & Grimaldi, 2005), , (Belderbos et al., 2014), (Balconi & Laboranti, 2006), (Goel & Göktepe-Hultén, 2013), (Dangayach, Pathak, & Sharma, 2005)
5.	Awareness about IP & filing process (F5)	Lack of awareness academicians and researchers at HEIs hesitate to apply for IP. The procedure to filling patent is complex and includes various steps for applying in Indian patent office.	(Baldini, 2009), (Ama & Fombad, 2011)
6.	Monetary incentives (F6)	This factor includes the personal benefits in monetary form. These benefits may be cash prizes provided for filling patents or royalty sharing for leasing the IP.	(Veer & Jell, 2012), (Lach & Schankerman, 2008), (Lam, 2011), (Stephan et al., 2007),

			(Goethner et al., 2012). (Sauermann & Cohen, 2010), (Friedman & Silberman, 2003)
7.	Prestige incentives (F7)	Academicians & scientists are strongly motivated for patenting their research, by the recognition and prestige bestowed by their professional peers. Previously publications are considered to be a respectable entity for researcher which is overshadowed by patent.	(Baldini, 2005), (Lam, 2011), (Göktepe-Hulten & Mahagaonkar, 2010), (Sauermann & Cohen, 2010)
8.	Work Load (F8)	Work load is an important factor for faculty members affecting patent creation. The research efficiency of faculty members degrades with increasing administrative and teaching work after a specific limit. The balance between the responsibilities of three type of job is a key to research output in term of patent.	(Ama & Fombad, 2011), (Baldini et al., 2007)
9.	Salary (F9)	Underpaid human resource in any organization does not produce good results. Good salary structure is the prime factor for job satisfaction. Innovation is the work of creativity; an unsatisfied researcher will be less motivated for doing quality research. Higher wages promotes creativity which results in IP creation.	(Baldini et al., 2007) , (Edvinsson & Sullivan, 1996)
10.	Autonomy (F10)	Research autonomy given to researcher HEIs gives them freedom of conducting research in the domain which fascinates them. Inter-disciplinary research is the result of higher autonomy given to research practices which results in patent generation.	(Baldini, et al., 2014), (Azoulay et al., 2007)
11.	Research facilities (F11)	For developing new technology a research facility with high end equipment and latest technology is required. Research facilities in Indian HEIs institutions are acting as a barrier in generation of IP as they are ill equipped and outdated.	(Owen-Smith, J., & Powell, 2001), (Carayol, 2007), (Agrawal & Henderson, 2002), (Zi & Blind, 2015)
12.	Funding (F12)	Financial assistance obtained from different sources encourage	(Azagra et al., 2006), (Carayol,

		researchers to patent their research. The monetary assistance could be used to cover research expenditure, patent fees or charges of drafting patent application. The research project funds could also be utilized for patenting if acceptable by sponsoring agency.	& Matt, 2004), (Elfenbein, 2007), (Baldini, 2011). (Carayol, 2007), (Landry et al., 2007), (Barrio Castro & García, 2009)
13.	Technology Incubator Facility (F13)	Technology incubators are the programs designed to accelerate the successful development of entrepreneurial companies through an array of business support resources and services, developed by higher academic institution. Most of the incubators assist their incubatees in safeguarding of core business technology though obtaining patents.	(Baldini, et al., 2007), (Friedman, & Silberman, 2003). (Thursby & Kemp, 2002), (Rubin et al., 2015), (Fini et al., 2009), (Stal, Andreassi, & Fujino, 2016).
14.	Subscription of Journals/Patent database (F14)	Another factor which was on low priority was the access and subscription to various journals and patent database. In case of database the academicians do not faces much problem in accessing the patent database since major patent database like those maintained by USPTO and EPO provides free access and provide advance searching tools used for patent search. But in case of journal subscription many participants from private institutes in FGDs are having problem in accessing reputed journal since their institutes lack funds and have very less journal subscriptions.	(Belderbos et al., 2014), (Balconi & Laboranti, 2006), (Goel & Göktepe-Hultén, 2013)
15.	Education/Training (F15)	The innovation culture in the organizations leads to technological development. The institute which provides training of practical intellectual property courses is actively involved in patent generation. Different courses on IP in academic programs also help in development of conducive environment for nurturing innovation.	(Baldini, et al., 2007), (Dangayach et al., 2005), (Kolympiris & Klein, 2017). (Zucker et al., 1998). (Sellenthin, 2009), (D'este & Perkmann, 2011), (Gonzales-Brambila & Veloso, 2007),

			(Meyer, 2006)
16.	Carrier Advancement Scheme (F16)	For maintaining quality in higher education UGC has issued regulations for promoting and appointments of teachers and other academic staff in HEIs. For this reason Career Advancement Scheme was introduced in most of the Indian HEIs. The faculty members for promotion have to fulfill the eligibility and performance criteria laid down as API (Academic Performance Indicators) score in PBAS (Performance Based Appraisal System). For academic higher position/grade faculty members require additional points on API scale. As patent bears high points faculty at HEIs are compelled to generate IP for promotion and thus a major factor responsible for IP development especially by mid-level faculties as a means to support professional and career goals.	(Göktepe, et al., 2010), (Moutinho, et al., 2007), (Knut Blind et al., 2018)
17.	Geographical location (F17)	The location of HEIs in the region has some relation with IP creation & commercial activities. Those institutes which are located near to industrial areas like specialized economic zone (SEZ) or near capital regions shows higher IP related accomplishments.	(Carayol, et al., 2004), (Gulbrandsen, et al., 2005), (Friedman, & Silberman, 2003), (Fuentes & Dutrénit, 2016)

5.3 Introduction to ISM

ISM is a methodology that helps on individual level as well as of cluster / group level for solving the multifaceted problems in a well-thought-out arrangement. Conferring to Sage (1977), "with the help of ISM process the ambiguous and inadequately articulated mental models of the systems can be transformed into the well-defined visible models, used to serve different purposes. It helps to identify the influence of different variables on each other and imposes the order and direction on the complex relationship among variables of a system".

ISM methodology is used extensively to find the specific behavior among the variables of any complex problem (Sushil, Qadri, & Kumar, 2012; Sushil, 2012). The term "complex" is being referred because the problems are not a single variable entity; instead it is defined by many

variables. Due to the presence of these numbers of variables, the effect of one variable on other variables is not an easy task to find.

5.3.1 Steps followed for ISM

Steps that are followed to perform ISM methodology is defined in the various literature (Raghuvanshi, Ghosh, Agrawal, & Gupta, 2017), Mathiyazhagan, et al. (2013), Thakkar, et al., (2008). The steps which are followed by this study are shown in Figure 5.1 which is the process adopted by (Attri, et al., 2013).

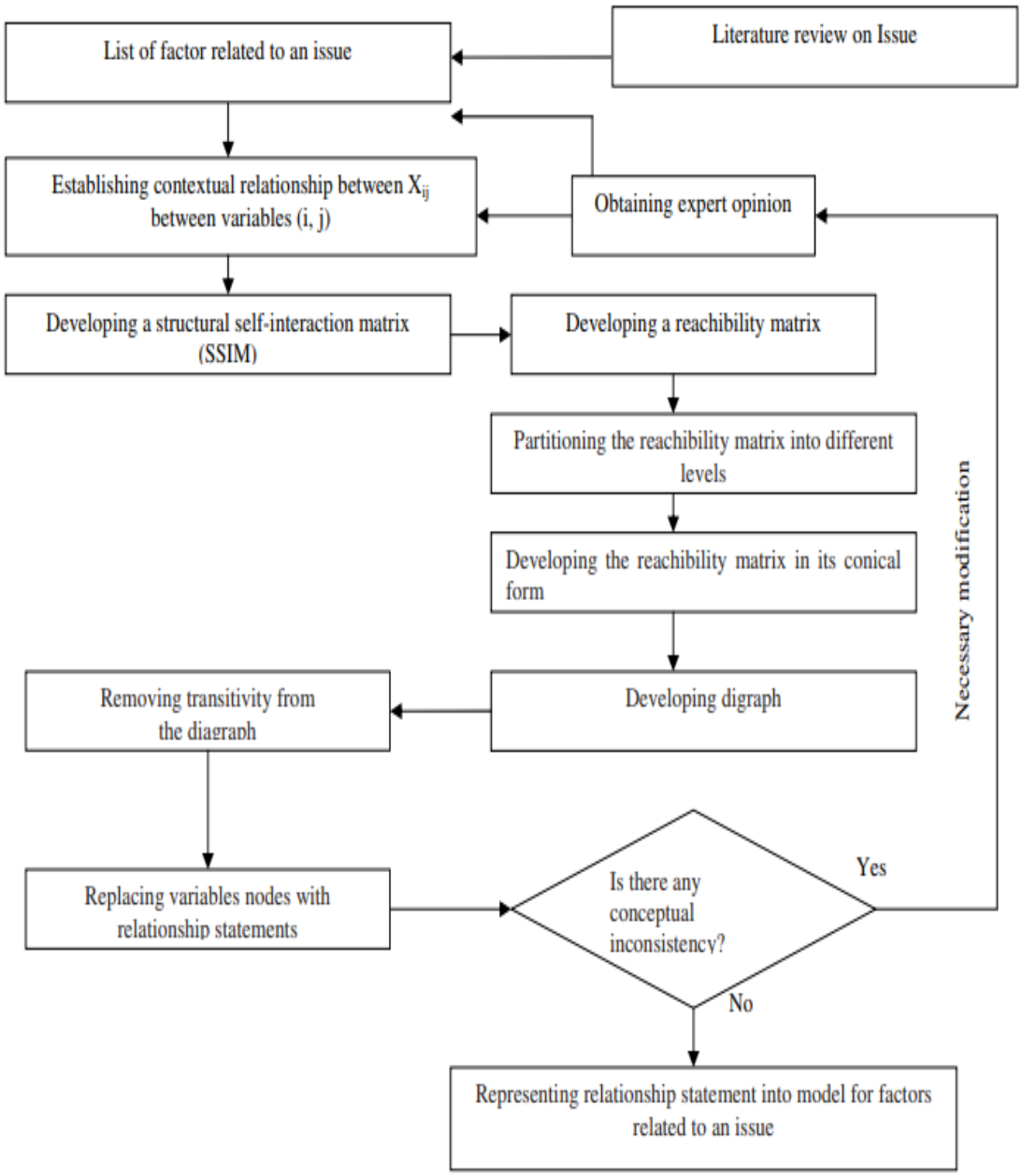

Figure 5.1: ISM Process adopted by Attri, et al., (2013)

The ISM arrange various directly and indirectly related variables that influence the framework, under observation, in a complete systematic model (Mathiyazhagan, et al., 2013). The excellence of ISM is that it depicts the organization of a difficult case using diagram and words. The ISM can be applied to any setup to know the relationship among its different components (Thakkar, et al., 2008).
The different steps involved while developing the ISM model are as follow:

Step 1: Find and recognize the important factors of system. Surveys otherwise literature review would be helpful in finding them.

Step 2: Establishment of interrelationship between the identified factors.

Step 3: Development of Structural Self-Interaction Matrix which gives description of one to one relationship between two factors.

Step 4: Next step is to construct Reachability Matrix. The intermittent steps include formation of binary initial reachability matrix which contains transitivity, which is removed to yield Reachability Matrix. An example of a transitive law is "If a is equal to b and b is equal to c, then a is equal to c."

Step 5: Once the reachability matrix is developed it is further classified into various multi-levels.

Step 6: The transitivity links are taken away considering the reachability matrix relationships, to from directed graph (di graph).

Step 7: Conversion of resultant digraph into ISM based model on replacement of variable nodes with statements.

Step 8: Revision of ISM model developed to check for conceptual inconsistencies and doing necessary modifications.

5.3.2 Structural Self-Interaction Matrix (SSIM)

A contextual relationship is developed between the different enablers in a matrix form. This matrix is known as Structural Self-Interaction Matrix (SSIM). The relationship between two IPVs (i & j) is directional in nature. To develop SSIM, four symbols are used to represent the relationship among the variables "i" &"j".

- "V" is used for showing the direction of relation link from "i" to "j".

- “A” is used for showing the direction of relation link from “j” to “i”.
- “X” is used for showing the bi-directional to & fro relationship between “i” & “j”.
- “O” is used if “i” and “j” are unrelated to each other.

The SSIM is converted into reachability matrix by applying following rules:

• if (i, j) value in the SSIM is “V”, (i, j) value in the reachability matrix will be 1 and (j, i) value will be 0

• if (i, j) value in the SSIM is “A”, (i, j) value in the reachability matrix will be 0 and (j, i) value will be 1

• if (i, j) value in the SSIM is “X”, (i, j) value in the reachability matrix will be 1 and (j, i) value will also be 1

• if (i, j) value in the SSIM is “O”, (i, j) value in the reachability matrix will be 0 and (j, i) value will also be 0.

Following the specified rules, the SSIM was developed with 17 factors (Table 5.2) which is used for further analysis.

Table 5.2: Structural Self-Interaction Matrix (SSIM)

	F17	F16	F15	F 14	F 13	F 12	F 11	F 10	F 9	F 8	F 7	F 6	F5	F4	F3	F2	F1
F1	O	V	V	O	V	V	X	X	O	O	O	V	A	V	V	V	
F2	O	O	O	O	A	A	O	O	O	O	O	O	O	O	O		
F3	O	V	O	O	V	O	O	O	O	O	O	O	A	O			
F4	V	X	A	O	X	V	X	A	V	V	V	V	A				
F5	V	V	V	O	V	V	V	V	V	O	O	V					
F6	V	O	A	O	A	A	O	O	O	O	O						
F7	V	V	A	O	A	A	O	O	O	O							
F8	V	V	O	O	A	O	O	A	V								
F9	V	A	A	O	A	A	O	A									
F10	V	V	V	V	V	O	V										
F11	V	O	V	O	V	X											
F12	O	O	V	V	V												
F13	O	O	V	O													
F14	O	O	V														
F15	V	V															
F16	V																
F17																	

5.3.3 Reachability matrix

The SSIM is converted into a binary matrix with the use of numbers 0 and 1 .Steps followed to form reachability matrix are:

1. If (i, j) entry in the SSIM is V, then the (i, j) entry in the Initial Reachability Matrix (IRM) becomes 1 and (j, i) entry becomes 0.
2. If the (i, j) entry in the SSIM is A, then the (i, j) entry in the Initial Reachability Matrix (IRM) become 0 and the (j, i) entry becomes 1.
3. If the (i, j) entry in the SSIM is X, then the (i, j) entry in the Initial Reachability Matrix (IRM) becomes 1 and the (j, i) also becomes 1.
4. If the (i, j) entry in the SSIM is O, then the (i, j) entry in the Initial Reachability Matrix (IRM) becomes 0 and the (j, i) also becomes 0.

SSIM was converted to Reachability matrix by substituting “V”, “A”, “X” and “O” by 0 and 1 (Table 5.3).The first table developed is called Initial Reachability Matrix.

