Sustaining Economic Development: Contributions from and Challenges to India's Software Industry

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I am grateful to the senior executives of many Indian software companies who allowed me to interview them and shared their useful insights in developing this paper.

ABSTRACT

The role of India's information technology industry in India's technology-based economic development even in the face of a global recession has caught the attention of policymakers, academics and industry experts. While future prospects for growth are unanimously reckoned to be high in every forum, one question is commonly posed: is this growth sustainable? Numerous studies conducted in the last few years point to a serious debate that India's competitive advantages, especially the advantage stemming from India's large technology workforce, may be eroding over time. While industry perceives challenges to growth lie in the shortage of human resources, policy makers in India contend that India is well prepared to meet future demand for the information technology workforce.

My paper explores this dichotomy in industry perception and government policy response in greater detail. Based on data from interviews of senior executives of Indian software companies in Bangalore and the US, and also by drawing upon secondary data sources, I develop a typology of India's competitive advantages and threats thereto in the information technology sector. An examination of the demand and supply constraints beyond quantitative estimates reveals a set of serious challenges to the expansion of India's information workforce. While the Government of India has taken many proactive assessments of existing policy gaps and has designed interventions to remedy those, there is an immediate need for greater interaction among industry, academia and the government to reorient the formal and non-formal education delivery systems toward the constantly evolving market needs.

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I. INTRODUCTION

In today's knowledge economy, information and access to information have replaced traditional factor inputs such as land, labor and capital as the primary inputs into production. This transformation, caused by recent technological revolutions and rapid changes in business models around the world, has presented enormous opportunities to developing countries. India, an otherwise slow adopter of technology and technology-based development strategies, appears to have successfully leveraged this opportunity and its large endowment of human capital to establish a fast lane to economic growth (Heeks, 1996, Arora et al, 2001 and Kambhampati, 2002).

Accolades have come from all corners to India's information technology industry, especially to the software exports sector, that has built a global reputation for quality software, has grown an average of 40 –50% in the 1990s, and has successfully withstood the recessionary pressure in the recent years. While the growth trends experienced by this sector and its contributions to India's economic development have been phenomenal until recently, questions have begun to arise on its sustainability. This paper explores those concerns in detail and examines the threats to the industry's competitive advantages.

After a brief discussion of the research objectives, data and methodology in the following section, I review the case of India's technology-based economic development brought in by the software sector. Then, in section IV, I develop a typology of India's competitive advantages and examine why human resources hold the key to future growth in this knowledge intensive sector. Section V discusses the threats to human resources, the most critical competitive advantage for India, while exploring the demand and supply side dynamics in detail. Specific challenges from Industry's perspective and policy responses to those concerns are discussed in Section VI. The paper concludes with a set of policy recommendations to supplement the IT action plan already under consideration by the government of India. The intent is to enrich the policy debate concerning India's information technology related skills base, and more importantly, to propose further alignment of government action with the industry's needs so that industry-wide growth is sustained in the future.

II. RESEARCH OBJECTIVES, DATA AND METHODOLOGY

Objectives: Numerous studies have been conducted in the recent past to understand and explain the various features of India's Information Technology industry. While most of these studies have focused on the evolution aspects and the inherent growth dynamics of this young industry (Bhatnagar and Madon, 1997, Saxenian, 2000, Arora et al, 2000 and 2001), a considerable number have studied the linkages between the rapid growth experienced by this industry and India's economic development (Bajpai and Shashtri, 1998, Arora and Athreye, 2002, Kambhampati, 2002, and D'Costa 2002). Only a handful of others have studied the innovation spillover from the information technology sector to other industries in India. In an attempt to decipher the drivers of growth in this sector, some studies have also examined the strengths and weaknesses of the software sector (Bajpai and Radjou, 1999, Saxenian, 2000).

However, despite the frequent mention of human resources as the most critical factor underlying the growth of India's IT industry, there has been only limited research specifically focusing on issues that surround India's IT labor pool. Most notable in this regard is the Fernandes and Arora study (2000) that explored in good detail the supply and demand situation of software developers in India. Their study reiterated Lakha's (1994) concern regarding shortages in personnel supply. These concerns have been echoed by a number of others in the global software industry, such as Barr and Tessler (1998).

