

**Knowledge-based Cluster Development in India
Opportunities and Challenges**

by

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Bachelor of Engineering (Civil), 1997 Punjabi University, India
Master of Business Administration, 2004 Panjab University, India

Submitted to the Department of Architecture
in Partial Fulfillment of the Requirements for the Degree of

Master of Science in Real Estate Development
at the

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Abstract

Knowledge-based industries tend to cluster. The nature of activities illustrate the importance of networks and virtual and proximity aspects of clustering. Review of existing literature brings out the advantages of clustering for such industries.

The purpose of the study is to comprehend the current status of development, both economic and real estate, in the knowledge-based industries in India. A stylized model is used as a reference to understand the status of economic development. Current body of literature and interview results from this study suggests transitioning nature of India's knowledge-based industry from being a services provider to becoming a knowledge provider. However, there are challenges in the transition process related to infrastructure and human resource.

This study suggests that a large scale mixed use project may in fact be able to address some of the ongoing issues in the economic domain. The proposed development may lead to clustering of business and universities thus, giving rise to a knowledge-based cluster in India.

Thesis Advisor: Brian A. Ciochetti

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Chapter 1: Introduction

Knowledge-based industries tend to cluster. The nature of activities illustrate the importance of networks and virtual and proximity aspects of clustering. Review of existing literature brings out the advantages of clustering for such industries. There are many examples where business clusters got created around centers of knowledge, such as world-acclaimed universities and research centers. The concept of Knowledge-based cluster as distinct from an industry cluster is discussed.

The purpose of the study is to comprehend the current status of development, both economic and real estate, in the knowledge-based industries in India. A stylized model of economic development, Economic Development Continuum Model, is used as a reference for comprehending the current status of development in the knowledge-based industries in India. Current body of literature and interview results from this study suggests transitioning nature of the knowledge-based industry in India from a services provider to becoming a knowledge creator. However, there are challenges related to infrastructure and human resource.

Combining the above mentioned concept and current scenario, leads to an important matter for consideration. Whether there is a causal effect of putting in place the infrastructure at the first place that could lead to the progression of economy, or whether infrastructure requirement is not a condition precedent but a requirement once the economy has progressed to a certain level?

This study suggests that given the transitional nature of Indian knowledge-based industries and the present state of infrastructure; a large scale mixed use development project could lead to an early mover advantage in the development of a knowledge-based cluster in India. Also, to attract and retain 'the creative class', it is essential that a mixed-use development is conceived of.

The research methodology consists of primary and secondary research. The research material is derived from articles, newspapers, journals and internet. The primary research was qualitative in nature wherein conversational interviews were conducted to gauge participants' opinion on different issues related to the knowledge-based industries.

The structure of thesis is as follows:

- Chapter 2: Concepts of cluster and knowledge-based clusters are introduced. Also, a stylized model, Economic Development Continuum model is introduced that would be used as a base to understand the current state of knowledge-based economy in India.
- Chapter 3: Current state of Knowledge-based industries in India is discussed. Here, the industry size, progression, potential and location concentrations are mentioned. This chapter is more informational in nature. This would give an idea of the landscape of knowledge-based industries in India.
- Chapter 4: Special Economic Zone policy in India is discussed. The chapter also highlights some of the issues that the SEZs are currently facing. A brief discussion follows on why SEZs are preferred by the knowledge-based industry.
- Chapter 5: The chapter highlights certain opportunities and challenges based on the Economic Development Continuum Model in India's transitioning process to next level of economic development. It also summarizes the earlier chapters and develops a case for putting in place the infrastructure required in the development of a knowledge-based cluster in India. Recommendations and potential topics for future research follow.
- Chapter 6: Conclusions and Recommendations

Chapter 2: Concepts

There are many studies on clusters that delve into explanation of clusters, their formation and benefits of being located in a cluster. For the purpose of this paper, a brief introduction to the concept of cluster and knowledge based cluster is presented in the section below. In the following sections, an economic development continuum model and role of creative class in a knowledge economy would be introduced that would form basis of further discussion of this paper.

2.1 Clusters: Definition, Traits and benefits

“Industry clusters are geographical concentrations of industries that gain performance advantage through co-location”¹

According to Rosenfeld (1997)², an industry cluster is: “a geographically bounded concentration of similar, related or complementary businesses, with active channels for business transactions, communications and dialogue that share specialized infrastructure, labor markets and services, and that are faced with common opportunities and threats.” He places importance on the role of social interaction and firm cooperation in determining the dynamic nature of a cluster.

Alfred Marshal, a famous economist, (1920) suggested three common reasons why clusters thrive: 1) benefits of a pooled labor supply, 2) access to specialized inputs, and 3) information flow between people and institutions. These reasons are relevant even today. In general, businesses locate where it makes the greatest economic sense, either in terms of accessing the market for their product, the labor pool, or required resources. The basic factors that drive industry clustering are very similar to the factors that encourage urban or location agglomeration economies.

The concept of clusters was popularized by Michael Porter (1990) in his book, *The Competitive Advantage of Nations*. He produced a “diamond of advantage” to explain conditions that favor cluster development. This diamond model consists of the following elements:

- Factor conditions – a region’s endowment of factors of production, including human, physical, knowledge, capital resources, and infrastructure, which make it more conducive to success in a given industry.

¹ Doeringer and Terkla 1995, *Business strategy and cross-industry clusters: Economic Development Quarterly*

² Rosenfeld, Stuart A. 1997. “Bringing Business Clusters into the Mainstream of Economic Development.” *European Planning Studies* 5(1): 3-23.

- Demand conditions – the nature of home demand for a given product or service, which can pressure local firms to innovate faster.
- Related and supporting industries – networks of buyers and suppliers transacting in close proximity to foster active information exchange, collective learning, and supply-chain innovation.
- Firm strategy, structure, and rivalry – The condition in the country that determines how companies are established, are organized and are managed and that determined the characteristics of domestic competition.

Porter explains that competition is a driving force behind cluster development. As one competitive firm grows, it generates demand for other related industries. It is the competition between rival firms in the cluster that drives growth because it forces firms to be innovative and to improve and create new technology. This, in turn, leads to new business spin-offs, stimulates R&D, and forces the introduction of new skills and services. The mobility of similar labor pool within the cluster leads to knowledge transfer and promotes competition and growth.

Saxenian (1994) discusses the importance of the social interaction in the growth of Silicon Valley, and attributes much of the early success of the area to the social infrastructure. The social infrastructure within the cluster helps facilitate technology and knowledge transfer that strengthens the cluster and promotes future growth.³

³ Saxenian, Anna Lee. 1994. *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*. Massachusetts: Harvard University Press.

2.2 Concept: Knowledge-based Clusters

Conceptually, clustering of knowledge-based industries is referred to as a knowledge-based cluster. The Organization for Economic Co-operation and Development (OECD) defines “Knowledge-based industries usually refer to those industries which are relatively intensive in their inputs of technology and/or human capital.” It further states that “it is desirable to include other activities that are intensive users of high technology and/or have the relatively highly skilled force that is required to benefit fully from technological innovation.”⁴ Therefore, certain industries such as life sciences industries-pharmaceutical, biotechnology, medical sciences, devices and equipments; information and communication technology and high end engineering; service activities such as finance, insurance and communications constitute what is referred to as knowledge-based industries. Organizationally, these industries tend to cluster around universities and research institutes.

Hans-Dieter Evers (2008) describes knowledge clusters as agglomerations of organizations that are production-oriented.⁵ Examples for organizations in knowledge clusters are universities and colleges, research institutions, think tanks, government research agencies and knowledge-intensive firms. Evers further distinguishes Knowledge clusters from knowledge hubs.

Knowledge hubs are local innovation systems that are nodes in networks of knowledge production and knowledge sharing. As meeting points of communities of knowledge and interest, knowledge hubs fulfill three major functions: to generate knowledge, to transfer knowledge to sites of application; and to transmit knowledge to other people through education and training. Therefore, knowledge hubs are an intangible set of processes that arise out of being in an agglomeration of organizations i.e., the knowledge-clusters.

An article describes the advantages as location externalities that arise out of geographical proximity and interaction between workforce, customers, suppliers, partners, competitors as well as educational and research institutions. Further, the process of knowledge exchange and spillover and how does it lead to further innovations is elaborated.⁶

Evers further extends his conceptualization to a higher degree and describes regions and countries as exhibiting “Epistemic Landscapes” of knowledge assets, structured by knowledge clusters, knowledge hubs, knowledge gaps and areas of high or low knowledge intensity.

⁴ www.oecd.org/dataoecd/42/34/2087188.pdf

⁵ ZEF Working paper series, Evers, Hans-Dieter, Knowledge Hubs and Knowledge Clusters: Designing a Knowledge Architecture for Development.

⁶ ‘Knowledge Spillover and Innovation in Technological Cluster’ (IAMOT, 2004), Fallah and Ibrahim

Evers explains that epistemic landscapes develop over long periods of time. These are more often shaped by the collective action of strategic groups. The government also plays its part in promoting such epistemic landscapes by providing support and incentives to develop knowledge-based societies and economies. Also, the firms' location decisions have an impact on epistemic landscapes as firms have a common interest to capitalize on the competitive advantage of clustering.

The above mentioned concepts are tabulated as shown in the table below:

Table 1: Knowledge Cluster and related concepts

Concept	Short Definition	Measurement (examples)
K-cluster	agglomerations of organizations emphasizing knowledge as output or input	number of organizations per location
K-hub	local innovation systems that are nodes in networks of knowledge production and knowledge sharing	number of knowledge workers and their products (patents, papers, software)
K-architecture	the structures and institutions of communication and the related type and intensity of knowledge flows	ICT governance regimes, regular meetings, knowledge-sharing incentives
Epistemic landscape	areas of high or low knowledge intensity	Regional R&D expenditure, location of k-clusters, k-hubs

Table adopted from working paper of Evers.

Types of Firms in a knowledge-based cluster: ⁷

- i. Established firms: These are essentially the city's major and long established high technology firms that continue to play important underpinning roles for the cluster. These are the industries that act as anchors for other industries to come and locate near them.
- ii. Other firms attracted by the area's attractive offering: There are other firms that move into the region or cluster, attracted by its reputation, research strengths and specialist labor supply.
- iii. Start-ups and spin outs: The start-ups and spin out firms are generally as result of knowledge and information exchange and spillover that avail niche opportunities in technology. Entrepreneurial pool and incubation is often necessary for these types of firms. Universities and research parks are increasingly seen to play an important role in facilitating growth of such industries.

⁷ Adapted from 'The Cambridge Phenomenon Revisited 2000 ISBN 0-95 10202-2-6: SQW Publications.

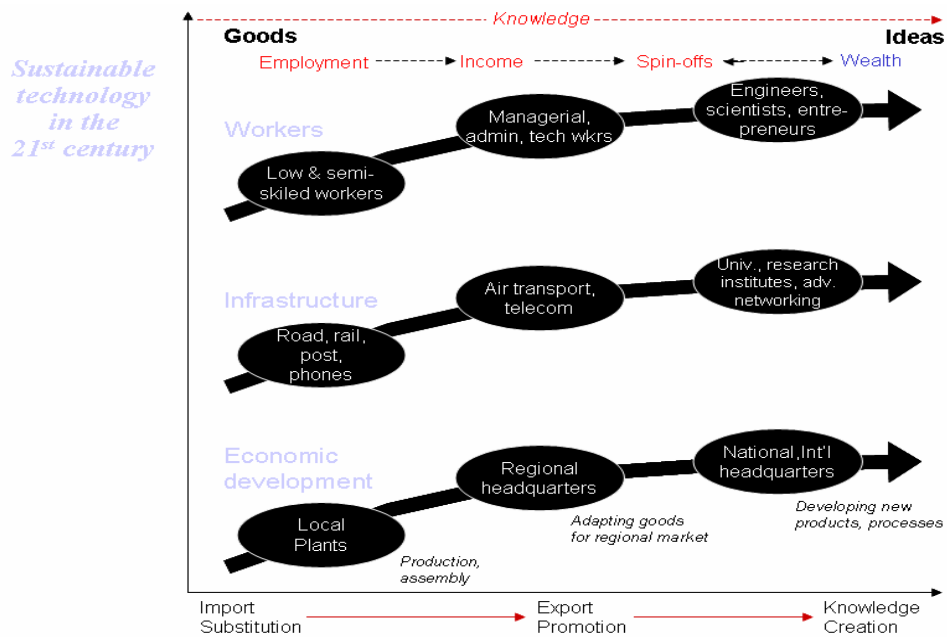
Research Parks, or sometimes known as Science Parks, often form an important constituent of Knowledge-based clusters. These parks are planned developments and provide for necessary infrastructure such as research labs and incubation facilities required by the start-up companies. (Refer Appendix 1 for studies on Research Parks). There are examples where the knowledge-clusters develop around the research parks. Research Triangle Park, North Carolina, USA and Hsinchu Science Park, Taiwan are among examples of successful knowledge-based clusters.

Knowledge based industries have largely remained in the domain of developed countries. This is because these industries form part of an economy once the economy has matured to a certain level of economic development. The next section introduces a model that details the evolutionary stages of economic development and the concomitant factors associated with each stage.

2.3 Economic Development Continuum Model

A stylized model, Economic Development Continuum Model (hereinafter referred to as model), is presented below. It highlights the progression of economy (highlighted on x-axis) and the concomitant factor conditions such as workers, infrastructure and firm’s organizational pattern (highlighted on y-axis). Each stage of economic development requires a set of factor conditions.

Figure 2: Economic Development Continuum Model



Source: Research paper: Research Park Redux: Changing landscape of the Garden, Michael I. Luger and Harvey A. Goldstein

In stage one of Economic Development Continuum, the main line of economic activity is import substitution and the factor conditions are basic in nature. Workers are semi-skilled, infrastructure is mainly provides for basic connectivity and goods are produced in local plants.

Export promotion becomes the main economic activity in stage two. Most companies start to adapt goods for regional markets and employ managerial and technical workers. There is income generation in the economy. Air and telecom infrastructure is required to support this stage of economy.

The third level is characterized by knowledge creation that leads to wealth creation as a result of development of new products and processes. Idea generation and knowledge sharing among engineers, scientists and researchers is considered essential for knowledge creation. Universities and research institutes are identified as the infrastructural requirements for transmission of ideas.

It must be mentioned that the model is a simplistic representation of a complex world. The purpose here is to highlight the different stages of economic development and their relative factor conditions. In today's global world, different stages of economy are at work at the same time, though the relative importance of one stage may be more than the other at any given time for a given country.

The next important concept is that of a creative class or knowledge workers.

2.4 Creative Class and Knowledge economy:

Human capital and supporting infrastructure are the critical elements for the development of knowledge economy. Creative Class is a term used by Richard Florida, author of the book, *The Rise of the Creative Class*, to define people who add economic value through their creativity.⁸ These include a good many knowledge workers, symbolic analysts and professional and technical workers. The creative class is characterized by creativity, individuality, diversity, and merit. Further, the author stresses that the creativity must be cultivated and motivated under appropriate social atmosphere, and nurtured by employers, by people themselves and by the communities where they locate. This is important because the creative class has a huge economic impact. In the future, they will determine how the workplace is organized, what companies will prosper or go bankrupt, and even which cities will thrive or wither.⁹

⁸ Richard Florida is one of the world's leading public intellectuals on economic competitiveness, demographic trends, and cultural and technological innovation.

⁹ *The Rise of Creative Class 2002* Richard Florida

Chapter Summary:

Summarizing the concepts as discussed in this chapter, concept of knowledge based cluster as distinct from an industry cluster and the constituent elements of the knowledge based cluster were highlighted. Next, the model that depicts stages of economic development and the concomitant factor conditions was introduced. Finally, the importance of the knowledge workers in sustaining a knowledge economy was highlighted.

The applicability of above mentioned concepts to India would be dealt with in later chapters. The next chapter presents an overview of knowledge-based sector in India is presented wherein the rise of knowledge-based industries and their location concentrations would be discussed.

Chapter 3: India: Overview of Knowledge-based Sector

India is emerging as one of the preferred destinations for the knowledge-based industries. Many home grown companies have emerged successful globally. Multinational companies continue to expand their R&D operations and production because of potential for speeding up the innovation process, cost savings and access to technical competency and markets. Some of the factors that favor India's emergence on a global scale are educated workforce, significant R&D related institutional infrastructure and entrepreneurial traditions. In this chapter, growing international investments in India's emerging knowledge-based industries, size of the industries, industry concentration and a transitioning trend of the nature of activities is presented.

In Indian context, the knowledge-based industries can be divided in two categories:¹⁰

Knowledge-based Service Oriented: This comprises of Information Technology and Information Technology enabled Services (IT/ITeS) that encapsulates Business Process Outsourcing (BPO), IT Hardware and Packaged software segments. IT is further leading to growth of Knowledge Process Outsourcing (KPO) Industry. Legal Process Outsourcing (LPO), Engineering Services Outsourcing and Financial and Market Research are emerging outsourcing segments of KPO industry in India. Financial, Insurance and Legal services also fall in this category.

Knowledge-based R&D Oriented: This comprises of industries such as biotechnology, pharmaceutical, medical technologies, devices and equipments, auto and aero space engineering. These industries are gaining prominence in India in recent times.

Raja M. Mitra, a US based strategist and economist, has examined key trends, drivers and prospects of India emerging role as a center for research and knowledge processing industries.¹¹ Mitra further explains that initially, the cost advantage led the companies to base their operations in India but slowly India is seen as a potential market itself. The research and development activities are now focused on localization and customization of products serving the Indian market in addition to being base for global markets.¹²

The next section highlights the international investment flows, Foreign Direct Investment, Private Equity and Venture Capital to India.

¹⁰ In this paper, the Knowledge-based industries would refer to both the service oriented and R&D oriented industries.

¹¹ India's Emergence as a Global R&D Center- An Overview of Indian R&D system and potential, published in 2007

¹² Ibid

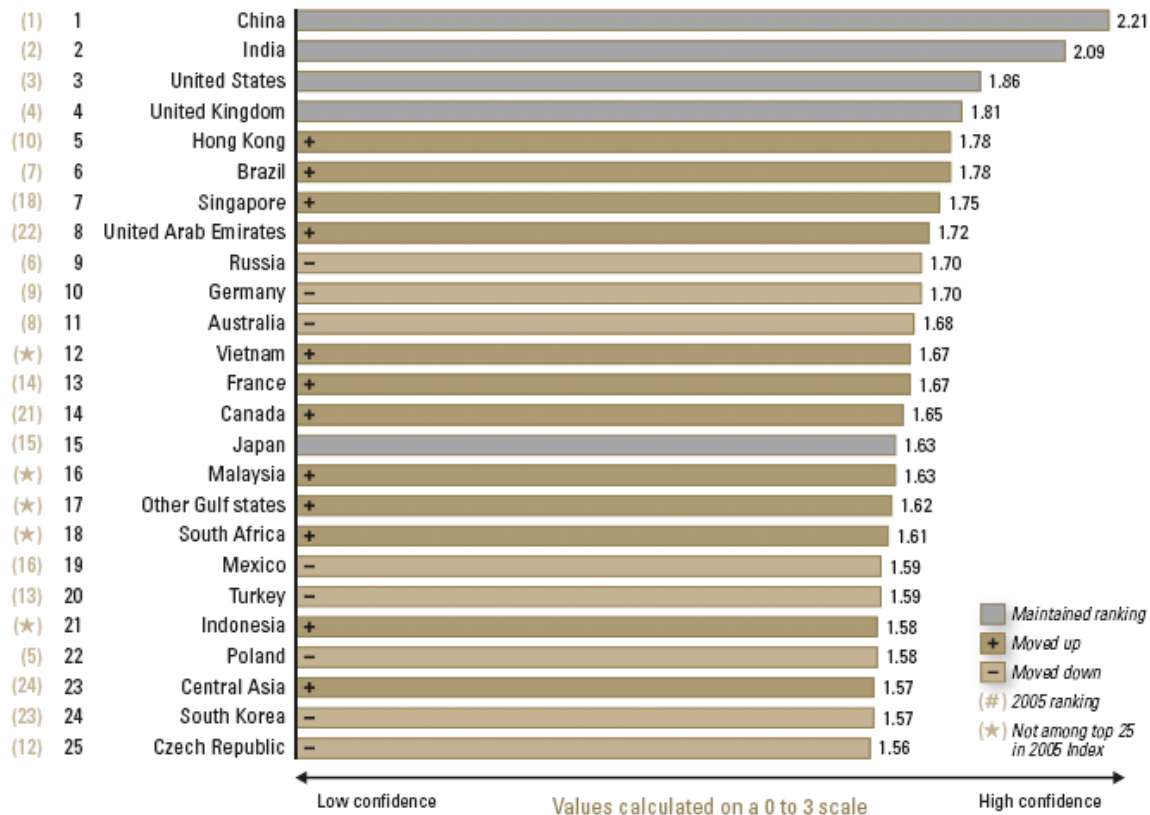
3.1 Foreign Direct Investment (FDI):

The increasing interest in the Indian market is also evident from the Foreign Direct Investments (FDI) that is flowing into the country. The FDI Confidence Index, as shown in figure below, prepared by consulting firm A.T. Kearney ranks India as the world's second-most desired destination for FDI after China. The index tracks the impact of likely, political, economic and regulatory changes on the foreign direct investment intentions and preferences of the leaders of the top companies of the world.