Table 5.3: Initial Reachability Matrix (IRM)

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17
F1	1	1	1	1	0	1	0	0	0	1	1	1	1	0	1	1	0
F2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F3	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0
F4	0	0	0	1	0	1	1	1	1	0	1	1	1	0	0	1	1
F5	1	0	1	1	1	1	0	0	1	1	1	1	1	0	1	1	1
F6	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
F7	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1
F8	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1
F9	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
F10	1	0	0	1	0	0	0	1	1	1	1	0	1	1	1	1	1
F11	1	0	0	1	0	0	0	0	0	0	1	1	1	0	1	0	1
F12	0	1	0	0	0	1	1	0	1	0	1	1	1	1	1	0	0
F13	0	1	0	1	0	1	1	1	1	0	0	0	1	0	1	0	0
F14	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
F15	0	0	0	1	0	1	1	0	1	0	0	0	0	0	1	1	1
F16	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	1
F17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

The IRM may contain the transitivity and it is removed to obtain final reachability matrix. (FRM) is obtained after checking for transitivity and removing transitivity if there is any, transitivity effects in IRM should be considered and it is to be removed. To remove the transitivity in Table 5.3, we need to follow these steps:

1. Locate for entry "0" in IRM.
2. Spot and detect the entry for any possible transitivity following the rule "if **A** leads to **B** is 1 and **B** leads to **C** is 1 this implies **A** leads to **C** is 1".
3. Once the transitivity is spotted than substitute the entry "0" with entry "1*".

The final reachability matrix with driving and dependence power is formed and shown in Table 5.4 which also highlights the driving power and dependence power of each variable. The row summation of each enabler gives the driving power of that enabler i.e. the number of other enablers it drives while the column summation of every enabler gives the dependency of each enabler i.e. the number of other enablers it depends upon. "MICMAC" study will consider these powers in formation of the ISM model discussed in the next section.

Table 5.4: Final reachability matrix with driving and dependence power

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	**Driving power (Y)**
F1	1	1	1	1	0	1	1*	1*	1*	1	1	1	1	1*	1	1	1*	**16**
F2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
F3	0	1*	1	1*	0	1*	1*	1*	1*	0	0	0	1	0	1*	1	1*	**11**
F4	1*	1*	0	1	0	1	1	1	1	0	1	1	1	1*	1*	1	1	**14**
F5	1	1*	1	1	1	1	1*	1*	1	1	1	1	1	1*	1	1	1	**17**
F6	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	**2**
F7	0	0	0	1*	0	0	1	0	1*	0	0	0	0	0	0	1	1	**5**
F8	0	0	0	1*	0	0	0	1	1	0	0	0	0	0	0	1	1	**5**
F9	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	**2**
F10	1	1*	0	1	0	1*	1*	1	1	1	1	1*	1	1	1	1	1	**15**
F11	1	1*	1*	1	0	1*	1*	1*	1*	1*	1	1	1	1*	1	1*	1	**16**
F12	1*	1	0	1*	0	1	1	1*	1	0	1	1	1	1	1	1*	1*	**14**
F13	0	1	0	1	0	1	1	1	1	0	1*	1*	1	0	1	0	1*	**11**
F14	0	0	0	1*	0	1*	1*	0	1*	0	0	0	0	1	1	1*	1*	**8**
F15	0	0	0	1	0	1	1	1*	1	0	1*	1*	1*	0	1	1	1	**11**
F16	0	0	0	1	0	1*	1*	1*	1	0	1*	1*	1*	0	0	1	1	**10**
F17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	**1**
Dependence power (X)	**6**	**9**	**4**	**13**	**1**	**12**	**12**	**11**	**14**	**4**	**9**	**9**	**10**	**7**	**10**	**12**	**16**	

5.3.4 Level partition

The reachability set and antecedent set for each factor are obtained from the final reachability matrix. The reachability set for a particular factor consists of the factor itself and the other factor, which it may help to achieve while the antecedent set consists of the factor itself and the other factors, which may help to achieve it. Intersection set is then derived for each factor. It is constructed by the factors which exists in reachability as well as antecedent set. Once the factors of both reachability and intersection set are similar, than that level was assigned the upper place in the hierarchy model. We need to repeat this step until the last level of the model is recognized.

Subsequently, an intersection set was obtained from the intersection of the variables present in both reachability and antecedent set. If the variables of reachability and intersection set match with each other than that level was assigned the top position in the hierarchy model of ISM. This process was repeated until the lowest level of the hierarchy model was not identified. In first iteration it could be seen that both TTO (F2) and geographic location (F17) has been identified as the first level and placed at the top of the hierarchy model. Outcome of total iterations that are carried out to form the ISM model are depicted from Table. 5.5 to Table 5.7.

Table 5.5: Iteration 1

Enablers	Reachability set	Antecedent set	Intersection set	Level
F1	1,2,3,4,6,7,8,9,10,11,12,13,14,15,16,17	1,4,5,10,11,12		
F2	~~2~~	~~1,2,3,4,5,10,11,12,13~~	~~2~~	I
F3	2,3,4,6,7,8,9,13,15,16,17	1,3,5,11		
F4	1,2,4,6,7,8,9,11,12,13,14,15,16,17	1,3,4,5,7,8,10,11,12,13,14,15,16		
F5	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17	5		
F6	6,17	1,3,4,5,6,10,11,12,13,14,15,16		
F7	4,7,9,16,17	1,3,4,5,7,10,11,12,13,14,15,16		
F8	4,8,9,16,17	1,3,4,5,8,10,11,12,13,15,16		
F9	9,17	1,3,4,5,7,8, 9,10,11,12,13,14,15,16		
F10	1,2,4,6,7,8,9,10,11,12,13,14,15,16,17	1,5,10,11		
F11	1,2,3,4,6,7,8,9,10,11,12,13,14,15,16,17	1,4,5,10,11,12,13,15,16		
F12	1,2,4,6,7,8,9,11,12,13,14,15,16,17	1,4,5,10,11,12,13,15,16		
F13	2,4,6,7,8,9,11,12,13,15,17	1,3,4,5,10,11,12,13,15,16		
F14	4,6,7,9,14,15,16,17	1,4,5,10,11,12,14		
F15	4,6,7,8,9,11,12,13,15,16,17	1,3,4,5,10,11,12,13,14,15		
F16	4,6,7,8,9,11,12,13,16,17	1,3,4,5,7,8, 10,11,12,14,15,16		
F17	~~17~~	~~1,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17~~	~~17~~	I

Table 5.6: Iteration 2

Enablers	Reachability set	Antecedent set	Intersection set	Level
F1	1, ,3,4,6,7,8,9,10,11,12,13,14,15,16	1,4,5,10,11,12		
F3	3,4,6,7,8,9,13,15,16	1,3,5,11		
F4	1,4,6,7,8,9,11,12,13,14,15,16	1,3,4,5,7,8,10,11,12,13,14,15,16		
F5	1,3,4,5,6,7,8,9,10,11,12,13,14,15,16	5		
F6	~~6~~	~~1,3,4,5,6,10,11,12,13,14,15,16~~	~~6~~	II
F7	4,7,9,16	1,3,4,5,7,10,11,12,13,14,15,16		
F8	4,8,9,16	1,3,4,5,8,10,11,12,13,15,16		
F9	~~9~~	~~1,3,4,5,7,8, 9,10,11,12,13,14,15,16~~	~~9~~	II
F10	1,4,6,7,8,9,10,11,12,13,14,15,16	1,5,10,11		
F11	1,3,4,6,7,8,9,10,11,12,13,14,15,16	1,4,5,10,11,12,13,15,16		
F12	1,4,6,7,8,9,11,12,13,14,15,16	1,4,5,10,11,12,13,15,16		
F13	4,6,7,8,9,11,12,13,15	1,3,4,5,10,11,12,13,15,16		
F14	4,6,7,9,14,15,16	1,4,5,10,11,12,14		
F15	4,6,7,8,9,11,12,13,15,16	1,3,4,5,10,11,12,13,14,15		
F16	4,6,7,8,9,11,12,13,16	1,3,4,5,7,8, 10,11,12,14,15,16		

Similarly after performing three more iterations, the final level of IP variables obtained is given in Table5.7

Table 5.7: Level of IP variables/factors

Enablers	Reachability set	Antecedent set	Intersection set	Level
F1	1,2,3,4,6,7,8,9,10,11,12,13,14,15,16,17	1,4,5,10,11,12		V
F3	2	1,2,3,4,5,10,11,12,13		I
F4	2,3,4,6,7,8,9,13,15,16,17	1,3,5,11		IV
F5	1,2,4,6,7,8,9,11,12,13,14,15,16,17	1,3,4,5,7,8,10,11,12,13,14,15,16		III
F7	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17	5		V
F8	6,17	1,3,4,5,6,10,11,12,13,14,15,16		II
F10	4,7,9,16,17	1,3,4,5,7,10,11,12,13,14,15,16		III
F11	4,8,9,16,17	1,3,4,5,8,10,11,12,13,15,16		III
F12	9,17	1,3,4,5,7,8, 9,10,11,12,13,14,15,16		II
F13	1,2,4,6,7,8,9,10,11,12,13,14,15,16,17	1,5,10,11		IV
F14	1,2,3,4,6,7,8,9,10,11,12,13,14,15,16,17	1,4,5,10,11,12,13,15,16		IV
F15	1,2,4,6,7,8,9,11,12,13,14,15,16,17	1,4,5,10,11,12,13,15,16		IV
F16	2,4,6,7,8,9,11,12,13,15,17	1,3,4,5,10,11,12,13,15,16		IV
F17	4,6,7,9,14,15,16,17	1,4,5,10,11,12,14		IV

5.3.5 Canonical matrix

The level of variables which were achieved from the partitioned reachability matrix was transformed into another type of matrix known as canonical matrix. In this matrix, the variables were placed according to their levels and the variables which possessed the same level were clubbed together. It is given in Table 5.8.

Table 5.8: Canonical Matrix

	F2	F17	F6	F9	F4	F7	F8	F3	F5	F10	F11	F12	F13	F14	F15	F16	F1	Driving power (Y)
F2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
F17	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
F6	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
F9	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2
F4	1*	1	1	1	1	1	1	0	0	0	1	1	1	1*	1*	1	1*	14
F7	0	1	0	1*	1*	1	0	0	0	0	0	0	0	0	0	1	0	5
F8	0	1	0	1	1*	0	1	0	0	0	0	0	0	0	0	1	0	4
F3	1*	1*	1*	1*	1*	1*	1*	1	0	0	0	0	1	0	1*	1	0	11
F5	1*	1	1	1	1	1*	1*	1	1	1	1	1	1	1*	1	1	1	17
F10	1*	1	1*	1	1	1*	1	0	0	1	1	1*	1	1	1	1	1	15
F11	1*	1	1*	1*	1	1*	1*	1*	0	1*	1	1	1	1*	1	1*	1	16
F12	1	1*	1	1	1*	1	1*	0	0	0	1	1	1	1	1	1*	1*	14
F13	1	1*	1	1	1	1	1	0	0	0	1*	1*	1	0	1	0	0	11
F14	0	1*	1*	1*	1*	1*	0	0	0	0	0	0	0	1	1	1*	0	8
F15	0	1	1	1	1	1	1*	0	0	0	1*	1*	1*	0	1	1	0	11
F16	0	1	1*	1	1	1*	1*	0	0	0	1*	1*	1*	0	0	1	0	10
F1	1	1*	1	1*	1	1*	1*	1	0	1	1	1	1	1*	1	1	1	16
Dependence power (X)	4	11	7	9	8	5	4	3	1	3	6	5	8	3	8	9	4	

5.3.6 Development of ISM based model

Relationships among various factors were identified from the conical matrix which is obtained as per the levels of factors, the model will show how the required objective is achieved at various levels and the arrow at various factors indicating relevance at different levels, the levels that were identified were used in building the diagraph and later to build the final model of ISM (Figure 5.2).

The conical matrix is constructed following the levels of critical factors. This matrix shows the interrelationship between the factors of the model. It is generated by nodes and lines of edges of the diagraph. The top level factors are positioned at the top of the digraph and second level factor is placed at second position and so on to later build on the final ISM model.

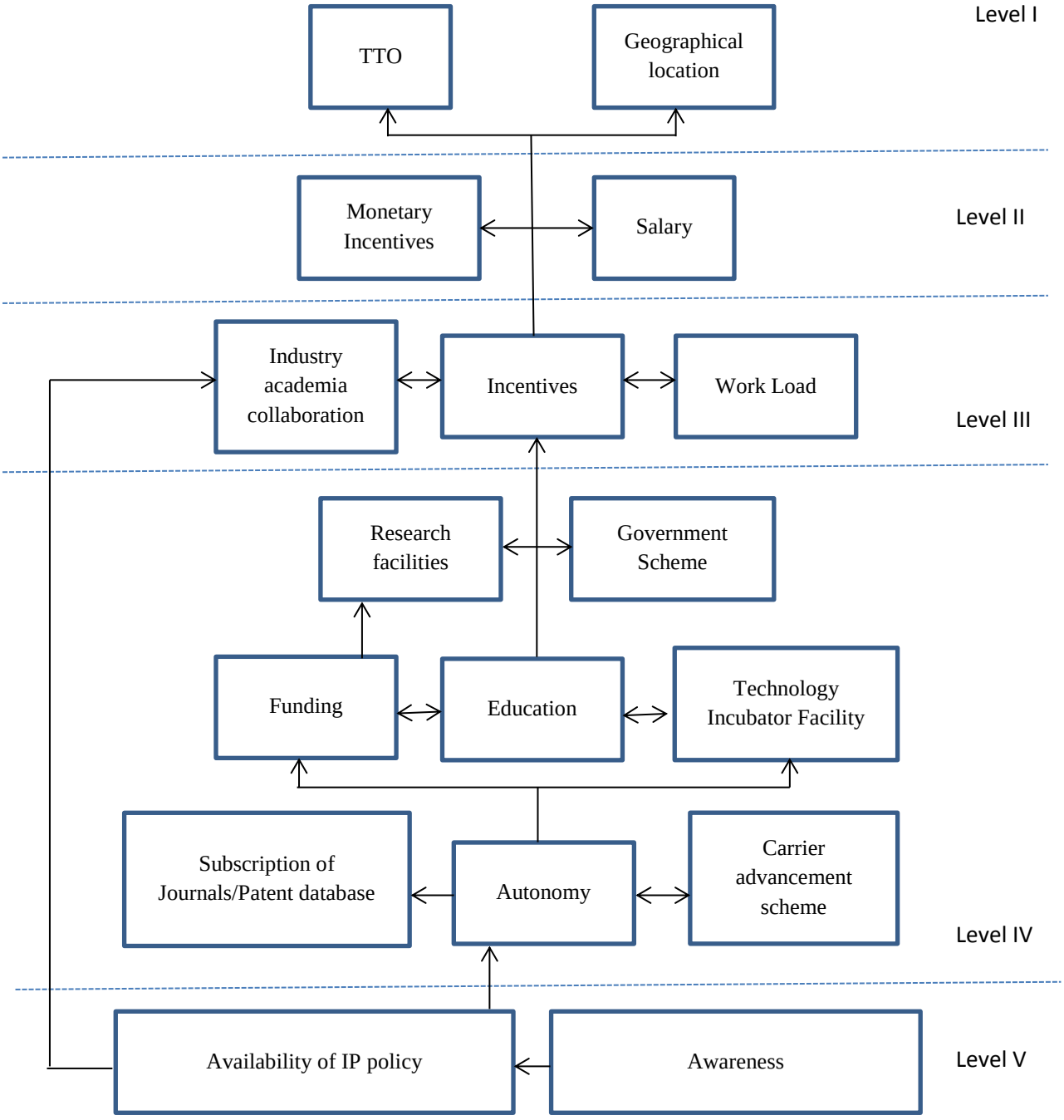

Figure 5.2: ISM based model

5.4 MICMAC Analysis

An indirect classification is done for critically analyzing the scope of each factor identified using MICMAC analysis. It is based on the on multiplication properties of matrices (Thakkar et al., 2008). This method is followed to examine the driving and dependence power of the factors. Regarding this study the driving and dependence power is shown in Table 5.8. The last column on the right hand side of table contains the addition of the rows to make the driving

power of each factor. The last bottom row contains the dependence power which is the total of column of each individual factor. The classification of these powers is shown in Figure 5.3. The clusters of factors are given in four category viz Autonomous, Dependent, Linkage and Independent factors. These are discussed as below:

Cluster 1-The Cluster 1 is formed of the autonomous factors which are having weak driving as well as low dependence power. Due to such low power, factors in this cluster are not well connected and shows an isolated relationship. In our case factors F14 and F2 are plotted in this cluster on the basis of power calculated in Table 5.8.

