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Role of Triple Helix in Emerging Regional Innovation System of Bangalore

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Abstract: Triple helix concept is old and well applicable in developed nations but in developing countries it is not so old and hardly applicable. It consisted on three basic elements of regional innovation system which includes government, universities and industry. Rather then taking regional innovation system as a whole now a day more emphasis is on these three key elements because of their great importance in the system. It is about how these three elements interact with each other and make a successful system. This study is mainly concern about the contribution and a generative role of universities in Bangalore regional innovation system. This study is also concern about how government, industry and universities interact and strengthen RIS of Bangalore. This study is also concern about how universities and science and technology parks strengthen IT industry of Bangalore and what are the weaknesses in Bangalore system. It is conclude that universities in Bangalore are actively playing a generative role by generating, exploiting and diffusing knowledge along with providing highly developed trained human resources and basic research in the shape of technological and scientific knowledge, human skills and human capital. It is also concluded that where in past Bangalore government, industry and universities were playing their role by restricting themselves in their institutional boundaries and working as isolated entities, now they are cooperating with each other by coming out from their traditional tasks and doing mutual efforts. Number of STP's increased in the country and they played key role in the development of IT industry of Bangalore.

Keywords: Bangalore, regional innovation system, triple helix, India, government IT policies, universities, IT industry, developing country, generative role

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List of Abbreviations

AICTE	All Indian Council for Technical Education
CET	Common Entrance Test
CISCO	Commercial & Industrial Security Corporation
CMM	Capability Maturity Model
CSIR	Council of Scientific and Industrial Research
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GPRS	General Packet Radio Service
HCL	Hindustan Computers Ltd
HEIs	Higher Education Institutions
HP	Hewlett-Packard
ICT	Information and Communication Technology
IMB	International Business Machines Corporation
IP	Intellectual Property
IT	Information Technology
ITES/BPO	IT-Enable Services/Business Process Outsourcing
JV's	Joint Ventures
M&A	Mergers and Acquisitions
MHRD	Ministry of Human Resource Development
MICO	Motor Industries Corporation Limited
MIT	Massachusetts Institute of Technology
MNC	Multinational Corporation
MPEG	Moving Picture Experts Group
NAAC	National Assessment and Accreditation Council
NASDAQ	National Association of Securities Dealers Automated Quotations
NASSCOM	National Association of Software and Service Companies
NNE	National Network of Education
ODC	Occupational Development Center
OECD	Organisation for Economic Co-operation and Development
PRS	Public Research Laboratories
PUC	Pre University Course
R&D	Research and Development
RIS	Regional Innovation System
SEI	Software Engineering Institute
SME's	Small Medium Enterprises
SSLC	Secondary School Leaving Certificate
STP	Science and Technology Parks
TNC's	Transnational Corporations
UGC	University Grant Commission
UNDP	United Nation Development Programme
WAP	Wireless Application Protocol
WIPRO	West Indian Professionals Outsourcing
WTO	World Trade Organization

Chapter 1 Introduction

Bangalore was founded in 1537 and it is the 6th largest city of India. From the period of 1831-81 in India it was the seat of British Government. This city is situated far away from all borders and that's the reason of establishment of military infrastructure there and such initiative was the first step in this city toward high technology research (Grondeau A., 2007).

Bangalore is the capital of Indian state Karnataka and it is the 3rd most crowded city and 5th most crowded urban agglomeration. For many well known research institutions and colleges in India Bangalore is known as home to them. Various public sector software companies, heavy industries, telecommunication, aerospace and defense companies are situated in Bangalore. As a leading IT exporter of India, Bangalore is known as Silicon Valley of India. Bangalore is a key cultural and economic center of India and also known as fastest developing key metropolis in India. It covers an area of 741km-square and on the globe positioned at 12.97 degree north and 77.56 degree east. Coolest month is January with average lowest temperature 15.1 degree centigrade and hottest month is June with average 33.6 degree centigrade. For civic administration of the city Bruhat Bengaluru Mahanagara Palike is incharge. By including City Armed reserve, Traffic Police, City Crime Branch Bureau and Central Crime Branch Bangalore City Police has six geographic zones and 86 police stations which included two women police stations. Through Bangalore Electricity supply company electricity in Bangalore is regulated. After 2001 there is no population censuses data available for India but according to 2010 estimates population of Bangalore is about 5,438,065 (Wikipedia/Bangalore).

This paper is concerned about the support of public research organizations and universities in initiating, sustaining and maintaining growth of regional innovation systems in Asian nations represented by Bangalore, India. Policy makers and researchers over past two decades more and more recognized importance of academia and other publicly financed research organizations as main part of knowledge based development

and improved innovative experiences in advanced economies. Particularly in regional economic growth viewpoint motivated by story of Silicon Valley, expectations on the existences and contribution of universities on regional high technology agglomerations are high (OECD, 2007).

1.1 Aim of Study and Research Question

Furthermore this paper will be concerned about the role of Government especially from policy point of view, educational institutions especially universities point of view and industries specially IT industry of Bangalore. By using qualitative approach this paper aimed to study what kind of role government and universities can play in initiating, sustaining and deepening Bangalore regional innovation system for software industry and Information Technology services. This will be done by focusing on the particular policies of the government along with particular strategies of the universities and firms situated there.

1) How universities contribute and play a generative role in Bangalore?
2) How government, industry and universities interact and strengthen RIS of Bangalore?
3) How universities and STP's strengthen IT industry of Bangalore and what are the weaknesses in system?

1.2 Delimitations

On the limitation side this paper is not going to discuss about interaction or communication among government, universities and industries how it takes place which is specific capabilities and competences of the government, universities and industries particular needs especially in growing nations. This paper is also not concern about the development role of universities. This paper is more concern about generative role of

universities in regional innovation system of Bangalore and in Bangalore IT industry growth.

1.3 Theoretical Outline

Study will be divided into different possible parts and in first part little introduction and background of topic will be presented. Second part of thesis will be based on theoretical base in which theoretical base will be formed by explaining regional innovation system and generative role of universities in triple helix. Major concern of this study is to investigate the generative role of universities in triple helix of universities, industry and government. Due to such reason major emphasis will be on performance and generative role of universities in Bangalore. Universities will be investigated in respect of their generative role. In third chapter government role and initiatives from policy point of view will be discussed along with industry role and development and universities role and contributions in Bangalore. In fourth chapter regional innovation system in developing countries will be discussed along with weaknesses and deficiencies in Bangalore system. Fifth chapter will be based on analysis and finally after that there will be some concluding remarks in the last section.

1.4 Methodology

In this study "Qualitative Research Methodology" will be used. Qualitative research methodology aimed to investigate deeply understanding of human behaviour and what are controlling it. It emphasizes on word rather than quantification in the analysis and collection of data.

It is like that if people want to investigate some specific phenomenon then some time they have to acquire appropriate linked information or else some fundamental information for it. In societal studies qualitative research is one of the earliest forms. Qualitative science was very popular during the period of 1950-60. During 1970-80 its used begins in other regulations and become an important form of research in the field of education learning's, disability studies, societal work learning's, administration studies,

females studies, nursing studies, psychology, human services studies, communication studies and others (Hakim, 2000).

Under qualitative research methodology there are four forms of data collection which includes participation approach in which researcher become part of that specific area or group which they want to study for a cretin time period. Direct observation is another form of data collection under qualitative approach, in this data collection method researcher directly observes desired information. Depth interview data collection is third kind of data collection under qualitative approach, in this data collection method researcher collect information through interviews from chosen sample. Analysis of documents and materials is the fourth kind of data collection method under qualitative research methodology. This data collection methodology is selected to be used in this research. In this data collection methodology researcher collect data from various historical done researches, reports, journals, articles and survey reports (Hakim, 2000). Under this kind of data collection the main disadvantage is some documents are might be sensitive and not publicly available. Such documents might be very useful for research but due to their sensitive nature it becomes difficult for researcher to access them and use them.

In qualitative research methodology investigator thought is the key form of data analysis. Data investigated by the expert or layman and build an impression and after that reporting of such thought in an ordered typically in quantitative outline. After all such things those thoughts will be the final results (Hakim, 2000).

In qualitative study reliability is one of key issue. With the use of many ways it can be established for instance member check or interviewer corroboration, negative case analysis or prolonged engagement, bracketing, conformability and balance or audit ability. Validation is naturally grounded on viewpoint of positivism. Validation is important as the research itself for the positivist perception (Hakim, 2000).

For this study data will be collected from different already done researches, survey and annual reports and websites specially Ministry of Information and Technology and other related Indian Government websites. Data will also be collected from Newspapers and Books.

With the passage of time very rapidly triple helix approach diffused globally and being more and more used in policy circles. Where it reaches to the other part of world also reaches to the many Asian Countries as new model for the design of innovation strategies. Theoretical framework used in this study is based on the conceptual framework developed by the Gunasekara C., 2006 in his study ''Reframing the Role of Universities in the Development of Regional Innovation Systems'' and the research conducted by Chaminade C., 2007 in ''Learning from the Bangalore Experience: The Role of Universities in an Emerging Regional Innovation System''. During this recent study these models are used with little modifications by including regional innovation system concept in little detail. More emphasis is on generative role of universities and the other role performed by universities which is development role and explained in these conceptual frame works developed by these researchers will also be discussed in theoretical base. Development role of universities will be discussed from the further research point of view and for the better understanding of readers to understand these two roles of universities.

For growing nations such issue is very applicable. Some current studies highlighted that in developing or growing circumstance use of triple helix concept is problematic. In many cases collaboration among university, government and industry does not become visible because of deficiency of power, resources and weaknesses of various actors engaged in system (Chaminade C., 2007). Very few researches are available on Bangalore from this research topic point of view. An effort has been made to use different researches done on this city and which are close to this topic and helpful in this research. Due to unavailability of current facts and figures some old facts and figures are used to support the study.

The validity parameter has been consistently considered during the whole research. Relevant sources of secondary data were used to get accurate secondary data. Author used officially published information by corporate websites. Articles published in renowned electronic databases for instance Emerald and Business source premier has been used. Utmost care has been taken to avoid unofficial and unauthenticated information to be used. In order to increase reliability during theoretical data collection process, author has used renowned authors from different regions and decades.

1.5 Background

India is a developing country and day by day their development process is increasing and in its development processes some cutting edge new sectors for instance information technology contributing a lot. Indian Information Technology industry attains international attentions not only because of its large scope in international markets but also for the reason that it is a pioneer ahead of its Western peers (Gustavsson, 2006).

In respect of IT industry India is a serious competitor for developed countries and considered to be a giant but as it is a developing nation so have weaknesses also. Total area of India is $3{,}287{,}263\ km^2$ which include 90.44 percent land and 9.56 percent on water and has population more then one billion which is 17 percent of total world population. Only 60 percent Indians know how to read and write and with such percentage interestingly represent potential market. In addition to this $520.3 only is the GDP per inhabitant and with more than 1000 euro a month 35 million Indians lives. 430 million Indians live with less than one dollar a day which is defined as poverty line. In respect of human development index out of 130 nations UNDP rank India on 127^{th} number. Because of such reasons with strong inequalities India is a giant (Grondeau A., 2007).

Until the starting of recent century research in most of the advanced economies for instance in United Sates was accomplished mostly inside the university, because of traditional scientific independence, specialization and Intellectual freedom. As a new

research driver profit was introduced when in the early 1900s industry start doing its own R&D programs. Later on to promote such kind of systems and relationships as primary sponsors of research industry, academia and government relationships were established. With the passage of time these concepts diffused and reached to other nations also all over the world. Encouraging innovation and providing a regulatory environment government plays a progressively more vital role. Not only with contract research and consulting academia is involved with industry but also involved through university based research forming companies. Academia, Industry and government triple helix relationship is established in new organizational systems which encourage innovation and new mutual activities (Jerome L. W., 1999). The association among industry and science has shifted from linear models of innovation of 1960s to non linear models and industry, university and government triple helix association in framework of knowledge based economy has been attracting attention. While having this thing in mind it is becoming more vital to realize changes and trends in association between industry, university and other sectors in regional innovation systems and also in national innovation systems (Sun Y. & Negishi M., 2010).

1.5.1 Background of IT Industry in India

According to Bratt (2006) Indian software industry growth started from 1990's and per year has grown on average 30-40 percent since 1992. In such period it has been the industry in India with highest development rate. With following factors development can be explain for instance good timing, government support and excellent India's educational institutions from where large number of scientists and engineers graduating each year. For the development of this sector another important factor has been the existence of foreign companies in country. Mainly in the past 15 years MNC's have entered the country but few companies had an impact on growth of industry previously in 1970's and 1980's. Mostly foreign Multinational Corporations are situated in Bangalore city and there is experimental proof of various kinds of positive effects of their existences there. From the existence of foreign multinational corporations Indian IT companies

gained opportunities related to business for instance new organizational capabilities, new business models and access to a satellite link through which they could export .

According to NASSCOM Information Technology Industry of India comprises on two sectors which are,

1) Actual IT Sector: consisting on hardware, software and Information Technology and training companies.

2) ITES/BPO sector (IT-Enable Services/Business Process Outsourcing)

In the fiscal year 2003-04 Indian software companies accounting for 79 percent of IT companies and for exports they are accounted for 75 percent of the total software sectors revenues. Key markets include Western Europe and US. As compared to the domestic market software exports increases faster that's the reason share of exports has actually increased over time (NASSCOM). Software industry grows from 0.36 percent to 2.6 percent of GDP in 1996-97 to 2003-04. In the past two decades number of software companies also increased rapidly.

In Bangalore today around 350 foreign companies are located. During 1990's to 2000's nearly all European and US leading IT companies have build software facilities in India and their exports are generally going to the parent firms. Generally in India foreign multinational corporations carry out four kinds of activities which include customer and sale support services, ITES/BPO, high end R&D laboratories with a high level of self-sufficiency from parent firms research and development and high end R&D activities which support the parent firms research and development operations. Customer and sale support activities, low end software development activities and ITES/BPO are the most common activities (Bratt, 2006).