Figure 3 : Foreign Direct Investment Confidence Index

2007 Foreign Direct Investment Confidence Index®

Top 25



Source: A.T. Kearney

Figure adapted from A.T. Kearney Report Dec.2007: New Concerns in an Uncertain World.

FDI plays an important factor in technology transfer and in growth of knowledge clusters. In an article published in July 2007, the authors, conducted data analysis of FDI flows between the years 2002-2005 by analyzing the number of projects, number of jobs created and level of investment made and found that the developing economies are increasingly becoming preferred destination for FDI flows.¹³

FDI Flows: Sector Distribution

FDI Statistics, as shown in Table 1, reveal that the Knowledge-based sectors, (here services sector, computer software and hardware, drugs and pharmaceuticals) are the sectors attracting the maximum percentage of FDI over the years. The cumulative investment in these sectors during period 2000-07 comes to approximately US\$ 20BB. It is notable that during the last two years i.e., 2006-07, there has been a steep rise in the FDI received in the above mentioned sectors.

Table 2 : FDI Inflow 2000 - 2008. (US \$1 = INR 43)

Sector	(Rs. crore)						
	Amount of FDI Inflows				Cumulative inflows (April 2000 to Nov. 2007)	Share of inflows (per cent)	
	2004-05 (April-March)	2005-06 (April-March)	2006-07 (April-March)	2007-08 (April-Nov.)		April 2000 to Nov. 2007	April-Nov. 2007
Services sector ^a	1,986	2,399	21,047	9,121	38,228	19.86	20.22
Computer software & hardware	2,441	6,172	11,786	4,217	30,760	15.98	9.35
Telecommunications ^b	570	2,776	2,155	3,963	15,607	8.11	8.79
Construction ^c	696	667	4,424	3,593	9,989	5.19	7.97
Automobile industry	559	630	1,254	1,191	8,350	4.34	2.64
Power	241	386	713	206	5,958	3.09	0.46
Chemicals except fertilizers	909	1,979	930	733	5,956	3.09	1.63
Housing & real estate	0	171	2,121	5,161	7,573	3.93	11.44
Drugs & pharmaceuticals	1,343	760	970	353	4,633	2.41	0.78
Metallurgical industries	836	654	787	1,909	4,572	2.37	4.23

Source: Department of Industrial Policy & Promotion.

^a financial & non-financial services.

^b radio paging, cellular mobile, basic telephone services.

^c construction including roads & highways.

¹³ Huggins, Robert, Demirbag, Mehmet and Ratcheva, Violina Iankova (2007) 'Global Knowledge and R&D Foreign Direct Investment Flows: Recent Patterns in Asia Pacific, Europe, and North America', International Review of Applied Economics, 21:3, 437 — 451

FDI Flows: Regional Distribution

Regional distribution table as shown in Table 2 reflects that the FDI is going to select cities and regions only. Though the table below gives the breakup of FDI received in all the sectors, it still gives an idea that the economic activity is largely concentrated in certain select locations only. That further indicates concentration of companies in those locations. Further, though each city is shown to cover FDI for the regions and states, it is likely that the cities or nearby areas are in fact the main recipients of the FDI received.

Table 3: Region-wise break up of FDI received (April 2000 to November 2007)

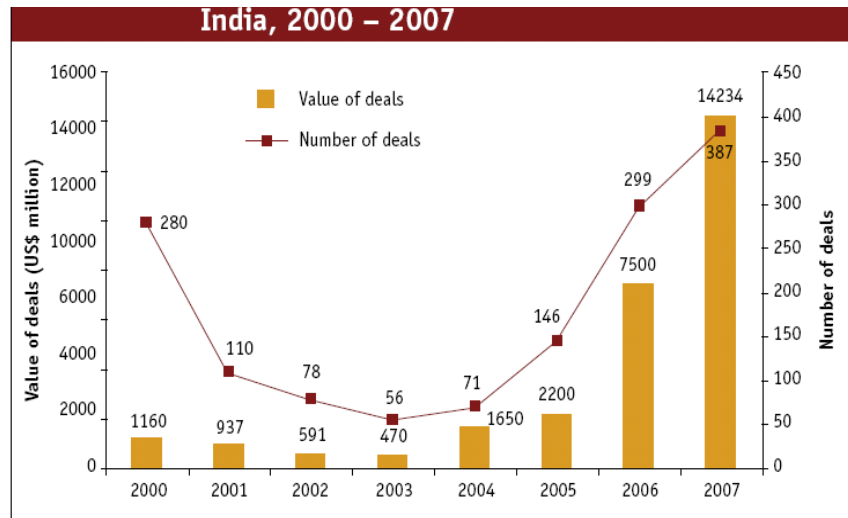
Region-wise break-up of FDI received (April 2000 to November 2007)		
Regional Office of the RBI	States covered	Share in FDI inflows (per cent)
Mumbai	Maharashtra, Dadra & Nagar Haveli, Daman & Diu	25.14
New Delhi	Delhi, parts of UP & Haryana	22.68
Bangalore	Karnataka	7.03
Chennai	Tamil Nadu & Puducherry	6.69
Hyderabad	Andhra Pradesh	4.12
Ahmadabad	Gujarat	2.84

Source: Department of Industrial Policy & Promotion.

3.2 Private Equity and Venture Capital Funds:

In addition to FDI, there is also growth in the Private Equity and Venture Capital funds flow to India. Number and size of Private Equity (PE) and Venture Capital (VC) deals in India are indicative of growth of new companies and emergence of entrepreneurship in India. Figure shown below shows the number and size of PE and VC deals in India during 2000-07.¹⁴ It is evident that there has been a rapid rise in the number of deals and the investments particularly in the last two years.

Figure 4 : Number and Size of PE and VC deals in India during 2000-07



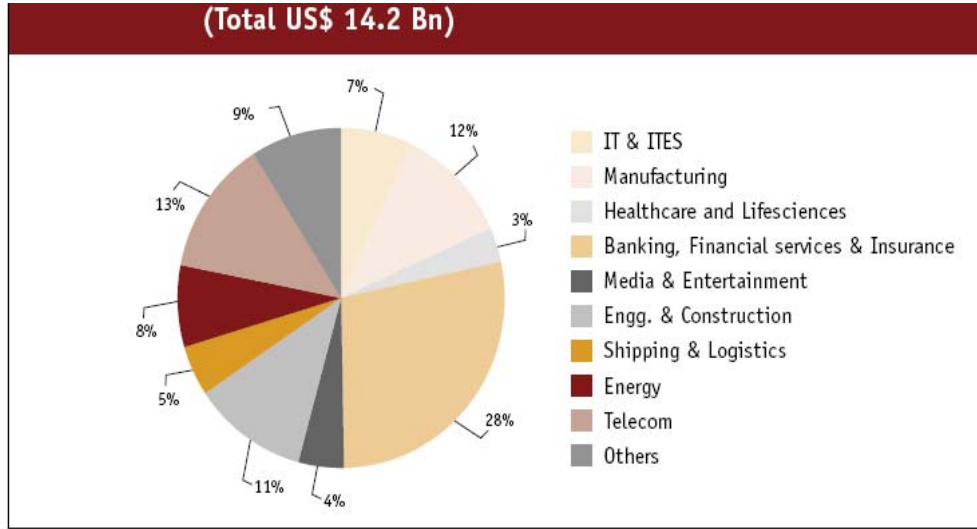
Source: TSJ Venture Intelligence

Sector-wise Distribution:

Sector wise distribution of PE and VC funds is shown in the figure on the next page. It shows that more than half of the funds are getting invested in IT/ITeS, Banking, Financial and Insurance Services, Telecom, Healthcare and Life sciences sectors. This reflects increasing level of entrepreneurial activity in the knowledge-based industries.

¹⁴ Source: Study conducted by National Knowledge Commission on Entrepreneurship in India in 2008

Figure 5 : Sector allocation of PE &VC Funding in 2007 in India



Source: TSI Venture Intelligence

The table below again reflects that the entrepreneurial ventures are also concentrated in the same cities where the knowledge-based industries are located. The relation could work in both dimensions i.e. the industry gets clustered where the entrepreneurial pool is, alternatively, entrepreneurs get located where the industry is present.

Table 4 : City wise distribution of number and size of PE &VC deals in 2007

City	No. of deals	Value (US\$ million)
Mumbai	103	5995
Delhi/ NCR	63	2688
Bangalore	49	685
Hyderabad	41	1380
Chennai	32	824
Ahmedabad	14	492
Kolkata	12	339

Source: TSJ Venture Intelligence

Therefore, there has been increase in the flow of international funds to India as India remains high on preference of multinational companies. Also, the increased activity in PE and VC space also highlights that there is growth in entrepreneurship and new businesses starting up. The investment flows are mainly concentrated in few cities. The growth in investment pattern in the knowledge-based industries is indicative that the industry is growing.

3.3 Knowledge-based Industries in India: Size of Industry & Location Concentration

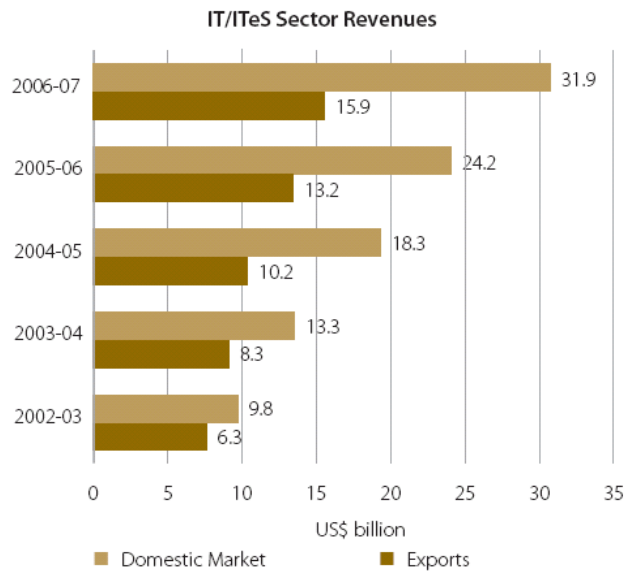
This section would cover the size of different industries and their location concentrations. Also, a general progression in the value chain wherein the service-based industries are adopting more knowledge intensive operations and functions is highlighted.

3.3.1 Information Technology (IT) and IT-enabled Services (ITeS)

IT/ITeS industry is by far the biggest and the most prominent service industry in India. There are more than 100 major foreign companies and a larger and more diverse group of Indian companies, ranging from large organizations with global operations to smaller companies focusing on exports or the domestic markets.

The industry has recorded a phenomenal growth in terms of revenues and employment generation. IT/ITeS revenues over the past 5 years are shown in the figure below. The domestic and export revenues increased from US\$15BN in 2002-03 to \$US50BN in 2006-07. Interestingly, over the years the domestic market (top bar) is providing more revenues than the exports (bottom bar).

Figure 6: IT/ITeS Sector Revenue 2002-2007



Source: NASSCOM

Size of the industry: Physical Space

It is estimated that the IT/ITeS sector employs about 2.3 million people directly and 6.5 million people indirectly. In terms of Class-A space i.e., premier commercial space, the industry has registered Compound Annual Growth Rate (CAGR) of 52% over past 6 years. IT/ITeS space grew from 35million square feet in 2001 to 85 million square feet by end of 2007. Attractive government policies by Central and State Government, tax benefits and higher allowable FSI to build IT parks are among the reasons for hyper growth of real estate catering to the IT businesses across the country. The growth in the industry suggests that there would be more space requirements in future. The estimates can be made based on the past growth rates and projections.

Industry concentration:

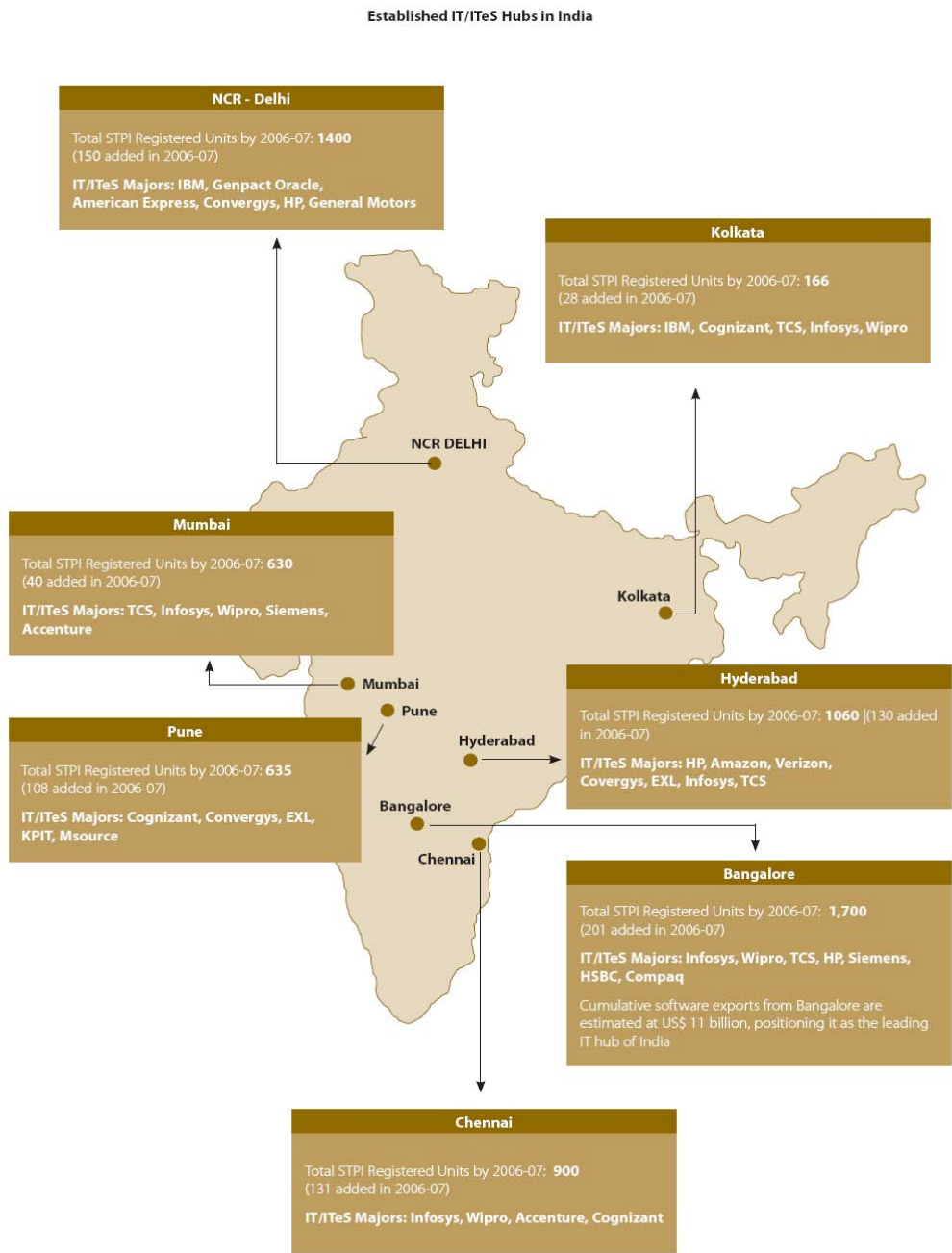
IT/ITeS industry is largely concentrated in few cities of India such as Bangalore (new name is Bengaluru), Hyderabad, Chennai, Pune, Kolkata and the National Capital Region (NCR) that comprises of New Delhi, Gurgaon and Noida

The established locations for IT/ITeS industry in India are shown in figure 3 on the next page. The boxes highlight number of software companies registered till 2006-07 with Software Technology Park of India (STPI).¹⁵ The maximum number of software companies is in Bangalore (1700); followed by NCR (1400) and Hyderabad (1060). Chennai, Pune, Mumbai and Kolkata follow next.

The boxes also highlight some of the known companies present at each of these locations. Also, almost the same number of companies got registered at Pune and Chennai as in Bangalore, Hyderabad and NCR.

¹⁵ STPI is a society set up by the Department of Communication & Information Technology, Government of India in 1991, with the objective of encouraging, promoting and boosting the Software Exports from India.

Figure 7 : Established IT/ITeS Locations in India



Source: Indian Brand Equity Foundation (IBEF) Report: IT/ITeS Markets and Opportunities,

Established Locations and Factors that favored Industry Concentration:

Case studies of three Indian cities, Bangalore, Hyderabad and Kolkata are presented in a working paper.¹⁶ It explains the factors that have led to concentration of firms in these locations. Bangalore is referred to as an early mover due to the historical, geographical, economic, cultural and political factors. The emergence of Hyderabad and Kolkata, as emerging IT clusters, is explained due to the State's initiatives such as providing incentives and laying down infrastructure; and presence of entrepreneurial pool that favored such cluster formation.

Bangalore has become one of world's leading clusters for software development. It is ranked fourth as a global hub of technological innovation behind the US cities of San Francisco and Austin and Taiwanese¹⁷. By far almost all major software companies have their campuses in Bangalore. Electronic city and Whitefield area of Bangalore is home to not only the big home-grown companies like Infosys and Wipro but also to many foreign companies including Dell, Microsoft, IBM, Intel, Samsung, Motorola etc. These companies have provided a vital contribution to the development of the Bangalore cluster through the diffusion of knowledge and the networks created with local firms and institutions.

Hyderabad developed as IT destination because of the pioneering role played by the State Government of Andhra Pradesh. The government invested in infrastructure and provided a much effective and responsive government. Most of the big foreign and domestic IT companies are located in Hitech city, a designated area for IT companies, in Hyderabad. Microsoft has set up its own campus in Hyderabad.

Pune, Chennai, Kolkata and NCR are other prominent IT destinations. Urban locations with new physical and social infrastructure and availability of skilled workforce attracted companies to these locations.

G. Balachandirane of Institute of Developing Economies presents case studies of Bangalore and Hyderabad.¹⁸ The paper highlights the factors such as presence of educational institutions, public sector undertakings, accommodating local population, conducive climate, entrepreneurial nature of the people and metropolitan character of the city that led to Bangalore's growth. Later, the government policy to promote the industry, availability of skilled professionals and role of Indian diaspora led to Bangalore's success as it capitalized on the factor conditions. In case of Hyderabad, the pioneering role played by the State Government in providing civic amenities to attract the industry is highlighted. Setting up of educational institutes such as Indian School of Business and the network of Professionals from the city with those in Silicon Valley are among other factors mentioned.

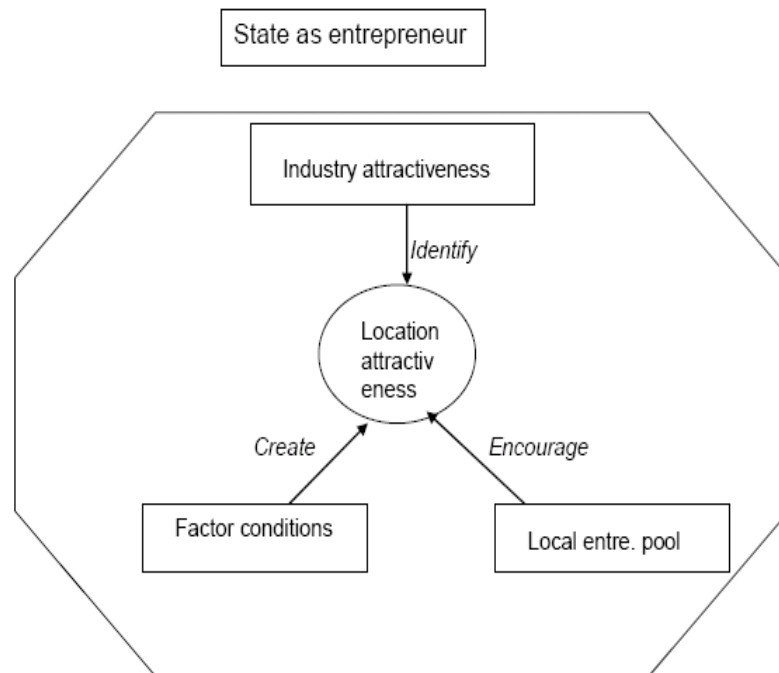
¹⁶ K. Ramachandran of Indian School of Business (ISB) Hyderabad and Sougata Ray of Indian Institute of Management (IIM) Kolkata titled, 'Formation of Information Technology Clusters- How Late Movers Follow Model Differently from Early Movers'.