Cluster 2-Second Cluster categorizes the variables having weak driving power but strong dependence power. Factor namely F6, F7, F8, F9 and F17 are classified under II cluster based on their driving and dependence power.

Cluster 3-The factors of this third Cluster possesses high driving power as well as high dependence power. Because of this characteristic these factors are opposite to the autonomous factors in Cluster 1. Factor F4, F13, F15, F16 are categorized under this cluster.

Cluster 4-This is the fourth Cluster of the MICMAC analysis. The factors of this cluster are the driver of the model since they depict high driving power and low dependence power. In this study Cluster IV has the highest numbers (six) of factors which are F1, F3, F5, F10, F11, and F12.

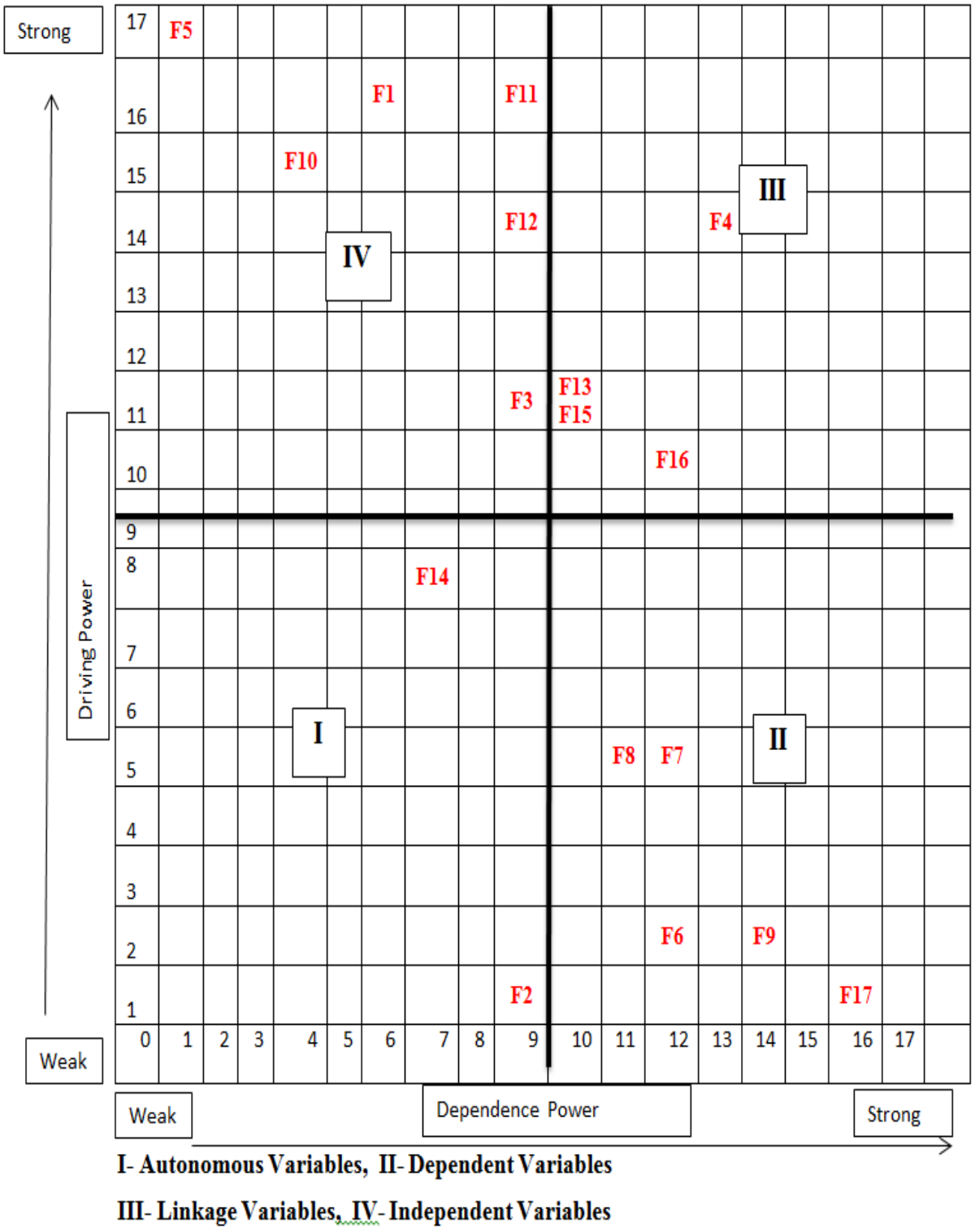

Figure 5.3: MICMAC Analysis: Driving Power and Dependence Diagram

5.5 Discussion

This section of the study was concentrated upon the identification of variables of IP creation, their interrelation and prioritizing them according to their importance. Although there are

theoretical and empirical studies are conducted aiming this issue but none of them have presented a model which could be beneficial for practical application. The hierarchical model presented in the study will help the senior level policy maker in decision making and strategy formation.

This study has identified seventeen variables which are related to IP creation capability. To ascertain the hierarchy level of these factors an ISM model is also build upon. The structural model gives a clear picture of the relationship that exists between the identified seventeen factors. We also come to know about the effect of these factors on the IP creation in institutes of higher education. Using MICMAC analysis the practitioners will come to know about the relative driving and dependencies of the factors. IP are important assets which could provide a competitive advantage to organizations (Agarwal, 2006), the finding of this analysis helps in removing various barriers and promoting IP creation.

This study depending on their ranks, identifies ”availability of IP policy”, “awareness” and “Research facilities” as the key factors or independent variables whereas salary and geographical location identified as most dependent variables. It implies that “IP policy awareness about IP” and ”research facilities” are the primary variables having considerable effect in IP creation and need to be given proper attention on the priority basis.

By analyzing the ISM model it could be seen that all the factors are depicting a very complex relationship among them. The whole model is although driven by two above discussed factors. These findings are in line with the studies of (Rizzo & Ramaciotti, 2014; Sattar & Mahmood, 2011) according to which a set of rules and regulations are very important for proper managing of IP management and resolving conflicts.

The IP policy is the most important set of rules which states about the rights and responsibilities of the stakeholders of HEIs. But at the same time other factors like research infrastructure, funding, training/education and incubators which are at the middle level of the models are also crucial for IP generation.

At third level of ISM model factor like incentives, work load and industry-academia collaboration are placed, playing a critical role. Like collaboration between industry and universities is necessity of both parties. For example state owned agro firms which are suffering from financial crises and formulating advertising strategies (Rautela, Sharma, &

Bhardwaj, 2016) to overcome the losses, may also collaborate with HEIs for hiring technology to improve their production efficiency. In turn HEI also gets a partner for their research work.

In previous chapter it is analyzed that in India most of the research work is done by public sector and largest numbers of researchers are employed in government research establishment. Because of such arrangement in India government schemes have a greater role to play. Same is depicted in the ISM model that scheme of GOI effects the research facilities, funding and research autonomy of the institute as well.

Concluding the chapter it could be put forward that proper handling of enablers and barriers present in the HEIs system as shown in model will eventually increase the IPCC to greater extent.

CHAPTER-6
SCALE DEVELOPMENT OF INTELLECTUAL PROPERTY CREATION CAPABILITY

6.1 Introduction

Patents granted found to be a better proxy for measuring innovations. Organizations could initiate management interventions to improve the stock of intellectual capital by developing routines that encourage innovation (Narvekar & Jain, 2006). In HEIs predominantly academic faculty have been remained crucial generators of new knowledge, although other kinds of organizations such as firms and research institutes are also increasingly engaged in knowledge production and dissemination (Ram, Göktepe-Hultén, & Goel, 2014). The importance of academic IP is also increased due to the shift of economic primary activities to knowledge base. Research at HEIs are under increasing pressure to translate the results of their work into privately appropriable knowledge through some commercial tool like patent (Henderson, Jaffe, & Trajtenberg, 1998). Considering the background the aims of this chapter are to:

- Develop a scale for measuring IP creation capability of Indian HEIs
- Propose a structural model that establishes relation between IP creation capability and its constructs with reference to Indian context.

This chapter presents first-hand findings of the faculty member's understanding of barriers and determinants regarding university patenting processes. Study results put forward valuable insights for understanding the present system & building efficient processes within academic institutes for supporting patent related activities as per perceptions and experience of faculty members.

6.2 Scale Development

Constructing a measurement scale is a systematic process where researcher needs to follow specific steps for better results. We followed the process suggested by Churchill (1979) which is also advocated by other studies like Anderson & Gerbing (1982); Bentler & Bonett (1980); Bagozzi, Yi, & Phillips (1991); Nunnally & Bernstein (1994); Hinkin (1998); Walsh & Beatty, (2007); Yoo & Donthu (2001). Both quantitative and qualitative methods were adopted for scale development, which also aligns with the exploratory design used in the marketing literature, considered useful "for exploring relationships when study variables are unknown;

developing new instruments, based on initial qualitative analysis; generalizing qualitative findings; and refining or testing a developing theory" (Harrison & Reilly, 2011).

This approach was adopted because the topic IPCC remained unexplored in India especially in higher education sector. As well, the connections between IP creation and other constructs were unidentified and needed advance study. Table 6.1 displays the scale development process and analysis methods used in the study. The scale development process is given in Figure 6.1.

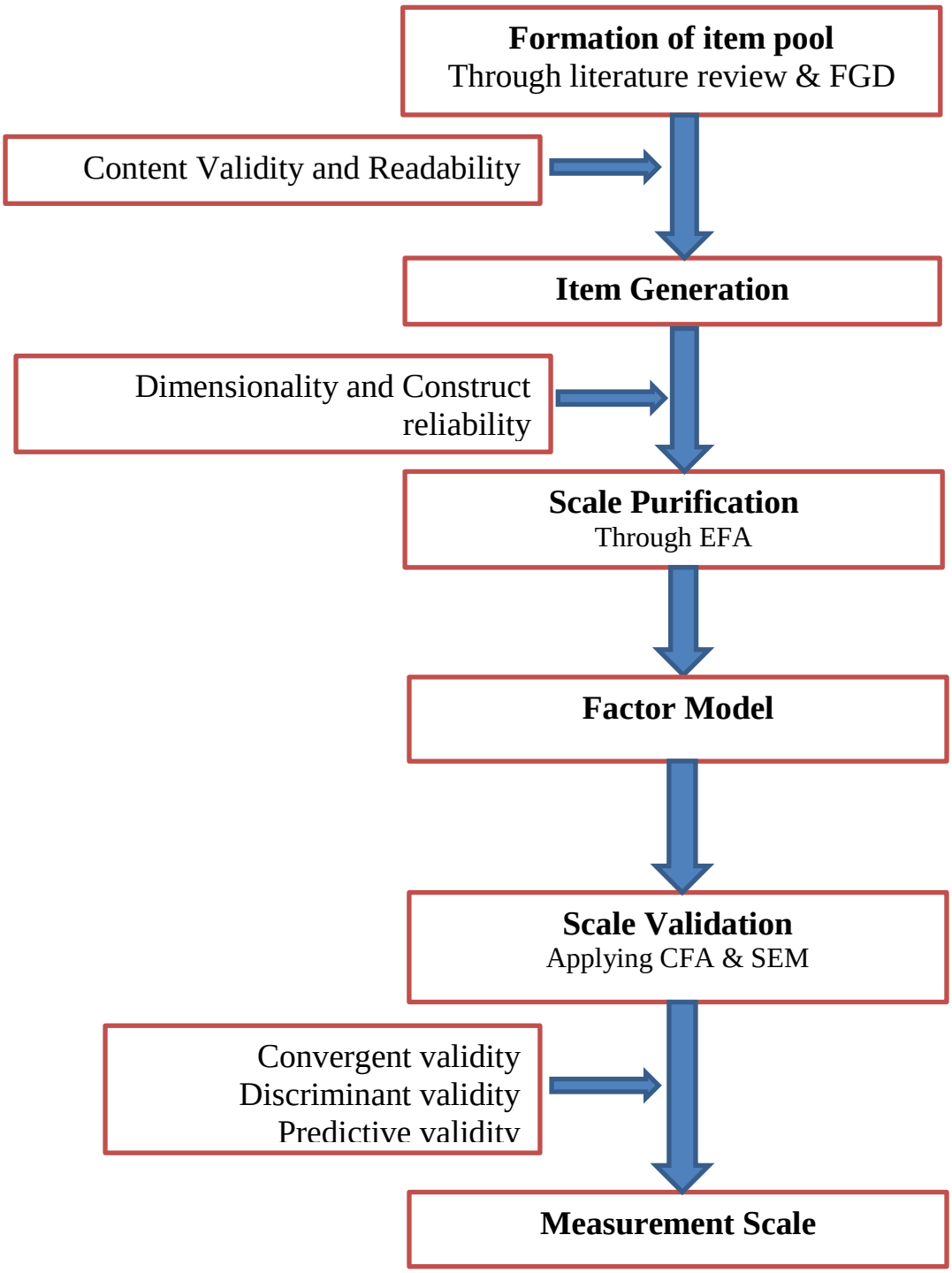

Figure 6.1: Flow chart of scale development process

6.3. Theoretical Framework and Hypotheses Formation

Scholars have proposed different measures of IP creation capability following either qualitative or quantitative approach. These measures differ across countries and contexts. In most of the studies incentives, research support (Rizzo & Ramaciotti, 2014), size of organization (Carayol, 2007), knowledge exchange, and culture are identified as dimensions. However, there are no measures present for the overall IPCC in HEIs for India. To address this literature gap, this study attempts to generate the scale items to measure IP creation capability.