1.5.2 Reasons for Bangalore Development

According to Athreye (2003) Bangalore software success is because of software clusters in various places in India for instance in Pune, Hyderabad, Bombay and Madras and majority of firms related to software industry are located in Bangalore. In India on emergence and development of software clusters various explanations are available. From these various explanations one of the principal explanation is the presence of large number of educational institutions in the field of science and engineering. From 1990s demand for engineers rose in the country and educational institutions respond with substantial increases in number of graduates. Sate support is another important factor in this success for instance Indian government has provided duty free hardware imports, installation of satellite facilities, freedom from income taxes, tax vacancies for companies working in software export zones and technology parks and exclusion from tiresome customs and export green light procedures. Such factors improved situations for both foreign and domestic software companies. Along with other factors FDI also play vital role in software industry growth.

According to Giarratana et al. (2003) presence of outstanding universities and healthy climate are also reasons for the emergence of software sector particularly in Bangalore. Such factors attracted both companies and people to locate there. State owned space and defense research centers in Bangalore are also important reasons for its development which provide good engineering knowledge and good communication skills. Because of the city location away from Indian Borders Bangalore was selected city for such technology intensive industries.

1.5.3 Knowledge Base Economy and Triple Helix Concept

A paradigm change is in process which encourage new ways of collaboration between industry, university and state agencies linkages with an importance on integration of empirical knowledge, commercialization and public good. Further more a triple helix of

be related areas of industry-university-state is getting more famous and getting more attention inspite of side-line of multinational, regional and national innovation systems (Jerome L. W., 1999).

Innovation systems research gives much importance to the contribution and important role of government policies, universities and industries relationship to enhance the innovative performance and growth in regions. For industrial innovation universities are considered being the creator and provider of spillovers of knowledge and in national and regional innovation system also consider being the key actors. Fundamentally triple helix concept or story has been mostly shows or explained as new policy paradigm which put universities at the center of knowledge based regional economic growth. It clearly looks for reshaping academia into entrepreneurial universities and to support industry-university-government linkages. Under these prototype it is believed that in respect to connect scientific knowledge for innovation, linkages of university and industry have to be encouraged with different systems and methods for instance establishment of incubator centers and science parks, promotion of academic entrepreneurship and setup of an infrastructure which support or facilitate technology transfer (Chaminade C., 2007).

In triple helix model of knowledge based economy key institutions which are defined first include university, industry and government. Nevertheless such institutions hold of a system of innovation which might be anticipated to entertain a dually layered set of connections, which include one layer of institutional associations in-which they control each other behaviour. Other layer based on their functional relations in which they shape each other expectation. For instance functions of industry and university association can be performed by various institutional arrangements like licensing agreements, spin-off firms, transfer office, etc. Institutional associations give us with network data but in knowledge based economy functions are judged in respect of transformative dynamics. In the structure of expectations knowledge base of an economy might be imagined as particular configuration which responded as a transformation system on the institutional arrangements (Leydesdorff L., 2010). Knowledge based growths can be well thought-out as a system which is reconstructed by increasing interaction with other sub-systems of

society. Attention toward non linear interaction among technological options and market perspectives are first drawn by evolutionary economists. At social level all network sub-systems for instance markets, technologies, institutions, etc are indirectly constructed and sustainably reconstructed. Thesis's related to triple Helix concept focuses on the interaction between these different interfaces. Various stakeholders for instance universities, industry and government re-combine from their particular viewpoints (Leydesdorff L., 2001).

Behind the notion of innovation systems one of the key concept takes place both within companies and transversely the boundary between institutional agents like industries, universities and government agencies. Systems of innovation differ in respect of how the changes through the set of connections are incorporated and whether the various changes give opportunities for synergy. The set of connections gives only knowledge infrastructure and at the same time formed knowledge base of a system of innovation by distribution of innovative labour at regional or national level. For the strength of an innovation system the synergy among geographical distribution, industrial structure and academic traditions can be well thought-out as key to the system (Fritsch, 2004).

To investigate the relation arrangements between such agents (agents mean government, universities and industry) triple helix of industry, university and government up till now developed mainly as a neo-institutional model. In an explanation to neo-institutional model it consisted on the process by which structures as well as rules, routines, norms and schemes become recognized as reliable guidelines for social behaviour. It investigates how such components are created, adapted and diffused and how they adapted over time and space and how they fall into disuse and decline. To define association between various functions for instance production of knowledge, its diffusion and control which operate in and on such links a neo-evolutionary model used by Leydesdorff and Fritsch, 2006 in their study. In an explanation to neo-evolution model it is apprehensive with directional, long term and evolutionary social change and through usual patterns of growth that might be seen in dissimilar, widely separated cultures. Agents which are university, industry and government carried out functions on the nodes

but one cannot expect one-to-one communication among institutions and functions because functions are also based on arrangements between institutions. From the presence of state agencies their quality of relations in a given configuration is more important. Functions are executed by various associations and agents so one can imagine an improbability which can be calculated as probabilistic entropy. From particular relations widespread effects might happen which cannot be traced back directly but appear more ultimately (Leydesdorff L. & Fritsch M., 2006).

Development of technology and innovation in any industry and the extent of gaining export markets depend on the level of social capital. Social capital is normally explained in respect of norm, trust and network. It is necessary to use social capital to encourage interactive learning in industrial cluster to support sharing and transferring of knowledge between companies. Policies of the local and national government have noticeable effects on key actors of Triple Helix to work mutually and contribute in the direction of the growth of networking culture along with sharing of best industrial practices and collaboration (Yokakul N. & Zawdie G., 2009).

In knowledge economies universities are seen as key driver for economic growth. Such thing highlighted their key contribution in com-modification of knowledge and in increasing number of flourishing high tech clusters, with actions like making of technology parks, support in technology transferring, creation of spin-off companies, licensing agreements and growth of a labour pool of brilliant graduates and scientists. As a result strategy makers more and more promoted advanced education institutions to grow and toughen their associations with industry and business with new venture partnerships and variety of initiatives. On the other hand universities has become more significant part of regional economies instead the ivory towers (Wells P., et al, 2009).

A long time before real contributions and potential of universities has been debated. A major reason in the poor performance of British industry in new electrical equipment and new chemical products which shaped roots of third and fourth Kondratieff cycles was the disappointment of British universities to grow research and teaching competences in

engineering and science in contrast to US universities and German technical universities. Strong collaboration among firms and technical universities in this field make it possible for German companies to beat the other leading industrial countries (Röpke J., 1998).

Recent studies has highlighted the use of triple helix notion in a growing environment is difficult. In majority of situations the communication among university-government-industry does not become visible because of lack of power, resources and flaws of various players engaged in system. Regardless of the importance of their assessment a more practical role of university and a nearer communication with industry is advantageous and with the intention strategy makers should be more aggressively sustaining the evolution from production and reproduction role to growth role of university. It is the most difficult topic when debating the prospect of high tech cluster in India for instance the Bangalore cluster (Chaminade C., 2007).

Chapter 2 Theoretical Base

In this chapter regional innovation system will be explained along with a generative and development role of universities and these two things will be used as theoretical based in this research excluding development role of universities.

2.1 Systems for Regional Innovation

In the theories of economic growth and innovation regions are emerged as an essential tenet. In the quality and types of systems regionally variations are noted along with different ways through which these processes and systems are sustained and developed. With the regional clustering of activities and resources innovation is linked. Regional clustering aimed to shine innovation and advances levels of productivity along with wealth and competitive power. The center of attention on regions as the most excellent geographical extent for an innovation grounded culture economy stresses the significance of regional capital in motivating the competitiveness of companies and innovation capability (Jerome L. W., 1999).

Regional innovation systems consist on human relations set of connections with different social associations. Social arrangement particularly in the shape of social set of connections effects economic outcomes as set of connections influence the quality and flow of information. Social networks have strong ties and weak ties and both ties are important to innovation (Kallio A., et al, 2009).

According to an explanation to regional innovation systems they are public and private organizations which function through organizational configurations and associations that are favorable to the creation, utilization and diffusion of knowledge (Doloreux D. & Patro S., 2004). A RIS is described by collaboration and competition among knowledge generating and knowledge diffusing organizations for instance universities, R&D organizations, firms, training organizations and technology transfer agencies. It is also

describe through culture which support innovation and enables these systems to develop. Innovative activities are encouraged by regional innovation system in two different ways which are 1) in a region presence and availability of inputs or resources to start some innovation projects possible that would or else not be accomplished or started and 2) particularly in local atmospheres where a high level of labour distribution is stimulated keen effectiveness and productivity of innovation development can happen (Fritsch M., 2002).

Three key features of regional innovation systems according to Doloreux D. & Patro S., 2004 include,

1. Through regional communities innovation capabilities are continued and innovation is a geographical process. These regional communities share localized resources and common knowledge bases for instance local traditions for cooperating, local learning process, suppliers, specialized labour market etc.

2. Innovation is rooted in social associations which grow with the passage of time with culturally determined lines. Regional framework succeeds over the set of rules, conventions and standards which form expectations and stipulate behavioral roles. Mostly these are casual social associations establish a particular picture and particular version and sense of be in the right place which increase the local capability of innovativeness through cooperative and synergic learning practice.

3. When geographical proximity and awareness are present innovation occurs.

The extent of innovation and notion of proximity both is changing by globalization. Worldwide geographical diffusion of technology, knowledge and industry is quickly happening with agglomeration to make intense handfuls of particular clusters. To sustain development of an enterprises cluster international connections emerge to be an important thing. Technology transfer, financial flow, interpenetration of business activities and information flow, partnership presents prolonged opportunities for them.

Furthermore it is observed that international associations and connections boost regional movements through opportunities for worldwide knowledge sourcing (Jerome L. W., 1999).

Regional innovation systems have three important mechanism which include,

- Clustering
- Knowledge spillover
- Absorptive capacity

2.2 Clustering

A cluster is a geographic attention of cooperating and contending firms, service providers, suppliers and linked institutions. Clusters aimed to happen in agglomerations. They make it possible to access utmost flow of ideas and information, accessibility of experts, growth of local pool of expert labour, customer choice and superior options, accessibility of opportunities for alliance, suppliers and subcontractors, less risk and competence of specific local services. Silicon Valley is the most famous innovation cluster (Jerome L. W., 1999).

Creations of cluster are realistically unsystematic and inexact exogenous events. However clusters might start by accident with the presence of important firms which create mostly origin of clusters or spin offs because of one or small alliance of companies. Spin offs normally located close to parent firms probably to keep away from load of relocating families and shifting away from community contacts. Such spin offs capable to settlement from preceding business and public contacts. Research on clusters commonly concentrating on parental practices, transfer of routines, blueprints and skills to new firms. Both on informal and formal levels in innovation clusters there is reliable and strong interface among many organizations and individuals. Mostly clustering is observed as main part of driving regional growth by constructing public and private sector corporation to shared benefits in the course of regional and government investment

in science cities and parks, innovation incubators and technology transfer offices. It is also observed that regions which are able to realize clustering outcome by design or accident have continued and attained larger success in worldwide marketplace (Tavares and Teixeira, 2006).

2.3 Knowledge Spillover

Once knowledge has been created its hard to hold it and might be that's why spillover to advantage other who are attentive and talented to identify its prospective. Knowledge spillovers reproduce a stream of most important knowledge from sources for instance the flux of employees among various employers, labour market, purchased services and goods, publication, trade and mutual associations (Jerome L. W., 1999).

According to Aharonson et al., 2004 in isolation knowledge creating actions do not happen but depend on admittance to new thoughts. Therefore locating on one place and geographical attentiveness of innovation doings smooth the progress of knowledge spillovers by given that chances for both unexpected and designed relations potential. This way encourages set of connections of companies involved in associated research.

2.4 Absorptive Capacity

A firm's ability to adopt or develop innovations is called its absorptive capacity for instance firm's talent to recognize opportunities and talent to utilize information for developing products or processes. Better absorptive competence turn out to be available with introduction to a large pool of ideas and in this way companies also benefits from intentional coalition of their neighbours (Jerome L. W., 1999). Firms derive benefits from locating on one place and growing intentional coalitions is reliant on company's ability to exploit on available spillovers. This way stresses the significance of absorptive ability and the distinctiveness of atmosphere inside the cluster to produce positive opportunities (Kallio A., et al, 2009).

According to Cohen, W. and Levinthal, L. (1990) ability of a company to value, incorporate and apply new knowledge is known as its absorptive capacity. Absorptive ability develops skills relating to problem solving and requires learning competence and learning ability is again the ability to incorporate knowledge for reproduction and skills for problem solving to produce new knowledge for innovation. Further more there are two different kinds of absorptive ability which included,

Potential Absorptive Capability

It is significant in obtaining and use of external knowledge.

Realised Absorptive Capacity

It refers to the meanings of transformation and use of obtained knowledge.

According to Upadhyayula R. and Kumar R., 2004 who talks about external and internal social capital. Potential absorptive capacity is increases by external social capital and realized absorptive capacity is increase by internal social capital. In regional innovation systems both are vital. Over the weak ties of innovation systems potential absorptive competence enable the use of knowledge and realized absorptive competence secures the use of knowledge in strong tries of associations. To recognize absorptive capacity distinctiveness better to know about its main parts which includes,

Acquisition:

Ability of a player to obtain and identify knowledge generated by externally and important to his or her functions.

Assimilation:

Ability of a player which allows him to understand interprets process and analyzes such information which was obtained by him or her from externally sources.

Transformation:

It refers to the ability of an actor to improve and grow routine which make it easy for him or her to merge existing and newly obtained knowledge and use it.

Exploitation:

It based on routines which permit actors to improve, grow, and control existing capabilities or generate new ones by using obtained and changed knowledge into their functions.

2.5 Role of Universities in Triple Helix

This section is specifically about the role of universities in the growth of high tech clusters specifically IT. As the IT industry of Bangalore is oftenly referred as Silicon Valley of Asia. That's the reason this section will summarize the role played by research institutions and universities for the appearance of Bangalore IT Cluster.