¹⁷ Ibid

¹⁸ Discussion paper titled IT clusters in India by G. Balachandirane

A stylized model, Dynamics of forming a Cluster, as shown in the figure below, is presented in Ramachandran and Ray's paper. It reflects the interplay of forces that have helped these locations to emerge as IT clusters.¹⁹

Figure 8 : Dynamics of forming a Cluster



The model presents interplay of forces fundamental in growth of a cluster. The state provides for factor conditions such as infrastructure and incentives that create location attractiveness. The industry identifies the location attractiveness and decides to establish itself. The local entrepreneurial pool further leads to growth in the industry.

IT/ITeS companies continue to be concentrated at the established locations for sophisticated and high technology work such as development of packaged software and embedded technologies. The nature of work and employability in these work areas is a factor that keeps the professionals bound to such premier locations.²⁰

¹⁹ Ibid

²⁰ There is no generalization attempted here as the companies operate out of multiple locations in different regions of the country.

A viewpoint expressed by a software professional was that the secondary locations such as the Tier-2 cities act as a feeder of workforce for the companies operation in Tier-1 cities.²¹ Skilled workforce is provided on job training and then relocated to premier locations for more sophisticated work. Presence of already established senior management further contributes to the concentration of certain work areas at the already established locations.

Emergence of other cities as destination for IT/ITeS Sector:

IT and ITeS Sector is seemingly expanding at a much faster pace than any other sector in terms of workforce employment and geographic reach. The established locations have already started feeling the growing infrastructural pressures. High cost of real estate and lower operating costs are among the factors that are leading companies to locate in other tier-2 cities.

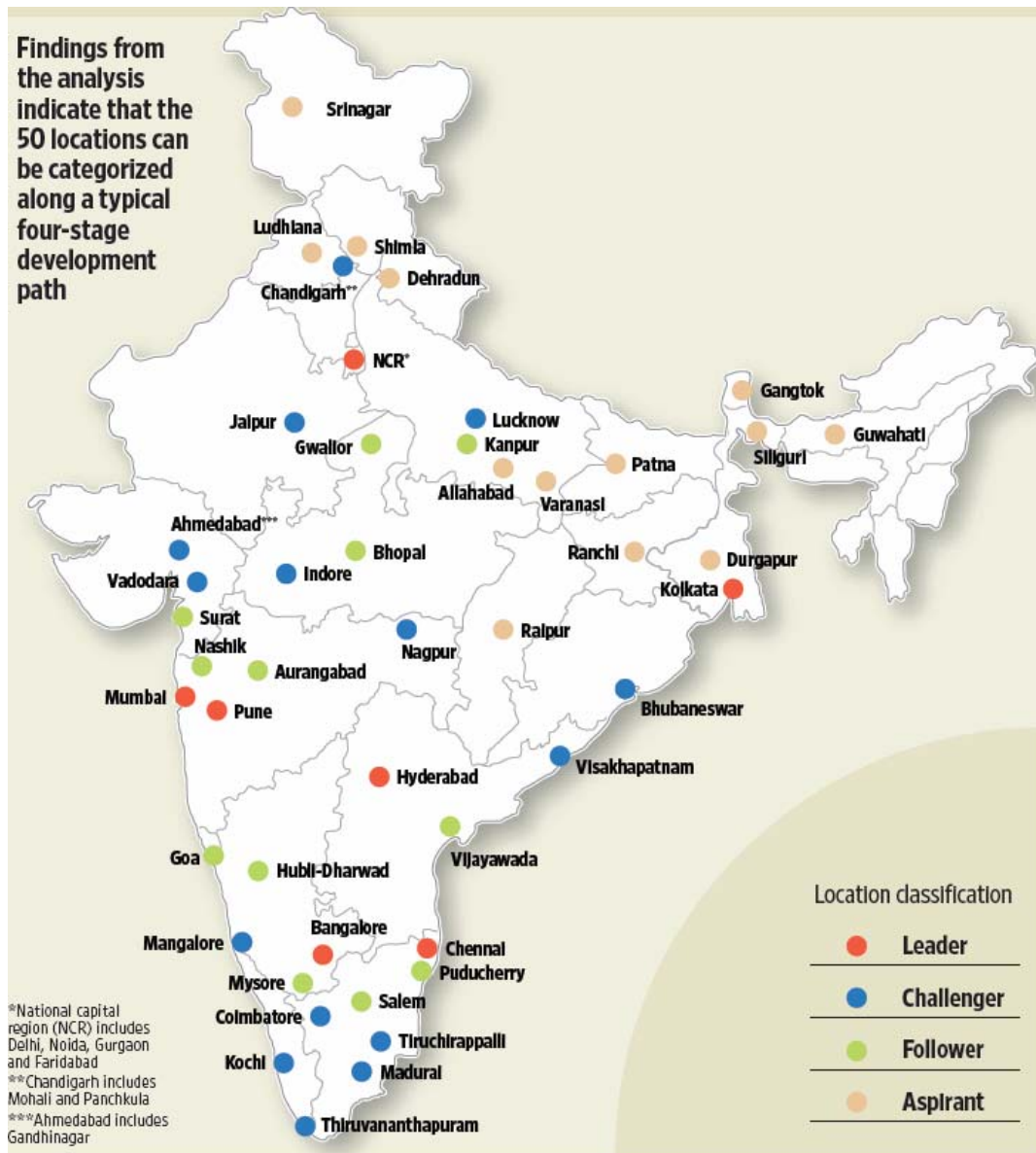
To meet with the challenges of infrastructure and high real estate costs, many companies are adopting a hub and spoke strategy to ease out pressures on the centralized locations such as Bangalore. According to this strategy, key functions are sought to be centralized and multiple small operations could be developed throughout a metro region to spare the labor market and infrastructure demands. This leads to proliferation of firms to the suburban and nearby tier 2 locations.

In May 2008, The National Association of Software and Services Companies (NASSCOM)-A.T Kearney, a consulting company, released a study Indian cities are categorized into four categories: Leaders, Challengers, Followers and Aspirants.²² The categorization is done based upon the current state of key parameters such as availability of knowledge pool, infrastructure, social and living environment, enabling business environment, government support and operating cost. In the leader category, seven cities stand out and fifteen are in the challenger category. (Figure shown on the next page)

²¹ Emerging cities in India that have significant growth potential are referred to as Tier-2 cities. Already established, often the metropolitans are referred to as Tier 1 cities.

²² Location Roadmap for IT- BPO Growth: Assessment of 50 leading cities: NASSCOM- AT Kearney

Figure 9 : Categorization of cities of India according to their potential in IT/ITeS Sector

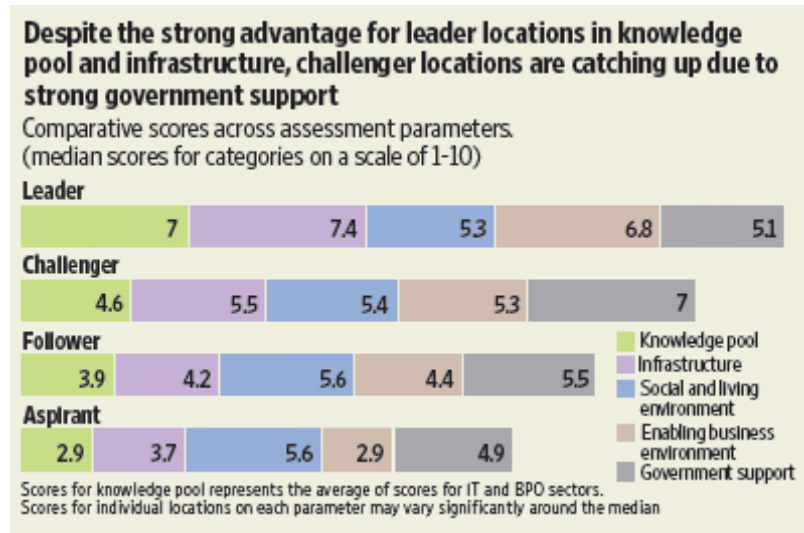


Source: NASSCOM-AT Kearney Study: Location Roadmap for IT/BPO Growth

According to the study, Leader cities account for 85% of IT employment and 90% of BPO employment. The results also show that the non leader category cities offer nearly 30% lower operating cost than the leader category cities.

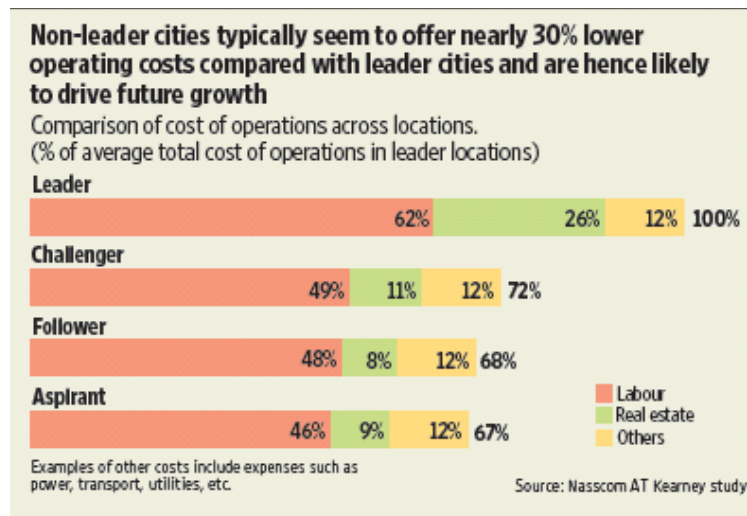
The results show that the availability of knowledge pool, infrastructure and enabling business environment are key distinctive features where leader cities have an advantage over others. Government support is particularly high for the Challenger cities. This shows that the government is actively trying to promote the growth of IT/ITeS industry in such cities.

Figure 10: Parameters on which categorization of cities is done in the study



The marked difference in the operating cost comes from the real estate category as the cost of real estate in the leader category cities is much more than the other categories. Real estate cost is a big factor that is pushing the industry out of big cities.

Figure 11 : Operating cost parameter

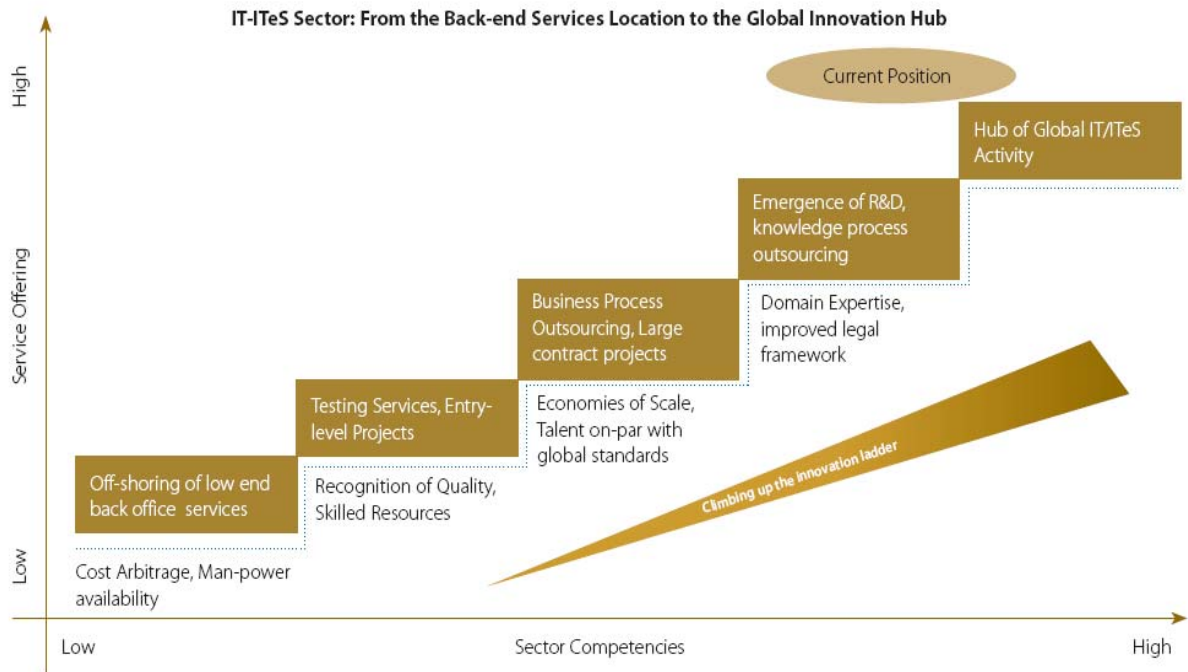


Thus far, it has been observed that the growth in IT/ITeS industry would lead to geographical expansion of the industry. The industry is also witnessing a transition from being a back-office service provider to a knowledge-process service provider. This indicates that there is a paradigm shift in the nature of activities that are increasingly being carried out of India. It is expected that going forward, activities related to technology innovation and R&D would be carried out from India.

The figure below represents different stages of sector competencies (represented on the x-axis) and service offerings (represented on y-axis). The figure highlights that the current position of the industry is high on both the sector competencies and the service offerings.

The sector competencies relate to the human resource capabilities and the service offerings relates to the nature of operations or activities being performed. Over the period of time, the competencies have increased from being a low cost service provider to being an expert in specific domains i.e., the business or knowledge areas. Consequently, the service offerings have progressed from off-shoring of back office services to Knowledge Process Outsourcing activities that require specialized skills.

Figure 12 : Progression in nature of IT/ITeS service



Source: Indian Brand Equity Foundation (IBEF) Report: IT/ITeS Markets and Opportunities

3.2.2 Knowledge Process Outsourcing (KPO)

Knowledge Process Outsourcing (KPO) is a form of outsourcing, in which knowledge-related and information-related work is carried out by a different company or by a subsidiary of the same organization, which may be in the same country or in an offshore location to save cost. Since, the nature of operations is knowledge intensive, KPO forms an important segment of Knowledge-based sector. KPO is among the fastest growing areas of the knowledge-based industries. The number of large and small, foreign and Indian, companies focusing on KPO has been growing rapidly since the early 2000s.

As shown in the figure below, the IT services sector is poised to become more knowledge oriented in their business operations and more diversified in different business areas. Currently, the work areas are business and technical analysis, market research, animation services, software and content development, legal research, Intellectual property rights, engineering services. The potential areas include R&D, simulation services, product development etc.

Figure 13 : Progression in nature of KPO services.



Adopted from IBEF: Knowledge Process Outsourcing: Markets and Opportunities

According to Evalueserve’s estimates, the global KPO market is expected to grow from US\$3.05 BN to US\$11.2 BN in 2011. The table below shows different service segments of the KPO industry and their present revenue size and the projected size by 2010-11. The top three segments of KPO are Data management, search and analytics; Contract Research and Biotech; and Engineering Design.

Table 5: Growth in India KPO Market Size by Services Segments for period 2006-11

Growth in India KPO Market Size by Services Segments: 2006-11 (US\$ million)		
	2006-07	2010-11
Data Management, Search and Analytics	590	2,510
Contract Research and Biotech	570	2,500
Engineering Design	315	1,000
Remote Education and Publishing	290	1,000
Animation and Gaming Services	245	950
Banking, Securities and Insurance Research	185	600
MR and Competitive Intelligence	175	450
Scientific and Medical Content Publishing	165	450
Business and Consulting Research	125	450
Network Optimisation and Analytics	125	400
Legal Research and IP	95	360
Translation and Localisation	85	160
Remote Logistic Services and Procurement	40	150
HR Research and Analytics	25	120
Marketing and Sales Support	20	100
TOTAL	3,050	11,200

Source: Evalueserve

Table adopted from IBEF: Knowledge Process Outsourcing: Markets and Opportunities

Financial Services: The financial and accounting KPO activity is located near financial center such as Mumbai. High real estate cost and shortage of class-A commercial space in Mumbai, however, may push the industry to other locations such as Pune. Pune may find preference because of proximity to Mumbai and the ongoing real estate developments.

An interview participant pointed that the financial services companies wait and allow other companies such as IT companies to test market other locations for 3 to 5 years. (IT companies are normally the first movers at many of the tier-2 locations in India). Once the confidence is gained that the location would adequately serve the business activity and the infrastructure is in place, the companies may start to move in to such tier-2 locations.²³

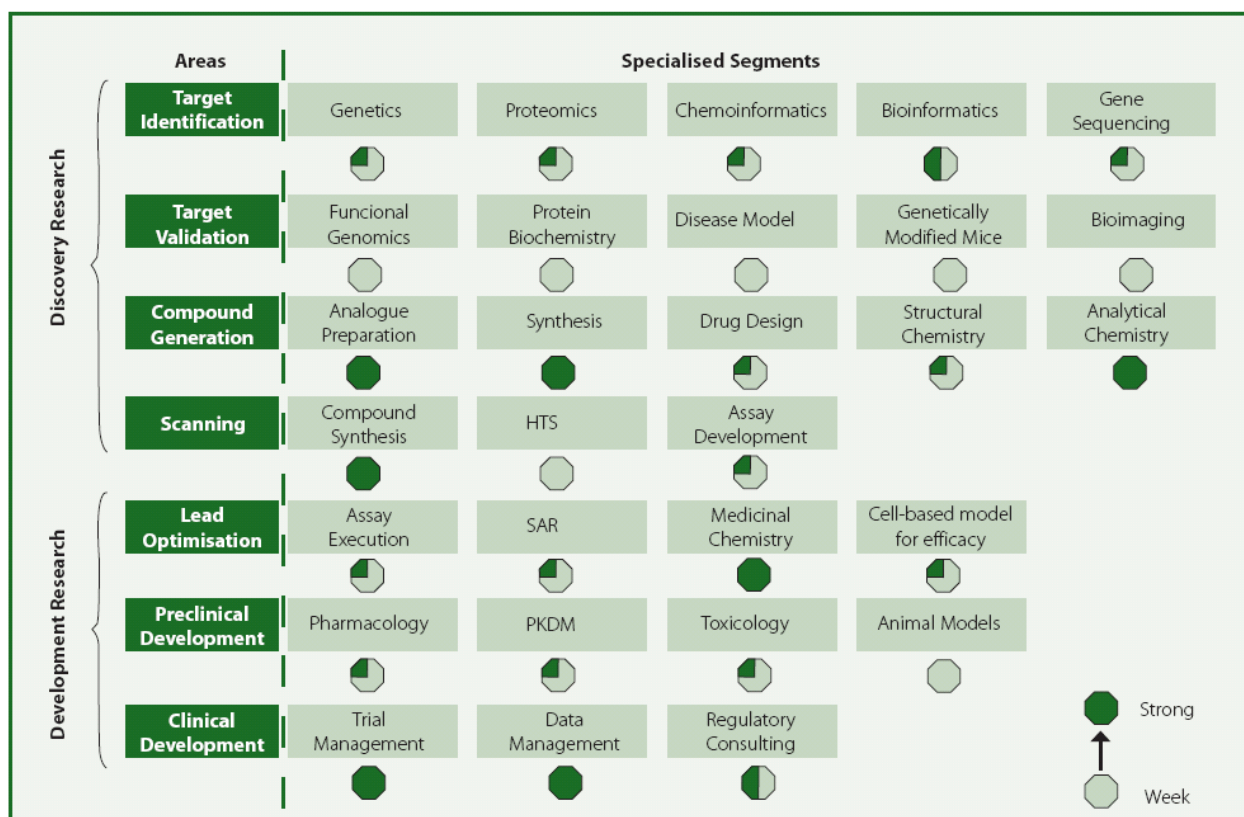
Research Services: The research services companies are mainly concentrated in NCR and Hyderabad.

²³ Phone interview on July 28,2008

Contract Research:

This segment is growing at a fast pace and India is becoming a preferred service provider. Outsourcing R&D to India is increasingly being looked at as integral to the strategic decisions of innovators, indicating the sector's shift from a cost-driven, low-value service, to a research-driven, high value activity. In addition to conventional clinical research, the segment has expanded to include contract research for preclinical drug discovery. Presently, a major portion of the services are limited to chemistry based lead identification/optimization, preclinical and clinical research stages. However, there are a handful of companies that provide biology based services for target validation.²⁴ India's strength in different research and development areas in different segments is depicted in the figure as shown below.