6.3.1 Policy & Strategic Support (PSS) and IP creation capability

According to the literature present, the Policy & Strategic Support has four major dimensions viz IP policy, awareness about the IP, industry academia collaboration, technology transfer and awareness about the government schemes for promotion of IP creation. Baldini et al. (2006) and Geuna et al. (2011) in their study found that IPR policy as a part of policy & strategic support influences academic patenting positively. The policy document gives the clear guidelines and procedure for executing various activities related to generation of academic IPR. Promoting technology transfer & commercialization of academic research further promotes IP creation (D'este & Perkmann, 2011; Fini, Lacetera, & Shane, 2010). A perceptible transition from closed innovation paradigm to open innovation paradigm is also observed (Bhardwaj, Padmanabham, Jain, & Joshi, 2015) which favours the industry-academia collaboration. Due to the lack of awareness academicians and researchers at HEIs do not have the knowledge of patenting process (Melorose, Perroy, & Careas, 2015). The patenting is an expensive affair to obtain and the cost plays an important role in the decision of applying for patent (Owen-Smith & Powell, 2001). In USA after Bayh–Dole Act, many universities under strategic framework established technology transfer office (Nelsen, 2009) resulting in higher commercialization of academic research. Policy environment and legal framework foster the university industry interaction (Bercovitz & Feldmann, 2006). Many large size firms have active university–industry links for technological needs (Schartinger, et al., 2001). The public subsidy given for industry interaction also helps in fostering innovation by promoting research cooperation (Szücs, 2018). Hence, hypotheses posit that:

H1. The Construct Policy & Strategic Support (PSS) has significant effect on IP creation capability (IPCC).

6.3.2 Incentives and IP creation capability

Incentives could be defined as the personal benefits in form of monetary or prestige based rewards. There are studies supporting for both types of rewards. According to a report of (IP Asset Development and Management, WIPO), "IP strategic planning involves establishing multifaceted incentives and support for IP asset development and commercialization. These include tax incentives, payments, patent application funds, venture funds for SMEs in cluster areas and financial rewards in private enterprise for inventors and creators". Majority of the scientists are more contented by the reputation gained by the commercial activities in patenting. In other words, they are motivated by receiving the traditional ribbon in their academic activities (Lam, 2011). Göktepe-Hulten Prashanth Mahagaonkar (2009) found that faculties in HEIs gain reputation through commercial activities is correlated with their patenting activities rather than the immediate personal financial gains.

Academicians wish to own patents, copyrights because it is used to build reputation among the academic community. The production of IP is a central objective of academic researchers, as it is related to big amount of money (may be in form of royalty, licensing fees) and prestige. On the contrary Lach & Schankerman (2008) and Veer & Jell (2012) discovered that the monetary incentives are major cause of patenting activities in HEIs. The benefits associated with patent commercialization like royalty, share in license fee and research lab supports are the research motivation for academic researcher. According to Lach & Schankerman (2008), "the faculty responds to royalties both in the form of cash and research lab support, indicating both pecuniary and intrinsic research motivations. The impact of incentives is larger in private than in public universities". In this study, it is proposed that since incentive formulation is the part of policy prospects of any HEIs, it acts as an intervening or process variable and explains relationship between PSS and IPCC. Accordingly, hypotheses posit that:

H2. Incentives (IN) has a relationship with IPCC and it mediates the relationship between PSS and IPCC

Table 6.1: Scale development process and analysis methods

Study	Purpose	Method	Analytical tool	Criteria	Expected outcomes
1	Item generation	Literature review Qualitative study • Selection criterion: faculty members having experience of more than 15 years and applied for patent in the past five years • Data collection: in-depth interviews and focus groups discussions • Participants: 10 Academic and 3 Industrial personnel		• Content validity • Readability	Formation of item pool
2	Scale purification	Quantitative study: • Selection criterion: faculty members from institutes where TEQIP centers are running. • Data collection: questionnaire • Participants: 275 faculty members	SPSS 21.0 (EFA)	• Dimensionality • Construct reliability	Factor model
3	Scale validation	Quantitative study: • Selection criterion: faculty members from institutes where TEQIP centers are running. • Data collection: questionnaire • Participants: 268 faculty members	SPSS 21.0 and Smart PLS 3 (CFA and SEM)	• Convergent validity • Discriminant validity • Predictive validity	Measurement scale

Note: EFA= Exploratory Factor Analysis, CFA= Confirmatory Factor Analysis, SEM=Structural Equation Modeling.

6.3.3 Research infrastructure competence and IP creation capability

Research infrastructure capability consider research facilities, funding/ grant for research work, availability of raw material for research experiments, technology incubator and subscription of journals/patent databases. Owen-Smith & Powell (2001) found that the patenting activities of faculty members depend upon the institutional support provided to them. Ama & Fombad (2011); Azagra, et al., (2003) and Berco et al., (2001) also advocate the availability of research infrastructure as an initial requirement for academic IP creation. It is also observed by Carayol (2007) that size of lab is having a positive effect on the patenting activity in French universities. Hence, hypotheses posit that:

H3. Research Infrastructure (RI) competence has relationship with IP creation capability (IPCC).

6.3.4 Work environment culture and IP creation capability

It has considered both institutional and individual factors in working environment culture. The working culture and attitude of people affect the IP creation & their commercial application (Wu, Welch, & Huang, 2015). Institutions where academicians are from traditional environment support open science and discourage patenting & commercial activities (Merton, 1973). On contract academicians with modern approach may be more likely to conduct research studies with high applicability and IP generation potential (Powell & Owen-Smith, 1998).

The job security in organization also effect patenting activities for e.g. senior academicians are more likely to patent because they have accomplished a firm career security (Allen, Link and Rosenbaum, 2007; Stephan et al., 2007).

Owen-Smith & Powell (2001) study the effect of teaching as well as administrative work load of faculty members on their patenting activities. The research efficiency of faculty members degrades with increasing administrative and teaching work after a specific limit.

Research autonomy given to researchers is related to the freedom of conducting research in the domain which fascinates them. Inter-disciplinary research is the result of higher autonomy given to research practices which results in patent generation. Similarly training of the researchers plays an important role in patent output of the university. Organization performance

could be enhanced through training support (Russell, Terborg, & Powers, 1985). The institutes which provide training of practical intellectual property courses are actively involved in patent generation. Different courses on IP in academic programs also help in the development of conducive environment for nurturing innovation. The innovation culture in the organizations leads to technological development (Russell et al., 1985). The inner initiative to innovate and desire to create something new leads researcher to patent creation (Lam, 2011). Therefore, hypotheses posit that:

H4. Work Environment and Culture (WEC) have significant relationship with IP creation capability (IPCC).

The theoretical model showing the networks among all the hypotheses is summarized and shown in Figure 6.2, where the critical factors of IPCC measurement evolution consists of Policy & strategy support (Availability of IP policy, Education Process, Awareness about IP filing process, Industry academia collaboration, TTO, Government Schemes); Incentives (Promotion, Monetary benefit, Prestige); Research Infrastructure (Research facilities, Funding, Availability of raw material, Technology Incubator);Work culture& environment (Work Load, Salary, Autonomy, University ranking/Geographical location , Education/Training, Experience, Job/intrinsic satisfaction).

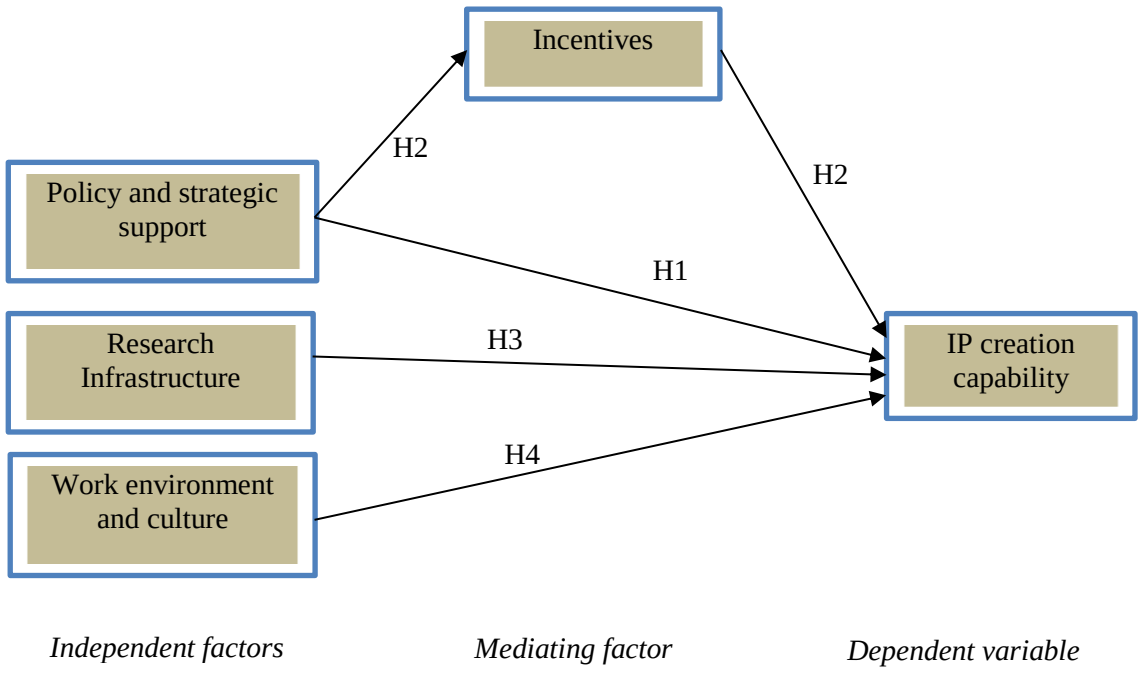

Figure 6.2: Hypotheses formation of IPCC at HEIs

6.4 Research Design

6.4.1 Instrument development

Identification, development and validation of IPCC measures in HEIs for the development of scale was done in two phases,

1. Qualitative phase

a. Identification of IPCC items through literature review

b. Identification of factors and sub factors for creating theoretical model through literature, experts and focus group discussions

2. Quantitative phase

a. Creation of IPCC scale using EFA and CFA

b. Testing of theoretical model by verifying hypothesis through SEM using PLS-3 software.

First, for the identifications of IPCC factors, extensive literature review using appropriate key words related to IP creation capability was conducted from various journal databases which include Science Direct, Emerald, Scopus, Web of Science and EBSCO. The studies which are relevant to our research were conducted in foreign countries and hence they lack the Indian scenario in general. To overcome this issue of lack of existing research in IP creation in Indian HEIs, the second step in the process was to consult eight experts from different Indian HEIs, who were involved in the process of obtaining an IPR or working at the senior positions with at least 20 years of experience. These experts were also involved in structuring the policies and regulations in their respective academic institutes. Apart from the expert opinion, a number of focus group discussions were also conducted with most of the young participants from academic back ground. Participants were fairly representatives of the overall population in the participating institutes. The reason to use FGDs for the study is that open-ended settings make free expression of thoughts, worries, feelings and concerns that might not come out by the use of other quantitative techniques. Discussions in groups and with experts were properly noted down to ensure systematic analysis of discussion. A semi structured questioning method was applied to the FGDs to remove any inconsistency in questioning and discussions. Still some adaptability was applied as per points raised and level of involvement of participants. The process yielded a questionnaire with a total of 44 items measuring five constructs as follows: seven items in Policy & Strategic Support; six items in Incentives; seven items in Research Infrastructure Competence; nine items in Human Resource Capability; fifteen items in Work Environment & Culture (Appendix-1).

Once the qualitative validity is tested through the theoretical study and through expert comments & FGDs, it is better to check the instrument with quantitative validity (Sahney, Banwet, & Karunes, 2006). Therefore, in the third step, the test for statistical validity was done through an Exploratory Factor analysis (EFA) followed by confirmatory factor analysis (CFA) (Churchill, 1979).

To conduct hypothesis testing a structural equation modelling (SEM) using the Partial Least Squares (PLS) method is adopted. "SEM assesses the properties of the scales employed to measure the theoretical constructs and estimates the hypothesized relationships among the said constructs" (Hair, Ringle and Sarstedt, 2013) . Data analysis for validating the structural model was conducted using the Smart PLS Version3.0 software. PLS in recent times is used extensively for estimating path coefficients in structural models and has established itself as a prominent method for conducting social studies (Hair. et al.,, 2014); (Sarstedt, et al., 2014). Our study also proposes a reflective first order and formative second order factor model. The reason for using PLS was that it can handle both reflective as well as formative constructs (Riel, et al., 2017), whereas other SEM techniques do not permit this.

"SEM is superior over other correlational methods such as regression because multiple variables are analyzed simultaneously, and latent factors reduce measurement error' (Beran & Violato, 2010). One more benefit of using SEM is that the same variable may represent a predictor (regressor) in one equation and a criterion (regressand) in another equation (Nachtigall, Kroehne, Funke, & Steyer, 2003) . In our work, the term "incentives" comes under this category which acts as regressor and regrand as well. SEM has greater statistical power (probability of rejecting a false null hypothesis) than other techniques and since our sample is large sized with few number of variables, SEM was suitable for upgradation in this research work.

6.4.2 Data collection

The respondents of the study were the faculty members of various HEIs across India. The selection criterion was the presence of Technical Education Quality Improvement Programme (TEQIP) at the Institute. TEQIP is a World Bank assisted project implemented to improve the quality of technical education system in India. TEQIP offices are established in different institutes including premium institutes like Institutes of National Importance (NITs & IITs) for better implementation of quality improvement in engineering study. As for awarding the TEQIP to institutes, selection of institutions is carried out through judging academic

attainment. Some parameters are designed and benchmark values are assigned to each parameter. The reason behind this criterion for selection of institutes is to bring about the uniformity among the respondents since in India the level & quality of HEIs varied substantially.

Survey method of data collection was used for collection of views personally or through email. The e-mail addresses of faculty members from several sources (Institutes' directories, web searches, etc.) were gathered for sending the questionnaire. For selecting respondents, convenience sampling was used. Total of 500 questionnaire were sent through e-mail, following (Dillman, 2011) procedure for questionnaire formatting, distribution and collection. We got 380 responses from which 38 were incomplete and hence rejected. 218 responses were gathered personally from the respondents out of which 17 were incomplete and hence rejected. Thus, a total 543 questionnaires were considered for the study. Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) test was conducted to check for the minimum specified level. The result of KMO (0.886) test showed that samples were adequate for the analysis. The sample size determination table given by Krejcie & Morgan (1970) also refer based on the number of variables to be analysed.