Teaching and research are two time honoured tasks for universities which are from a long time providing particular skills, ideas and new knowledge's to society. With the passage of time expectations and demands related to universities and their role has been increased a lot. Now days in economic expansion, better forms of governance and political organization and social development, universities are increasingly playing more key roles along with giving education to more and more students and in transferring technology to industry along with developing. In developing and developed world capacity of universities to respond is not enough. To support the development of universities new models include creation of particular or entrepreneurial universities, triple helix, and notion of development universities or large scale excellence driven environments. Eventually most of them propose that universities move towards technology leaning third mission's consequently as quicker relations with enterprises (Göransson B. et al, 2009).

In the systems of innovation universities are always imagined as important factor and currently there is an increase in interest in the particular role they can play in sustaining the growth of various systems of innovation where particular concentration has been given on the professed mission or third task. Universities have three tasks which include teaching/education and research. Normally third task refers to direct dealings among society and university. In various ways it can be explained. Third task or mission of universities for instance can be consulting for local industry, giving guidance to policy makers and politicians, determining the national spatial allocation of social services and opportunities, producing new high technology companies and enlighten general public debates. While previously universities were involved with society in different respects and majority of innovation system scholars aimed to benefit direct economic dealings on other possible roles. Third task or mission mostly refers direct communication among industry and university. In knowledge utilization and knowledge discovery subsystems such direct communication among actors fit extraordinarily fine in a Regional Innovation System structure. That's why third task of universities is mostly advocated from a regional innovation policy viewpoint (Chaminade C., 2007).

Universities play important role in the growth of the immediate economy in which that university is situated. Additionally with university research and their graduates a university might affect economies in many other regions (Armit E., Robert, 2004). Mostly universities are considered as key player in science and technology based economic growth that has turned out to be of attention to catch-up regions in addition to leading innovation locales (Youtie J., & Shapira P., 2008).

For industrial revolution universities are considered as providers and creators of knowledge and as key actors in regional innovation systems and national innovation systems. Specifically concept of triple helix is mostly considered as new policy paradigm which has putted universities at the center of knowledge based regional economic growth. It unambiguously looks for to reorganize academia into entrepreneurial universities and to enhance and give support to interactions among industry, university and state. Under such considerations it is assume that in respect to connect scientific

knowledge for innovation, association among industry and university has to be used through different systems and methods like encouragement of academic entrepreneurship, incubator centers, establishment of science parks and establishment of infrastructure which support technology transfers (Chaminade C., 2007).

Universities have become a major source of regional innovation system with knowledge creation, application and workforce training and other important functions. Some universities in America and Europe in current years leaded the configuration of many technology concentrated regions in the course of scientific and technological innovation or revolution of technological and scientific accomplishments. For example Silicon Valley is the attainment of Stanford University's Scientific and Technological innovation and its industrialization. Universities develop into an important source of production of knowledge in the period of knowledge based economy along with vital effects on encouraging social growth (Lei W., & Ying Z., 2009).

2.6 Universities and their Generative and Development Roles

This section will present an introduction to the development of universities role along with explanation to universities generative and development roles.

2.6.1 History of Universities Role

The global economy places great emphasis on science-rooted technologies. Hence university-educated students and university–industry research collaborations have become the focus of future plans of both government and industry worldwide. Traditional academic and business cultures have begun to accommodate each other in mutually supportive arrangements in the larger interests of a global economy (Bera R., K., 2009).

Up till now, on university system industry had little effect. If we take the example of US then in US the formal transfer of knowledge from universities started with spread of scientific agriculture practices in the course of land-grant university system. Otherwise

majority of academic institutions avoid involvements in real world problems and prefer seclusion of their ivory towers. World War II on the other hand brought a major shift. US, Canada, England and Germany governments turned to their universities for the growth of required technologies to win war. MIT's Radiation Laboratory in United State contributed to anti-aircraft gun control, electronics and radar and Columbia physicists George Pegram, John Dunning, Enrico Fermi and I. I. Rabi served the war effort in the course of Manhattan Project in building atomic bomb. So in 1945 future of research in US changed with spectacular success of academics in designing weapons of war. Both in non-military and military research respect federal funding of academic research steadily roses after war (Bera R., K., 2009).

Many of the inventions that resulted from funding of US Government in 1970's United State government discovered that freely available to public and required more investment to turn them into marketable products. In 1980 US Government realized that they held about 28,000 patents and very few were licensed to industry for growth of commercial products. They resolved this problem with Bayh-Dole Act 1980. Main purpose of such act was to promote the utilization of inventions happened from federal research funding. Universities were encouraged to work together with and encouraged exploitation of their inventions by commercial concerns particularly small businesses though licensing. From public dissemination explanation of inventions were given lawful protection and from requirements under Freedom of Information Act for a realistic period to allow patent applications to be filed. Government keeps a royalty-free, non-exclusive license in return to carry out such inventions all over the world and held march-in rights. Bayh-Dole Act of 1980 brought a revolutionary change in contributions of universities in US by bridging the great divide among industry and university system in US. For instance before 1980 universities in US sought and receive less than 250 patents annually and a decade later they were average 1600. Nearly 80 percent of those come from the federally funded research. From that time research and academic institutions become keen seekers of patents. Where they were just pioneering engineering and physical science inventions to patent in past they started to promote invention disclosures from business schools and computer science departments. Few already have some active offices of technology

transfer paying attention on constructing portfolios and developing plans to guard their patents and to stay away from infringement claims by others. It is widely believed that this Act animated State Governments into targeting universities as engine for economic development (Bera R., K., 2009).

2.6.2 Universities Generative and Development Role

Discussion regarding role of universities in growing nations is important for two reasons. First reason is that knowledge is an essential tool for prevail over underdevelopment and second reason is that knowledge is not a goods that can be purchased and used with little extra effort. A powerful local knowledge foundation is required to be established and maintained for the benefits of world's information to wealth. Current discussion is about the generative and development role of universities (Gunasekara C., 2006).

Over last 20 years role of universities changed and developed from the innovation systems approach. In regional knowledge spaces the research and educational activities carried out by the universities, innovation system approach highlighted value of knowledge spillovers from them toward development of a third role performed by universities in animating regional social and economic growth. Where in past they were more emphasizing on teaching and research inside a worldwide community of knowledge generating institutions now universities are taking on a third role in regional economic growth. This role is redesigning the two customary roles carries out by universities and this role transforming and moving universities as major institutional spheres in economic policies beside the state and industry. This concept based on two bodies of literature which includes triple helix model of university, government, industry relations and literature on university engagement. Universities role has been further divided into two types by these bodies of literature which include generative role of universities and development role of universities (Gunasekara C., 2006).

Gunasekara C., 2006 presents his own conceptual frame work which encompasses the role of universities in the development of RIS. He segregates the role of universities into

two categories (1) generative and (2) developmental for the improvement of regional innovation system. He took into consideration literatures regarding "the triple helix model" and "university engagement".

He further talks about aforesaid categories i.e. generative and developmental possess their own characteristics that can be enumerated on the basis of four key elements of regional system, as found in literature on regional systems and new regionalism.

Such four key elements are:

(1) Regional agglomeration
(2) Proximate stock of (human) capital
(3) Associative governance framework
(4) Cultural norms of openness to learning, trust and cooperation between firms.

These two approaches the literature on university engagement and triple helix model of university-industry-government overlap but they also have few visible vital differences in emphasis. Both bodies of literature highlighted that increasingly universities are connected to place but they present dissimilar analyses of driving forces which shaping that association. In regional economies the triple helix model sharpen the focus on the role of universities by pointing to the expectation of hybrid government-industry-university association which is engaged in the growth of capital and resources formation projects for instance real estate development in STP's and firm configuration in incubator facilities. Main insight presented by this model is the recursive, cross institutional, hybrid nature of association between the three helices. Institutional specialties of university, state and the industry were previously separate entities that work together across strongly safeguarded boundaries. Within the helices the organizations and individuals increasingly are taking other roles than were attributed to them customarily. In triple helix model emphasis on academic entrepreneurialism is centered on capital formation projects and knowledge capitalization and such role of universities has been defined by the writer as generative role of universities where these institutions drive development (Gunasekara C., 2006).

University engagement literature in regional development also centers on third role of universities but in a different way as compared to triple helix model in emphasizing on adaptive response by universities which embed a stronger regional focus in their research and teaching missions. For external engagements this approach has nothing to do with the development of hybrid, boundary spanning mechanisms rather it takes a broader growth focus which includes a range of mechanisms by which with their regions universities engage themselves. In institutional capacity building and in regional networking universities through their resources based on knowledge, skills and people play an important role. Moreover in informal or formal capacities staff may act as regional animators in the course of representation on outside bodies ranging from local cultural organizations to local authorities and school governing boards and development agencies. Universities make an indirect contribution in such ways to cultural and social basis of effectual regional governance. That's why university engagement approach highlighted a development role carry out by universities in regional economic and social growth which centers on intersection of learning economies and regionalization of regulation and production (Gunasekara C., 2006).

Through such explanations above these two bodies of literature point to dissimilarity among development and generative roles performed by universities in regional innovation systems.

Generative and development role of universities explained by Gunasekara C., 2006 is further simplified by Chaminade C., 2007 and wrote that Universities capability of production or reproduction role highlighted the contribution of universities to knowledge based regional growth with creation of highly developed basic research and trained human resources. Knowledge based outputs created by universities can take various shapes like technological and scientific information, human capital, human skills, equipment and instrumentation, set of connections of technological and scientific potentials and prototypes for new processes and products. Across industry such distinct productions have varying potentials to turn out to be commodified knowledge. It is not

the purpose of universities produce and reproduce capability role to provide industry with knowledge solutions in applied knowledge sense but to produce science in sense of basic knowledge and train personnel. From university-industry association visibly high technology and science based industry benefits more as compared to other industry for instance service providers. Production and reproduction role of university which is known as generative role mostly understood in respect of knowledge spillovers. Knowledge spillovers related to academia mostly calculated through location of creators mentioning university patents, contain a propensity to be restricted in the university regions. Mechanisms or systems by which such spillovers related to knowledge are understand such measurements do not explain them much. Mostly localization of spillovers related to knowledge is explained with institutional similarities (Chaminade C., 2007).

Knowledge diffusing and producing activities highlighted in generative role and on the other hand development role places a stronger stress on university's impact in the supremacy of RIS and in close communication among industry and university in the development of what has been entitled economically valuable knowledge. Such thing conceptualizes university not only as an independent player strongly engaged in knowledge generation but also as an actor which contributes informally and formally in shaping social and regional institutional capacities through close interaction with industry. As compared to production and re-production role of university the developmental role is chiefly anxious with how industry and university network in a RIS is structured. Consequently it has a stronger focus on original associative modes and structures of supremacy in contrast to research that deals with production and reproduction role of universities (Chaminade C., 2007).

Generative role of university involved supply of basic research and qualified human capital and in developmental role universities play their roles as entrepreneurial university and driver of regional growth. In research type carried out by universities, generative role is distinguished as basic research and non-industry specific applied research and developmental role is distinguished as prominently applied research along

with some basic research also. In Generative role function of university is distinguished as education and research and in developmental role third task along with training and research. In networks with local actors university generative role is weak independent institution and university developmental role is distinguished as strong blurring boundaries in the role of the different organizations as knowledge providers (Chaminade C., 2007).

Chapter 3 System of Triple Helix in Bangalore

This chapter will explain the role of Karnataka State Government in the development of Bangalore and IT industry of that state from policies and strategies point of view along with IT industry role in economic development of Bangalore and India and universities role in this triple helix system.

3.1 Role of Government

This section will explain the role of Karnataka State Government in the development of IT Industry in the state.

Karnataka state priority sectors include telecom, infotech, auto and auto ancillaries, electronics, pharma, leather, agro-processing and garments. According to the industrial investments policy of the state government which is effective from 1st November 1990 state has been divided into four zones with different incentives and exemptions for them. Karnataka state has 175 taluks (taluk: administration division of some countries) and zone I covering 2 taluks, zone II covering 38 taluks, zone III covering 129 taluks and zone IV covering 6 taluks and 6 growth centers. Bangalore urban and rural areas comes in zone II and the investors in that area have 100 percent tax exemptions for a period of 4 years from the date of commencement of commercial production (KUM, 2000).