Figure 14 : Strength areas in different specialized segments of R&D in Contract Research Segment



Source: Offshoring in the Pharmaceutical Industry: Mridula Pore, Yu Pu, Charles Cooney, MIT, E&Y Analysis

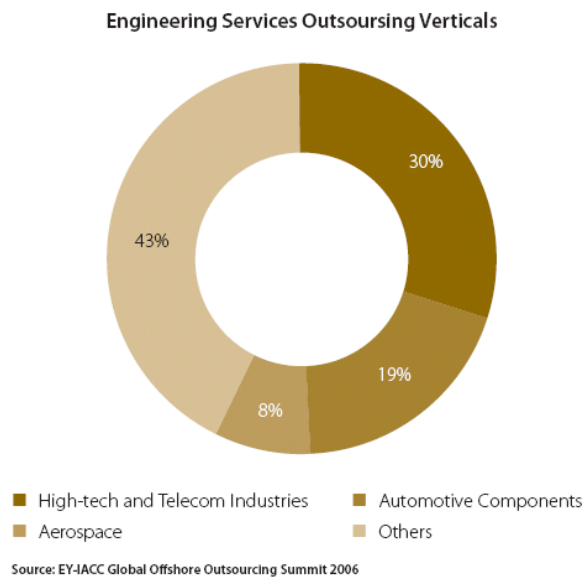
Figure adopted from IBEF: Pharmaceutical: Markets and Opportunities.

²⁴ IBEF: Pharmaceuticals: Markets and Opportunities

Engineering Outsourcing: Auto engineering R&D and services industry is emerging in a big way in India. Many global companies have set up their base in India and many home grown companies have gone global. NASSCOM report indicated that the size of the industry would be \$50BN by 2012.²⁵ The figure below shows the areas of engineering outsourcing areas.

Another report provides a detailed perspective on the potential for outsourcing in engineering services and key enablers for India to address this opportunity. The reports states that “recognizing the benefits of offshore engineering – which include cost savings of the order of 20-50 percent, quality improvements, enhanced resource utilization and access to best practices and cutting-edge technologies – large global companies are turning to India for sourcing these services”²⁶

Figure 15 : Sector-wise Share of engineering outsourcing



²⁵ Globalization of Engineering services, 2006

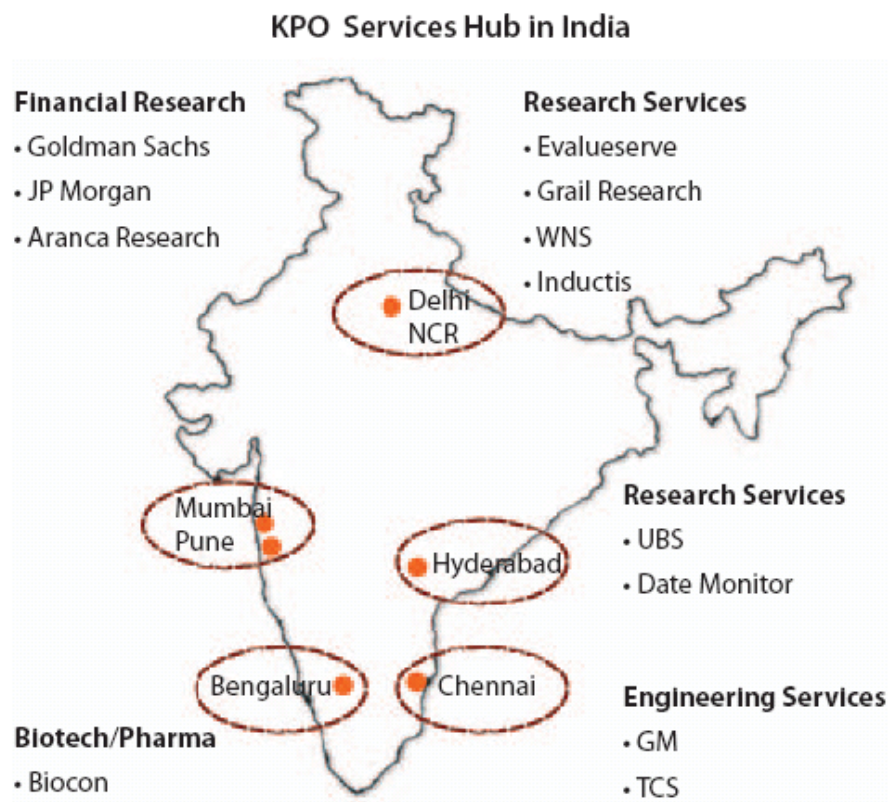
²⁶ Off-shoring Engineering Services: The Next Frontier & Potential for India compiled by NASSCOM in partnership with Booz Allen and Hamilton

Industry Concentration:

There are some traditional stronghold locations in different sectors and the KPO service firms tend to concentrate near the locations where the respective business segments could be serviced. These are:-

- Mumbai is a financial capital of the country;
- Chennai, Pune and NCR Auto engineering and
- Bangalore for Biotech

Figure 16 : KPO Services Locations and some important companies



Source : EVS Analysis

Adopted from IBEF: Knowledge Process Outsourcing: Markets and Opportunities

3.2.3 Pharmaceuticals:

Indian Pharmaceutical market is estimated at US \$8.7BN and is expected to grow to US\$11.6 BN by 2009. The industry is growing at a rate of 10%. India's strength lies in the generic space as India had process patent regime and has, in recent years, transitioned its process patent regime to product patent regime. This means that the patented products cannot be developed or reengineered using a different process.

In generics space, India has about 22% of the global market share. It is estimated that about US\$ 65 BN of drugs are coming off patent into the generics space next year. Since India has a developed generic industry, more business is expected to come to India. It is expected that Indian pharmaceutical industry would transition and develop New Drug Discovery technologies. The table below shows that many companies have drugs in the pre-clinical phase. This is the phase when the drug is formulated and then it is tested in three phases. 'There could be five or six New Drug Discoveries (NDD) that could take place from India in coming 5 years time.'²⁷ Many Multinational companies are also looking at opportunities in India because of cost advantages and speed for trial of drugs. The pharma industry in India may witness more M&A activity in times to come on account of collaborative efforts required in NDD.

Table 6: Drug Development pipeline for Indian Companies

Drug Development Pipeline of Key R&D companies in India				
	Discovery/ Preclinical Phase	Phase I	Phase II	Phase III
Ranbaxy	4-6	0	1	0
Dr Reddy	2	3	1	1
Glenmark	3	1	2	0
Wockhardt	4	1	1	0
Zydus Cadilla	1	2	2	0
Nicholas Piramal	2	1	2	0
Lupin	0	1	2	1
Orchid	12	2*	1*	0
Sun	3	0	1	0
Torrent	7	0	0	0

Source: Company Websites, Secondary Research, *expected to enter

Table Adopted from IBEF: Pharmaceuticals: Markets and Opportunities

²⁷ Quotes from Interview with Amitabh Gupta, VP, M&A and Business Analysis, Ranbaxy, in Gurgaon on June 19, 2008. Ranbaxy is a leading pharmaceutical company of India, recently taken over by Japanese company, Daichi.

Industry concentration:

Pharmaceutical industry comprises of big corporate and vast number of small and medium enterprises (SMEs). It is estimated that there are 20000 firms in Pharmaceutical industry. There are pharma stronghold locations in Hyderabad, Ahmedabad, Mumbai and NCR. The growth of pharma industry in Hyderabad is due to presence of big Indian public sector company Indian Drug and Pharmaceutical Limited (IDPL) that gave rise to many private companies. Ahmedabad flourished because of the entrepreneurial society in Gujarat and it is estimated that 50% of pharma production takes place from state of Gujarat. The promoters of Ranbaxy established the company in Punjab, hence its presence in Mohali²⁸ and other places.

Most domestic companies have in house R&D facilities. However, there are many companies that outsource the R&D work or have set up captive units to perform the work. Captive units are often subsidiaries of foreign companies units in a different location than where the parent company is located. Contract Units are third party units that perform work on contract basis for different companies. Most of the captive and contract units are located at the locations such as Hyderabad, Chennai, Bangalore, Mumbai and NCR. The location concentration of R&D operations of Pharmaceutical Industry in India is shown in figure on the next page.

Certain state governments such as those of Uttaranchal and Himachal Pradesh offered special incentives to manufacturing industries. Pharma manufacturing shifted to certain pockets in these states. Therefore, the manufacturing related sectors are cost sensitive and would always want to avail fiscal benefits wherever they are offered.

Proposed Developments: A pharma city is coming up on 2140 acres near Vizag in Andhra Pradesh. Many Pharma companies have got their SEZs approved. For example, Zydus is setting up SEZ 'Pharmez' in Gujarat. Wockhardt is coming with its SEZ in Maharashtra.

²⁸ Interview with Mr. Amitabh Gupta, Vice President, M&A and Business Analysis, Ranbaxy, in Gurgaon on June 19, 2008.

Figure 17 : Pharmaceutical R&D Clusters

Key R&D Clusters



Captive R&D Units	National Capital Region Ahmedabad Mumbai Aurangabad Hyderabad Bengaluru Chennai
Contract R&D Units	Mumbai Hyderabad Bengaluru Chennai Ahmedabad

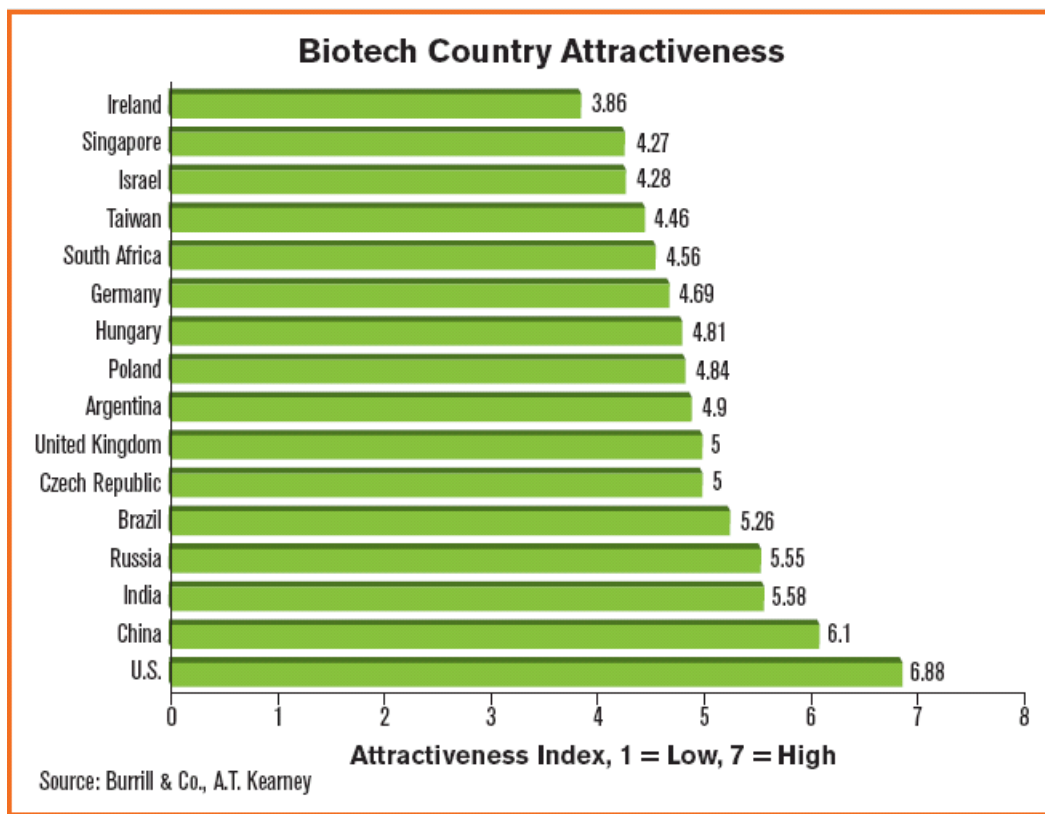
Source: E&Y Analysis

Adopted from IBEF: Pharmaceuticals: Markets and Opportunities

3.2.4 Biotechnology

India's biotechnology²⁹ industry is presently 2% of the global biotechnology industry. The figure below shows that India is among the top three nations for Biotech Attractiveness. The attractiveness³⁰

Figure 18 : Country Attractiveness Index in Biotech



²⁹ Biotechnology in India is largely chemistry based and not biology based i.e., based on living organisms. Pharmaceutical companies utilize Biotechnology for new drug discoveries.

³⁰ Global R&D report, 2008 Battelle and R&D Magazine

The main segments of Biotechnology are depicted in the table below.

Table 7: Segments of Biotechnology

BIOTECH SEGMENTS	
•	BioPharma consists of the diagnostics, vaccines, and recombinant therapeutic proteins
•	BioAgri includes production of high quality seeds, crops, biofuels, bio-fertilizers and pesticides
•	BioInformatics is related to technology that includes study of genes and its function and proteins. It is the interface between biological and computational sciences
•	BioServices include clinical research, contract research organizations and custom manufacturing
•	BioIndustrial includes manufacturing of enzymes

Source: Cushman & Wakefield Research Report: Bio Reality in India, January 2008

According to E&Y survey, India is one of the emerging biotech leaders ranked third in Asia-Pacific region based on number of biotech companies that now stands at 340.³¹ Number of Bio-Pharma firms is the largest but other segments are growing rapidly. The table below shows the distribution pattern of companies according to the biotech segments.

Table 8: Percentage distribution of companies in different biotech segments

Companies (in percentage) involved in each Biotech Segment 2006-07

Bio-Pharma	40%
Bio-Services	21%
Bio-Agri	19%
Bio-informatics	14%
Bio-industrial	6%

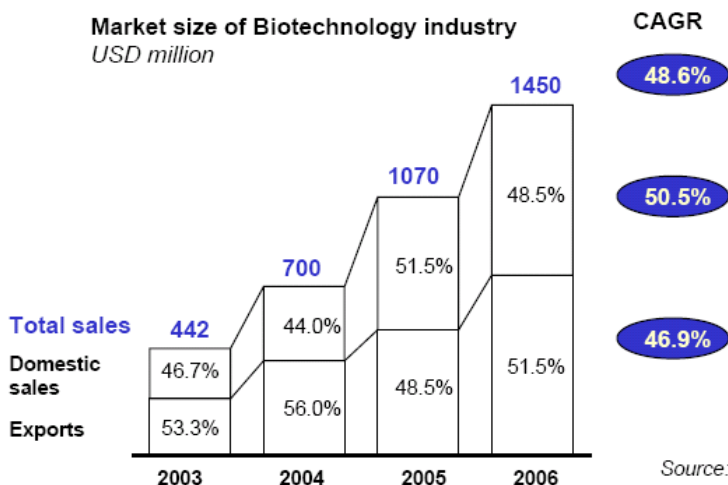
Source: Biospectrum-ABLE Annual Survey 2007

³¹ Source: Indian Brand Equity Foundation, (IBEF) website

Size of Biotech Industry in India:

According to the fifth Bio Spectrum-ABLE Industry survey, the growth percent, Compound Annual Growth Rate (CAGR) for the industry is in range of 45-50%. The industry revenues were \$2BN in 2007 but it is expected that by 2010, the industry would generate revenues in the range of \$5BN to \$7BN. The figure below shows the domestic and export sales growth rates of Biotech industry.

Figure 19 : CAGR of domestic and export sales for the Biotech Industry



Source: ICRA Management and Consultancy Services Presentation on Indian Life Sciences Industry

Biotech companies' R&D operations in India are mostly built on a contract or collaborative research model. India is emerging as a significant site for conducting clinical trials, the prime drivers being low costs and large and varied demographic profiles. Multi nationals, off shoring in this area, expect to grow rapidly in the next 10 years and beyond, according to industry analysts. It is further estimated that 70% of workforce would be in the Bio-services field and 30% in the clinical research segment.

The cost advantage and speed to conduct trials offer powerful incentives for multinational companies to undertake R&D initiatives in India in pre-clinical and clinical research. Both new drug discovery research and novel drug delivery system programs can be conducted in India at a significantly lower cost than in developed countries. It is estimated that the comparative cost advantages are in the range of 30-60% depending upon the phase of testing.

Table 9: Comparative cost advantage during different study phases of drug discovery

Study phases	Average U.S. cost (million USD)	India-cost advantage
Phase I (tests on small groups of healthy humans)	20	50 percent less
Phase II (tests on individuals afflicted with the condition for which the drug was developed)	50	60 percent less
Phase III (tests on large groups of afflicted patients)	100	60 percent less

Source: Hindu Business Line as presented in FICCI 2005.

Table Adopted from Mitra: India's Emergence as a Global R&D Center: An Overview of Indian R&D system and potential, 2007

The foreign investors in the Indian clinical research space include global drug research giants like Pfizer, Eli Lilly, Merck, Novartis, Aventis, Bayer, Atlanta, AstraZeneca and GSK. Prominent Indian companies are Serum Institute, Biocon, Panacea Biotech, Novo Nordisk, Biovel Life sciences, GVK, Aventis Pharma etc.

Genzyme and Biogen Idec have recently started their Indian operations in Gurgaon near Delhi.

Indian biotechnology firms are steadily moving up the value chain by offering research and development services for global pharma companies to aid drug discovery and manufacture.

"Co-development agreements are leading to interesting models," said Kiran Mazumdar-Shaw, chairman and managing director, Biocon group. "Today, global pharma firms seek partnerships with companies in India and China based on intellectual property (IP) sharing, which involves carving-up markets and sharing licensing revenue."³²

³² As quoted in Business Standard, July 30, 2008

Industry Concentration:

Biotechnology is an emerging sector in India, dominated by top few companies. Table below represents the regional distribution of biotech revenues. However, this distribution pattern is because of revenues emanating from top few companies based in south and west regions.

- Western Region- Mumbai and Pune. The region accounts for 48% of industry revenues.
- South India- Bangalore, Hyderabad and Chennai, with 40% of revenues
- North India mainly NCR and Lucknow accounts for the rest

Table 10: Regional distribution of Biotech Revenues

Biotechnology Revenues by Regions

Region	2006-07 (US\$million)	Share
North	249	12%
South	831	40%
West	998	48%
Total	2,078	100%

Number may appear inconsistent because of rounding off

Source: Biospectrum ,July '07

Reason for concentration:

In India, biotechnology is in its nascent stages but is evolving. Primary reasons for location of biotech industry that are cited are the availability of skilled workforce, presence of educational and research institutes, pharma companies and medical institutes and investor friendly policies of states. The figure on next page shows concentration of the Biotech Industry and that it is heavily dominated by top few companies.

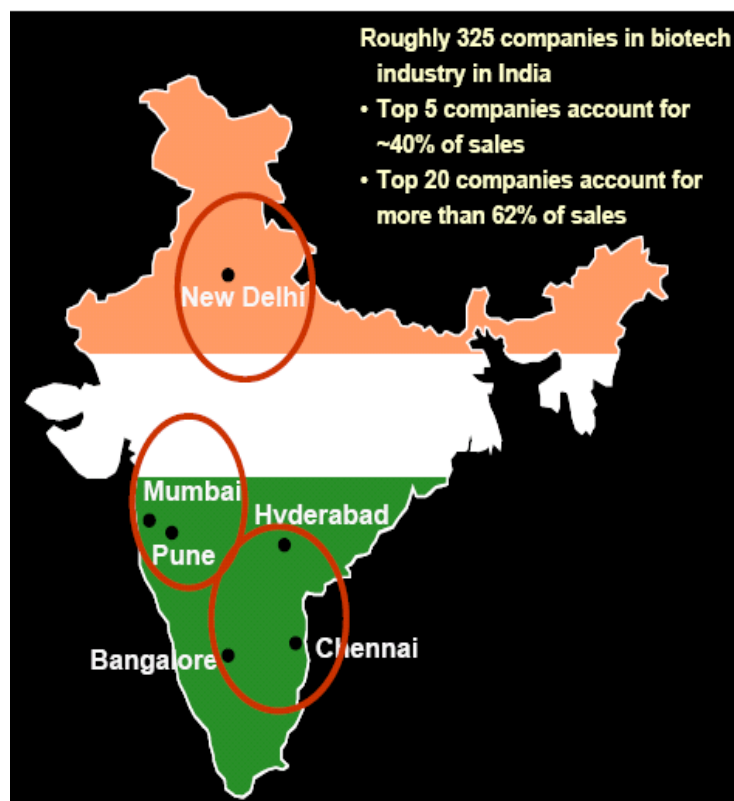
There are obvious advantages of locating near the educational and research institutes. However, the interview results with different participants showed that the functional relation between academia and industry is not very well established.