6.4.3 Statistical validation

No researcher or study has given a measurement scale of IP creation in higher education using concerned dimensions (Baldini et al., 2007). Therefore, EFA was performed to analyze the answers of faculty on five distinctive domains (policy, incentive, human resource, research infrastructure & work environment) of the questionnaire to confirm and determine the dimensions of the IPCC scale. Principal Component Analysis with promax rotation was used (Gorsuch, 1988). The steps followed by Hair et al., (1998) are implemented for the improvement of the model, in which items with loading less than 0.40 were removed; the items that were cross-loaded on two or more factors/variables were also removed; and the factors with Eigen value of 1 and more were considered for cut-off value for extraction.

The initial matrix from the factor analysis showed that eleven factors explained 67% of the total variance. To find the four most important variables influential factors, exploratory factor analysis was performed by limiting the total factors to four and the variance explained was 74% well exceeding the threshold (DeVellis, 2016), with the first two factors (policy and incentives) accounting for 42.51% and 54.67% of the variance respectively; the third and fourth factors (research & infrastructure and work environment) explaining 66% & 74% respectively. The

outcome of EFA shows the factor loadings for 12 item scale with all the item loadings were exceeding 0.50 and above (Table 6.2). All the items indicated uni-dimensionality. No item had multiple cross loadings, thus, implies the preliminary discriminant validity of the scale. For the four factors, the Cronbach's alpha values were .845, .821, .811 and .757 respectively , thus, indicating a reasonable measure of reliability (Nunnally & Bernstein, 1994).

Table 6.2: Pattern Matrix from EFA (Exploratory Factor Analysis)

Items	Components with factor loadings			
	1	2	3	4
PS3	.917			
PS2	.880			
PS1	.838			
IN39		.915		
IN9		.913		
IN41		.679		
RIC24			.942	
RIC25			.859	
RIC5			.720	
WEC37				.872
WEC12				.721
WEC20				.708

Extraction Method: Principal Component Analysis.
Rotation Method: Promax with Kaiser Normalization.

6.5 Data analysis and results

6.5.1 The measurement model

The four factors i.e. Policy & Strategic Support (PSS); Incentives (IN); Research Infrastructure competence (RIC) and Work Environment Culture (WEC) obtained after dimension reduction following EFA. A series of confirmatory analysis was performed to find the best fit. Based on the result analysis of CFA, factor loading was assessed and correlated measurement model for measuring IP creation capability was constructed (Figure.6.3). However, no item was deleted since all of them load adequately.

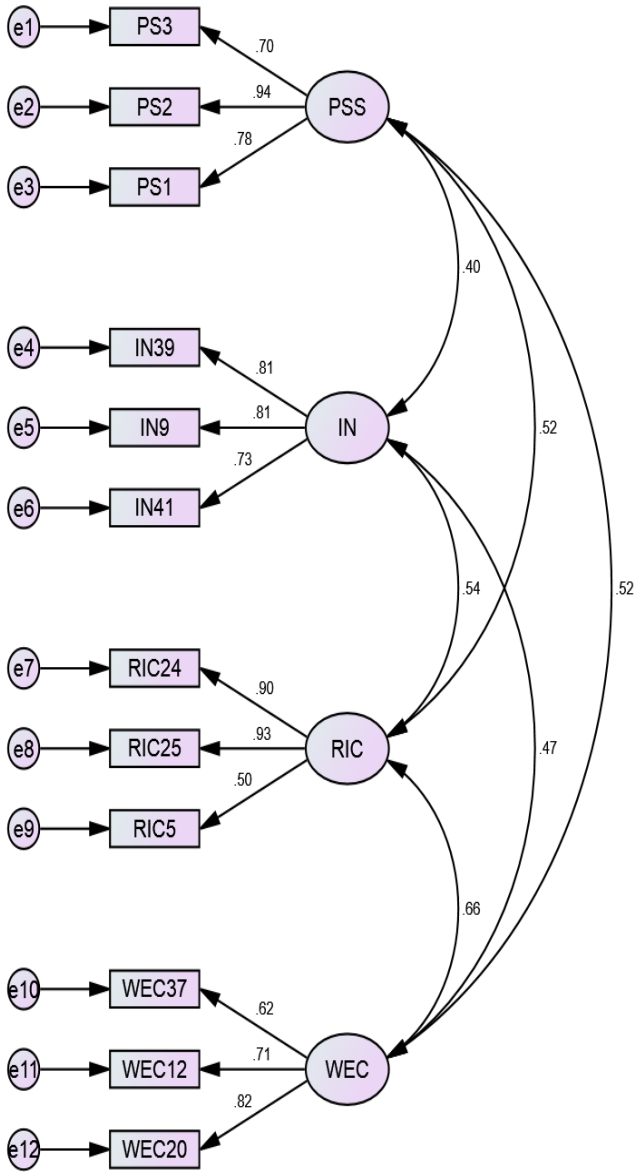

Figure 6.3: Confirmatory Factor Analysis: Measurement model of IPCC

The convergent validity of all the constructs were also taken care of, with all loadings being above the threshold value of .70 (Hair et al., 1998; Segars, 1997) except for items RIC5 (RIC) and WEC37 (WEC) with loading of .50 & .62 respectively. Since removing these items shows a decrement effect on the model fit, both were considered. All other values were within the range. Thus, the measurement model obtained is within the accepted threshold values of test statistics. The results showed excellent fit for all the statistics and are within the limits. These parameters are i) the goodness of fit index (GFI = .927), ii) the adjusted goodness of fit index (AGFI = .878), iii) the normed fit index (NFI = .919) and iii) the root mean square error of approximation (RMSEA = .050). These values are given in Table 6.3. As the standardized

residuals were having values smaller than 2.58, it means that no changes were required for the assessment of the standardized residuals.

Table 6.3: Summary of results derived from confirmatory factor analysis

Test Statistics	Value
CMIN (minimum of discrepancy function)/DF(degree of freedom)	2.032
AGFI (adjusted GFI)	.878
GFI (goodness-of-fit index)	.927
NFI (normed fit index)	.919
CFI (comparative fit index)	.956
IFI (incremental fit index)	.937
RMSEA (root mean square error of approximation)	.050

For obtaining a best fit model, the results from factor analysis should be interpreted properly and the reliability and validity should also be checked necessarily (Churchill, 1979; Hair et al., 2013). The four factors had excellent convergent and discriminant validity (Table 6.4).

Table 6.4: Convergent and discriminant validity of the constructs

	CR	**AVE**	**MSV**	**Max R(H)**	**RIC**	**PSS**	**IN**	**WEC**
RIC	0.834	0.640	0.430	0.918	**0.800**			
PSS	0.851	0.660	0.274	0.908	0.520	**0.812**		
IN	0.825	0.612	0.292	0.830	0.540	0.396	**0.783**	
WEC	0.762	0.519	0.430	0.785	0.656	0.523	0.471	**0.720**

6.5.2 The structural model

The hypotheses were tested using Smart PLS 3.0. The second-order latent variable (IPCC) was set up using four items. We constructed the reflective, hierarchical construct model in PLS path modeling (Guinot, Latreille and Tenenhaus, 2001). "The PLS algorithm uses the path weighting scheme (the default setting for the weighting scheme) and the default setting `Mean 0, Var 1' for the data metric" (Shahsavar & Sudzina, 2017). A bootstrapping procedure with 1,000 iterations was performed to test the statistical significance of the weights of sub-constructs and path coefficients (Chin, Peterson, & Brown, 2008). Following Tenenhaus et al.,

(2005) the goodness of fit (GoF) index was used to assess the model fit. In our study, IPCC; endogenous construct GoF was measured using the geometric mean of the average communality and the average R^2. The accepted values of GoF for model fit should be between .1 to .36 (Hoffmann & Birnbrich, 2012) , this model yielded a value of 0.34 which indicates a decent model fit. However, recent researches advocate that GoF is not suitable for model validation as it cannot reliably distinguish valid from invalid models and its applicability is limited to certain model setup (Henseler & Sarstedt, 2013). The final scale is as follows in Table 6.5.

Table 6.5: Description of items for measurement

Dimension	Code	Measures
Policy & Strategic Support (PSS)	PS3	There are guidelines and a basic framework to settle IP disputes in my institute
	PS2	Institute IPR policy is reviewed internally and with stakeholders on periodic basis
	PS1	Training of teachers programs on IP & innovation are conducted from time to time
Incentive (IN)	IN39	Monetary benefits are given by my institute for obtaining an IPR like patent
	IN9	My institute follows an IP based carrier advancement scheme
	IN41	Proper recognition is given to person who obtain an IPR
Research infrastructure competence (RIC)	RIC24	My institute is regularly updating the research facility
	RIC25	Institute has good number of collaborations with R&D labs regarding sharing of research and ideas
	RIC5	My institute has access to various reputed paid international journals from different domains of study
Work Environment Culture (WEC)	WEC37	There are programs running in my institute to broaden entrepreneurial skills of faculty and students
	WEC12	Separate department/ office is functional for carrying out innovation related activities
	WEC20	Focus of learning is more on developing innovative thinking

6.6 Hypothesis Testing

6.6.1 Analysis of the direct effect.

The hypothesized relationships of the structural model were tested. The results of the structural model show the standardized path coefficients and their respective t-values which were referred for testing the relationship between the construct in structural model (Lowry & Gaskin, 2014).

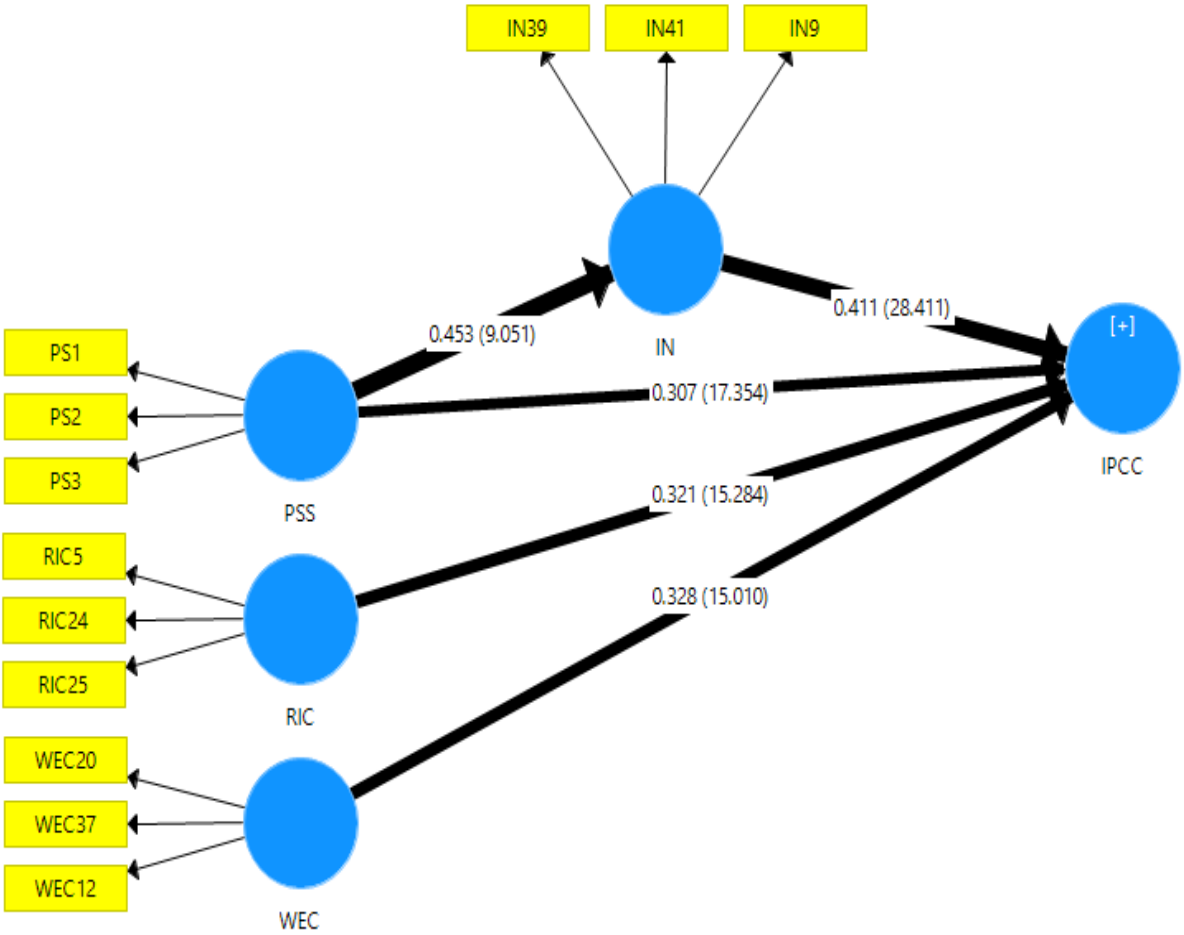

Figure 6.4: Structural model for IPCC

The results of structural model and hypotheses testing are given in Figure 6.4 and Table 6.6.

Table 6.6: Results of structure modeling

	Original Sample (O)	**Sample Mean (M) (R^2)**	**Standard Deviation (STDEV)**	**T Statistics (|O/STDEV|)**	**P Values**
IN » IPCC	0.411	0.412	0.015	28.411	0.000
PSS » IPCC	0.307	0.305	0.018	17.354	0.000
RIC » IPCC	0.321	0.320	0.021	15.284	0.000
WEC » IPCC	0.328	0.329	0.022	15.010	0.000

All four hypotheses were strongly supported by the results obtained by statistical tests. H1 which hypothesized that construct Policy & Strategic Support has significant positive effect on IP creation capability was supported by results (*H1*: beta=.307and t=17.354, sig =0.001). These values confirmed that IP creation at HEIs is strengthened by Policy & Strategic Support provided by the Institute. Likewise H2 hypothesized that incentives given to the faculty members for patenting is the highest motivator for them which leads to augmented IPCC and was supported by results (H2: beta=.411 and t=28.411, sig =0.001). H3 which hypothesized a significant effect of research infrastructure competence on IPCC was also confirmed (H3: beta=.321 and t=15.284, sig =0.001). Similarly H4 which hypothesized positive effect of work culture on Institute IP creation capability was also confirmed by results (H4=.328 and t=15.01, sig =0.001). The findings of these four hypotheses are matched with the findings from earlier studies with developed countries.

Table 6.7: Summary of hypotheses testing

Hypothesis	Standard beta	T statistics	Result
H1. The construct Policy & Strategic Support has significant positive effect on IP creation capability	*.307*	17.354	Supported
H2. Incentives has significant positive impact on IP creation capability	.411	28.411	Supported
H3. Research Infrastructure competence has relationship with IP creation capability	.321	15.284	Supported
H4. Work Environment Culture and IP creation capability has significant relationship with IP creation capability.	.328	15.010	Supported

6.6.2 Analysis of the indirect effect

For analyzing the indirect effects between PSS and IPCC a two-step bootstrapping method was adopted (Chin, 2010). The first step was to assess the direct effect of the exogenous variable on the endogenous variable. For confirming the result obtained, we also calculated variation

accounted for (VAF). The VAF value .37 indicates that incentives (IN) is exhibiting a partial mediation between exogenous variable PSS and endogenous variable IPCC (Hair Jr, Hult, Ringle, & Sarstedt, 2016) and 37 % of the total effect on IPCC was explained by indirect effect. The results are given in Table 6.8.