Karnataka state in India is the first state to announce state wise IT Policy in the year 1997. This IT policy acted as important catalyst for development of IT Industry in the state. This IT policy focuses on using e-governance as a tool and delivering a government which is more responsive and proactive to its citizens. Karnataka State government in December 1999 formed a unique taskforce to prepare an action plan to exploit the power of IT to address core issues regarding the state. Mahithi –The Millennium IT Policy is the outcome from such efforts of the state government (KUM, 2000). This policy also emphasizes the value of taking IT to the common man. Some e-governance projects in the sate under this policy include,

1. Facilitate use of IT for common man and provide technical support to state departments

2. For decision makers develop a comprehensive database on Karnataka for developing a sophisticated decision support system
3. To facilitate farmers in establishing ownership of land, recording agriculture crop details, recording succession of ownership and recording information regarding obtaining loans from banks
4. Support in making land registration system easy and simple
5. Support in computerizing treasuries all over Karnataka
6. Support in checking evasion of taxes on certain commodities
7. Support in introducing online transactions in silk market
8. support to ensure that commodities prices are easily available to farmers all over the state
9. Support in computerizing all transport office in Bangalore
10. Support in enhancing police intelligence
11. Support in introducing a system to simplifying property tax payments, death and birth certificate issuance

Main objectives of Millennium IT Policy according to ''KUM, 2000'' includes,

1. Utilization of information technology power in overall goal of Karnataka Government in empowering women and eradicating poverty
2. By absorbing major share of educated youth into IT Industry effectively reduction of unemployment
3. Promotion of Kannada (one of the major dravidian languages of India) usage in Information Technology
4. Deliver a government and use e-governance as a tool which is more responsive and pr-active to its citizens
5. To unleash Karnataka incubation engine
6. With non-English speaking nations encouragement of business
7. In the field of Information Technology maintenance of pre-eminent position of both Karnataka and Bangalore

IT sector provide huge variety of employment opportunities for instance software services, hardware development, several sectors in IT enable services and in networks. IT enable

services include financial and accounting services, customer interaction, call centers, engineering and design data management etc. In Karnataka State the estimated number of professionals is approximately 75,000 and it was predicted that in 2010 in IT sector potential for employment in Karnataka State alone will reach 10 lac. In all over the state this policy seeks to establish 225 training centers for training unemployed educated youth in different IT skills and government also provide reasonable concessions to these centers. Through this policy development of IT skills in college students is also another initiative of government. Program initially covers all engineering colleges approximately 150 ITI's, 100 polytechnics and 300 colleges. Encouragement of private sector to set up training centers, research centers and up-gradation of laboratories was also part of this program and program also allow usages of such centers for limited commercialization. Through this policy government also took initiatives to take IT to school children in all parts of state by encouraging private companies to set-up training centers in school. Before and after school hours private companies allowed to use same centers for commercial use. Government of Karnataka established an autonomous institution name Indian Institute of Information Technology (IIIT) which has world class infrastructure and state of the art facilities. Indian Institute of Information Technology has laboratories sponsored by Informix, Microsoft, Novell, Sun Microsystems, Compaq, IBM, SAP, PTC, Ramco, Computer Associates and CISCO. IIIT is playing a tremendous role in the development of human resource and in producing high quality professionals as well as training the trainers. IIIT is also offering advanced courses in post graduation and Doctoral programmes. Kannada is the major language used in Karnataka state and all over in offices in state that's why government was very keen in the usage of Kannada language in the state via Information Technology. Researchers also evolved a common keyboard in this language. For the improvement of education department Karnataka state efforts are remarkable. They computerized payroll accounting system of all 2.4 lac teachers in Karnataka state. They computerized the detail of more than 18 lac students who take PUC, SSLC and university examinations and on website they made the availability of SSLC results. For astounding manner education department used Information Technology in Common Entrance Test (CET) for professional courses. For admitting students to professional courses in dental, medicine and engineering Karnataka state government conducted Common Entrance Test. Every year more than 55,000 students appear for such examinations and looking for admission to more than 128 colleges covering 27 courses. In most transparent manner examination is conducted. Through computerized counseling

process this is the best ever designed education system in India. Karnataka state government also computerized information on registration of candidates for employment along with computerization of information on employment market. They also computerized the permanent registration of more than 2.5 lac small scale industries. Firms in Bangalore are in forefront of IT and many core technology areas for instance MPEG, Voice over IP, Home RF, WAP, Products on Blue Tooth, GPRS, etc., are more and more becoming focus areas. Many multinational firms have applied for international patents and Texas Instruments was the first MNC in Bangalore who already applied for 115 patents before this policy. More than 55,000 high quality professionals boasted by Bangalore city in the area of integrated chip design, application software, communication software and also in other services. Through information network all districts and taluk head quarters has been connected in Karnataka. Currently through a Fiber Optic Network 140 taluks out of 175 taluks has been connected to each other. Here is a comparison of Silicon Valley California with Silicon State Karnataka on the bases of Anchor Companies, Research Centers, Universities and Venture Financing (KUM, 2000).

Table: 1 Comparison of Silicon State, Karnataka & Silicon Valley

	Silicon State, Karnataka	Silicon Valley, California
Universities	Indian Institute of Information Technology, Indian Institute of Management, Indian Institute of Science	California State University, Stanford University of Southern California
Anchor Companies	CBSI, Satyam, CG Smith, Infosys, WIPRO, Honeywell, Texas Instrument, Microland, TCS, i-Flex	Fair Child, HP, Sun Micro Systems
Venture Financing	ICF Ventures, Indus Ventures, ICICI Ventures, CAN Bank, KITVEN, IL&FS Ventures, Draper	Walden NICCO, Draper, Kleiner Perkins
Research Centers	Raman Research Institute, ISRO, CSIR, NAL, Center for AI & Robotics, GTRE, LRDE	Palo Alto Research Center, XEROX

Source: (KUM, 2000)

By giving incentives to the new companies Karnataka state government encourage them to create new employment opportunities in the field of Information technology. All new IT firms who will create new employment opportunities over 250 in Bangalore and 100 in other

areas in their first year are eligible for rebate on stamp duty and also on cost of land. Labour laws also simplified for the development of IT industry and different state enactments also introduced for its development. Karnataka State Government also takes different initiatives for the improvement of infrastructure. For instance during 1997 first International Technology Park was established there with joint venture of Karnataka State Government, Singapore Consortium and TATA group. Incentives given to these parks includes exemptions from entry tax on capital goods, equipments, machines and construction material bought for completion of infrastructure projects for a period of three years or till the date of completion of projects. Export promotion industrial park consisted on 288 acres build exclusively for export oriented industries. Software Technology Park of India (STPI) is also situated there in Karnataka. Software Engineering Institute of Carnegie Mellon University developed Capability Maturity Model (CMM). Purpose of this institution is to assess the capability of software firms and categorize them into different levels for instance CMM/SEI/Level 1 to 5. Level-5 firm indicates most sophisticated software firm who has exceptional human resources management with abilities in delivering quality software services. A homegrown company from Karnataka named WIPRO is the 1st recipient of Level-5 certification. There are 19 level-5 companies in all over the world and out of them 12 are in India and 8 of those are in Bangalore (KUM, 2000).

3.2 Development of IT Industry & STP's and their Role in Economic Development

This section is divided into two parts. First part will describe the development of IT Industry and STP's in India and particularly in Bangalore, Karnataka. Second part of this section will explain their role in economic development.

In 1990's labour intensive and time specific demands in software industry coming simultaneously and general increase in the use of software formed a huge demand for skilled labour particularly in developed industrial nations that's use Information Technology extensively. Stress to limit the cost of labour concentrated projects and lack of people with particular skills forced companies in United State to look somewhere else for suitable skill-cost mixture. Between the nations who can offer this combination World Bank in 1992 sponsored a survey which revealed that European and United State vendors ranked India as

top preference for offshore and on-site software development ahead of Ireland, China, Philippines, Israel, Hungary, Singapore and Mexico. In 1984 Gandhi became Prime Minister of India after Rajiv and liberalization received strong political backing, by consisting on commercially and technologically sensible bureaucrats. They were eager that the software industry globalization process should not bypass India. In its consequence the period of 1990 witnessed many initiatives and two key initiatives are the formation of November 1984 Computer Policy and the Computer Software Export, Development and Training Policy of December 1986 which explicitly intended to enhance India's share of world software production. Through such initiatives companies in India were provided liberal access to worldwide technologies to promote thousands of small software firms in the nation and to enhance export along with local growth. In 1988 National Association of Software and Services Companies formed to encourage the software industry. The clearest example of this was the establishment of Software Technology Parks in 1990. Science and Technology Parks offered data communication facilities for instance which firm could offer offshore service from India. One year after the establishment of STPs in 1991 a major shift in economic policies induces by a balance of payment crises, including rupee devaluation, duty rationalization and trade liberalization, openness to overseas venture and a new policy belongs to industry which removed entry barriers for new companies. Where these economy-wide changes have benefited software industry on the other hand many sector specific policy changes also appeared from continuous state-industry interaction. For instance in 1992 tax freedom on profit from service exports, in 1997 removal of import duties on software and in 1998 authorization to grant American Depository Receipts/Global Depository Receipts linked employee stock options (Parthasarathy B., 2004).

Table : 2 Employment Development in Indian Software Industry from 1985 to 2003

Years	Software Export Sector	Software Domestic Sector	Software in House Captive Staff	ITES-BPO	Total
1985					6,800
1990					56,000
1995					140,000
1999	110,000	17,000	115,000	42,000	284,000
2000	162,000	20,000	178,000	70,000	420,000
2002	205,000	25,000	260,000	180,000	661,000
2003	270,000	28,000	290,000	253,000	841,000

Source: (Badge S., 2008)

In 1985 number of professionals were 6800 and in the next five years increased more than eight fold and reaches to 560,00 in 1990. In next decades development was at smaller pace and number of professionals reached to 841,500 in 2003. As compared to the IT enable services number of professionals in software exports sector increased more slowly in later years for instance in 1999 from 110,000 to 270,000 by 2003.

Internet and entry of Information Technology brought a sea change in Bangalore Industrial environment and in its consequence companies get a boost in their development and performance. In early 1980's rapid development began in Bangalore. To escape from the increasing costs companies relocated from Delhi and Mumbai to Bangalore. Better environment and availability of English speaking labour with high quality skills convince Indian government to concentrate its defense and telecommunication research in Bangalore and this decision attract multinationals to this

city. Good quality education and remarkable development of software exports from Bangalore earned it the name ‘’Silicon Valley of India’’. Undoubtedly with having 4 and half million peoples Bangalore city is the fastest developing city of Asia and the roots of global way of life are very well-known between people of Bangalore. Textile exports from Bangalore particularly of silk also have very high demands worldwide (Discover Bangalore/Bangalore).

Bangalore becomes a key player of software market worldwide and companies like Texas instruments and Motorola open their offices in Bangalore. With the entrance of various multinational software firms Bangalore emerged as leader of information technology and star firms among them were the Bangalore based firms which are well known because of their superior quality software products. These companies include WIPRO which headed by Ajim Premji and Infosys Technologies which is headed by Narayana Murthy and Nandan Nilikeni. Most workers of these companies are product of Bangalore colleges and universities (Discover Bangalore/Bangalore). Motorola’s Bangalore center during 1994 was one of the only two software centers globally to achieve CMM Level Five. In 1980’s well-known domestic companies for instance Infosys which is first Indian company listed on the NASDAQ, early trickle of MNC’s to India and second largest software exporter during 1999-2000 located in Bangalore. Skilled labour in the region attracted them. Establishment of first Science and Technology Park in Bangalore provided basic infrastructure to strengthen the alarming skill advantages the region already obsessed. For the expansion plans of domestic companies Bangalore become the center and first choice in India for the greater number of firms from Silicon Valley wishing to establish ODC’s in the country. (Parthasarathy B., 2004).

Over the last century Bangalore developed its engineering educational institutions. Some well known companies of world are situated there for instance MICO which is automotive parts manufacturer and a subsidiary of Robert Bosch GmbH Germany. WIDI is also a well know company and it manufacture machine tools. Public sector companies include Bharat Electronics Limited, Hindustan Machine Tools and Indian Telephone Industries (Discover Bangalore/Bangalore). Electronic City and International Tech Park which are two very important science parks of India host a number of specialized ICT

high technology firms. Out side USA Google has created its first research and development center in Bangalore and French companies doing the same too. In Bangalore Valtech which is a data processing consultant firm in April 2004 decided to setup its first offshore development center (Grondeau A., 2007).

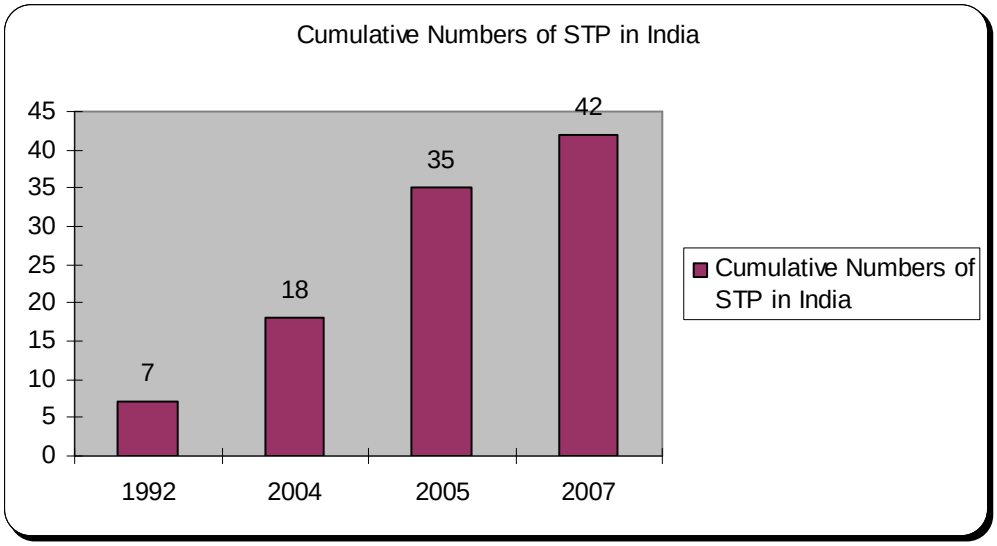
In biotechnology and information technology Bangalore has all the ingredients for a successful incubation. Bangalore has world renowned research centers and institutions along with excellent firms and venture capital funds. Few of the operating venture funds in Bangalore include Canbank Venture Capital, IDBI Venture Capital, APIDC Venture Capital, IFB Venture Capital, Gujarat Venture Capital, KITVEN Fund, IFCI Venture Capital, Marigold Advisors, Industrial Venture Capital, UTI Ventures, SICOM Venture Fund, Barings Pvt. Equity, SIDBI Ventures, Alliance Venture Capital, HSBC Private Equity, Pathfinder Investment, Global Tech ventures, Indus Venture Management, Chrysalis Capital, Blueshift Ventures, KVP Ventures, JF Electra, Connect Capital, SIFY Innovations, Ant Factory, Jumpstartup Advisors, e4e Labs, 2i Capital, eIndia Capital, iNestor, Passion Fund, Newbridge Capital, AIG Capital, Chase Capital etc. (KUM, 2000).

3.2.1 Development of STP and Firms in India

In easy term science park is defied as an infrastructural method for transferring technology from universities to companies and promote knowledge production. On the other hand in respect of objectives of a science park its task includes promote technology transfer from research centers or universities to companies, encourage start-ups and spin off's and eventually furnish for reindustrialization and improve regional inventive performance (Almeida A., at el, 2009).

Figure 1 shows the development of science and technology parks in India from 1992 to 2007 and figure 2 shows the development of firm's linkages from 1992 to 2007 with science and technology parks in India.