Bangalore has the maximum number of biotech companies and it attracted the maximum Foreign Direct Investment made in the sector last year. To further promote the sector, the government has set up a facility. Bangalore Helix is an upcoming biotech facility near the Electronic city, IT Park of Bangalore, to accommodate biotech companies, research entities and start-ups.

In case of Hyderabad, the state government developed policies to develop the sector and identified a location to set up a biotech park. It appointed Ernst and Young as consultants to prepare a road map for future developments. This resulted in setting up of two parks under Public Private Partnership (PPP)³³ model -ICICI Knowledge Park and Shapoorji Pallonji (SP) Biotech Park having areas of 200 acres and 300 acres respectively. ICICI Knowledge Park is primarily for R&D purposes only. In SP Biotech Park, many companies have bought land parcels and some have started building their own facilities. The promoters are also building wet lab spaces to be given to lease to companies.

Likewise, the State government of Maharashtra took the initiative and partnered with a developer, The Chatterjee Group Real Estate (TCGRE) to develop International Biotech Park, Pune. Other parks that are operational are TICEL Biotech Park in Chennai, state of the art facility built on 5 acres and Lucknow Biotech Park.

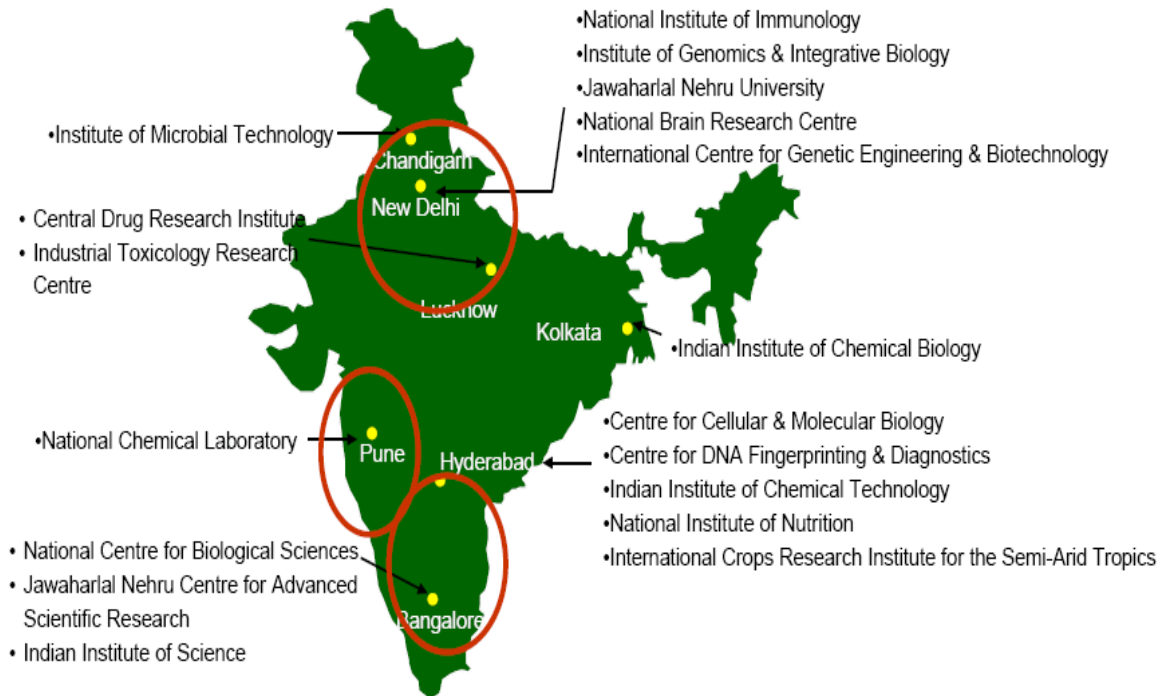
Figure 20 : Location Concentration of Biotech companies in India



Source: ICRA Management & Consultancy Services Presentation on Indian Life Sciences Industry

³³ Under PPP model, the government acquired the land and then entered into an equity deal with the developer

Figure 21 : Educational and Research Institutions located in India



Source: ICRA Management and Consultancy Services Presentation on Indian Life Sciences Industry

The figure shows the geographic locations of known educational and research institutions in India. This correlates with the industry concentration at the same places where the institutions are present, though functional relationship is not well established.

Incentives for the Biotech Industry:

Many state governments such as State Govt. of Gujarat, Tamil Nadu, Kerala, Rajasthan, Uttar Pradesh, Madhya Pradesh, Himachal Pradesh, Punjab, Haryana and Union Territory Chandigarh have formulated biotech policies and are at advanced stages of creating biotech parks. Department of Biotechnology (DBT) that works under Ministry of Science & Technology, Government of India, is also promoting the growth of the sector and has plans to develop 10 Biotech parks by 2010.

The government is also taking steps to strengthen legal and regulatory systems, to harmonize international standards and to provide financial support to early-stage development. The Department of Biotechnology (DBT) is playing a significant role in coming up with various schemes and incentives for the development of the sector. It has recently come out with National Biotechnology Strategy Document that highlights its proposed strategy going forward.

The growth potential of Biotech and the incentives provided by the Government for the promotion of the industry is attracting companies. It is expected that many multinational companies would want to set up their base in India in the coming times. Many entrepreneurial ventures may also take place going forward.

Figure 22 : Incentives for the Biotech Sector

INCENTIVES FOR INVESTMENT IN BIOTECHNOLOGY INDUSTRY AND R&D
<ul style="list-style-type: none">• FDI up to 100% is permitted on the automatic route for manufacture of drugs and pharmaceutical, subject to certain conditions• Fast Track Clearance route for FDI• Depreciation allowance on plant and machinery set-up based indigenous technology• Customs duty exemption on goods imported for use in Government funded R&D projects• Customs and Excise duty exemption to recognized Scientific and Industrial Research Organisations• 125% weighed tax deduction on R&D Expenditure• Three-year excise duty waiver on patented products• 100% rebate on own R&D expenditure• 125% rebate if research is contracted in public funded R&D institutions• Special fiscal benefits to joint R&D projects

Physical Space Requirement:

For the Biotechnology sector, there are different estimates that are doing the round in the market. According to Cushman and Wakefield January 2008 Report, the biotechnology industry would grow to \$US 5 BN by 2010 and would have the potential to employ 1 million³⁴ people. Therefore, there would be space requirement of 139 million square feet by 2010.

Another estimate by Jones Lang LaSalle-Meghraj report published in Sept. 2007 on Real Estate opportunities in Biotechnology Sector also mentions that by 2010 there would be 400 firms in the biotech sector generating employment for 1 million people³⁵. The space requirement, according to JLL-Meghraj estimates is 80-100 million square feet, calculated on the basis that a worker would require 80-100 square feet of space.

³⁴ Email response from Ashim Choudhary, Senior Associate, Research and Business Analytics Group India, Cushman Wakefield confirming that the figure is sourced from Department of Biotechnology, Ministry of Science and Technology, Government of India.

³⁵ As mentioned in the report the figure is sourced from Presentation by ICRA Management Consultancy Services at the Forum for International Business, 2007 Zurich on Indian Life Sciences Industry.

However, the estimate given by real estate developers and consultants for space requirement in the Biotech sector is far less than those mentioned in the above mentioned two reports. It is estimated that the space requirement would be approximately 10 million square feet, estimate developed on modeling different parameters.³⁶

Observation: The discrepancy seems to be on account of employment figure of 1 million people that has been sourced from a government projection. However, this figure does not seem to be accurate. A comparison with IT/ITeS industry revenue and employment size would indicate the inaccurate projections. IT/ITeS revenues are already in excess of \$50BN and the industry provided direct employment to 2.3 million people. Whereas, the biotech industry revenue projection of \$ 5-7 BN would not be able to absorb 1 million people. It could at best be a hundred thousand. If an estimate of space is made with a figure of 100,000 people employed, the Cushman & Wakefield analysis would scale down by 10 to 13.9MM and Jones Lang LaSalle-Meghraj estimate would scale down to 8-10 MM. This is in sync with the developers’ projections.

Distinction between Biotech Special Economic Zone (SEZ) and Biotech Park:

Biotech SEZs are regulated under the Central (Federal) Government rules, whereas both the central and the state government regulate policies for Biotech Parks. The table below highlights the distinction.

Table 11 : Comparison between Biotech SEZ and Biotech Park

BIOTECH SEZ V/S BIOTECH PARKS	
<p>BIOTECH SEZ</p> <ul style="list-style-type: none"> • Duty free import / domestic procurement of goods for development, operation and maintenance of SEZ units • Exemption from central / sales tax, service tax and minimum alternate Tax • The EGoM has stipulated a minimum built-up area of 40,000 sq.metres besides the minimum land area requirement of 10 hectares • Only new units and enterprises in an SEZ can claim tax benefits • Central government is empowered to formulate the policies 	<p>BIOTECH PARKS</p> <ul style="list-style-type: none"> • Duty free import of equipment, instruments and consumables • Tax holiday period is subject to state policy • Minimum built up area might be specified by respective state government. For e.g. Biotech Park in Karnataka shall have a minimum built up area of 50,000 sq. ft. • New enterprises as well as existing can claim tax benefits • Both central and state government formulate policies to encourage investment

Table adopted from Cushman & Wakefield report on Bio Reality in India, Jan 2008

³⁶ Interview with The Chatterjee Group Real Estate (TCGRE) Team in Mumbai- Prasanta Biswal, CEO , International Biotech Park and Anmol Puri, Associate –Investment, TCGRE. Figure also echoed by Vishal Goel, Associate Director, E&Y, Hyderabad.

Chapter Summary:

In this chapter, an overview of the knowledge-based sector was presented. The sector is currently on high growth trajectory and the size of the sector is poised to further grow. The international funds are increasingly getting invested in India as India maintains high ranking in investor confidence index. Multinational companies are setting up operations in India because of certain cost advantages and availability of labor pool. Many domestic companies have grown in size and many new companies are emerging.

The sector is largely services oriented, but there is also growth in R&D activities. IT/ITeS industry is getting transformed from just being a low end BPO service provider to high end KPO provider. The nature of such operations and activities are much more knowledge intensive. Also, footprint of R&D oriented industries such as Biotech and Engineering R&D is growing in India.

The industry is largely concentrated in the few cities such as Bangalore, Hyderabad, Chennai, Mumbai, Pune, Kolkata and NCR. Main reasons for this are the availability of human resource, presence of educational and research institutes and urban environment prevalent in these cities.

Increasing population pressures and infrastructural constraints in some of the metropolitan areas are pushing the industry to the peripheral areas of the cities and even to other Tier-1 and Tier-2 cities. Most of the current real estate development is taking place in the Special Economic Zones in these cities. Therefore, it becomes relevant to discuss the SEZs and why they are gaining popularity for the Knowledge-based industries.

A detailed discussion on Special Economic Zones follows in the next chapter.

Chapter 4: Special Economic Zones (SEZs) and Proliferation of Knowledge-based Industry SEZs.

A large number of Special Economic Zones are being set up in India for promoting exports from different industries. SEZ policy and some of the related issues are discussed below:

4.1 Special Economic Zone Policy

Enacted in 2005, the SEZ policy was aimed at creating special zones that would be offered fiscal incentives for export oriented activities in order to promote investments, trade, job creation and growth.

The policy has provided impetus to real estate developments that specifically target the IT and other services oriented industries. The host of incentives and benefits available to developers and unit owners has led to proliferation of number of proposals for setting up of SEZs.

Almost two-third of about 222 notified SEZs out of the 462 formally approved belong to IT/ITeS sector. Formal approval implies that the government has accepted the request for demarcating an area as SEZ, whereas notified SEZ means that the development activity could only start when the government issues a notification with respect to the formal approval in the government gazette.

The policy defines a developer as ‘A person or body of persons, company, firm and such other Private or Government Undertaking who develops, builds, designs, organizes, promotes, finances, operates, maintains or manages a part or whole of the infrastructure and other facilities in the Special Economic Zones as approved by the Central Government’ The developer is thus the key person/party for the formation, development, growth and running of a SEZ. Also, Unit owners/holders are the parties who set up their factories within SEZ and operate them.³⁷ Any entity or entities can apply to set up a SEZ- Public sector, private sector, joint sector or State Governments.

Categorization of SEZs and Zones within a SEZ:

The table below highlights the different categories of SEZs that could be set up. The distinct categories are Multiproduct; Multi Services; Sector Specific; IT, Biotech, Gems and Jewellery and Non Conventional energy fall under one category and the last is for Warehouses.

Multiproduct SEZ signifies a SEZ where units may be set up for manufacturing or rendering of services of two or more goods or services in a sector or goods or services in two or more sectors. The area requirement varies, for Multiproduct the minimum area required is 1000 hectares of contiguous land. Minimum area requirement exclusively for services is 100 hectares.

³⁷ SEZ Report, Colliers International, 2007.

Sector specific SEZ is meant for one of more goods or services in one sector. Minimum area requirement varies so does minimum built up space requirements. For electronic hardware and software including IT/ITeS, minimum area requirement is 10 hectares with minimum built space requirement of 10000 sf.

According to latest amendment of Nov.2006 to SEZ rules, for biotech sector specific SEZ, the area has to be more than 10 hectares with minimum built up area of 40000 square meters. For sector specific SEZ, the area requirement is 100 hectares.

Zones within the SEZ: Each SEZ is further divided into two types of Zones.

Processing Zone would be deemed foreign territory within the SEZ having restricted movement of goods and services subject to inspection by the Customs Department. Also, the physical space in a processing zone could only be leased and not sold because of the special status of the processing zone.

Non Processing Zone, on the other hand, is conceived of as offering support infrastructure facilities such as hospitals, schools, residences, retail and recreation. This zone is exempt from any Customs regulations.

Processing Area Requirement:

The area requirement varies depending upon whether the SEZ is Multiproduct or Sector specific. For a multiproduct SEZ, at least 35% of the total SEZ area must be a processing zone and for a sector specific SEZ the processing zone must at least be 50% of the total SEZ area. The 35% requirement for a Multiproduct SEZ could be relaxed to 25% by the Central Government. (SEZ Amendment Rules, 2006).

Table 12 : Area Requirements for Types of SEZs

Minimum Area Required for Various Types of SEZs in India		
Type	Minimum Area Requirement	Minimum Processing Area Requirement
Multi product	1,000 Hectares	50 per cent
Multi Services	100 Hectares	25 per cent
Sector specific	100 Hectares	50 per cent
IT, Gems & Jewellery, Bio-tech and Non-conventional energy	10 Hectares with minimum built up area of: - IT : 100,000 sq mtrs - Gems & Jewellery: 50,000 sq mtrs - Bio-Tech & Non conventional energy: 40,000 sq mtrs	50 per cent
Free trade warehousing zone	40 Hectares (minimum built up area of 1 lakh sq mtrs)	50 per cent

The incentives and facilities offered to the units/ unit holders in SEZs for attracting investments, including foreign investment, include:

- Duty free import/domestic procurement of goods for development, operation and maintenance of SEZ units
- 100% Income Tax exemption on export income for SEZ units under Section 10AA of the Income Tax Act for first 5 years, 50% for next 5 years thereafter and 50% of the ploughed back export profit for next 5 years.
- Exemption from minimum alternate tax under section 115JB of the Income Tax Act.
- External commercial borrowing by SEZ units' up to US \$ 500 million in a year without any maturity restriction through recognized banking channels.
- Exemption from Central Sales Tax.
- Exemption from Service Tax.
- Single window clearance for Central and State level approvals.
- Exemption from State sales tax and other levies as extended by the respective State Governments.

The major incentives and facilities available to SEZ developers include:-

- Exemption from customs/excise duties for development of SEZs for authorized operations approved by the BOA.
- Income Tax exemption on income derived from the business of development of the SEZ in a block of 10 years in 15 years under Section 80-IAB of the Income Tax Act.
- Exemption from minimum alternate tax under Section 115 JB of the Income Tax Act.
- Exemption from dividend distribution tax under Section 115O of the Income Tax Act.
- Exemption from Central Sales Tax (CST).
- Exemption from Service Tax (Section 7, 26 and Second Schedule of the SEZ Act).

The incentives for both the developer and the unit holders act as a huge attraction to locate in the SEZs. Some quotes from interviews are “Because of the fiscal benefits, companies don’t have a choice but to locate in the SEZs.”³⁸ “Since the SEZs offer the fiscal benefits, they would always be preferred as companies would locate where bottom line makes sense.”³⁹ For developers too, the fiscal incentives on development are too huge to be ignored. “The development cost goes down significantly because of the fiscal incentives; therefore, SEZs become a profitable development proposition.”⁴⁰

³⁸ Vishal Goel, Associate Director, E&Y, Transaction Advisory Services, Hyderabad on July 3,2008

³⁹ Amitabh Gupta, VP, Ranbaxy, Gurgaon, June 19, 2008

⁴⁰ Nitin Khare, CEO, KTMS, Pune, June 30, 2008

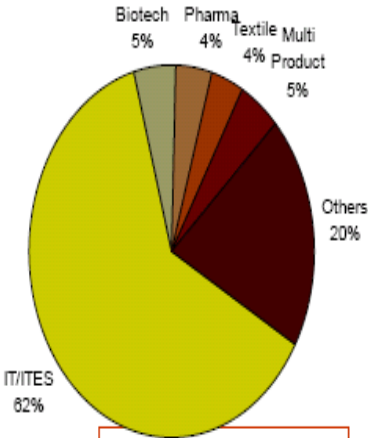
The table below shows that the majority, about 70%, of SEZs (Formally approved & Notified) belong to IT/ITeS Services Hardware & Electronics (289,147); Pharma (20, 13); Biotech (21, 4). The size of the SEZs varies from 10 ha. to 1000 ha, but majority are less than 100 ha.

Table 13 : Number of SEZ under Formal, In-principle and Notified categories for different sectors

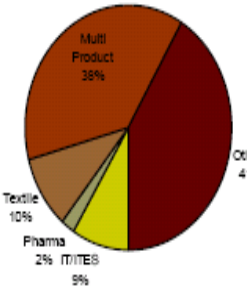
SEZs : Sectorwise Distribution

Sectors	Formal approvals	In-principle approvals	Notified SEZs
Aviation/Aerospace	1	1	
IT/ITES/Electronic Hardware/Semiconductor	289	12	147
Textiles/Apparel/Wool	17	13	8
Pharma/chemicals	20	3	13
Petrochemicals & petro.	1	1	1
Multi-Product	21	51	10
Building product/material	1	1	
Beach & mineral	1	1	
Bio-tech	21	1	4
Ceramic & glasses	1		
Engineering	18	11	11
Multi-Services/Services	14	8	4
Metallurgical Engineering	1		
Electronic product	3	4	3
Auto and related	3	4	1
Energy related			
Footwear/Leather	7	2	4
Gems and Jewellery	9	4	2
Power/alternate energy	4	1	1
FTWZ	4	6	1
Metal/Stein. Steel/Alum/Foundary	6	5	3
Food Processing	4	2	3
Non-Conventional Energy	1		1
Plastic processing		1	
Handicrafts	4	1	1
Agro	3	2	1
Port-based multi-product	6		2
Airport based multiproduct	1		-
Writing and printing paper mills	1	-	1
GRAND TOTAL	462	136	222

Formal



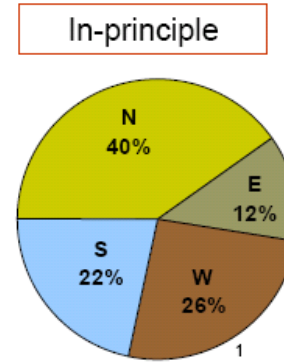
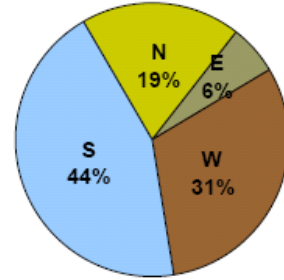
In-principle



Source: SEZ website, Government of India: www.sezindia.nic.in

Table 14 : SEZs distribution in different states of India

SEZs : Statewise Distribution			
State	Formal approvals	In-principle approvals	Notified SEZs
Andhra Pradesh	75	3	54
Chandigarh	2		2
Chattisgarh	1	2	
Delhi	2		
Dadra & Nagar Haveli	4		
Goa	7		3
Gujarat	39	9	19
Haryana	38	17	18
Himachal Pradesh		2	
Jharkhand	1		1
Karnataka	42	9	20
Kerala	12	1	8
Madhya Pradesh	13	5	3
Maharashtra	89	37	27
Nagaland	2		
Orissa	9	4	4
Pondicherry	1		
Punjab	7	8	2
Rajasthan	8	9	4
Tamil Nadu	59	12	40
Uttar Pradesh	26	4	10
Uttaranchal	3	-	1
West Bengal	22	13	6
GRAND TOTAL	462	135	222



Source: SEZ website, Government of India: www.sezindia.nic.in

States that have majority of SEZs approved & notified are: Andhra Pradesh, Gujarat, Haryana, Karnataka, Maharashtra, Tamil Nadu, Uttar Pradesh and West Bengal. Formally approved 390/462; 194/222 notified.