Table 6.8: Mediation Analysis: Incentives as Mediator

Endogenous Variables	Direct Effect	Indirect Effect	Total Effect	VAF Range	Mediation
IPCC	.307	.186	.493	.377	Partial

Regarding the effect of exogenous variables on IPCC, it is vital to assess if this effect be generalized for entire population or a variation with regard to basic gender and age distinction is present. The results of the structural model suggest that moderation effect might be present. For checking the moderation effect of age, two distinct sub groups were formed on the basis of age i.e. G1 (20-35yrs old) & G2 (above35 yrs old) and running the PLS analysis for both the sub groups. Then, the path coefficients from WEC with IPCC were compared. The path coefficient was higher in the senior age group (β=0.11) as compared to junior age group (β=0.04) as expected. The difference was statistically significant [$t(32)=1.75$, $p<.05$]. On the contrary no moderation effect was found for the gender on IPCC.

6.7 Discussion

This work presents the first endeavour to develop a well-structured scale for measuring IP creation capability especially with the context of Indian higher education system. This scale provides practitioners with a reliable and valid analytical tool for the measurement of faculty's perceptions about IP. Successful application of the scale would increase the competitiveness among HEIs related to IP matters and would be beneficial for institutes having lower rankings. Further, this research confirms the validity of SQM-PLS application in the context of HEIs capability in trying to enhance IP creation. The outcomes of our research are more precise because the questionnaire were filled by the faculty members of the premium HEIs that have been selected for the TEQIP and having great achievements in their name.

The study makes important contribution in the academic field for improving the IP creation in HEIs, which is an important output of higher education process (Kashyap, et al., 2018). The

results provide empirical evidence that there are four constructs (Policy & Strategic Support, Incentives, Research Infrastructure competence and Work Environment Culture) dimensions of IP creation. In relation to the construct incentive, results indicated significant positive (beta=.411 $p \leq .05$) relationship with IPCC and have the strongest effect on IP creation. This is similar to the findings of previous studies conducted by Göktepe-Hulten & Mahagaonkar (2010); Owan & Nagaoka (2008); Owen-Smith & Powell (2001); Perez & Osuna (2015); and Sun & Wu (2006). The second best T value was shown by another related dimension, "Policy & Strategic Support". This dimension is related to administrative matters related to IP such as active IP policy, rules & regulations regarding the commercialization of academic research, induction of IP courses in academic curriculum or presence of support mechanism for IP creation (Owen-Smith & Powell, 2001) .

The current study also supports the dimensions, namely, Research Infrastructure, Competence and Work Environment Culture and their role in IP creation. The finding is supported by several studies done by Tian (2015); Zeebroeck, et al., (2008); Walter, Ihl, Mauer, & Brettel (2013). The findings from this study strengthen these results further and show that institutes having better quality of various dimensions of IP creation capability at higher education are more likely to form and possess high intellectual capital. HEIs should try to concentrate more on faculty views rather than on other determinants as they have been part of the system for a long time and are directly related to the system (Aaboen & Holgersson, 2016; Perez & Osuna, 2015; Sun & Wu, 2006).

CHAPTER-7
STRATEGIES FOR IMPROVING IP CREATION CAPABILITY

7.1 Introduction

To formulate and propose strategy for enhancing IP creation in Indian HEIs, it is first important to understand the prevailing higher education system. To begin the process it is required to know the various processes involve in IP creation & its commercialization in the field of higher education to further suggest the recommendations for its various stakeholders- researchers, industries, universities, nation etc. The start-up enterprises from universities are considered to be an important contributor to regional economy and provide a sustainable alternative to traditional entrepreneurship (Bezerra, Borges, & Andreassi, 2017). With the aim to better understand system, we adopted a soft system Soft system methodology. The IP generation in HEIs could be improved by applying the recommendation proposed by the researcher. The logical examination for the objective is carried out by sorting the issues in a systematic manner. The first phase begins with the accessing of higher education system prevailing in India using Soft Systems Methodology (SSM). This helps to understand the whole system and views of all the primary stakeholders of academic system. In the end the strategies to enhance IP creation are given. The authority of HEIs, corporate agencies and government policy makers are required to give due attention to these strategies & recommendations for generating more IP from institutes of higher educations.

7.2 Strategy for IP Creation in HEIs

Strategy refers to the actions that give the organization a competitive edge (Porter, 1996). According to Agarwal (2006) "The key to competitive intelligence is processing of data & information gathered into strategy, and turning strategy into actionable items, thereby improving organisational performance and operations by maintaining an organizational advantage". The strategy process is given by Andrews (1980), as shown in Fig.7.1

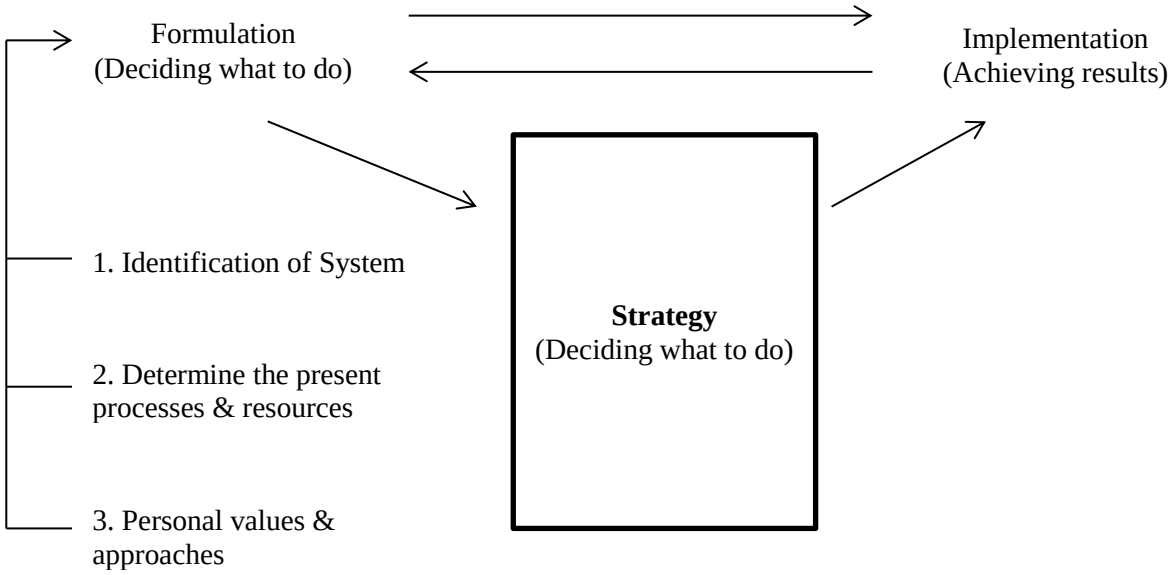

Figure 7.1: Strategy formulation & implementation process. Source: (K. R. Andrews, 1980)

In business parlance, the terms strategy refers to is a unique plan designed with an aim of achieving a competitive position in the market and also to reach the organisational goals and objectives. In short, it is an interpretative plan that guides the enterprise in realizing its goal.

The recommendations and strategies that are necessary for enhancing IP creation & commercialization could be formulated by analyzing the small practices that are followed in a typical Indian HEIs. A well formulated strategy is required for effective transfer of research output to industry (Bhardwaj, et al., 2017). For this purpose the use of Soft System Methodology (SSM) is best suited because it is the approach used mainly for analyzing complex management systems like organizational process modeling. SSM also find its application in general problem solving and change management in big organizations like HEI.

7.3 Soft System Methodology (SSM)

SSM is especially suitable for the assessment of complex administrative system having many diverse alternatives. According to Platt & Warwick (1995), Soft Systems Methodology (SSM) deals with ambiguous problems related to vague objectives and diverse perceptions. It is an approach that is used for the examination and critical thinking of unpredictable and out of order circumstances. Zlatanovic & Mulej (2015) found that the approaches related to selected soft systems can contribute to socially responsible innovative behaviour through the introduction of the concept of knowledge-cum-values management.

SSM utilizes "systems thinking" through exploration, learning, and reflection in a cyclical motion to help in comprehending different opinions that exist among the thought process of distinctive individuals present in a particular situation. According to the interpretive, the actions of individuals or groups have no discernible reality unless viewed through the values and norms of those involved, that is, understanding from within through the means of attempting to understand the world by re-enacting or reliving the experience of others (Stowell, 2009).

This methodology is relevant to numerous spaces including the change of administration and human asset administration or human resource management. Delicate frameworks intuition investigates the confusing and difficult circumstances that emerge because of human movement. However, instead of diminishing the intricacy of the messy situation in relation to the goal that can be demonstrated numerically (hard systems), soft systems endeavour to benefit from the distinctive observations that exist in the psyches of the diverse individuals involved in the circumstance (Checkland, 2000). SSM has found its applicability in organizations ranging from a corporate dealing with tangible products and business management to educational institutes. It is comprehensively used to provide assistance with regard to the different types of crisis situations, like driving suggestions for system enhancement, restructuring, and job analysis (Sheu & Lee, 2011).

7.3.1 Seven steps of SSM for the study

1. Defining the problem (Unstructured form)
2. Conversion of problem to structured form (Rich Picture)
3. Root definition of system concern (CATWOE Analysis)
4. Building of conceptual model
5. Comparing with real system
6. Determining the improvement suggestions
7. Action/implementation on the suggestions.

7.3.2 Identification of problem (Stage 1)

To be more responsive to the societal needs, the HEIs have to widen the basic purpose of education, especially by aligning their academic excellence keeping in mind the innovative transformation of business outlook and industrial perspective that economically accomplish the society. The biggest challenge in front of the professional HEIs is the way of implementing the strategies for IP creation within Indian culture of research and development by coordinating

several stakeholding factors.

7.3.3 Structuring the problem using "Rich Picture" (Stage 2)

The former model of functioning government is essentially deficient to the modern needs of the nation. The requirements of the modern nation are inventive and creative answers are the necessity for cultivating manageable development, securing employments, and expanding focused capacities for deliverance to the society. The real world overview of the societal system can be broadly explained with the help of a "rich picture" diagram that expresses the movement of the process of innovation and its contribution to the national revenue generation. This process is largely unstructured from the thoughtful and philosophical researcher's standpoint, but the rich picture can express the problem for necessary formulation. In order to generate a solution addressing this challenge, over thirty interviews were conducted with the experts, academicians and members of policy making committees. The interviews carried out were semi structured and the issues related to topic were freely discussed. A rich picture diagram (Figure 7.2) is presented for the purpose that shows the value judgments and relationships that are felt to be of high importance in the process of mapping the opportunities for IP creation in HEI.

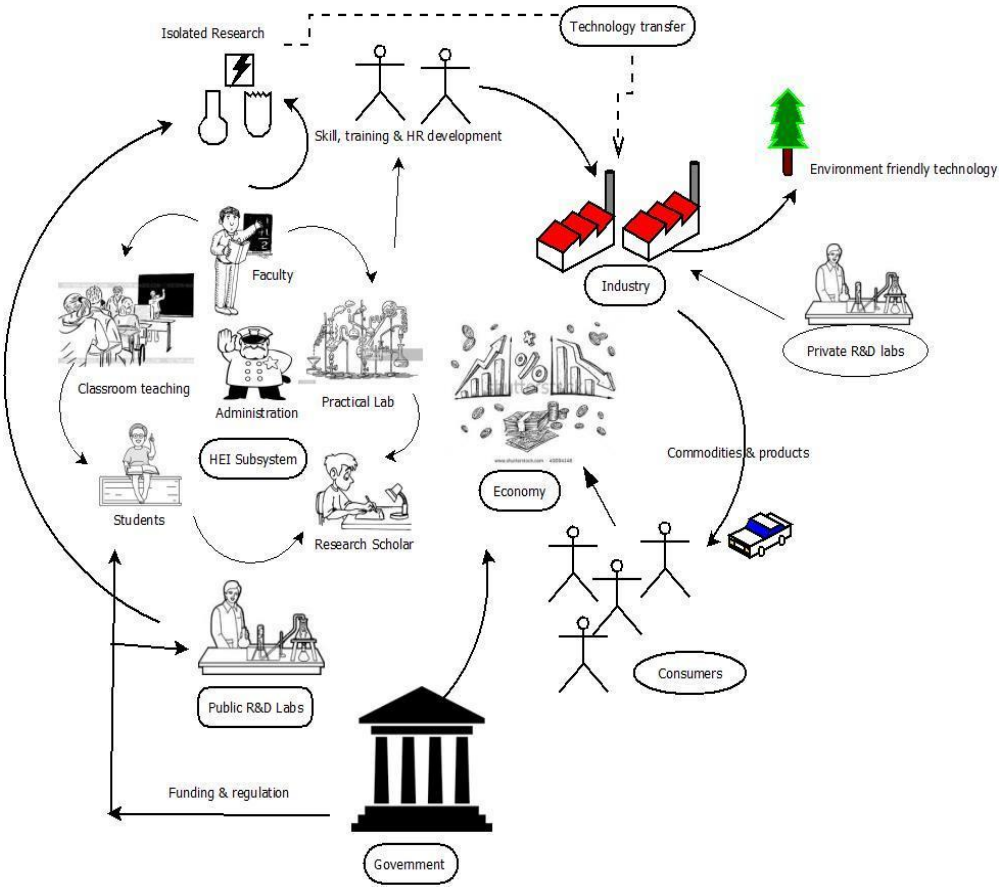

Figure 7.2: Rich picture depicting processes in HEIs.

7.3.4 Root definition using “CATWOE Mnemonic” (Stage 3)

CATWOE Mnemonic deals with the formulation of root definition from the rich picture. The rich picture gives the premise from which a root meaning of a specific system could be determined. It is possible to utilize the CATWOE mnemonic as a checklist to make certain the completion of the root definition (Platt & Warwick, 1995). This process moves out of the "real" world and into the universe of systems. Firstly, the root definition gives the identification of a problem or in other words what needs to be tackled, and secondly, it recognizes the system in which the successive investigation will be done. The formulation of a root definition indicates that the expressed unstructured area of concern has been structured for enabling further systemic analysis. The root definition is a statement of several sentences, which gives a form to the concerned part of the system, that answers what or how or why an activity is carried out and outline a particular world-view. Table 7.1 shows the CATWOE analysis of the study.

Table 7.1: CATWOE Analysis

Key elements of the higher education system	Description
Customer or stakeholders	Industries, Corporate, IP Agencies.
Actors	Faculty members, Student, Research scholars, Scientist, Policymaker.
Transformation	Making the apparently poorly organized research efforts of the faculty, scientists, students, and research scholars into a more professionally structured form to obtain object based innovation for the marketplace.
Weltanschauung or overview	Considering the potentials of commercial application of the intangible and tangible products, service, and process obtained through SI in HEIs for the deliverance to society and generation of national revenue.
Owner	Universities and other institutes of higher education.
Environment	Policy makers, Government Departments, and Sponsoring Agencies.