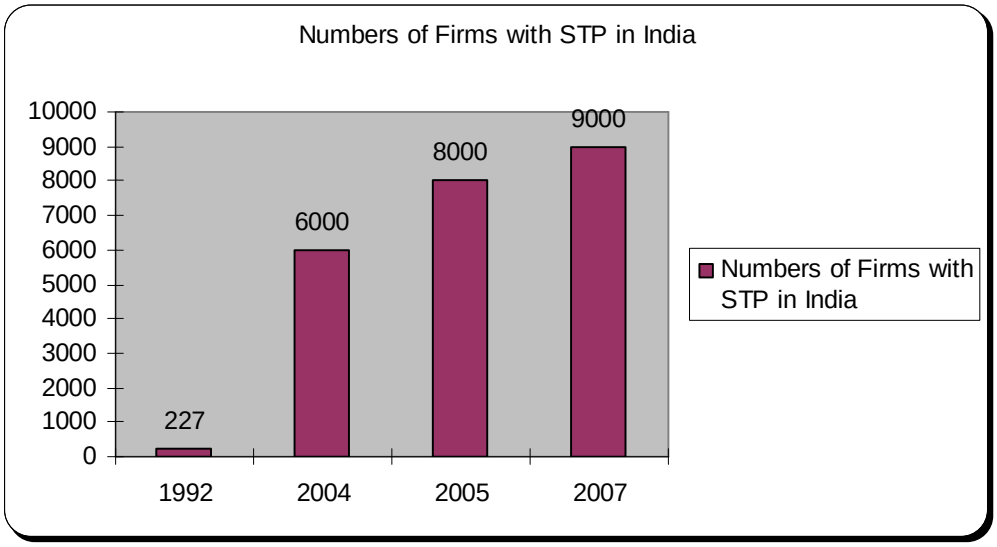
Figure: 1 Cumulative Number of STP in India



Source: Krishna V. V., (2007)

From 1990-1992 there was 7 Science and Technology Parks in India and in 2004 this number reaches to 18. In 2005 there was 35 STP and in 2007 there was 42 Science and Technology Parks in India.

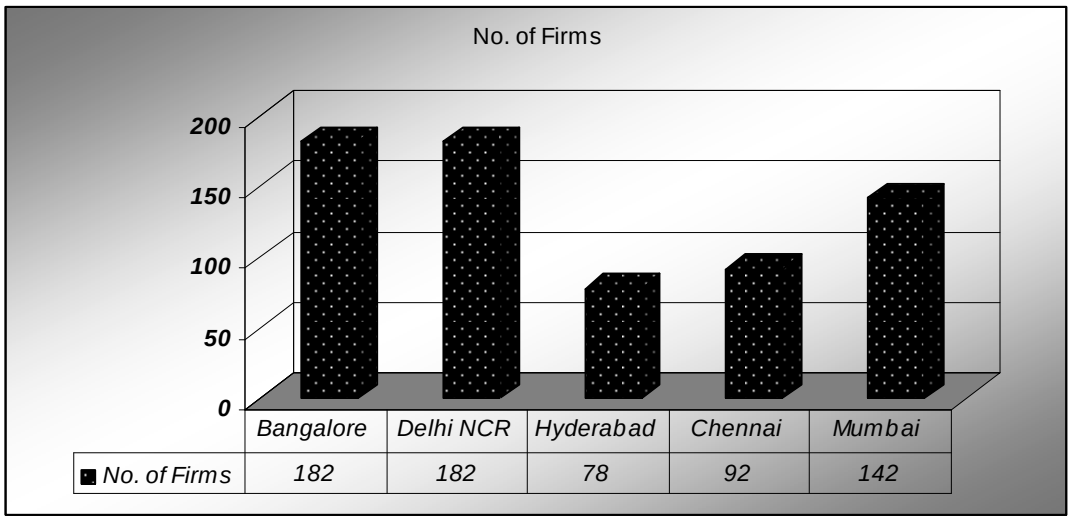
Figure: 2 Number of Firms with STP in India



Source: Krishna V. V., (2007)

From 1990-92 227 firms were attached with STP in India and in 2004 this number reaches to 6000. In 2005 there were 8000 firms attached with STP in India an in 2007 this number reaches to 9000 firms.

Figure: 3 Pattern of Clustering of Top 675 ICT Software Indian Companies 2003



Source: Krishna V. V., (2007)

This figure shows the number of ICT software firms in five cities of India. In 2003 there were 182 ICT Software firms in Bangalore and in the same year there were also 182 ICT software firms in Delhi. In Hyderabad there were 78 ICT Software firms. In Chennai there were 92 ICT Software firms and in Mumbai there were 142 ICT Software firms in India.

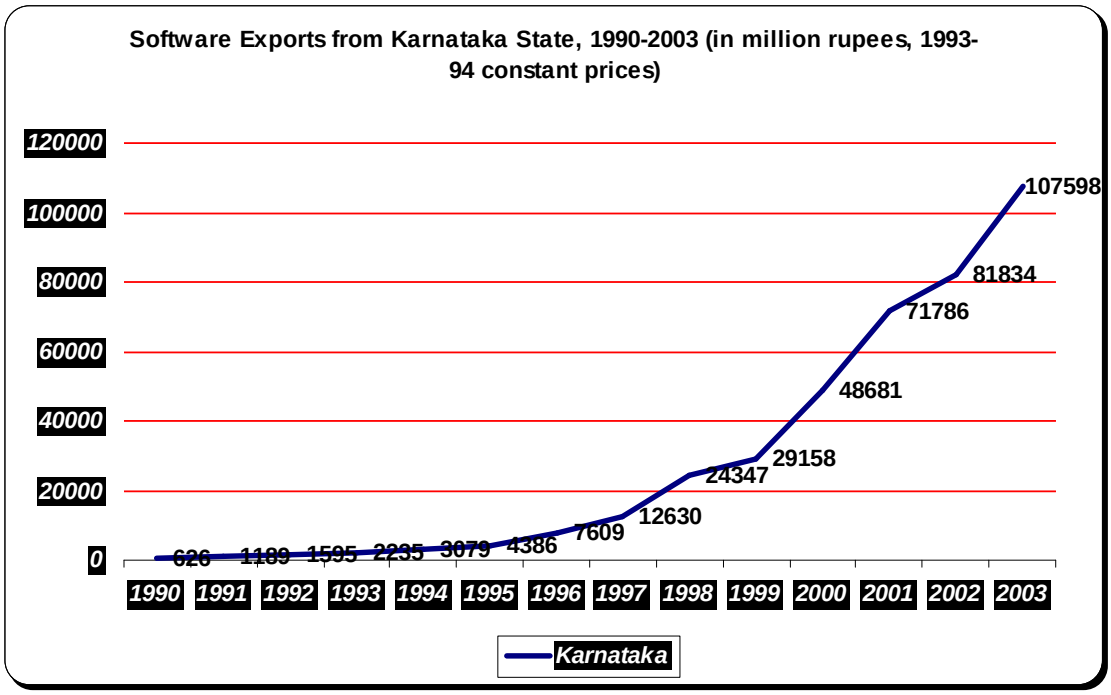
Table: 3 Timing of Entry and Type of Firms

Entry Cohort	Foreign Branch	Diaspora	Spin-off	Diversifying	Startup	Others	Total
1991-98	**38**	**20**	**17**	**12**	**8**	**14**	**109**
1999-00	**14**	**6**	**13**	**17**	**6**	**5**	**61**
2001-03	**49**	**29**	**44**	**40**	**16**	**25**	**203**
Total	**101**	**55**	**74**	**69**	**30**	**44**	**373**

Source: (Badge S., 2008)

Over time type of entrants changed. In 1991-98 foreign branch companies are largest group in cohort; in 1999-00 diversifying companies are largest and in 2001-03 spin-offs are largest. Important software growth platforms of foreign companies are foreign branch and diaspora and if we combine them then in 1991-98 and 2001-03 in cohort they are the largest group and together they have 40 percent share of total companies.

Figure: 4 Software Exports from Karnataka State, 1990-2003 (in million rupees, 1993-94 constant prices)



Source: (Badge S., 2008)

This figure shows software exports from Karnataka state of India from 1990-2003. In 1990 software exports from Karnataka state was 626 million rupees which reaches to 107,598 million rupees in 2003 and such increase shows a tremendous performance and expansion of this industry in this state during that time period.

Karnataka state of India in which Bangalore city is situated is an autonomous state. But on the other hand level of autonomy as compared to Shanghai and Silicon Valley appears smaller in it. For instance taxation power of local government is little while power of state government is oftenly limited to indirect taxes like sales tax but Shanghai can decide, use and collect local tax and they provide tax return and tax break to TNC's. In shaping the development of this particular region where regional government policies and local cluster effects contributed a lot US industrial development also played a major role. But until the late 1980 most of its development is based on local investments and its distinctive position in the country also played a key role in its development. Foreign

companies also played major role in Bangalore development. As compared to Bangalore in Shangahi exogenous sources played an important role but Bangalore did not depend on refining endogenous potentials. Low cost labour, twelve hour time zone difference with US, good skilled technicians and English language skills also contributed a lot in its growth. One key difference among India and other growing nations is the well developed infrastructure of human capital of India which make this country an attractive region for international firms. They developed high quality IT colleges. Due to firms strategies in India absorptive capacity was low initially. Such strategies did not provide much knowledge transfer and interactive leanings and also did not increase the absorptive capacity of local firms. Due to deficiencies in the system Bangalore city competitive advantages are diminishing and there is a need for Regional Innovation System policies like strategic procurement from regional or state authorities. Such policies can stress regional alliance dimension with intentions of bringing Indian companies closer to each other (Vang J., & Asheim B., 2006).

In Indian IT industry competition is on rise. Such competition is not coming only from further low cost regions but also from inside the nation particularly from MNC subsidiaries who established shops in India. It is popular that development of Indian Information Technology industry is mostly fueled by their contribution in export markets through other kind of inter-companies coalition or outsourcing. A simple picture of worldwide company's coalition is that they commence with little offshore projects which afterward develop into big and more complex. With the passage of time and trust building such projects converted into devoted growth centers and then of equity JVs. Foreign companies mostly choose transfer of ownership and to facilitate such thing favours to foreign companies also available according to M&A and FDI policies. Another change in IT industry is also notable in which in initial phase of alliance US companies in tier-1 category makes connections with Indian companies of tier-1. For instance a large number of Indian companies like Wipro, Infosys and Tata Consultancy services started competing with worldwide Information technology companies like Computer Science Corporation, Electronic Data Systems and IMB. In such phase in which Indian companies start competing with US multinationals it is about to happen that each nation's

tier-1 company make connections or get hold of tier-2 companies in other countries. To compete with the tier-1 category companies of India worldwide IT companies of tier-1 would acquire Indian IT services of tier-2 companies to compete with them. In reaction to this Indian IT companies of tier-1 need to get hold of companies in Europe or US included in tier-2/3 category (Basant R., 2004b). Top 15 firms included in Tier-1 and Tier-2 accounted for 70 percent revenue of IT services. In respect of IT services huge portion of companies still accountable for only 15 percent. In addition to these in 2001-02 to 2004-05 Tier-1 companies increase their market share from 32 percent to 45 percent and Tier-2 companies decrease their market share from 35 percent to 16 percent (Chaminade C., 2007). Usually tier 1 company means companies which have revenue more than 1 billion dollar and have more than 50000 employees. Tier 2 companies mean a company which have revenue more than 100 million dollar and have approximately employees from 4000 to 10000. Those companies which have revenue less than tier 2 classified as tier 3.

During 1997 at US patent office 183 patents filed by Indian companies or individuals. In 1999 this number reached to 285 and in 2001 883 applications were filed. Separately from chemical, electronics, pharmaceutical and electrical sectors which are other sectors where significantly patenting increased. In fast developing sectors Electronics and electrical also include. In 2003 from India few small IT companies filed 35 patent applications in US patent office. During this period patent filing also increased rapidly in India. During 2002 245 patents was granted to Cisco Systems and out of them 120 patent applications were filed from Indian entity from January to September 2002. These numbers show a major part of Cisco Systems inventive activity is being undertaken in India. For instance in respect of other companies Adobe systems file 30 patent and out of them 10 were from Indian entity which is 33 percent of total filing, Texas instruments file 745 patents and out of them 225 were from Indian entity which 30 percent of total filing and Analog Devices file 87 patent and out of them 33 were from Indian entity which is 38 percent of total filing (Basant R., 2004b). According to IT professional's suggestions in outsourcing activity IP associated issues are not so important because majority of

Indian companies engaged in low end tasks and a shift from low to high end tasks brought such issues to fore (Basant R., 2004b).

3.3 Role of Universities

This section will explain the role of universities in triple helix system of Bangalore by explaining system of universities in Bangalore and their contribution in Bangalore and its IT industry development.

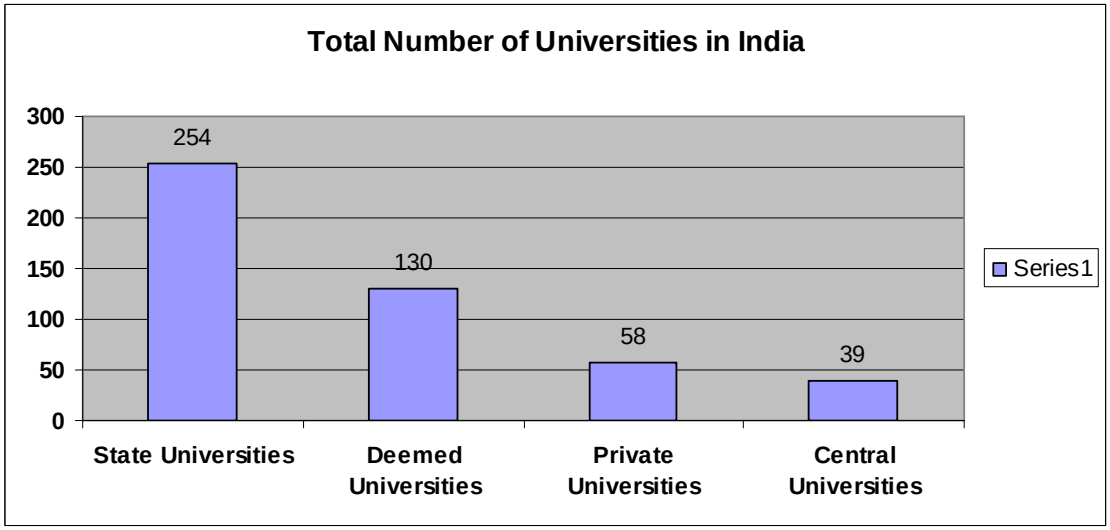
India has both public and private universities and majority of them are maintained by state governments and Government of India. There are also private universities exist apart from them which are supported by different societies and bodies. Majority of universities listed under south Asian top universities are situated there in India. There are more then 481 universities in India with approximately 45000 colleges of different types and with such great number of educational institutions India is considered to be the home for education. Majority of such institutions required recognition from a regulatory power or a competent body which is maintained by state governments, Government of India or by societies (NNE/List of Universities in India).