Cities of Hyderabad, Vizag (Andhra Pradesh), Ahmedabad, Gandhinagar, Vadodara (Gujarat), Gurgaon(Haryana), Bangalore, Mysore(Karnataka), Mumbai, Pune, Nasik(Maharashtra), Chennai, Coimbatore(Tamil Nadu), Noida, Greater Noida(Uttar Pradesh)and Kolkata(West Bengal) have the maximum approved and notified SEZs. This highlights concentration of SEZs near Tier-1 and emerging tier-2 cities.

4.2 Issues with SEZs in India:

Issues with SEZs in India that have emerged in recent times are as follows:

Confusion over Fiscal Benefit Rule interpretation: Recently, an issue has emerged that could have a far reaching effect on the efficacy of locating in SEZs. It relates to the interpretation of Section 10AA(7) of the Income Tax Act that allows for only a percentage of profit and not all emanating out of a SEZ to be tax exempt. Under Section 10AA (1), which defines the benefits under SEZs, 100% of the export profits from the unit are tax-exempt. According to another Section 10AA (7), profits in proportion of export sales from the SEZ unit to the total revenue of the company, will be exempt. (Economic Times, 17 June 2008). As per this rule, if the revenue generation from a SEZ is 30% of the total revenue of the company, only 30% of the SEZ revenue would be tax exempt and not 100%. Since software companies are among the first ones to located in a SEZ, these companies are slowly building up their capacities in the SEZs. The revenue generated from the SEZs is, at present, only a small percentage of total revenues. It is expected that the revenues emanating from SEZ would touch 50% by 2010. However, if the revenues are taxed as per the new interpretation, there would hardly be any incentive for the companies to locate in the SEZs. This presents significant hurdles to a successful implementation of the SEZ policy.

Land Acquisition: Acquisition of land for SEZ has become a problematic issue as many State Governments has had to face ire of the farmers and people displaced because of acquisition. Violent protest movements and farmer killings in Nandigram and Singur in West Bengal created a huge controversy about the government's role in land acquisition process. These incidents led to similar protest movements elsewhere in the country. As per Indian law, Government could acquire land for public purposes only. Since, setting up of facilities for commercial purposes does not qualify to be a public purpose; the government has virtually stopped playing a role in the acquisition process for a developer or private party. Also, a separate notification is issued that 90% of the land meant for SEZ should be non-agricultural. There are, however, concerns with respect to adherence to this rule.

Number and Size: The large number and the small size of SEZs is ironically a matter of concern. There seems to be a mad rush to create SEZs in fields of IT/ITeS, biotechnology and other areas. There are over supply concerns if all the proposed SEZs actually get developed. According to an industry expert, "the 'mortality rate' of SEZs would be about 50%." This comment brings forth the issue of scale and dynamics of these SEZs. The area size of most SEZs is small. There were some 'big ticket' SEZs planned, but the Government's new ruling to limit the size of SEZ to maximum area of 5000 ha only has forced the SEZs to be of limited size only. Without a critical mass of firms in a given sector, the synergies arising from clustering may get lost. Also, in the absence of scale, it may become difficult to recoup the cost of

building a world-class infrastructure.⁴¹ How the SEZs unfold over a period of next few years remains to be seen.

No clear definition of Biotech: As regards to the Biotechnology sector, there have been few SEZs approved by the government. But it is not clear whether the SEZs would actually be carrying out 'biotech activities'. As mentioned earlier, the life sciences industry is largely chemistry based, so it is not clear whether the 'chemistry based' industry would qualify for the benefits reserved technically for 'biology based' industry. The lack of definitional clarity was an issue pointed out by Head of SP Biotech Park, Mr. P. Gopalakrishnan. However, the actual situation could not be verified from a government source.

Operational Issues: The custom procedural requirements each time something goes in or out of a processing zone may become an operational issue in times to come.⁴²

De-notification of 3 SEZs in the state of Goa has led to a concern as the Central Government has clarified that it is up to the states to allow setting up of the SEZs. Protests against SEZ by local population led to de-notification of SEZs in Goa on Dec 31, 2007. The Goa State Government asked the Union Government to de-notify the SEZs stating that the SEZs would adversely affect tourism and environment. The issue is pending in the judicial court.

SEZ becoming a Real Estate Success story: The prospects of earning real estate returns from Non-processing areas real estate in SEZs have led to mushrooming of SEZs across the country. The real objective of creating SEZ for economic development is getting shaded and development of SEZ is becoming more of a real estate success story.

4.3 Reason for Proliferation of Knowledge based Industries in SEZs:

SEZs policy is mainly targeted towards export-oriented industries. The Knowledge-based industries are mainly services oriented providing outsourcing services, therefore, significant portion, about 50%, of revenues come from export earnings. Thus, the proliferation of the Knowledge-based service industry in the SEZs.

Though the underlying objective of SEZ policy is to facilitate the economic development of a region, yet its basis is different from the knowledge-based cluster concept. SEZs do help in agglomeration of industries but because of size and scale, they may not be able to create/provide conditions that would enable benefits of knowledge cluster to accrue. Nevertheless, the fiscal incentives favor location of industries in these zones.

⁴¹ The Politics of SEZs in India: Promises and Pitfalls by Rob Jenkins, visiting scholar, Center for the Advanced Study on India, University of Pennsylvania, 2007.

⁴² Views expressed by Sudhir Kant, President, Millipore India, July 4, 2008

Chapter 5: Knowledge-based Cluster Development in India

In this chapter, an attempt is made to relate the concepts introduced in Chapter 2 to the current situation and developments as highlighted in Chapter 3 and 4. Firstly, India's current state of Knowledge-based industry and the projections going forward would be related to the Economic Development Continuum model. Secondly, India's current status vis-à-vis organizational aspects of a knowledge-based cluster would be presented and lastly, based on the concept of creative class, discussion on knowledge-based cluster in India would be developed.

5.1 India's transition to Knowledge-based Economy: Opportunities & Challenges

In Chapter 3, an overview of the knowledge-based industries was presented. Current status and projections in size and nature of activities of different industries suggest that India is in transitioning stage. Relating to the Economic Development Continuum model, it is suggestive of the fact that India is moving along from the second stage of export promotion to the third stage of knowledge creation. The transition here means that the features of the third stage are getting perceptible, while the second stage continues to be maintained.

At present, the knowledge-based industry is largely service based; the human resource consists of managerial and technology workers and the infrastructure development is still focused on building roads, airports and providing optic cables. This signifies the state of industry around the second stage of continuum. However, there are transitional trends that signify that in coming years, the industry would move towards the third stage.

This section brings forth the current state of the factor conditions as highlighted in the economic continuum model. The factors such as organizational structure of companies, infrastructure and human resource would be discussed and also some of the associated challenges.

5.1.1 Organizations and Nature of activities

The knowledge-based industry in India is predominantly service based. Most multinational companies already have or are opening their regional headquarters in India and the main line of activity is predominantly adapting the products and processes for regional economy. Multinational companies (MNCs) adopt following organizational pattern for their operations in India:

- In-house R&D, which means that it is performed by a fully owned or principally controlled subsidiary of the multinational company in India
- collaboration with other companies
- contracts or other forms of collaboration with private entities, public sector laboratories and universities

The organizational pattern has relevance from real estate perspective as it could be estimated where Multinational companies would want to locate. For the first category, the multinationals would generally look for factor conditions that would ideally suit them. For the later two categories, the tendency would be to locate near the collaborating entities. This may, however, vary depending upon individual firm's strategy.

In a working paper, the authors explain the strategy behind MNCs decision to enter a regional knowledge cluster. Three modes of entry are used by MNCs: Acquisition, Joint Venture and Greenfield Investments. The paper states that the entry mode used by a MNC depends upon the type of agglomeration economies those related to network relations; to local labor market specialization; or to institutional specialization the latter seeks to appropriate.⁴³

Decentralization Motives of Multinational Companies

Multinational companies are increasingly decentralizing their R&D operations to developing countries such as India. Two key motives why foreign companies decentralize their R&D operations are presented as below:⁴⁴

Capability exploitation motive: Here, the decentralized R&D facilities focus on adapting the available technology to the local markets. This ensures that the available technology is commercially applied effectively in differentiated segments of the global market. Therefore, the technology is adapted to the local conditions and commercialized in a local market setting. This provides the multinational companies access to local markets.

Capability augmentation motive: Here, the decentralized locations supply new knowledge in order to enhance capabilities and create new competencies within the firm. Companies seeking augmentation motive seek potential spillovers from existing R&D organizations such as research institutions and innovative competitors. Therefore, the decentralized location acts as technology sourcing location for the centralized firm location. This way new knowledge gets augmented that further helps in process and product development.

Kuemmerle (1999)⁴⁵ develops a distinction between home-based-exploiting (HBE) and home-base-augmenting (HBA) sites, based on the typology of capability-exploiting and capability-augmenting

⁴³ Global Strategy and Acquisition of Local Knowledge: How MNCs enter Regional Knowledge Clusters, Mark Lorenzen, Volker Mahnke, Danish Research Unit for Industrial Dynamics (DRUID)

⁴⁴ Huggins, Robert, Demirbag, Mehmet and Ratcheva, Violina Iankova (2007) 'Global Knowledge and R&D Foreign Direct Investment Flows: Recent Patterns in Asia Pacific, Europe, and North America', *International Review of Applied Economics*, 21:3, 437 — 451

⁴⁵ Kuemmerle, W. (1999). The Drivers of Foreign Direct Investment into Research and Development: An Empirical Investigation, *Journal of International Business Studies*, 30, pp. 1–24.

motives for FDI in R&D. Further it is explained that HBA sites are more likely to be located in proximity to universities and innovative competitors as the motive is to become knowledgeable about new technology. On the other hand, HBE sites are more likely to be located in proximity to production facilities and important market. It was concluded that firms generally establish HBE units abroad before establishing HBA units.

An interview participant indicated that their reason for entering Indian market is more akin to HBA strategy in contrast to HBE as they want to understand the market better and enhance their capabilities. Interview results with other participants showed that the companies are still having mix of both HBA and HBE objectives.⁴⁶

A comparative table, (Table shown on next page), represents the different level of activity undertaken by Indian, Multinational and Public Sector companies in different knowledge-based industries. Level of activity is based on R&D expenditure, number of employees, patents and technical publications.

The trend seems quite evident that for the knowledge based industries, here mentioned as Information and Communication Technologies (ICT); Life sciences and knowledge processing industries the product development and process development activities are ranging in medium and high categories respectively. This trend is more pronounced than those related basic and applied research.⁴⁷ Besides, minor variations, the trend is almost uniform for both Indian companies and foreign companies.

Therefore, it becomes evident that the companies are engaging in development of products and services. Majority of these are of the nature of adapting to the regional market but new product developments are also picking up.

⁴⁶ Views expressed by interview participants, Interviews conducted in different cities in India in June,2008

- ⁴⁷ Basic research is a research conducted to gain greater knowledge or understanding of a subject without specific applications in mind;
- Applied research refers to research in order to gain greater knowledge or understanding to meet a specific need;
- Development is the systematic use of the knowledge gained by basic and applied research to produce useful materials, devices, systems, or methods. Further the term product development relates to utilization of research in development of products whereas process development refers to a research of producing the same product, may be with minor variations, but utilizing different process.

Table 15 : Comparative table highlighting level of R&D Activities undertaken in India

	Basic Re- search	Applied Research	Product Develop- ment	Process Develop- ment
Stakeholders				
Indian government, public enterprises and academic institutions	Medium	Medium	Low	Low
Indian companies	Low	Low	Medium	High
Foreign companies	Low	Low	Medium	High
Sectors				
ICT: software services and products, IT hardware and telecommunication	Low	Low	Medium	High
Life sciences: biotechnology, and pharmaceuticals	Low	Low	Medium	High
Engineering and related industries: automobile, industrial and other machinery, textile, consumer durable goods, and other manufacturing, energy and other utilities, infrastructure and construction related industry and environmental	Low	Low	Medium	Medium
Space, aviation, defense, nuclear technology	Medium	Medium	Medium	Medium
Agriculture, chemicals and material sciences	Medium	Medium	Medium	Medium
Other R&D and knowledge processing industry related capacities including financial, accounting, insurance legal, education, health, publishing and other humanities, social and natural science related disciplines	Low	Low	Medium	High

Source: Estimates derived from published information and interviews and the sector review sections (Mitra 2007).

Note: Estimated levels of activity (low, medium and high) are broadly defined in an India-specific comparative context covering levels of R&D expenditures, numbers of employees, patents, technical publications and product and process development. Activity level as used here differs from research intensity, which is often defined as R&D expenditure as a percentage of sales/revenue/expenditure at the company level, or as GDP at the national level. Estimates for stakeholders and sectors are based on preliminary generalized observations and do not reflect that there are significant variations in levels of R&D activity within each sector, industry and individual entities.

Table Adopted from Mitra: India's Emergence as a Global R&D Center: An Overview of Indian R&D system and potential, 2007

Challenges

Though India is increasingly becoming a top global innovator for high tech products and services, it is underperforming relative to its innovative potential.⁴⁸ India is currently faced with issues and challenges related to infrastructure and human resource. Each of these factors is discussed below:

5.1.2 Infrastructure:

India is still grappling to put in place the infrastructure related to air, telecom, roads and power. Infrastructural problems have started to emerge especially those related to traffic and power in some of cities where the knowledge-based industries are concentrated. The various infrastructure issues are discussed as below:

Road Infrastructure and traffic: Bangalore is often cited as an example facing traffic problems. This creates challenge for the companies to plan for alternative locations. Main reason for this is the productivity loss of the workforce because of long hours spent on commuting.

An article highlighted that Bangalore is losing its sheen as premier destination for IT companies. It stated “During 2007-08, software exports from the state—the bulk of it from Bangalore—grew by just 11 percent even as Andhra Pradesh galloped at 41 percent and Tamil Nadu at 37 percent, raising serious doubts whether Bangalore still deserves its title as the technology capital of India.” There is a general concern in the industry about appalling infrastructure conditions that have marred Bangalore’s image.⁴⁹

An interview participant, commenting on the traffic problem, remarked that ‘Bangalore has missed a golden opportunity of becoming an IT hub.’ Mumbai too is facing a similar problem where it takes hours to commute for work. Such pressures are emerging in other cities as well going forward.

The government is putting in efforts to restore the infrastructure and has plans in place to create new ones to ease the ever increasing pressure on cities. For example, in Hyderabad, Outer Ring Road (ORR) project is planned that would connect the developments that have taken on the periphery of the city. Likewise, in Bangalore, senior executives of the top companies are working in conjunction with the government to develop plans to mitigate the infrastructural problems. Recently, an expressway connecting Delhi with Gurgaon, satellite town of Delhi that is now called the commercial hub, got operational. A 120 km long outer ring road expressway, Kundli-Manesar- Palwal (KMP), is coming up that would link satellite towns of around Delhi. Similar projects are also planned for cities with high population.

⁴⁸ Mark A. Dutz, Overview: Towards an action agenda for Innovation

⁴⁹ Economic Times, financial newspaper of India, NASSCOM 2008

Air Connectivity: Air connectivity is one of the most important infrastructural requirements in today's globalized world. Only few cities in India have international air connectivity. It took too long a time for upgrading and building International airports at locations where Knowledge-based industries are established. Bangalore's new airport has recently started its operations. Modernization of Mumbai and Delhi airports is still going on. Pune's airport still operates out of an Indian Air Force base. However, the scenario is changing gradually as the airport infrastructure is provided for and upgraded in many cities. An interview participant identified the air connectivity to be one of the critical factors in their location strategy.

Power: Power infrastructure in India is yet to meet the demands that the economy is placing on it. The situation is no better for the urban cities that often have to face the power cuts. This turns the businesses off. Many state governments assure the business houses of continuous power supplies but the situation still remains grim in most cases. Private players have started putting up their own captive generation plants to meet with the requirements of power.

Cost of Real Estate: Concentration of industries in few cities has led to astronomical rise in the cost of real estate. For the area's established companies, this factor doesn't matter as most companies own their space. However, for the newer companies and those in expansion mode, it is a big challenge to find a suitable location at reasonable prices. An industry expert observed that for any type of project in India, cost of real estate is approximately 50-60% of the total project cost. For commercial and office projects, the figure could be higher also in some cases.

Social Infrastructure: High real estate cost factor is pushing the industry to look for alternate locations either on the periphery of big cities or smaller less well established cities. At such locations there is a general lack of good social infrastructure. It is imperative to make provision for good schools for children, good hospitals, recreational amenities etc.

The above mentioned are some of the infrastructural problems. If these are to relate to the Economic Continuum model, the reflection is that India is trying to address the infrastructure requirements of the second stage. However, the pace of development is picking up as the private sector is increasingly getting involved in the modernization process.

A prominent developer was of the view that for their proposed developments, they would rather rely on their own capabilities rather than on the government for infrastructure requirements.⁵⁰

Another major challenge currently being faced is that of human capital. This is discussed in the next subsection.

⁵⁰ Telephone interview on July 25, 2008

5.1.3 Human Capital:

Human capital is the most important constituent in the matrix of knowledge-based industry. It was referred to as ‘the raw material for the knowledge-based industry’ by an interviewee. Though, India is riding the success story in the knowledge industry sphere, availability of human capital is becoming one of the most formidable challenges being currently faced.

The industry is facing shortage of trained and skilled manpower that is readily employable. This is despite the fact that India produces a large number of graduates and post graduates every year. According to a report, there is a shortage of skilled professionals across different science, engineering and management streams.⁵¹

The problem of shortage of human capital is even felt in the IT/ITeS industry. To overcome this problem, many of the IT sector companies such as Infosys and Wipro have started their own educational and training programs to enhance and augment the skills level of the workforce. Promoters of technology parks and SEZs concurred that it is imperative to have “finishing schools” wherein professionals could be trained for industries located in the technology parks.⁵²

An interview participant from a life sciences company remarked that ‘Finding employable talent is a major challenge’. The interviewee explained that shortage gets tied to the scalability issue wherein not many graduates get a chance to enter the premier institutes. The remark was made in connection to the limited number of vacancies that the premier institutes offer each year.

Another reason, for the shortage of human capital in the country is the problem of “brain drain”. This is the term used for the graduates and post graduates who leave India for opportunities in developed world. The prospects of higher education, better job avenues and a better lifestyle act as a major pull factor. An academician stated that post doctoral system, on lines of US Universities, is essential to retain the manpower in India. Also, the scientists and engineers don’t get paid as well as the management personnel do, therefore, there is a general lack of attraction towards the basic and applied sciences.

The government in its effort to meet with the challenge has announced plans to set up premier technology (Indian Institute of Technology) and management (Indian Institute of Management) institutes in different parts of the country. It has also set up pharma and biotech institutes such as National Institute of Pharmaceutical and Research (NIPER) and is planning to establish similar types of centers in times to come. However, more needs to be done to attract and retain talent in the country.

⁵¹ Emerging Direction in Global Education (EDGE) 2007

⁵² Views expressed by R.K.Nair, CEO Technopark, Kerala, Telephone Interview on July 7,2008; Interviews with Prasanta Biswal, CEO, International Biotech Park, Pune and Nitin Khare, CEO, KTMS, Pune on June 30, 2008

5.2 Infrastructure requirement for the third level of economic development continuum model: Universities and Research Institutions and Networking Infrastructure:

This section would present the present status of linkages between Universities and Industry and also touch upon the organizational structure concept of Knowledge cluster as defined by Evers, earlier mentioned in Chapter 2. Finally, the section would present some recent measures initiated to promote entrepreneurship.

The economic continuum model suggests that Universities and research institutes constitute the infrastructure for attaining the third level of economic development. Also, the networking environment should be such that it facilitates flow of knowledge and information. Globally, there are numerous examples of knowledge-based industries clustering around well-acclaimed universities, research and public funded institutions. However, the current set up in India is still wanting on this aspect.

Indian educational and research institutional set up for R&D has been heavily balanced in public sector domain. Research in most of the public funded institutions remains academic in nature. The benefits of publicly-funded research are not fully available to the industry for commercial use.