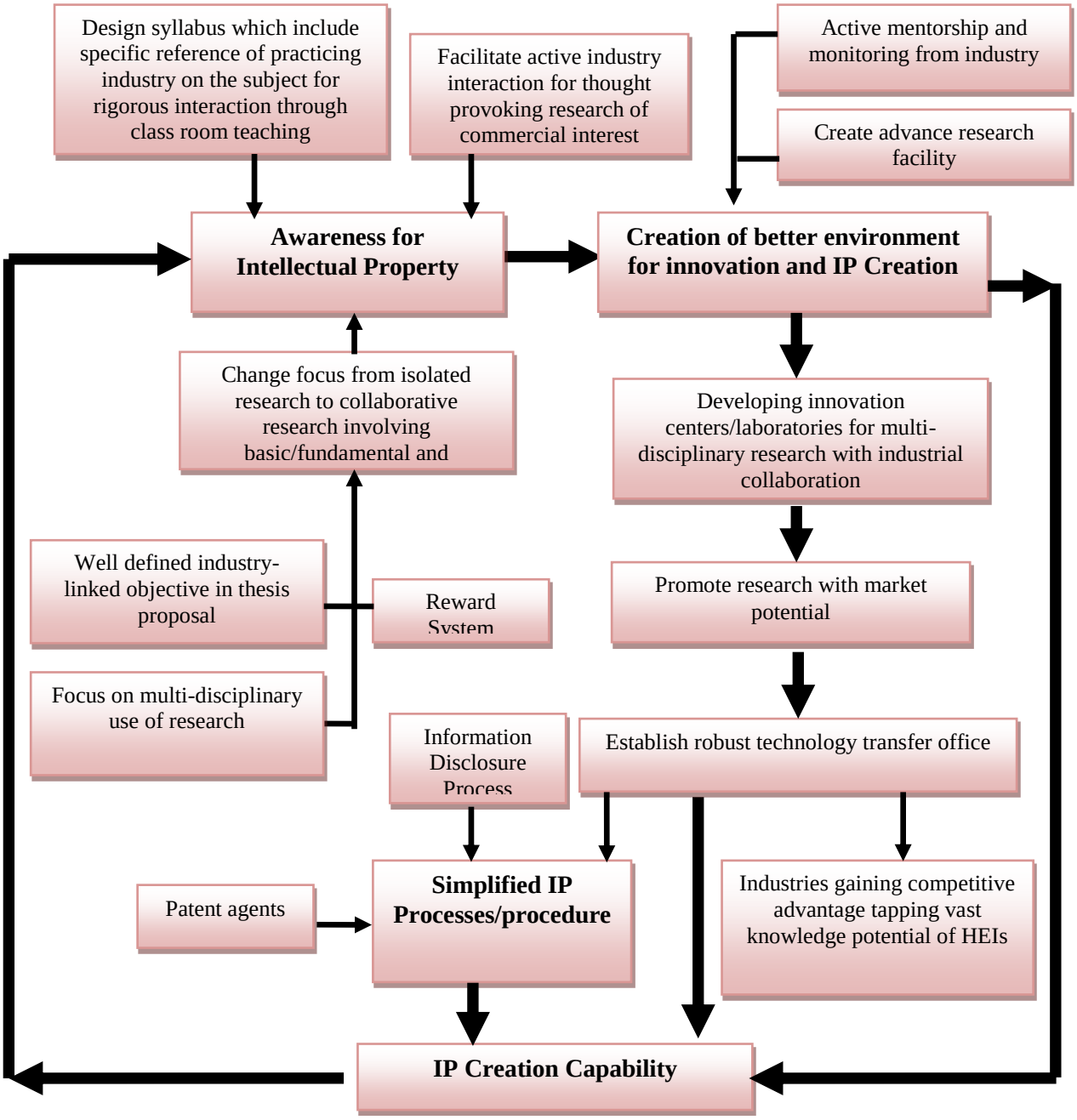

Figure 7.3: Conceptual model for innovation and IP generation in HEI. Adopted from Kashyap et al., (2018)

7.3.5 Formation of conceptual model (Stage 4)

The procedure of displaying through SSM has a prerequisite of having a creative and imaginative dimension of the experts that can be achieved by constructive addressing of the concerns in reality. The examiner needs to concentrate on the root description and to deduce the base important exercises which can accomplish the rationale behind the system in question. In preparing the conceptual model, the logical activity of the rational argument is utilized to infer

appropriate actions in the human activity system which is identified as a conceptual model, where, all actions will be executed within the limits of a defined system. Figure 7.3 shows the conceptual model generated from the outputs of first, second and third stages.

7.3.6 Strategy Formation: Actions of conceptual model in the context of real world activities in HEIs (Stage 5,6,7)

The implementation starts from comparing the actions of "conceptual model" with that of the "real world" for identifying the gap to fill certain recommendations on each activity. Based on the views of the personnel related to this study, the author listed down the actions or activities in a logical manner, which are thought to be essential for creation of IP and shows the present status of the activity in the real world. The incremental changes recommended by the experts to improve the existing situation with new actions are also represented. Once the actions suggested by conceptual model are transposed on real world actions, the remarks may describe the ways in which a current action is carried out; the possible benefits of the recommendation given and the importance of action in a broader perspective. The next section of the chapter will give the strategies and actions which cater to the fourth objective of the thesis.

7.4 Strategy Formulation and Measure Recommendation

Based on the content analysis of the data gathered through FGDs and considering the dimensions of the structural model (as discussed in Chapter 6), two most prominent elements have evolved which are i) awareness level, and ii) process simplification & customization. Having analyzed the matter of IPCC these two aspects plays a key role in progression of said capabilities in Indian HEIs. On plotting these two elements on two axis as shown in Figure 7.3, one can envisage the relative role of these two aspects with the perspective of the enhancement of IP creation capability in HEIs. Considering the mutual relationship between patent awareness level (y axis) and procedural complexity (x axis), it was found that the academic patenting increased as the procedure complexity of patenting decreases and patent awareness level of primary stakeholder of HEIs i.e faculty members & researchers increases.

The effect of decreasing procedural complexity & increasing patent awareness is exponential on patenting activities of HEIs as depicted in lower part of the Ist Quadrant. But along the curve of patenting activities, as it progresses, the slope shows a limited effect of procedural complexity and the growth of patenting activity is dominantly led by awareness level (as shown in upper part of Ist Quadrant). Therefore separate strategies are suggested for tackling different phases lead by the two most prominent aspects of IP generation.

These strategic measures and recommendations are arranged accordingly in this section.

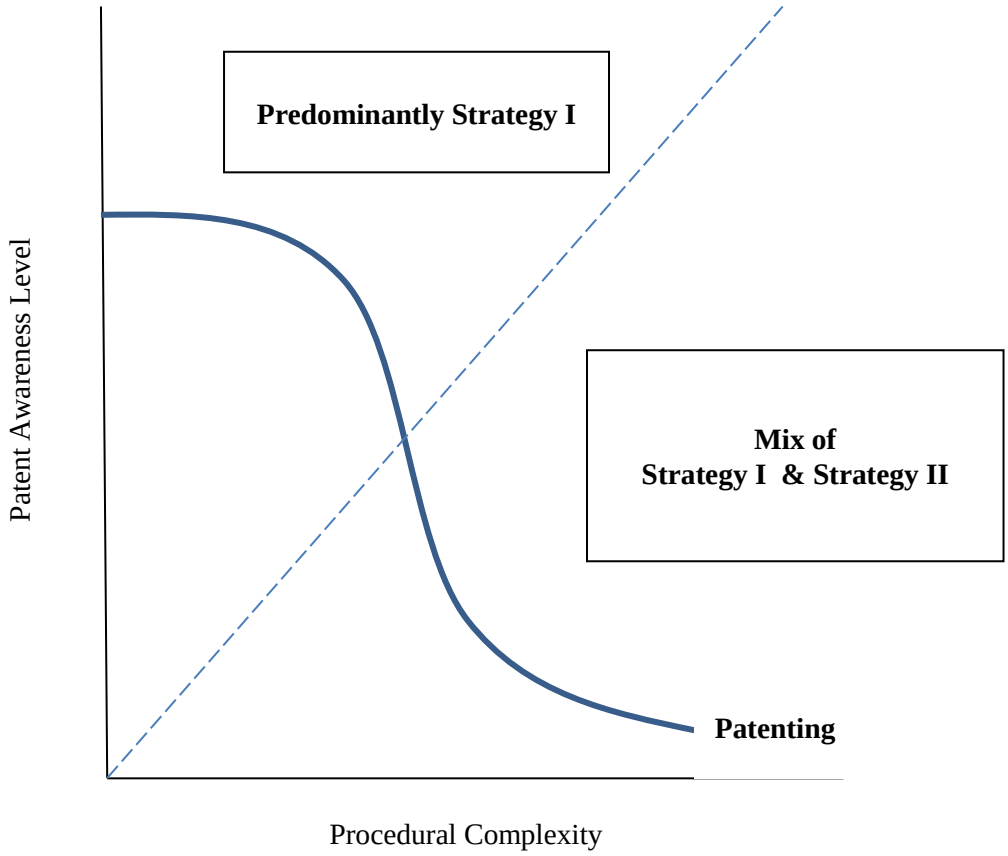

Figure 7.4: IP creation and suggested strategy mix in HEIs

7.5 Strategy I: For Increasing Patent Awareness Level

Various actions are required for increasing the awareness level of the stakeholders of HEIs about patents and other intellectual property. The faculty members and research scholars, who are the main pillars of research activity at universities, are not aware about the benefits of IP. Eight actions and recommendations along with their present status in HEIs are shown in Table 7.2. The first column in this table list the actions required for enhancing IP generation in HEIs. Here the author list down the actions or activities in a logical manner, which is thought to be essential for the said purpose and shows the present status of the activity in the real or present world in second column under heading "Present Status". The third column "Current approach" shows the current approach of tackling the issue and next column "Evaluation Criteria" analyzes the accumulated data for understanding how the action is measured in the present to figure out if it meets certain execution criteria. The fifth column titled "Recommendation" records the incremental changes recommended by the experts to improve the existing situation

with new actions. The last column contains remarks, once the actions suggested by conceptual model are transposed on real world actions.

7.6 Strategy II: For Patent Process Simplification & Customization

The procedure for applying for a patent is a complex procedure. There are various steps that are needed to be followed for filing a patent application. A patent application is a techno-legal document. This means that it has both the legal and technological aspect. This may be possible to lower down various types of fees charged by office of registrar or a separate office of registration for academicians or a separate type of patent with some less rights assigned to it. An ideal combination of strategy I & strategy II is required to enhance IP creation capability of HEIs. Five actions and strategic recommendations along with their present status in HEIs are shown in Table 7.3. This table has having same description as given in previous 7.5 section of this chapter, other than the actions comes under second strategy.

7.7 Measures and Strategic Recommendations Related to Research & Teaching other than Strategy I & II for Enhancing Academic IP Creation.

Other actions that are not categorized under strategy I and II are general in nature but are important for enhancing IP creation. These strategic recommendations are listed in Table 7.4. Total eight actions are suggested by the experts under this category.

Table 7.2: Strategy I: Measures and strategic recommendations for increasing patent awareness

Actions	Present Status	Current approach	Evaluation Criteria	Recommendation	Remarks
Reward for patent filing	Not present	None	None	A separate section for handling reward system for IP related activities	Enhance the scope for better patenting activity
Including IP in formal performance evaluation	Partially Present	Only patents (filed or granted) are counted	Determine by higher authority	Patent citation also be included for evaluating the importance of patent	Facilitate quality based patenting.
Well defined industry-linked objective in thesis proposal	Not present	None	None	Make it a compulsory part of doctoral program	Increases the relevance of research
Focus on multi- disciplinary use of research	Infrequent	Individual based	None	Joint supervisors / collaborator from different places	It broadens dimensions of innovation
Regular training course on IP	Partially present	Short term ToT Programs	None	Held on regular basis in each semester.	Enhancing IP awareness

Developing innovation centers/laboratories for multi-disciplinary research with industrial collaboration/MOU	Insignificantly Present	Through industrial consultancy	Policy and norms of the Institute	Encourage such activity explicitly	Support competitive industrial growth and HR development
Change focus from isolated applied research to collaborative one involving basic/ fundamental research	Present on individual level	None	None	A procedure for recording and analyzing the updated knowledge is required.	Increase chances of breakthrough innovation
Active mentorship and monitoring from industry	Scarcely present	None	None	A resource personnel pool may be formed involving the local industries.	Enhance the scope for better professional learning.

Table 7.3: Strategy II: Measures and strategic recommendations for patent process simplification & customization

Actions	Present Status	Current approach	Evaluation Criteria	Recommendation	Remarks
Well defined information disclosure process	Partially	None	Committee based	More proactive administrative action is required	Facilitate patent filing
Separate fee structure for applicants from HEIs	None	None	None	Nominal low fees for application	Promotes patent filing
In-house patent agent to draft patent application	Partially Present	Contract with private patent consultant	None		Quick and effective drafting of patent application
Separate patent application examination for academic inventors	None	None	Same for all types of applicants		Fast settlement of patent application

Establish well equipped technology transfer office	Available in few institutes only	Governed by the relevant policies of institute and industry	Policy based	More proactive administrative action is required	Facilitates revenue generation

Table 7.4: Measures and strategic recommendations related to research & teaching other than strategy I & II for enhancing academic IP creation

Actions	**Present Status**	**Current approach**	**Evaluation Criteria**	**Recommendation**	**Remarks**
Design syllabus in reference to practice industries of the subject for relevant interaction through class room teaching	Partially Present	Industry referencing in syllabus is insignificant	None	Establish a procedure for syllabus designing with support from industry	Industry references should be contemporary
Create advance research facility	Moderate initiative	Government supported resources	Expert Committee evaluation	Establish industry supported facilities of techno-commercial interest	Improve confidence level of cooperation
Comprehensive consideration of wild thoughts on probable solution	Partially active	Present in research	Evaluated by research	Require more professional	Use market oriented subjective

to a problem		proposal	committee	evaluation procedure	consideration
Align research potential in the industrial context	Partially	Through consultancy project	Informal peer review	It should be done in the planning of any research activity	Improves involvement of HEIs in National economics
Generating reference and contact of prospective users of research outcome	Not present	None	None	Develop a proper structure for industry referencing	May help in deliverance to the society
Promote research with market potential	Present at individual level	Through external funding agencies	As per policy of the institute and funding agency	Monitoring committee with the representation of relevant industries should coordinate	May truly establish research for the society
Facilitate active industry interaction for thought provoking research of commercial interest.	At times	Through industrial visits	None	Boost industry interaction for stimulating thought provoking activities through close cooperation on current interest.	May bring up object oriented thought process for innovation
Creation of better environment for	Present at	Use of existing	None	Explore the	Requires more

structured innovation	individual level	resources		possibility of making this activity formal	organized effort
Monitoring and Controlling of project performance	Partially present	Informal	Evaluation Criteria: Determined by institute policy and administrative procedure	Designing a formal process of evaluation	Establish authentic and timely delivery system

7.8 Conclusion

In this chapter a comprehensive description of strategies and their related actions, which are required for enhancing IP creation in Indian HEIs, are given. By the application of Soft System Methodology we have come to reveal the role of various stakeholders and entities of Indian HEIs. The rich picture helps us in framing the duties and responsibilities of individual units working in a typical Indian HEI. Based upon these insights strategy formulation was done which leads into two major strategies catering to increase patent awareness level and patent process simplification. Various actions and recommendations along with their present status are also presented under different tables in this chapter.