Many scholars acknowledged early growth of Bangalore as specialized center in IT industry was because of some well known world class educational institutions which are situated there. These institutions include Indian Institute of Information technology, National Institute of Mental Health and Neuro-Science, Indian Institute of Science, Raman Research Institute, Indian Space Research Organization, National Aeronautical Laboratory and Central Food Technological Research Institute, etc. Remarkable number of availability of world class educational institutions resulted in competent and qualified cheap labour in large number and also explain the early interest of US companies to setup their outsource activities in Bangalore. From university research direct research spillovers appear to some extent insignificant (Chaminade C., 2007). In India Bangalore has some remarkable educational institutions and as compared to the other states of India in respect of education standard Bangalore is considered very high. It is because students graduating from Bangalore universities are most sought after by the corporates,

multinationals and big industrial houses. For many regions of globe and all over India Bangalore is center of education for students. To take admission in professional courses like Medicine, Engineering and Information Technology Common Entrance Test which is popularly known as CET is very popular all over the Indian nation. Majority of students from every nook and corner of India tries their best to get admission in colleges and universities in Karnataka state and especially in Bangalore along with other institutions (Discover Bangalore/Bangalore).

Few of the well known institutions in Bangalore are Indian Institute of Management at Bannerghatta Road, Indian Institute of Science at Yeshwanhpur, Institute of Bioinformatics and Applied Biotechnology and Indian Institute of Information Technology. Some of the best schools of Bangalore are Frank Anthony Public School, Bishop Cottons, and Sophia High School for girls, Baldwins for boys and girls and Bangalore International School. Admission in such schools are difficult so that's why parents book their child place in advance more than one year before and might be sometime before their birth also. Some best medical colleges in Bangalore are Bangalore Medical College, M.S. Ramaiah Medical College, Dr. B.R. Ambedkar Medical College and Kempegowda Institute of Medical Science. Few of them are known allover the globe and offer exchange programs with popular institutions worldwide (Discover Bangalore/Bangalore).

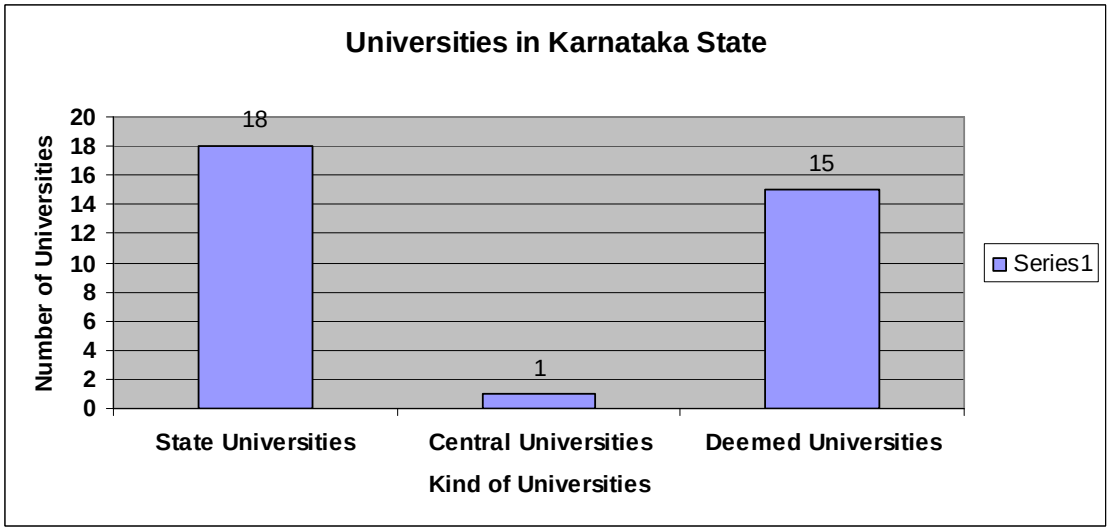
Figure: 5 Total Number of Universities in India



Source: (NNE/Universities in India)

From the number of universities presently in India and the quality of education the importance of higher education might be understood. From total 481 universities in India 39 are central universities, 130 are deemed universities, 254 are state universities and 58 are private universities.

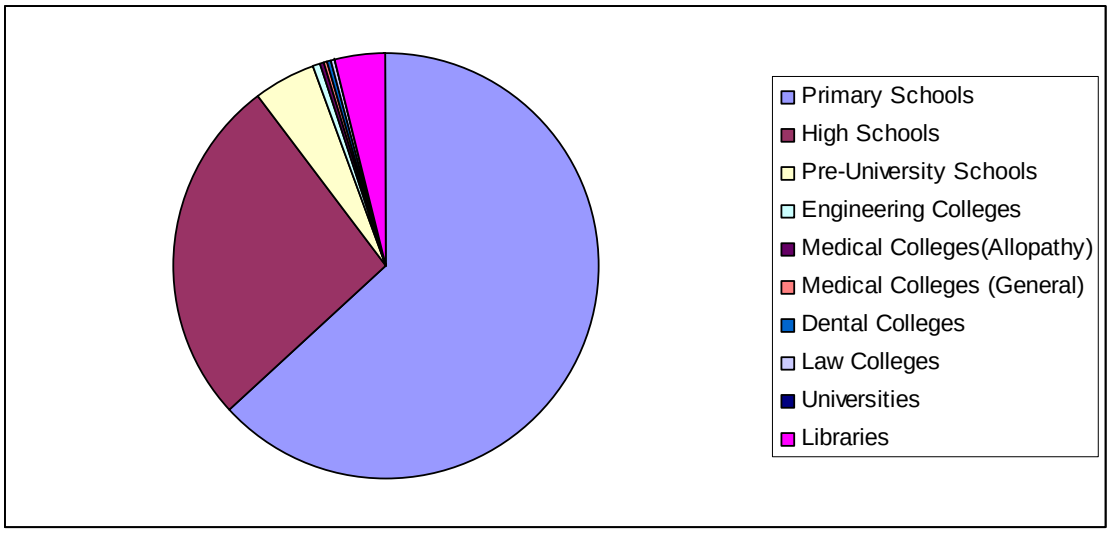
Figure: 6 Universities in Karnataka State



Source: (NNE/Universities in India)

In Karnataka state of India where Bangalore city is located there are about 18 state universities, 1 central university and 15 deemed universities according to National Network of Education.

Figure: 7 Number of Educational Institutions in Bangalore



Source: Discover Bangalore/Bangalore

There are about 2,772 Primary Schools, 1,177 High Schools, 209 Pre-University Schools, 170 Libraries, 4 Universities, 26 Engineering Colleges, 13 Law Colleges, 12 Dental Colleges, 6 Medical Colleges (General) and 9 Medical Colleges (Allopathy) in Bangalore.

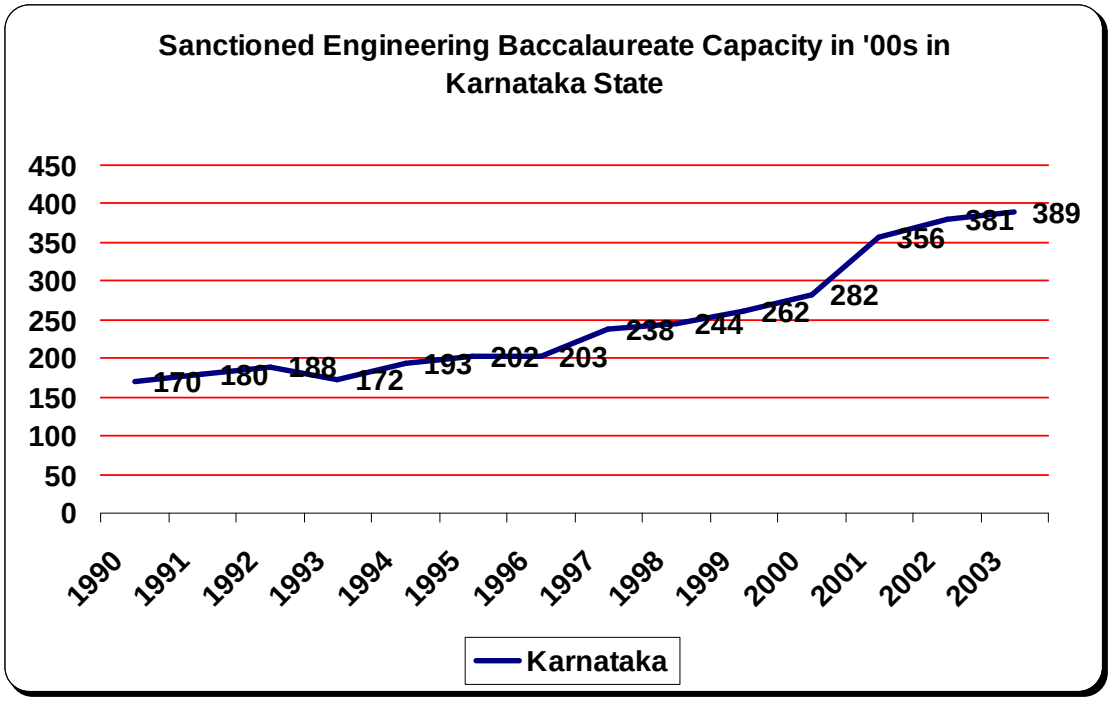
Table: 4 Engineering Baccalaureate Capacity in India from 1952-2004

Years	Population (Millions)	Engineering Baccalaureate Capacity
1951	361	4788
1985	765	451,36
1995	928	105,000
2004	1086	439,689

Source: (Badge S., 2008)

Engineering baccalaureate capacity of India roses from 4788 in 1951 to 439,689 in 2004 and engineering baccalaureate capacity increases 91 times in 2004 from that of in 1951.

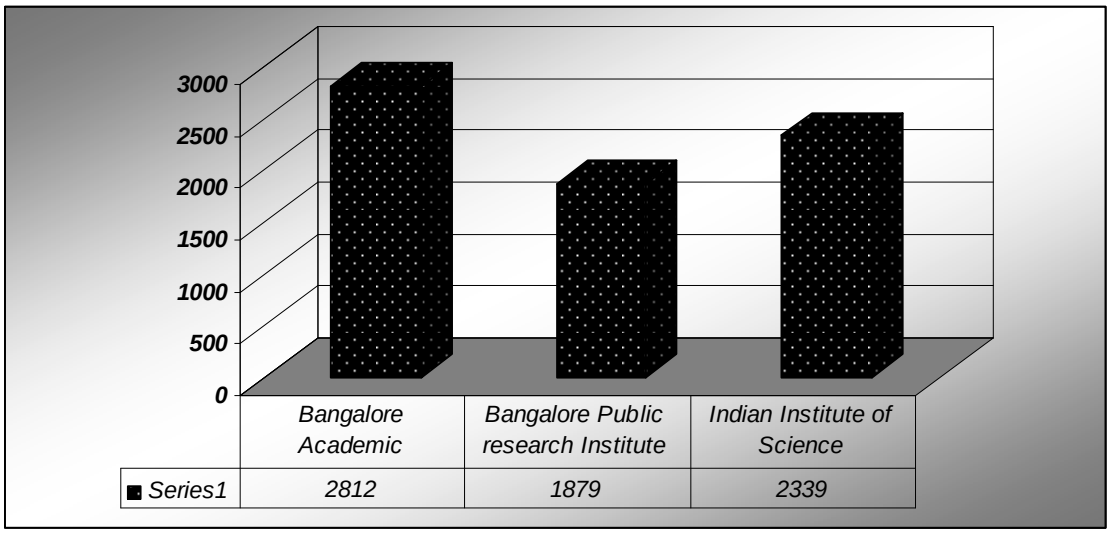
Figure: 8 Sanctioned Engineering Baccalaureate Capacity in Karnataka '00s



Source: (Badge S., 2008)

This figure sows the increases in sanctioned engineering baccalaureate capacity in Karnataka from 1990 to 2003.

Figure: 9 Total Numbers of Publications from Some Institutions at Bangalore



Source: Basant R., & Chandra P., (2007)

There was about 2812 publications from Bangalore Academic Institutions during 2003-05, 1879 from Bangalore Public Research Institutes and 2339 from Indian Institute of Science Bangalore during the same period.

Innovation is not new to India as in 2500 BC Innovative constructions techniques were exist in India. Innovation was also existed in India in other fields like Medicine or metallurgy and mathematics. Presently India is very favourite in ICT field and it can be confirmed with such explanation that out of 10 most top firms of India 5 firms are from ICT sector. These important ICT sector firms include HCL Technologies, Manager Telephone Uigam, Wipro Corporation, DSQ Software and Infosys. In 2004 Infosys build subsidiaries in North America and Europe. In 2001 there were about 4 million technicians and scientists in India along with about 7 million students. Access to 200 research laboratories, 237 universities and 10 famous scientific institutes were available to such students like Indian institute of Technology. As an Indian government priority 200,000 people were trained in fields of technology and science and majority of them were trained in the field of computer science. In the year 2002 more than 75000 students were living in USA which were belong to India and they were two times more than in 1996. Such

peoples and students who were living abroad were the real assets of India and contributed a lot in its development. From total European patent applications in the year 2001 0.14 percent was filed by the India and in the same year China filed 730 applications. From the deficiencies side in India there is lack of basic research and lack of PhDs in computer science field. There is also deficiency of material, good tools and teachers. In 2008 7 million engineers were required in India which includes 2.2 million in software and 4.8 million in other fields. Majority of Indian research centers are in south and west side of nation which includes 226 research centers of Karnataka, 305 in Tamil Nadu, 660 in Maharashtra and 221 in Andhra Pradesh. Excluding Delhi north side of country is not very much active in research and development work. From the north side 73 research and development centers are in Bihar, 41 in Assam and 43 in Punjab (Grondeau A., 2007).