Almost all interview participants recognized that the University-industry link is important but expressed reservation on its applicability to Indian conditions in present times. Part of the reason was that the public institutions and industry don't collaborate and the other was that there is no need for such linkage as most of the research and development activities are carried out in-house by the companies. The University-Industry link utilization, therefore, largely remains sporadic.

An interview participant commented that "the global companies may not require such a linkage with the Indian academic or research institutes for the reasons that the companies already have collaborations with international research institutes."

There are few examples that reflect that the industry does collaborate with the centers of excellence in India. Several technical institutes are working on various R&D projects in close collaboration with various multinational companies and Indian companies in India. (FICCI 2005)⁵³

- Indian Institute of Technology (IIT) Kharagpur undertakes research in collaboration with MNCs such as, Motorola, Compaq, Oracle and GE Caps.
- IIT Chennai and Hewlett-Packard (HP) run a joint laboratory at IIT's campus. This lab develops technologies for emerging economies.
- HP Labs are also partners with IISc Bangalore, BITS Pilani and the National Institute of design, Ahmedabad.

⁵³ Source: Adopted from Mitra: India's Emergence as a Global R&D Center: An Overview of Indian R&D system and potential, 2007; FICCI- Federation of Indian Chambers of Commerce and Industry

- Intel has formed alliances with the IITs, Indian Institute of Science (IISc) and Indian Institute of Information Technology (IIIT) at Bangalore to conduct Curriculum Development Workshops for the faculty of engineering colleges, which help to bridge the gaps between academia and industry. Intel strives to promote R&D activities based on its design, through its Intel Technology Laboratories (ITL) at IIT Mumbai, Chennai and Delhi; IISc Bangalore and at the National Center for Software Technology(NCST), Mumbai.
- General Motors (GM) has teamed up with 21 institutes in India, including the IITs and IISc. It conducts research with the IISc on fuel alternatives and light-weight engine materials.
- IBM collaborates with the IITs, Center for Development of Advanced Computing (C-DAC) Pune, IITs, and IISc Bangalore
- Texas Instruments has set up its Digital Signal Processing (DSP) laboratory at IISc Bangalore and IIT Bangalore.
- Samsung undertakes designing of color televisions, washing machines and air conditioners in collaboration with IIT Delhi's Industrial Design Department. It also has a Consumer Laboratory at IIT Delhi that undertakes usability studies
- Hindustan Lever Limited collaborates with the IITs, IISc and the University of Mumbai's Department of Chemical Technology.

The above examples relate to a functional relationship to develop specific technologies. The knowledge sharing and spillover effects are hardly realized in such kind of arrangements and consequently, the benefits that accrue from being in a cluster don't get materialized.

Part of the problem is related to the proximity factor. Most Indian academic and research institutes are developed within the large cities and there is hardly any land available near such institutes. Also, most of these institutes are in the public domain, it is a challenge to get the land released for commercial purposes. Therefore, collocation or development of industry in proximity to the academic set up remains a challenge.

Collocation not always necessary:

However, it must also be realized that the collocation of university-industry may not always be necessary. Knowledge spillover effect between university-industry interaction and inter-firm contacts is contrasted in a paper. The author states that inter-firm informal contacts are more numerous than informal university contacts and that knowledge is more frequently acquired from other firms than from formal university-industry contacts. However, the author also recognizes that firms in high-tech sectors tend to interact more with the universities more often than with other firms.⁵⁴

⁵⁴ "Knowledge flows through social network in a cluster- Inter firm versus University-Industry Contacts". Christian Ostergaard of Danish Research Unit of Industrial Dynamics (DRUID)

On similar lines, the author points out that proportion of active clustering firms appear to vary between subsectors being notably strongest in life sciences.⁵⁵

This is an important observation that directs our attention to the fact that only few high-technology areas such as biotech, nanotech, and stem cell research may actually require a university-industry collocation setting.

Government Initiatives to promote academia-industry linkage and cluster development approach:

There is a growing realization among Indian policy makers, scientists, industry and think tank that it is critical to foster a more collaborative and functional relation between academia and industry if India is to become competitive in the knowledge-based industry arena. Several policies have been initiated in this regard.

National Biotech Development Strategy document⁵⁶ states that “cluster development is a key strategy to promote innovation and accelerated technology and product development. This new approach has been given the green signal by the government. Four technology clusters are at an advanced stage of planning.”

- Agri-food Technology Cluster to be located in Knowledge city, Mohali, Punjab
- UNESCO Regional Center for Science, Education and Innovation in Biotechnology is being established at Faridabad, Haryana by DBT as part of a Health, Science and Technology Cluster.
- Animal Science and Biotechnology Cluster at a university location to be identified
- Marine Science and Technology Cluster at a university location to be identified.

The policy also mentions that “R&D collaborations will be forged with major international laboratories/bodies (e.g. WHO, CGIAR, MIT-Harvard University, Stanford University, Welcome Trust) in biotechnologies related to health, agriculture and bio-energy, bio-manufacturing and other relevant sectors.

Therefore, steps are being taken to address the issue of University-Industry linkage. However, pace of such initiatives often remains slow. The private sector would have to step in and play a defining role in addressing this issue.

It came out in conversation with an interview participant that Georgia Institute of Science and Technology, (Georgia Tech) is establishing a 250-acre SEZ near Hyderabad focusing on research and

⁵⁵ The University and the social-economic environment: Reflections from Cambridge U.K. Contribution by Bill Wicksteed, Director SQW

⁵⁶ Department of Biotechnology has recently come out with a Strategy Document on Biotech in India

industrial collaboration in diverse areas such as biotechnology, nanotechnology, aeronautical and semiconductors apart from off-shore campus.

There is a need for more such collaborations with well-acclaimed institutes going forward. This would ensure access to world-class education, help in developing university-industry linkages and facilitate entrepreneurship. This may also lead to companies collocating near the academic and research institutes.

Promoting Entrepreneurship:

Another significant move by the Government is that it plans to formulate its own version of the US government's Bayh-Dole Act.⁵⁷ A Draft Bill, called "Public Funded R&D (Protection, Utilization and Regulation of Intellectual Property) Bill, 2007 has been prepared and would be debated on soon.

The press note said 'The move follows the Prime Minister's direction to encourage development and commercialization of innovations. The government may also exempt researchers working in publicly-funded research organizations and universities from central civil services (CCS) conduct rules, enabling them to set up companies while continuing in government service. This would allow professors and research scholars to set up commercial entities while being employed in academic institutes. Academics will also be allowed to invest their knowledge and skills to pick up equity stakes in companies. This has a lot of potential to further revolutionize the knowledge-based sectors in India.'⁵⁸

Success of a knowledge-based cluster is also dependent upon the entrepreneurial pool present at the location. Generation of new ideas eventually lead to development of new products and processes that further leads to wealth creation. Entrepreneurship is on the rise in India. However, steps have to be taken to further promote it. The National Knowledge Commission Report on Entrepreneurship lists the factors that need to be addressed in order to promote entrepreneurship in India. The study calls for finding ways:

- To ensure expansion, excellence and inclusiveness of higher education,
- To intensify quality and scale of industry interaction with academia
- To provide commercial and legal incentives that promote such collaboration

⁵⁷ In 1980, the Bayh-Dole Act (PL 96-517, Patent and Trademark Act Amendments of 1980) created a uniform patent policy among the many federal agencies funding research. As a result of this law, universities retain ownership to inventions made under federally funded research. In return, universities are expected to file for patent protection and to ensure commercialization upon licensing. The royalties from such ventures are shared with the inventors; a portion is provided to the University and department/college; and the remainder is used to support the technology transfer process.

⁵⁸ April 2008, Economic Times

Therefore, stress should be placed on collaboration among knowledge resources so that benefits of commercialization of technology are shared and wealth gets created. Below mentioned are some of the academic and research institutes that offer incubation and support facilities to foster entrepreneurship:

- Some of the Government institutes such as CSIR, IISc and IITs have already devised mechanisms to start incubation centers to nurture start-up companies and give the students a first-hand experience in entrepreneurship.
- Department of Biotech has launched number of schemes under its program to foster entrepreneurship and growth of biotech sector.
- Some of the private universities and institutes have also started offering incubation facilities on their campuses. Amity University in Noida is one such example.
- IIT Chennai is offering incubator facilities to foster entrepreneurship. IIT-Madras has managed to get 11.5 acres of land for setting up IITM Research Park but such an area may not be able to suffice and support the developments of the nature that a knowledge cluster might need.

In chapter 2, a brief mention of concept of Research Parks was made. Many policy makers view research parks as panacea for boosting a regional economy. The concept does have merit and there have been some successful examples of research parks. Below mentioned are few projects that are modeled on Research Park concept:

- Gandhi City is a 1000 acre Research and Development SEZ⁵⁹ that is coming up near Bangalore on Bangalore-Mysore Expressway. The park is promoted by a group of entrepreneurs who have entered into strategic partnership with Research Triangle Park (RTP), North Carolina, USA, Biocant Research Park, Portugal and other research parks and Universities across the globe. Gandhi City is based on the Research Park concept that envisages providing access to research and educational institutes, venture capital, infrastructural facilities and a large talent pool. The park has incorporated protection of Intellectual Property rights and set up mechanism to commercialize the knowledge created in the park. Research centers, lab facilities and infrastructure would be created to promote Agriculture and Food Processing, Automotive and Aerospace, Pharmaceuticals and Biotechnology and Information Technology.
- Bangalore Helix, when completed, will have 7,00,000 sq ft of built area to accommodate biotech companies, research entities, start-ups with an incubation centre and common facility, besides the Institute of Bioinformatics & Applied Biotechnology, and the Centre for Human Genomics with their hostels.

The research park model is useful, but it is more applicable to the start-up companies who need incubation and other support facilities. The established companies can also set up their operations in research parks and share the amenities and also benefit from the networking.

⁵⁹ Gandhi City is a SEZ, but often referred to as park on the Gandhi city website.

It is worthwhile to mention here that the rise in entrepreneurial activity in India is to a great extent attributable to the role of Indian diaspora. There are many Non-Resident Indians (NRIs), as popularly called, who are either professionals or are entrepreneurs in countries such as the US. In recent times, there has been a rise in the number of professionals and entrepreneurs repatriating to India. This class not only brings its technical competence and experience, but it also has leverage to raise funds through PE & VC route. It is important that that an enabling environment is created for this class as they would be having an important role to play in the growth of knowledge-based industries in India. The reason for this is that most of such professionals are graduates from premier institutes of India and later have had advanced degrees and experience in the developed world.

5.3 Creative Class Concept and Cluster Development in India:

The creative class is the concept forwarded by Richard Florida in his book, wherein he stresses that it is important that the creative class is taken care of as this class has a huge economic impact. The growth of knowledge-based industries is dependant to a large extent on human capital. At this juncture when the Indian economy is transitioning, it becomes imperative to create infrastructure that meets the needs of talented people. Housing, physical and social infrastructure and overall quality of life are vitally important in attracting people with choices, especially when they are internationally mobile.

There is a need for planned communities offering work-live-play environment for professionals. Highlights of such development would be to create state-of-the-art facilities for knowledge based industries, provide 24x7 work and live lifestyles aimed to enhance quality of life of professionals and other intended users. It is perceived that world class mixed use development would attract industries to such knowledge clusters that shall lead to a synergistic relation between the knowledge centers and the industry, hence magnifying the positive impact on the local economy.

The world is not flat but spiky; argues Richard Florida, as today's key economic indicators—talent, innovation and creativity—are concentrated in strategic areas, not spread out evenly across the world.⁶⁰ This is true to a large extent. The role of non-economic, social factors is tilting the location choice to a place that provides better quality of life. This leads to demands for better working and living environment and support infrastructure for families.

There is increasing competition globally to attract talent and the latest developments in different countries have planned their developments keeping this factor in mind. The upcoming Allston project, an extension of Harvard University is planned to attract the stem cell researchers and scientists from across the world. On similar lines, Biopolis project in Singapore has been planned. Therefore, it becomes imperative to plan for world class cluster-based projects so that the talent could be attracted and retained in India as well.

⁶⁰ Who's Your City, An Interview with Richard Florida By: Tracy Certo Grand Rapids – Rapid Growth

Discussion on development of Knowledge-based clusters in India:

From the above mentioned issues of organizational set up of companies, the nature of activities they currently perform; challenges in infrastructure development and availability of human capital, the scenario that emerges is that India is still in the zone of transition. So the question arises, could a development of knowledge-based cluster be actually planned for and superimposed in India given the current scenario?

There are different views to this question. One viewpoint expressed in a report is that “the most successful bio-clusters have developed as a result of a coincidence of factors rather than as the result of deliberate design and public policy.”⁶¹ Here, the quote relates to bio-clusters but this paper tends to generalize this to other areas as well.

But, according to another viewpoint, “A key strength underpinning the Cambridge cluster’s performance has been that each of the key factors has been present in one way or another; sometimes through lucky chance but often through the **vision and energy of key people**.(emphasis existed).”⁶²

The author believes that sometimes things should be allowed to evolve, but sometimes they have to be created. Given the competition from other fast developing countries in the knowledge-based industry sphere and given the pace at which the development in knowledge-based industry is taking place and the potential at which it could grow, providing the required supporting infrastructure would actually catalyze the process of transition. There is a compelling need and a case for such a development.

A world class development incorporating the essential elements of a knowledge-based cluster would be instrumental in creating the factor conditions required to realize the full potential of India’s strength in the Knowledge-based areas.

Location factor for Knowledge-based cluster:

Most knowledge clusters around the world are located in locations having connection to urban areas as the ‘creative class’ tends to prefer high level of urban services. The knowledge-based industry in India is heavily concentrated in few cities only, as observed in Chapter 3. The infrastructural pressures and the cost of real estate may not, in fact, allow a cluster development in those cities, but the peripheral areas of such cities and some other cities that have the support infrastructure in place would be an ideal choice for setting up a cluster.

⁶¹ A report by the UK House of Commons Trade and Industry Committee (2003)

⁶² The University and the social-economic environment: Reflections from Cambridge U.K. Contribution by Bill Wicksteed, Director SQW

A report suggests several opportune locations for knowledge-based industries such as Hinjewadi near Pune, Manesar near Gurgaon, Shamshabad near Hyderabad, Greater Noida in NCR region, Panvel-Virar near Mumbai and Dewanhali near Bangalore and so forth.⁶³ A careful analysis of local economy and potential of location is, however, suggested.

- Andhra Pradesh Government is promoting a “Knowledge Corridor” Project to promote entrepreneurship and attract large corporations to set up their R&D centers.⁶⁴

There are a couple of mixed-use mega-projects that have been envisaged based on cluster approach⁶⁵:

- Nano city, promoted by Sabeer Bhatia Group in collaboration with Haryana Government, is an 11000 acre mixed use integrated township project modeled on lines of Silicon Valley is coming up near Chandigarh. The city would specifically target the knowledge-based industry. The knowledge city will deal in future technologies like nano-technology, biosciences, software product development, next generation Internet products, materials research and energy. The Nano City had been conceptualized and planned by the College of Environment Design, University of California, Berkeley.⁶⁶
- Odyssey Science City project 65000 acre project near Anantapur district of Andhra Pradesh, around 170 km from Bangalore on Bangalore- Hyderabad road by a consortium of four Australian and Singaporean companies. It is conceiving of becoming a national centre for IT and supercomputing, biotechnology, artificial intelligence, robotics, high-tech manufacturing industries, export oriented centers, media and telecommunications, tourism and entertainment, medical and health and finance and banking. The project envisages a self-contained, hi-tech complex with its own comprehensive infrastructure, including power, expressways, telecom networks, desalination plants, biotech parks, IT/biotech parks, industrial parks, hospitals, educational institutions, hotels, convention centers and recreation facilities. The planners aim to replicate the Greater Springfield model of Australia, claimed to be world's only master planned edge city.⁶⁷

It would be interesting to see how these developments shape up going forward.

⁶³ Cushman & Wakefield: GRI India Real Estate Investment Report 2007: "India Gaining Momentum"

⁶⁴ Knowledge Corridor is an area on both sides of expressways connecting the already established centers with the nearby satellite towns and cities.

⁶⁵ The author was not aware of these projects before the start of the study and found out about these during the course of study.

⁶⁶ Economic Times, 2006; The Hindu, Oct, 2007

⁶⁷ Economic Times, 2007

Chapter 6: Summary

Knowledge based industries tend to cluster because of the exigencies of the nature of activities. Knowledge-based cluster concept was introduced in Chapter 2 and a stylized model of economic development was presented that later formed the basis of comprehending the level of economic development going on in India.

Current snapshot of Knowledge-based industries was presented in Chapter 3. It was found that there is an increase in investments flowing to the country. In recent times, there has been proliferation of knowledge-based industries as companies seek new destinations for reasons such as lower costs, incorporation of new knowledge and diversification in product type and new markets. The knowledge-based industry size in terms of revenues and their geographical location pattern was studied. It was also observed that Knowledge-based industries are witnessing a transition as they are constantly moving up the value chain and are becoming innovative and knowledge creation oriented.

Current state of affairs related to knowledge-based industry was analyzed using the stylized model as a reference. The analysis across the three dimensions of organizations, infrastructure and human capital suggests opportunities and challenges faced by the knowledge-based industry. There are challenges on infrastructure and human resource front. Nevertheless, the opportunities seem to exist. There is increasing realization both in the academic and the corporate circle to foster a close University-Industry functional link going forward.

A case is made for the development of knowledge-based cluster in India and also stress is laid on developing a mixed-use development based on work-live-play concept so that the creative class is attracted and retained in the country.

Recommendations:

There is a greater need for a collaborative effort on part of the government and private sector to address the issues of infrastructure and human capital. Governments, at the Center (Federal) and at State level, have to play an entrepreneurial role in dealing with the issues. Major reforms are required in education system and research institutional infrastructure. Also, policies have to be put in place to enable the development of world-class innovation-oriented knowledge-based clusters. Development, too, has to match such initiatives.

However, the biggest real estate issue in India is land acquisition. The government may be constrained on this issue because of the SEZ controversy. But the government should devise some mechanism to incentivize the developer such as allowing higher floor area ratio or reduction in transfer charges and lower user charges. There should be some incentives reserved for the stakeholders as well. This would help in attracting industry. Also, a collaborative consultation process may be initiated between the government and private developer to identify strategic locations for a knowledge-based cluster. This would enable pooling in the efforts and resources.

Also, while conceptualizing a knowledge-based cluster, it is imperative to develop proper understanding of dynamics of local economic conditions, in addition to analyzing the location and infrastructural factors. Absence of any element may prove detrimental. It is, however, possible that attracting a high tech company or a reputed educational or research institute may provide an anchor effect that would lead to boost a regional economy.

Though some evidence suggests knowledge-based cluster formation is coincidental in nature, but this may not be applicable to a fast paced transitioning economy. A pioneering real estate development effort may actually be all that is required to catalyze the transitioning process.

Potential for Future Research:

The limited time for this research project could not allow a detailed study on potential locations where knowledge clusters could be developed. This study could be taken forward and certain potential locations in India be studied in detail.

The proposed large scale mixed-use development projects- Nano City and Odyssey City Projects could be taken up as a case study. These projects may be investigated for successes and weaknesses. This would help in conception of future projects.

Comparison of developments in Special Economic Zones with other large scale developments may be done. This may provide an insight to the dynamics of evolving economy and how the developments get affected by it. Also, it would help in gaining concessions/variances from the government for the proposed developments.

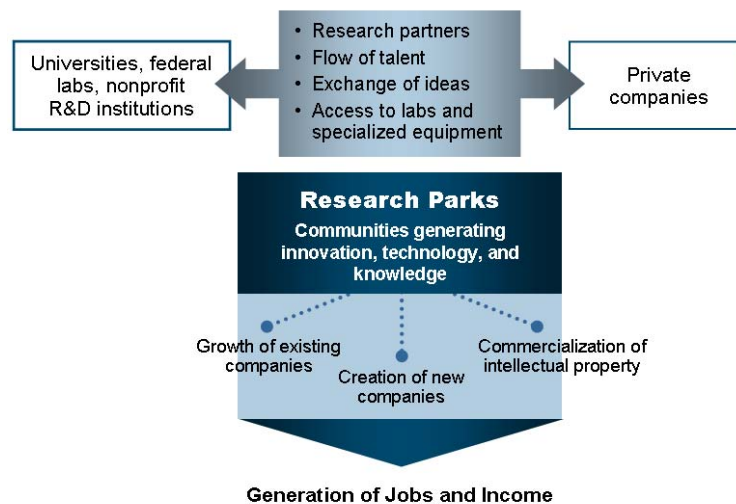
Appendix 1: Research Parks

Research parks play an important role in facilitating the growth of a knowledge-based cluster. This model is prevalent in the developed and some of the developing countries. These are perceived as instrumental in development of regional economy.