CHAPTER-8
DISCUSSIONS, IMPLICATIONS, AND CONCLUDING REMARKS

8.1 Summary of Research

This thesis tries to reduce the paucity of research work in existing literature in the field of IP and HEIs. For the purpose, the research was undertaken to analyze and measure IP creation capabilities of Indian HEIs and proposed models (one qualitative and one quantitative) which cover both the analyzing and measuring the critical factors of IP creation. These models are presented in Chapter 5 and 6. The qualitative model describes the existing relationship within the enablers & barriers of IPCC. The statistical structured model of IPCC is given in Chapter 6.

Chapter 1 gives a back ground about the issues that are taken up in this research. It includes the problem statement and research questions that are needed to undertake for achieving the research objectives that are formulated after literature review in chapter two.

Chapter 2 develops the literature background that is needed to further execute the research study. The basics of IP are also covered for better understanding of the issues pertaining to the IP creation capability. The existing literature on IP is reviewed systematically to identify the research gaps and support the need of conducting the research. Literature review for the factors of IPCC was also carried out which critical factors under four major criteria viz Policy & Strategic Support; Incentives; Research infrastructure competence; and Work Environment Culture. The sub factors clubbed under were: Availability of IP policy, Awareness about IP filing process, Industry academia collaboration, TTO, Government Schemes, Promotion/CAS (Carrier advancement scheme), Monetary, Prestige, Research facilities, Subscription of Journals/Patent database, Funding (Public & Private), Technology Incubator, Education/Training, Work Load (teaching & administrative), Salary, Autonomy, and Geographical location.

Chapter 3 deals with the methodology that was followed for present research. This chapter included description of research objectives, research questions and hypothesis formulation. It also gives a detailed description of research approaches covering all the three types i.e qualitative, quantitative and mixed one, giving their advantages as well as disadvantages of using these. Scale development process is also discussed with explanation of sampling design and data collection procedure followed for developing scale.

First objective “To compare and contrast role of HEIs in economic development of India vis-à-vis some other nations with reference to Intellectual property rights” is carried out in Chapter 4 of the thesis using the secondary content analysis and data triangulation for validation. There are many factors on which economic growth and development of a country depends. As the world has moved from the industrial revolution to knowledge revolution and from an industrial economy towards a knowledge economy, there has been a major change in the arrangement and importance of the factors responsible for economic growth. One such entity is higher educational institutes (HEI) whose role and contribution has become crucial for prosperity of a nation in the last two decades or so. It has been observed in many instances that education and more specifically higher level education has a vital role to play in supporting sustainable development (Isaksson et al., 2009). The findings of this chapter justified the crucial role that higher education plays in the economy of a country and also explains their increasing contribution for economic recovery.

The interrelationship between the factors of IP creation is formulated with the help of ISM and MICMAC analysis. The findings and final qualitative model are presented in Chapter 5 which shows that factors “Government Schemes” and “Availability of IP policy” are the drivers of the IP creation in HEIs. While factors like Work Load (F8), Incentives (F7), Monetary Incentives (F6), Salary (F9), Geographical location are (F17) are the dependent variables in ISM model.

Chapter 6 presents the scale development process for measuring IPCC in HEIs. The section gives a detailed theoretical background necessary for hypothesis formulation. The items are generated with the existing literature and FGDs. An expert panel is also formed for better questionnaire construction. Dimension reduction was carried out with exploratory factor analysis using SPSS 21 software. Further the scale was refined with Confirmatory factor analysis which checks the internal consistency, convergent validity and discriminant validity of the constructed measurement tool. Hypothesis testing was done using smart PLS 3 software to form SEM model and establishing the links between the four construct viz Policy & Strategic Support; Incentives; Research infrastructure competence; and Work Environment Culture.

Chapter 7 caters to the fourth objective of the thesis i.e “to propose strategies for enhancing IP creation in Indian HEIs”. For achieving the objective Soft System Methodology (SSM) was employed on outputs of FGDs and interviews with the senior level academicians. This section suggested strategic actions and recommendations to various specific actions that are carried out

in the existing higher educational system taking into account of present status, current approach used and evaluation criteria followed currently.

Chapter 8 presents concluding discussions about the finding of the analysis. The implications; future scope and avenues for further study on IP creation capability are also given in this chapter.

8.2 Conclusion

The conclusions of this research work are summarized as follows:

- It is believed that HEIs contributes to the Gross Domestic Product (GDP) of a country. In this study, the role of HEIs (with reference of Intellectual Property) in economic development of India and other nations are compared. For this study, the gross domestic product (GDP) is taken as the parameter for the national economic development and the analysis is performed for the top 15 countries of the world based on their gross domestic product. Dataset from various international sources like UNESCO, World Bank are used for secondary data analysis. The decision determinants used in mapping the position of HEI are student enrolment in higher education, university ranking, expenditure incurred by government, export of high technological products, research publication, employment rate of researchers and interaction of industry with academia. The results support the idea that the higher education is one of the factors that help in national economic development. But the determinants have mixed distributions among the countries and the weightage of these dimensions of pattern followed are different from one country to other country. The developing countries tend to spend more on higher education. Countries are usually spending 1.5 to 5% of their GDPs on higher education. There is considerable evidence that countries which spend more on development of higher education based research they get benefitted from the investment financially, but this linkage can be very complicated. The results are in line with previous studies which highlights the role of Indian HEIs like IITs, NITs having young team of researchers in the development of various industrial sectors (Momaya & Lalwani, 2017).

- The various variables of IP creation and their relationship is identified in Indian HEIs. Based on the review of literature and discussion with the experts, this research has identified 17 enablers and the relationship among them. Interpretive Structural Modelling (ISM) methodology is applied to arrange variables that influence IP creation.

These results show that availability of “IP policies in an organization” , “awareness about IP methods” & “filing patent applications and research facilities” present at the institutions have the highest driving power i.e. they influence the other variables in creating IP. The variables that possess high driving power are to be taken care first as there are some dependent variables that could be influenced by them. The IP variables that have high driving power are more of the strategic orientation, whereas the variables with more dependence power are towards the achievement of effective IP.

- A key finding in this research is the development of a scale for measuring the IP creation capability of an HEI. A structural model is also been proposed that establishes a relationship between IPCC and its constructs. This scale is developed considering the institutions which are basically government funded and having some elementary awareness about IP issues. For scale development four dimensions- policy & strategic support, incentive, research infrastructure competence and work environment culture are used. Four direct and one indirect hypothesis related to IPCC are formulated and tested using. The hypothesized findings indicate that the all four constructs support IP creation and the construct “incentives” has a mediating effect on IP creation capability. “Policy & strategic support” found to be second most important construct. The scale for IP creation capability in HEIs developed in this study provides practitioners with a reliable and valid analytical tool for the measurement of hands over the managers or practitioners a suitable tool for measuring faculty’s perceptions about IP. This research also confirms the validity of SQM-PLS application in HEIs capability of generating IP.

- The strategies for enhancing IP creation in HEIs are also suggested in this work. For this purpose, Soft System Methodology (SSM) is used which has always been suitable for complex administrative systems, Through “rich picture” and “CATWOE analysis”, a related conceptual model for implementation of IPCC in HEIs is constructed and strategies are formed for filling the gaps between the conceptual model and real world activities. This work suggested strategy mix for patent awareness and patent simplification & customization.

8.3 Contribution of the research

Some of the important value addition made through this research are listed as follows,

- The comparative study of the fifteen countries regarding HEIs provide a hint for the countries to know where they are standing in the world statistics. It could be helpful to

other countries, where higher education is lagging, to show them the direction in which they could proceed.

- This study provides a relatively comprehensive review of the literature and identifies the IP enablers for IP creation in HEIs.

- A questionnaire based survey of higher institutions is conducted to investigate various issues of Intellectual Property Creation Capability and its integration in HEIs. A total of 543 respondents participated in this survey from HEIs where Technical Education Quality Improvement Programme is running.

- The present work develops a framework for guiding the implementation of IPCC in HEIs. For this purpose, Soft System Methodology (SSM) is used. The strategies are proposed for the implementation of SI for four dimensions "Policy and Strategic support, incentives, research & teaching and work environment culture.

- This study identifies the variables of IPCC through ISM

- A scale is developed for the measurement of IPCC in HEIs in the present work. Further, the relationship between IPCC and its constructs is established with reference to Indian context. All the hypotheses are tested for their significance.

8.4 Implications of the Research

8.4.1 Managerial implications

- An ISM framework is developed to find the interrelationship among IP variables for higher educational institutes. The framework comes out with the identification of IP variables that have high driving powers and IP variables that have high dependence. This result helps management to give attention to these variables accordingly.

- The scale developed for the measurement of IP factors could help institutions to measure their capabilities and further to improve it.

- The scale developed could be used for formulating policy for enhancing their IP creation capability. Through the qualitative model, the practitioners could identify the interlinkage of the enablers for improving the decision making process.

8.4.2 Academic implications

- A bibliographic record provided in the literature review of the present research work may work as a guideline for future work in this field of study.
- The study of IPCC in HEIs is probably the first of its kind in Indian context. Therefore, it may serve as a starting point for further research in this area.
- The comprehensive questionnaire and the scale developed can be used with some modifications to serve as a benchmark for further research instruments in HEIs.
- Further research could be initiated on other issues of this research work, according to their geographical area and setup.
- The assessment of issues related to IP creation in HEIs may be used as teaching support for the development of case studies.

8.5 Limitations

Every study has some limitations and this study is no exception. This section highlights some of the limitations of present research.

- The sample of the study is from Indian HEIs and hence the results are specific to this region only.
- The study is conducted on limited number of HEIs which could be further increased to generalize the finding. These findings could also be validated with large sample size and using different statistical tools.
- Another limitation is that we have only considered patent for the study. Other IP like copyrights, industrial designs & GI may also be considered.
- The scale is developed for Indian conditions. It may not function properly in other countries that have different atmosphere from our country.
- The analysis cycle of SSM is conducted only once in this study. For better results, the implementation of the suggestions should be attended more than once.
- The ISM method was developed with the help of experts of respective fields. They, as being human, can have biased views individually or in groups.

8.6 Future Scope

The limitations with the present research work provide avenues for future studies. Some of these are listed below:

- Although in higher education, faculties are considered as primary source of Intellectual Property generation, but apart from faculty members, future studies may include students, as they are also involved in research activities which may lead to IP creation.

- This work suggests some other areas of further research, for example, taking this work to higher level, the relationship between IP creation capability & commercialization of patents through spin-of or start-ups could be researched.

- The strategies suggested by the study for enhancing IP creation capability are at generic level. Future studies could be counted for any specific group of HEIs having similar features and characteristics.

- There is a future scope in validating the proposed strategies empirically.

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APPENDIX

Questionnaire

About Questionnaire

The present questionnaire is divided into two sections. Each section is supposed to collect particular information. Section –I consist of questions related to demographic information of the respondent and some basic facts about the institute in which he/she is working.

Section –II comprise of questions related to the IP creation capability.

Instructions

1. Please read each item carefully before answering them.
2. Indicate your decision by placing a tick ("√") or cross ("×") in the box to the right of the items.
3. Make sure to complete **ALL** the items.

Section–I

1. Demographic Information of the respondent and the institution

Name: ……

Position:……..

Name of Institute/ University:……

Email address: ……

Age:…… Gender:……....

2. Type of institution

i.	CFTI (Centrally Funded Technical Institute)	
ii.	Central University	
iii.	State University	
iv.	Deemed University	
v.	Private Institute	
vi	Other:……..	

3. Does your institute have an IPR Policy? Yes ☐ No ☐ Not aware ☐

4. Does your institute have an incubation center? Yes ☐ No ☐ Not aware ☐

Section–II

5. Please indicate your response by ticking (√) in the appropriate boxes, to indicate level of agreement to the each statement in reference to your Institute.

		Strongly Disagree (1)	**Disagree (2)**	**Can't Say (3)**	**Agree (4)**	**Strongly Agree (5)**
1	There are guidelines and a basic framework to settle IP disputes in my institute					
2	Institute IPR policy is reviewed internally and with stakeholders on periodic basis					
3	IP agencies/consultants are deputed by institutes for processing IPR applications					
4	Our institute encourages regular visits of industry experts to the campus					
5	My institute creates opportunity to develop MOU with industries					
6	Faculty members go on deputation to industries.					
7	My institute facilitate the licensing of academic patents					
8	A fair share of income generated from technology transfer is been given to the researcher at my institute					
9	In my Institute awareness programs related to IPR are organized frequently					
10	My institute is regularly					

	updating the research facility					
11	Allocation of funds for innovation remains a top priority					
12	Separate department/ office is functional for carrying out innovation related activities					
13	Process of identifying the innovation at an early stage is present at the institute					
14	My institute has access to various reputed paid international journals from different domains of study					
15	My Institute has access to national/international IP data bases					
16	There are frequent programs organized by institute to enhance skills of faculty & staff for future needs					
17	The faculty and staff are well trained for innovation.					
18	At our institute the professional and pedagogical qualification of the faculty is up to the mark					
19	Regular seminars and workshops on IP fillings are organized by the administration					
20	Training of teachers programs on IP & innovation are conducted from time to time					
21	The faculty and staff keep themselves updated with					

	contemporary research knowledge					
22	The faculty member has good academic experience					
23	Faculty members have sufficient time to conduct research					
24	Faculty members are burdened with extra academic duties					
25	Faculties, departments, laboratories and administrative units act independently					
26	There is coordination between students and faculty members.					
27	Seniors level professors help their subordinates & students					
28	Long-term relationships are developed within the faculty fraternity					
29	Supervisors guide their scholars at every step of research					
30	There is suitable platform to exchange ideas for interdisciplinary research					
31	Monetary benefits are given by my institute for obtaining an IPR like patent					
32	IP related achievement are counted for carrier advancement					
33	Proper recognition is given to person who obtain an IPR					
34	My institute follows an IP based carrier advancement scheme					
35	Regular evaluation and updation					

	of the curriculum is carried out at institute level					
36	There is induction of IP teaching in syllabus					
37	There are programs running in my institute to broaden entrepreneurial skills of faculty and students					
38	Focus of learning is more on developing innovative thinking.					
39	The faculty frequently tries out new ideas in teaching					
40	Students are more inclined towards the professional subjects than any other disciplines.					
41	A proper system is present in my institute for delivery of innovation to market place					
42	Institute has good number of collaborations with R&D labs regarding sharing of research and ideas					
43	Institute is successful in commercialization of Institute based Intellectual property					
44	Students at my institute seeks new ways of doing things					