Partnerships in respect of R&D among local sector educational institutions/labs and private sector companies is also on rise. More and more public sector institutions becoming IP savvy. For instance in India Texas Instruments company very actively working with top four technical institutions of India which are Indian Institute of Science in Bangalore, Birla Institute of Technology and Science in Pilani and Indian Institute of Technology at Chennai and Kharagpur. In India educational institutions cannot own equity and mostly struggle is done to create configuration to facilitate such institutional ownership. It is belief that in future main market development in Information Technology Industry will take place in Asia particularly in China and India (Basant R., 2004b). Science parks and institutes in Bangalore host various research labs from various firms for instance Indian Institute of Technology host Intel, Honeywell, Siemens and HP. Along with them there are other research centers also which include C-Ait which is researching on automotive software's, C-Bit which is researching on banking systems and C-Hit which is researching on IT and healthcare. In the development of biotech cluster Indian Institute of Science and Technology also contributed a lot and making few vital spillovers in respect of bioinformatics research for Information technology related industry. But on the weak side of all such things interacting learning with universities of such top high educational institutions is weak (D'Costa, 2006).

In a mixture of ways academic institutions relate with a city cluster and such ways can be associations belong to labour market, associations for services and goods supply and demand, new enterprises generation associations and knowledge generation, acquiring and diffusing associations. In institutions availability of certain capabilities might enable them to build few associations in city clusters and use of available opportunities. The internal and external association's co-existence might generate spillover benefits for the city cluster (Basant R., & Chandra P., 2007). Private and public both entities contributed in such associations or connections and in 1991 nature of such connections changed. Before such period cooperation at government level has taken different shapes for instance institution construction like Punjab Agriculture University in Ludhiana and Indian Institute of Technology in Kanpur. In specific fields mutual research of Indian public sector research and development institutions and US entities. In public based technology programmes participation of US agencies for instance in vaccination programmes. ''*Organization of workshops and exchange of science and technology personnel''*. During the period of 1998 with Carneige Mellon University of USA Department of Electronics Government of India signed a contract for cooperation in software Process Improvement Technologies. CMM level 5 is the highest level of certification in IT industry field and during the period of 2002 out of total 58 CMM Level 5 companies in the world 32 were based in India. In December 2001 from the top most 300 software companies in India 216 firms were already have some form of quality certifications. During the period of 1998 Government of India makes regulatory modifications to allow setup of venture capital companies which can obtain equity stock in firms without the prior government sanction and price setting (Basant R., 2004a).

Chapter 4 Regional Innovation System and Developing Countries along with Deficiencies/Weaknesses in Bangalore System

This chapter will present the explanation to emerging regional innovation system concept of Bangalore along with an overview of deficiencies and weaknesses in Bangalore system.

Regional innovation system model developed in developed countries grounded on refining and mobilizing endogenous economic prospective in a region. On the other hand dependency on endogenous sources primarily is not a possibility for growing nations regions. Because of their limited training, limited capital and formal education, etc and they have to depend on exogenous sources of knowledge, capital and technology. Growing nations typically targeting high tech industries due to the need of knowledge, technology and capital and for them the main source of capital, knowledge and technology is international organizations and TNC's. That's why impact of TNC's on growth of high-tech region critically rely on kind of strategic coupling among TNC's assets and regional assets, untradeable and tradable. Strategic coupling means coupling process among global production networks and regional economies that is mediated through particular practices and actions of key institutions and actors (Vang J., & Asheim B., 2006).

Well working Regional Innovation Systems grounded on strong interactive learning and such thing normally found in developed nations but not often in growing nations. In spite of a high level of heterogeneity in growing nations RIS they however have a propensity to be distinguished by a low level of institutional thickness and consequently weak interactive learning. As compared to it in developed countries they are distinguished by both intense local social relations and knowledge sharing in addition to intense worldwide and inter-regional links to outside partners and knowledge sources. In growing

nations clusters are mostly just local agglomerations of companies contained by the similar industry without local interactive learning or they are just informal agglomerations with irregular horizontal associations, limited collaboration and weak local institutions which refer to weak interactive learning. That's why in regional innovation system deficiency of local knowledge resources in growing nations in addition forces local companies to depend much more on TNC's as providers of capital and knowledge. In developing countries good research and educational institutions are scarce; their competences generally insufficient, their administrative capability inadequate and their governance are mostly problematic. As a result quality of knowledge providers may be far below what firms especially SME's required to shift from being low end to high end providers of services and good in worldwide networks. If one consider that regional innovation system only exists when all of its systemic features are in place than it would be not possible to identify and trace any regional innovation system in growing nations. So that's why it will be better to conceptualized regional innovation system in growing nations as an evolutionary perspective. It should be understood as emerging system where few of its construction blocks are in place but connections between its elements are still in configuration and therefore appear fragmented (Chaminade C., & Vang J., 2007).

For the emergence of regional innovation system without any doubt co-location of remarkable number of research and educational institutions and high tech clusters sets grounds. That's why on the other hand if one eliminates the handful of outstanding technical institutions then there should be underinvestment in research facilities and shortages of high quality staff. With few exceptions universities are always remain major source of providing manpower to the local companies. Most of the time research is more basic and in its result universities are not performing noteworthy role in sustaining innovation and producing research results for local companies. Such thing shows the reason why TNC's (Transnational Corporations) in Bangalore started to build their training centers increasingly. Interactive learning with universities therefore weak while studies reveal some good results from cooperation among industry and universities. For instance cooperation among Indian Institute of Science and Indian Company Encore has led to a low cost computer named Simputer. Studies reveal that none of the systemic

feature of regional innovation system is strong in Bangalore yet. Interactive learning with universities or final user and other firms is far from satisfactorily developed (Chaminade C., & Vang J., 2007).

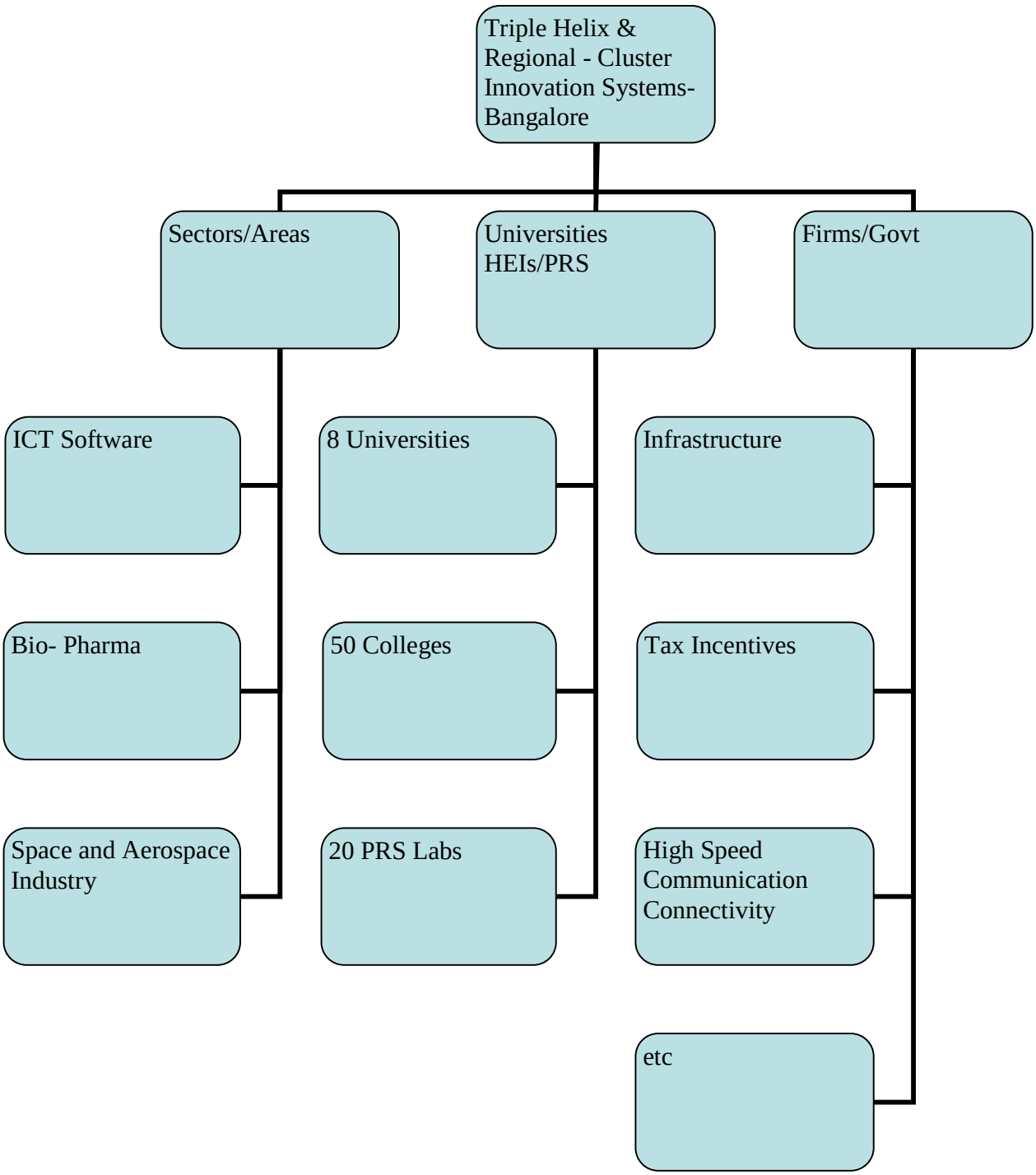
In India power is an insufficient resource. Every grid in the country excluding few small pockets in eastern regions experiences constant shortages. In the meantime power breakdowns without any schedule mostly lasting for hours are everyday. Peak requirement in the country is 73000MW and the available power is only 64000MW. Associations among consumer and electrical utilities are ineffective and are distinguished by high losses, defective supply and poor quality and numerous interruptions. On the other hand along with all such things State electricity boards do not have funding to invest in production capacity or upgrade sharing and transmission networks. One can easily imagine IT industry of any region is more based on regular supply of electricity and for the better growth of such industry or any other industry how important is the regular supply of electricity. Poor management of this sector is also another problem in its betterment (IEE, 2004). Now they are fixing these problems with the use of IT tools for instance by developing geographical maps in digital format to create detailed land base data. Digital data creation on electrical feeder networks was also another option. Use of such tools reduced power shortages and boost power quality (Loganathan 2004).

4.1 Human Capital, Knowledge Skills, Competencies and Social Capital Absorptive Capacity in Developing Countries

Human capital means education, skills, training and health of individuals. Human capital in developing countries which is relevant to high tech production is scarce. At least after primary schools for formal education resources are limited there. Secondary school enrollments in developed nations are 90-100 percent but in developing nations it is usually around 50 percent. For instance in 2003 number of enrollments in India is about 44 percent and for China it was 55 percent. But with the passage of time Indian developed their educational system and number of enrollments also increased. Foreign

Direct Investment inflows form a possibility for knowledge spillovers to local labour force and at the same time level of human capital of host nations determines how much Foreign Direct Investment they can attract and whether local companies are capable to absorb the possible spillover benefits. Due to remarkable reasons Bangalore become one of the most attractive regions for FDI in India. Management skills are normally very essential in high-tech industries but in growing nations they are scarce even in those countries that have successful development strategy for instance China and India. Incremental development, refining craftsmanship knowledge or reorganization of production processes is limited in developing countries. Human capital profile development is essential for absorbing technology and knowledge and afterward developing mutually dependent associations among the local firms, regions and TNC's are crucial. In high tech industries absorption of knowledge rely on formal competencies or highly developed academic. That's why in high-tech industries building absorptive capacity is to a large extent about investing in human capital (formal training) and engaging in alliance among universities and companies. Learning by doing in these industries is also central. Social capital varies a lot and social capital mostly reliant on local culture which is mostly heterogeneous. Social capital normally refers to the norms, relationships and institutions that shape the quantity and quality of a society's interactions. Social capital is not only the total of institutions that strengthen a society it is the glue that hold them collectively. Social Capital consisted on two dimensions which include trust particularly on law enforcement system, political and administrative system and local trust other dimension of social capital consisted on cooperative ability which is grounded on peoples ability to work collectively. Social capital strengthens the development of absorptive capacity of a region. If social capital is exclusive in this respect that it hinder cooperation among local companies than the technology and knowledge spillover will be limited too. Knowledge can be spread regionally/locally through interactive learning and localized knowledge sharing and knowledge can make possible a higher degree of self-sufficiency. In developing countries these factors count a lot because people do less trust on each other and they do less cooperation with each other as compared to developed countries but now due to improving conditions such deficiencies in their systems also improving (Vang J., & Asheim B., 2006).

Figure: 10 Triple Helix & Regional - Cluster Innovation System – Bangalore



Source: Krishna V. V., (2007)

4.2 Deficiencies/Weaknesses in Bangalore System

Bangalore road capacity is limited to 350,000 cars but the number of cars in Bangalore during the 40 years increased from 20000 to 1.3 million. Concerning firms location territorial competition especially in resects of specialized ICT firms has now become international. In near future Bangalore city will also face such challenges. China and Taiwan is strong competitor for it as they are providing superior atmosphere to high technology firms. Bangalore might be also become victim of foreign or local businessmen. In 1998 for instance Microsoft setup its very important research and development center in Hyderabad out side USA. In Bangalore it was also observed that there is lack of technological dissemination toward peoples who live close by. From the location of R&D centers and innovation support in India all the states do not benefit in the similar way. Deficiency of skilled and qualified professionals exist in India each year for instance during the year 2008 7 million engineers were required which include 2.2 million in software specialized fields and 4.8 million in other specialized fields (Grondeau A., 2007).