“A research or a science park is a group of interrelated companies, universities, institutes and service providers supervised by an administrator to promote research and development, technology transfer and partnership between tenants.” This concept has generated enough interest among policy makers, economists, scientists and developers across the world. Research parks are primarily aimed at nurturing the start-up companies’ by providing them research, infrastructural and other such facilities to enable them to develop commercially viable technologies. These facilities ultimately give rise to growth of companies that later grow into larger companies. According to United Nations estimates there are about 400 research parks across the world.

A model is presented in the report, as shown in the figure on next page, depicts the dynamics of a research park.⁶⁸ It shows how a research park can facilitate the University- Industry interaction and be instrumental in achieving the desired outcome of boosting innovation and commercializing of knowledge.

Figure 23 : Model showing Dynamics of a Research Park



⁶⁸ Battelle Technology Partnership Practice in collaboration with the Association of University Research Parks (AURP) and Insightrix, titled “Characteristics and Trends in North America Research Parks – 21st Century Directions”

In a report on Research Parks in North America, published in Oct.2007, various issues pertaining to the research parks have been investigated and documented.⁶⁹The report highlights results of survey that was conducted across 174 research parks in North America and provides an insight why research park locations are preferred. Accessibility to skilled labor force, university faculty and facilities, knowledge sharing, leasing options and business related support services were some of the factors that favored research park locations.

Nature of research parks has been changing over period of time. Research parks are finding preference with urban settings than the suburban settings that were earlier preferred. The table below highlights the changing dynamics of research parks.⁷⁰

Table 16 : Changing Dynamics of Research Park

Early Parks: Stand-Alone Physical Space	1990s: Connections	2000 and Beyond: Economic Driver for the Region
<ul style="list-style-type: none"> ▪ Real-estate operations ▪ Campus-like environment, selling single parcels of land ▪ Focus on industrial recruitment ▪ Few, if any, ties between tenants and university or federal laboratories ▪ Little provided in terms of business assistance or services 	<ul style="list-style-type: none"> ▪ Anchor with R&D facilities aligned with industry focus of park ▪ Innovation Centers and technology incubators more common ▪ Multitenant facilities constructed to accommodate smaller companies ▪ Some support for entrepreneurs and start-up companies provided directly 	<ul style="list-style-type: none"> ▪ More and more mixed-use development, including commercial and residential ▪ Increased focus and deeper service support to start-ups and entrepreneurs ▪ Less focus on recruitment ▪ Formal accelerator space and plans for technology commercialization roles emerge ▪ Greater interest on part of tenant firms in partnering with universities ▪ Universities more committed to partnering with research park tenants ▪ Amenities from day care to conference and recreational facilities added

The table highlights the characteristics of research parks as they existed in the decades of 60s onwards till the 80s. The parks were stand alone with little ties between the industry and the University. There

⁶⁹ Battelle Technology Partnership Practice in collaboration with the Association of University Research Parks (AURP) and Insightrix, titled “Characteristics and Trends in North America Research Parks – 21st Century Directions”,

⁷⁰ Ibid

occurred a perceptible change in the 1990s, with the parks becoming centers of innovation and providing incubator facilities and support to entrepreneurs. The University-Industry interaction grew at a functional level. In the 21st Century, stress has become more on mixed-use development and a deeper service support to start-ups and entrepreneurs.

Efficacy of research parks in promoting regional economic development:

There have been success stories of clusters and research parks across the world. Some of the notable ones are:

- Silicon Valley, California that benefited from unique network of entrepreneurial and venture capitalists that developed symbiotically with research institutions like Stanford University;
- Research Triangle Park, North Carolina that had an advantage of being the pioneer but actually got successful when bigger companies moved in.
- San Francisco and San Diego parks are among other successful ones.
- Internationally, Hsinchu Science Park in Taiwan, Biopolis in Singapore, Babraham research campus, Cambridge, UK are quoted as successful.

Critique:

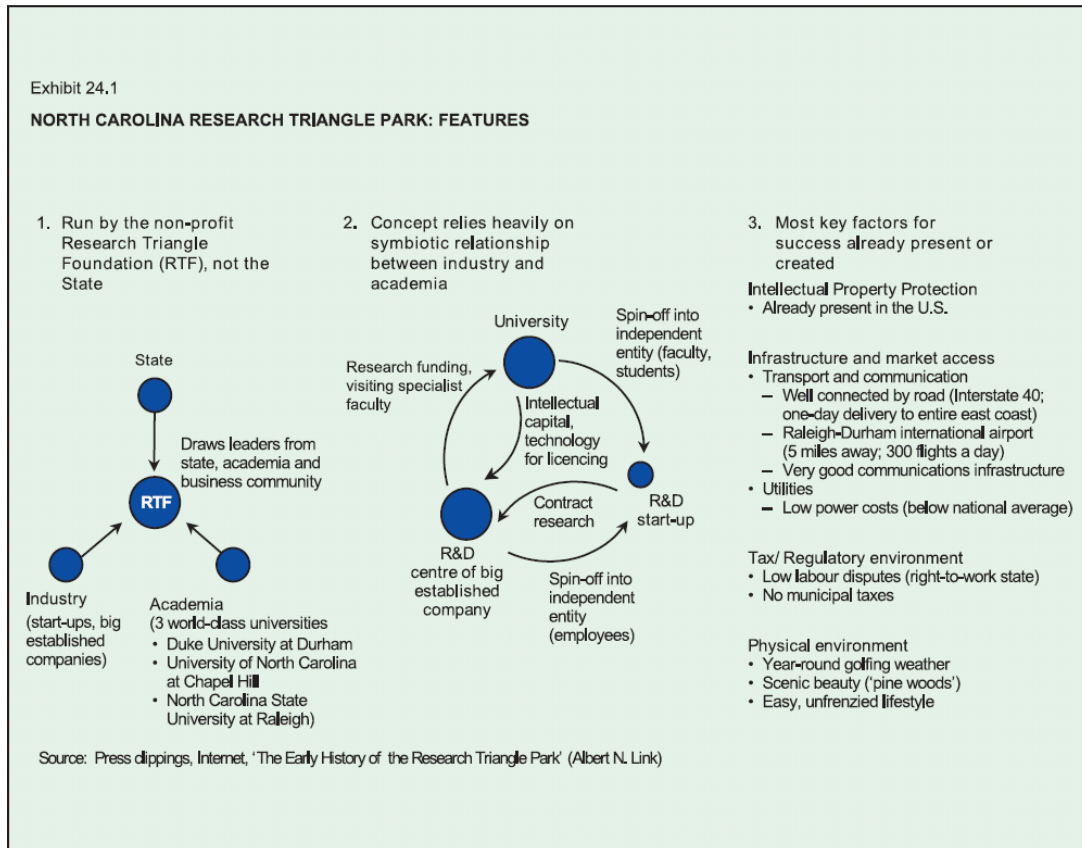
However, the policy of setting up research parks in order to promote regional development has not always met with success. In a study, the author mentions many instances of unsuccessful or lesser successful research parks that could not achieve the desired objectives despite the presence of critical factors such as presence of universities to facilitate knowledge sharing and spillover, provision for fiscal incentives to encourage industries or setting up a high profile institute. Examples of Scripps Research Park in California, Texas Research Park in San Antonio, Maryland Science and Technology Center in Prince George's County, MD and Malaysian Bio valley are quoted. The main reason for this is the absence of critical mass of activity.⁷¹

Christian Ketels, Principal Associate at the Institute for Strategy and Competitiveness at Harvard Business School, Cambridge, USA, believes that what really distinguishes the winners from the losers is not only a strong cluster-specific business environment and a critical mass of activity, but also the focus on a specific area or market for which the cluster provides unique value to companies and researchers. Further it is advocated that a thorough evaluation of local dynamics, research potential and entrepreneurial environment is essential before deciding to locate a research or science park.

⁷¹ Scott Wallsten, American Institute Enterprise of Policy Research "*High Tech Cluster Bombs: Why Successful Technology Hubs are Exception, Not the Rule*"

Ketels is of the view that only technologically sound tenants should be selected that can spur high-tech and biotech progress.⁷²

Figure 24 : Features of North Carolina Research Triangle Park



Adopted from Website Article: <http://unpan1.un.org/intradoc/groups/public/documents/APCITY/UNPAN013227.pdf>

⁷² EMBO Report, Vol.7. No.2, 2006

The table below highlights characteristics of two Research Parks: Hsinchu Science-based Industrial Park, Taiwan and North Carolina Research Triangle Park.

Table 17 : Research Park examples: Hsinchu Park, Taiwan and North Carolina RTP

Exhibit 24.2
A TALE OF TWO RESEARCH PARKS

	Hsinchu Science-based Industrial Park, Taiwan	North Carolina Research Triangle Park
History	<ul style="list-style-type: none"> Taiwan's first industrial park, located an hour away from Taipei, in Hsinchu Established in 1980; 400 ha in size Home to 170 companies (30% foreign); R&D expenditure averaging 6% of sales 	<ul style="list-style-type: none"> Established in 1958 6,800 acres (8 miles long, 2 miles wide) Home to large research and manufacturing companies – IBM, NT, Burroughs Wellcome, etc.
Concept	<ul style="list-style-type: none"> Established to foster hi-tech industry development in Taiwan 3 science and technology institutions situated close by to provide intellectual capital Manufacturing allowed in the park Facilities (utilities, services, housing, etc.) funded and provided by the state 	<ul style="list-style-type: none"> Established as R&D park to encourage innovation and move away from traditional low value-added industries Flanked by 3 world-class universities that jointly educate 75,000 students a year, provide scientific manpower and have symbiotic relationship with industry Manufacturing not allowed, only assembly operations
Facilities	<ul style="list-style-type: none"> Special incentives to investors—low-cost loans and government grants, tax waivers, tax holidays, capital repatriation, easy access to venture capital Handling of export/import licences, warehousing, shipping, etc., by Park's administration 	<ul style="list-style-type: none"> World-class communication/transport infrastructure Low-cost utilities No municipal taxes Technology Licensing Committee to speeden up licensing procedures
Impact	<ul style="list-style-type: none"> 23,000 people employed in Park Industry growth 4 times that of rest of Taiwan in 1996 Labour productivity twice that of rest of Taiwan Industry turnover \$11 billion, went up by 68% in '96 over '95; profitability up by 38% 	<ul style="list-style-type: none"> Highest per capita PhDs and engineers \$1 billion in wealth added every year Has 94 R&D companies and numerous start-ups Hosts some 36,000 technical people R&D firms in the RTP have relocated their manufacturing locations to areas close to RTP

Source: Media articles, Internet, 'The Early History of the Research Triangle Park' (Albert N. Link)

Website Article: <http://unpan1.un.org/intradoc/groups/public/documents/APCITY/UNPAN013227.pdf>

Appendix 2: Operational and Proposed Biotech Parks in India

Table 1: Biotechnology Parks in India				
Biotechnology Park	State – City	Total Area (acres)	Focus Sector	Status
Shapoorji Pallonji Biotech Park	Andhra Pradesh – Hyderabad	300	Bio-pharma	Operational
ICICI Knowledge Park	Andhra Pradesh – Hyderabad	200	Biotechnology and pharma	Operational
Biotech Park Lucknow	Uttar Pradesh – Lucknow	8	Agri-health care	Operational
Ticel Bio Park	Tamil Nadu – Chennai	5	Biotechnology	Operational
Golden Jubille Biotech Park for Women Society	Tamil Nadu – Chennai	20	Agri-biotechnology	Operational
International Biotech Park	Maharashtra – Pune	103	Bio-pharma	Operational
Agri-biotech park – Jalna	Maharashtra – Aurangabad	100	Agri-biotechnology	Proposed
Bangalore Helix	Karnataka – Bangalore	104	Biotechnology	Proposed
Kerala biotechnology park	Kerala – Kochi	50	Agri/pharma/industrial biotechnology	Proposed
KINFRA Apparel Park (facility for biotechnology housed within this park)	Kerala – Thrivandrum	25	Agri/pharma biotechnology	Proposed
Sitapur biotechnology park	Rajasthan – Jaipur	30	Biotechnology	Proposed
Bhiwda biotechnology park	Rajasthan – Bhiwda	30	Biotechnology	Proposed
Boranda biotechnology park	Rajasthan – Jodhpur	30	Biotechnology	Proposed
Haldi biotechnology park	Uttaranchal – Haldi	1,000	Agri/pharma biotechnology	Proposed
Manesar biotechnology park	Haryana – Gurgaon (NCR)	50	Agri/pharma biotechnology	Proposed
Herbal pharmaceutical biotechnology park	Madhya Pradesh – Indore	167	Agri/pharma biotechnology	Proposed
Guwahati biotechnology park by TERI	Assam – Guwahati	100	Agri-biotechnology	Proposed
Solan biotechnology park	Himachal Pradesh – Shimla	134	Agri-biotechnology	Proposed
Jogindernagar biotechnology park	Himachal Pradesh – Shimla	-	-	Proposed
Chandigarh biotechnology park	Punjab – Chandigarh	100	Agri/pharma/industrial biotechnology	Proposed
Salvi biotech park	Gujarat – Vadodara	100	Biotechnology	Proposed
Marine Biotech Park	Andhra Pradesh – Vishakhapatnam	218	Marine biotechnology	Proposed
Agri biotechnology park – Patan Cheruvu	Andhra Pradesh – Hyderabad	200	Agri-biotechnology	Proposed
Orissa biotechnology park	Orissa – Bhubaneshwar	74	Agri/pharma biotechnology	Proposed
Konark biotechnology park	Orissa – Konark	22	Marine biotechnology	Proposed

Source: Jones Lang LaSalle

Appendix 3: List of companies engaged in R&D activities in India

Major In-House R&D Operations		Major Outsourcing of R&D to Indian Parties
Adobe	Hewlett-Packard	Alcatel
American Express	IBM Global Services	Cisco
Baan	Intel Novell	Computer Associates
Cadence Design Systems	Microsoft	Ericsson
Cisco	Motorola	Farmer's Insurance
Citigroup	Oracle	General Electric
Computer Associates	Philips	General Motors
Cognizant	SAP	Home Depot
Deutsche Leasing	Siemens	IBM
EDS	Sun Microsystems	Lucent
Ericsson	Synopsys	Motorola
General Electric	Texas Instruments	Nokia
General Motors	Yahoo!	Nortel Networks
Google		Xerox

Source: Compiled based on TIFAC 2006, company reports, Times of India, Business Standard, Financial Times and interviews.

Note: R&D and sector demarcations are broadly defined. List is intended to be illustrative.

TIFAC: Technology Information Forecasting and Assessment Council

Table Adopted from Mitra: India's Emergence as a Global R&D Center: An Overview of Indian R&D system and potential, 2007

Appendix 4: Global Biotechnology Cluster Map

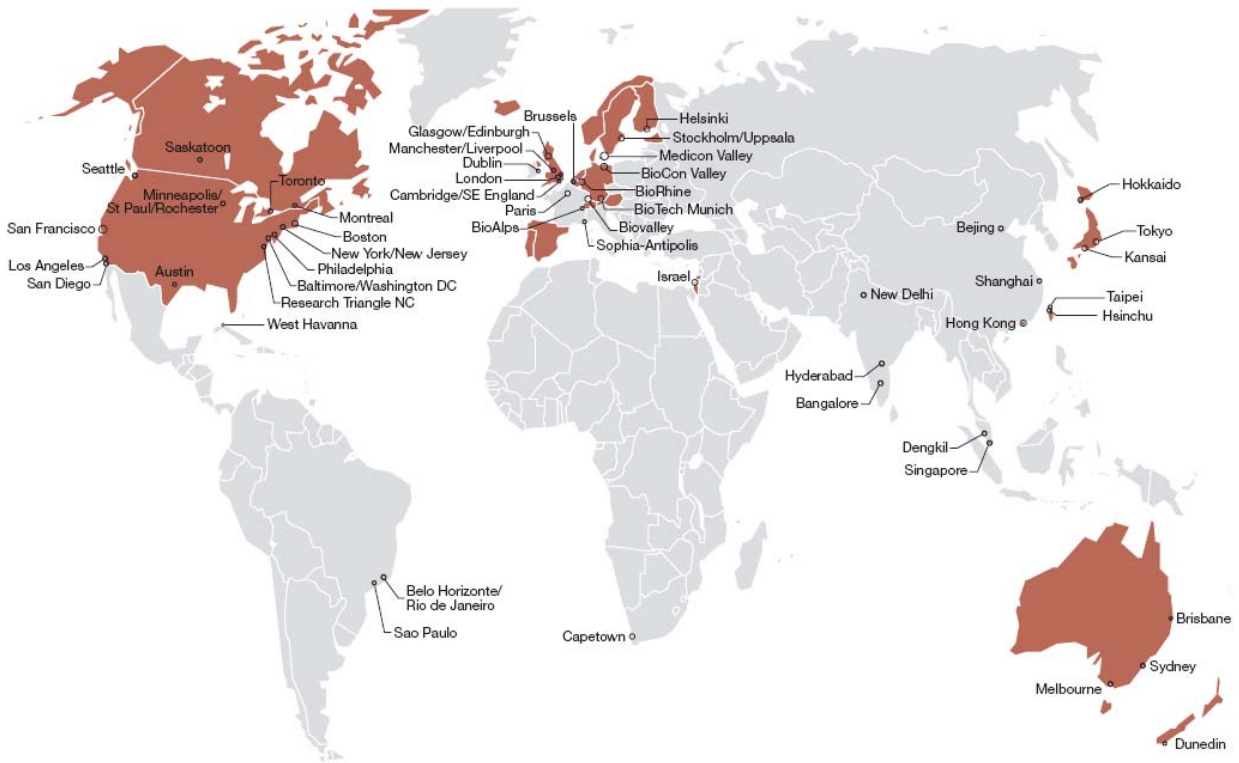


Fig 1 | The Global Biotechnology Clusters map. Countries coloured in brown rank highly in the Growth Competitiveness Index 2004–2005, World Economic Forum. Black circles represent selected biotechnology and life-sciences clusters. Fig adapted from image supplied by William Hoffman, MBBNet, University of Minnesota, Minneapolis, MN, USA.

Appendix 5: North American Life Sciences Cluster

Table 1 | MAJOR NORTH AMERICAN LIFE SCIENCES CLUSTERS

MARKET	SIZE	PRIMARY FOCUS
Boston/Cambridge	10.3 million sq. ft.	HQ – product R&D, medical research
Los Angeles	5.5 million sq. ft.	Medical research, medical device manufacturing
Metro New York	6 million sq. ft.	HQ market, medical research
Metro Philadelphia	18.5 million sq. ft.	Education, ancillary to big pharma
Raleigh-Durham	8 million sq. ft.	Product manufacturing (vaccines), agrotechnology
San Diego	11 million sq. ft.	R&D
San Francisco	25–30 million sq. ft.	R&D
Seattle	5 million sq. ft.	R&D
Suburban Maryland	9 million sq. ft.	Research (federal and private)

Note: Puerto Rico inventory difficult to establish; primary focus on R&D and manufacturing.

Source: Colliers International Report

Appendix 6: Questionnaire:

Conversational Interviews were conducted in India with about 20 participants. The participant pool consisted of academicians, government officials, industry experts, scientists and developers.

1. What has been your experience doing business in India? Look for components- regulations, infrastructure, business environment, manpower, cost, real estate. Mention, if missing.
2. What are some of the successes and failures? What are the reasons for success / failures?
3. What are the key success factors in your industry?
4. Why do you choose to locate in a particular location? Are there critical linkages that you seek? Is the decision based on cost? Or is it related to availability of workforce? Which factor was fundamental in your decision making?
5. What are some of the challenges you face- infrastructure related.
6. What is the size of managerial and technical workforce? What are some of the issues related to the workforce? What are your HR Practices in terms of providing a good working environment?
7. Do you see further growth in your business in India? Which areas? How do you plan for expansion? Comment on reports on R&D activities relocating to India. Also, mention government regulations and incentives.
8. What are your views on the SEZs development? Do you feel that the current state of development would meet your standards?
9. Introduce the AURP Knowledge cluster model and elicit views on University- Industry linkages going forward.
10. Your views on mixed use developments. Work-live-play concept. What components do you feel are important for your industry in such mixed use developments?
11. How do you see India's emergence on a global level in your industry. What are its competitive advantages vis-à-vis other competing countries? What are the impediments?

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