In India to improve the efficiency of remarkable number of training institutions there is a need of investment and such thing can facilitate and improve the performance of remarkable number of companies in RIS and consequently contributing in all-purpose improvement on Regional Innovation System. Additionally they need to invest in language skills also because due to lack of Japanese, Spanish or French language skills they are loosing market in Easter Nations and in China. Interaction among mid level universities and indigenous SME's required to be improved and such thing required modifications in salaries, structure of internal incentives, budgets and formalized competency building (Chaminade C., 2007).

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According to Mollman S., (2006) there was about 600 technical staff needed by Juniper Networks which is a maker of high end routers in Bangalore during 2006. In the same year in Beijing another company name Worksoft Creative Software Technology which is an outsourcing company in Bijing and has clients for instance IBM was required more than 850 engineers and more than that in up-coming year. These two Asian companies

were facing the same problem and the problem is new hires just are not there. Basic reason behind such thing was the disjoint among what competences the firms needed and what universities were teaching or giving to tech students. Universities in the regions were too theoretical in their approaches and ignoring soft skills. They were placing general concepts over hands on training. According to Global Savvy Company who has clients like IBM, Juniper and HP observe that ‘’*new college grades are not as polished as they would like’’. M*anagement abilities of few of them leave a lot to be desired. Talent shortage reasons include decreasing course enrolments, more concentration on theory; on IT staff changing demands, missing soft skill sets and hot job market. There solutions include courses with industry and university linkages, internships, on job skills training, cadetships and apprenticeships.

Chapter 5 Analyses

This chapter will present an analysis of literature reviewed above and try to seek the answer for the following under mentioned questions step by step and later present the concluding remarks in separate section.

Research Questions are,

4) How universities contribute and play a generative role in Bangalore?
5) How government, industry and universities interact and strengthen RIS of Bangalore?
6) How universities and STP's strengthen IT industry of Bangalore and what are the weaknesses in system?

According to the explanation of triple helix given by Gunasekara C., 2006 all three actors of triple helix which are government-industry and universities actively taking part together for the development of regional innovation system in Bangalore. Where in the past they were working as isolated entities for the development of Bangalore, today they have strong ties with each other and so many successful examples of their mutual success and cooperation are exist now in Bangalore. By keeping in mind the explanation of triple helix given by Gunasekara C., 2006 Karnataka State Government contributed a lot for the development of Bangalore and their IT industries by making new polices and soften existing regulations for this industry. One wonderful example of government initiatives is the introduction of state owned IT policy which was announced in 1997 and come-forth in the form of Mahithi –The Millennium IT Policy 2000. Through this policy government in Karnataka state in which Bangalore city is situated takes different initiatives and gives various incentives to the entities engaged with this industry. For instance government has assigned a specific area for this industry and gives land on low prices to the people who want to start their business there in the field of IT. Establishment of International

Technology Park in 1997, Export Promotion Industrial Park and Software Technology Park in Karnataka are also examples of government initiatives. Through information network connection of all districts and taluk head quarters in Karnataka is also an initiative of Karnataka Government for the development. Currently through a Fiber Optic Network 140 taluks out of 175 taluks has been connected to each other in Karnataka. Through this IT policy government spread IT education in almost all the educational institutions in the state from schools to university level which include initially all engineering colleges, 150 ITI's, 100 polytechnics and 300 colleges . For the promotion of IT industry Government has also given different exemptions to the people engaged with this industry for instance tax exemptions on first few year incomes. Government also develop new employment opportunities with these initiatives and in 2010 in IT sector potential for employment in Karnataka State alone reaches to 10 lac. 225 training centers were established for the training of unemployed educated youth in various IT skills. For the development of Karnataka State government has divided this state into four zones and Bangalore city comes in zone II. By focusing on this specific zone government has given 100 percent tax exemptions to the investors in that area for a period of 4 years. Through these initiatives government created jobs in software services, networks, various sectors in IT enable services and in hardware development (KUM, 2000). Few other key initiatives of government include formation of November 1984 Computer Policy and the Computer Software Export, Development and Training Policy of December 1986 and in 1988 National Association of Software and Services Companies formation to promote the software industry. In 1992 tax freedom on profit from service exports, in 1997 removal of import duties on software and in 1998 authorization to grant American Depository Receipts/Global Depository Receipts linked employee stock options are also remarkable initiatives of government (Parthasarathy B., 2004).

Where government in Karnataka State took such initiatives the IT industry and Universities in the state also respond in the positive way. In 1985 number of professionals engaged to different fields of IT industry were 6800 and in the next five years increased more than eight fold and reaches to 560,00 in 1990. In next decades development was at smaller pace and number of professionals reached to 841,500 in 2003

(Badge S., 2008). From 1990-1992 there was 7 Science and Technology Parks in India and in 2004 this number reaches to 18 and in 2005 there was 35 STP and in 2007 this number reaches to 42 Science and Technology Parks in India (Krishna V. V., 2007). From 1990-92 227 firms were attached with STP in India and in 2004 this number reaches to 6000 and in 2005 there were 8000 firms attached with STP in India and in 2007 this number reaches to 9000 firms. In 2003 there were 182 ICT Software firms in Bangalore (Krishna V. V., 2007). One of the autonomous institution with world class infrastructure in Karnataka State is Indian Institute of Information Technology which has laboratories sponsored by Microsoft, IBM, Compaq, CISCO, Sun Microsystems etc (KUM,2000).

These figures show remarkable performance and development of IT industry and infrastructure in Karnataka State and Bangalore city. These expansions have remarkable positive effects on the regional development of Bangalore and its emergence as Silicon Valley of India. These figures also reveals that where these expansions contributed in the economic and regional development of Karnataka State and Bangalore city they also created new links and role of different institutions. These new links and roles also become a key reason for such tremendous performance and expansion of IT industry and regional development there.

According to Badge S., 2008 over time type of entrants in the field of IT industry changed. In 1991-98 foreign branch companies are largest group in cohort; in 1999-00 diversifying companies are largest and in 2001-03 spin-offs are largest. Important software growth platforms of foreign companies are foreign branch and diaspora and if we combine them then in 1991-98 and 2001-03 in cohort they are the largest group and together they have 40 percent share of total companies (For more detail check table 3). In 1990 software exports from Karnataka State was 626 million rupees which reaches to 107,598 million rupees in 2003 and such increase shows a tremendous performance and expansion of this industry in this state during that time period.

During 1997 at US patent office 183 patents filed by Indian companies or individuals. In 1999 this number reached to 285 and in 2001 883 applications were filed (Basant R., 2004b). CMM level 5 is the highest level of certification in IT industry field and a homegrown company from Karnataka named WIPRO is the 1st recipient of Level-5 certification in India. Previously there was 19 level-5 companies in all over the world and out of them 12 were in India and 8 of those were in Bangalore. But later in 2002 out of total 58 CMM Level 5 companies in the world 32 were based in India. In December 2001 from the top most 300 software companies in India 216 firms were already have some form of quality certifications (KUM, 2000 & Basant R., 2004a). A successful example of university industry cooperation is the cooperation among Indian Institute of Science and Indian Company Encore has led to a low cost computer named Simputer (Chaminade C., & Vang J., 2006). More than 55,000 high quality professionals boasted by Bangalore city in the area of integrated chip design, application software, communication software and also in other services (KUM, 2000). World Bank in 1992 sponsored a survey which revealed that European and United State vendors ranked India as top preference for offshore and on-site software development ahead of Ireland, China, Philippines, Israel, Hungary, Singapore and Mexico (Parthasarathy B., 2004).

Where these two actors of triple helix which are government and industry improve and play their role in the regional development of Bangalore and make the way smoother for its regional innovation system maturity by remaining in their institutional boundaries inside and out. The third actor of triple helix which is Universities also played a key role in the development of Bangalore region and its IT industry by coming out from its two traditional tasks which are teaching and research.

There are more then 481 universities in India with approximately 45,000 colleges of different types and with such great number of educational institutions India is considered to be the home for education (NNE/List of Universities in India). Many scholars acknowledged early growth of Bangalore as specialized center in IT industry was because of some well known world class educational institutions which are situated there. From total 481 universities in India 39 are central universities, 130 are deemed universities, 254

are state universities and 58 are private universities. In Karnataka state of India where Bangalore city is located there are about 18 state universities, 1 central university and 15 deemed universities according to National Network of Education (NNE/List of Universities in India). There are about 2,772 Primary Schools, 1,177 High Schools, 209 Pre-University Schools, 170 Libraries, 4 Universities, 26 Engineering Colleges, 13 Law Colleges, 12 Dental Colleges, 6 Medical Colleges (General) and 9 Medical Colleges (Allopathy) in Bangalore (Discover Bangalore/Bangalore).

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Engineering baccalaureate capacity of India roses from 4788 in 1951 to 439,689 in 2004 and engineering baccalaureate capacity increases 91 times in 2004 from that of in 1951. During 1991 sanctioned engineering baccalaureate capacity in Karnataka State was 17,000 which reach to 38,900 in 2003. From the states which permit the private sectors in undergraduate engineering education Karnataka was among the first state. In 1957 first such college was opened one in 1962 and two in 1963. Engineering students were considered to be smart and their educational backgrounds were considered to be useful in signaling quality to potential customers (Badge S., 2008). There was about 2812 publications from Bangalore Academic Institutions during 2003-05, 1879 from Bangalore Public Research Institutes and 2339 from Indian Institute of Science Bangalore during the same period (Basant R., & Chandra P., 2007).

Where Universities contributed in such ways and take part actively in the development India become favourite in ICT field and it can be confirmed with such explanation that out of 10 most top firms of India 5 firms are from ICT sector. These important ICT sector firms include HCL Technologies, Manager Telephone Uigam, Wipro Corporation, DSQ Software and Infosys. In 2004 Infosys build subsidiaries in North America and Europe. In 2001 there were about 4 million technicians and scientists in India along with about 7 million students. Access to 200 research laboratories, 237 universities and 10 famous scientific institutes were available to such students like Indian institute of Technology (Grondeau A., 2007). Science parks and institutes in Bangalore host various research labs from various firms for instance Indian Institute of Technology host Intel, Honeywell, Siemens and HP (D'Costa, 2006).

Key universities in Karnataka State include Indian Institute of Information Technology, Indian Institute of Management, Indian Institute of Science. Key anchor companies in Karnataka State include CBSI, Satyam, CG Smith, Infosys, WIPRO, Honeywell, Texas Instrument, Microland, TCS, i-Flex. Key venture financings in Karnataka are ICF Ventures, Indus Ventures, ICICI Ventures, CAN Bank, KITVEN, IL&FS Ventures, Draper and key research centers includes Raman Research Institute, ISRO, CSIR, NAL, Center for AI & Robotics, GTRE, LRDE (Kum, 2000).

Where universities played their role in development the other regions also played important role in Bangalore city and Karnataka State development. These regions include Tamil Nadu, Maharashtra and Andhra Pradesh they played their role and facilitate the development of this state. There are 226 research centers in Karnataka, 305 in Tamil Nadu, 660 in Maharashtra and 221 in Andhra Pradesh, 73 research and development centers are in Bihar, 41 in Assam and 43 in Punjab (Grondeau A., 2007).

Where explanations above reveals university role in triple helix by keeping in mind the explanation of triple helix given by Gunasekara C., 2006 study also visibly reveals the generative role of universities in the development of Bangalore according to university generative role explanation given by Gunasekara C., 2006 and Chaminade C., 2007. Literature review reveals that universities played their role in knowledge formation, its exploitation and its diffusion. Universities also improve the quality of human capital along with demand for human capital where in other fields also in the field of Information Technology specifically.

Literature review also reveals that's where triple helix actors are playing their role in the development of Bangalore and where universities are playing generative role on the other hand there are some other factors in Bangalore which are playing their role but required some improvements. Bangalore regional innovation system is an emerging regional innovation system because Bangalore city is existed in a developing country. In developing country it's difficult to conclude that all factors of regional innovation system

are in systematic form. It should be understood as emerging system where few of its construction blocks are in place but connections between its elements are still in configuration and therefore appear fragmented (Chaminade C., & Vang J., 2006). Deficiencies or weaknesses in Bangalore system include lack of technological dissemination toward peoples who live close by. From the location of R&D centers and innovation support in India all the states do not benefit in the similar way. Limited road capacity and insufficient power resources also exist in Bangalore (Grondeau A., 2007 & Loganathan 2004).

Scarce human capital, limited enrollments after secondary school, scarce management skills, and incremental development, refining craftsmanship knowledge or reorganization of production processes is also limited. People do less trust and less cooperation (Vang J., & Asheim B., 2006). More investments required in language skills, interaction among mid level universities and indigenous SME's required to be improved (Chaminade C., 2007). Solutions like courses with industry and university linkages, internships, on job skills training, cadetships and apprenticeships required to improve these deficiencies in the system (Mollman S., 2006).

Conclusions

Study visibly reveals that universities in Karnataka State and Bangalore city are playing generative role. Study reveals that universities are playing generative role by creating highly developed trained human resources and basic research in the shape of scientific and technological knowledge, equipment and instrumentation, human capital, human skills, by constructing networks of technological and scientific potentials and prototype for new products and processes. Study reveals that actors of triple helix which are government, industry and universities actively contributing in the development of regional innovation system and regional development in Bangalore. Where in the past Bangalore government, industry and universities were playing their role by restricting themselves in their institutional boundaries and working as isolated entities, now they are cooperating with each other by coming out from their traditional tasks and doing mutual efforts for development. For instance introduction of new policies and incentives from government side played a major role in the expansion and development of IT Industry. Government has softened already existed regulations with introduction of new policies for supporting and promoting industry and university-industry mutual cooperation. Such things facilitate the expansion and development of IT Industry. With the expansion and development IT industry economically contributed in the development of region and created new employment opportunities. Appearance and existence of quality and world-class universities in Bangalore also contributed positively and play key role in development of region. Number of STP's also increased in the region and played remarkable role in development. Bangalore city is situated in a developing country so study also reveals that some deficiencies also existed in Bangalore regional innovation system. Further research can be done on the development role of universities in the regional innovation system of Bangalore alone or else on the comparison of a generative and development role performed by universities in Bangalore regional innovation system.

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