This study intends to delve into further details regarding the competitive advantages of and threats thereto India's software industry. Rather than replicating the scholarly work already done in this area by academics, industry analysts and the government of India, this study intends to draw upon them to lay out the base assumptions and quantitative estimates of the demand and supply of software personnel. This study intends to carefully examine the recent economic, industry and technology-related trends that challenge earlier assumptions of demand and also purports to expand certain supply side constraints overlooked in earlier studies. The ultimate goal of this exercise is to understand the inflow and outflow patterns relating to human resources in the software industry and to

compare the positions of the government sector and the industry on the adequacy of knowledge professionals to meet the projected and desired growth in India's software sector. It is hoped that this study will enrich the policy debate concerning India's information technology related skills base.

Data and Methodology: Researchers agree that existing literature in the study of human capital requirements in the context of the Indian IT industry is limited and largely tentative partly because of lack of data, and partly because this industry is young and evolving (Kambhampati, 2002). Almost all the pioneering researchers in this regard have relied on field work and data collection through interviews (Heeks, 1996, Balasubramaniam and Balasubramaniam, 1997, and Arora et al, 2000) or other creative ways such as compilation of newspaper advertisements on skills requirements, and small and known samples for surveys (Fernandes and Arora, 2000).

Owing to this problem, I have structured much of my data collection strategy around a series of face-to-face interviews in Bangalore and another set of follow-up interviews by telephone in the US, and Bangalore. The selection of firms in India was restricted to Bangalore, the southern city often dubbed the Silicon City (Stremalu, 1996) or the Silicon Valley of Asia (Saxenian, 2000). The rational for this choice is that although multiple cities in India have now become prominent locations for software firms, Bangalore has had the early-mover advantage. Southern cities like Chennai and Hyderabad, New Delhi in the northern region and Mumbai and Pune in the western India have caught up well in the last decade. However, no significant distinction has been observed among these regional clusters in terms of the functional focus of the technology companies, business domain targeted or the mix of domestic and multinational firms operating in these technology clusters. Additionally, my decision to select Bangalore was influenced by the fact that Bangalore is home to many of the old and established firms as well as small and medium software enterprises in close proximity, and therefore, provided ease in sampling and access to companies of various sizes.

The first set of interviews was conducted in January 2002 in Bangalore and the second set of interviews was conducted in January 2003 in the US. While the interview sample remained the same, targeting senior executives of Indian software companies, the spread of these over a period of one year helped capture some of the newly evolving patterns in the face of the global slowdown in high-tech industry. All of these interviews were semi-structured, to help focus on key research questions while simultaneously encouraging the interviewees to offer insights and personal or company specific perspectives on the issues at hand.

Before selecting the candidate firms for interview, stratified random sampling technique was employed to retain similar, though not exact, proportional representation of firms of different sizes. This was especially important because bigger firms tend to exhibit a set of dynamics relating to growth and challenges that is different from the small and medium sized firms (Arora et al, 2000). The list of companies represented by NASSCOM served as the underlying population. While an expanded list of interviewees would have increased the generalizability of the study findings, constraints on time and resources compelled the interview schedule to be limited to 12 firms.

Table 1: Population and Sample of Firms by Size

Annual Turnover	No. of Companies Represented by NASSCOM in 2000-01	No. of Companies Interviewed
Above $ 220 million	5	1
$ 110 - $ 220 million	7	0
$ 55 - $ 110 million	14	1
$ 22 - $ 55 million	28	1
$ 11 - $ 22 million	25	1
$ 2 - $ 11 million	193	2
Below $ 2 million	544	6
Total	**816**	**12**

Apart from questions relating to the size of their firms in terms of revenue and number of employees, and the growth aspects, the interviews were asked to rank, from their perspective, the three most serious obstacles to growth of their companies. As regards specific issues relating to human resources, the interviewees were asked a set of common

questions ranging from their recruitment process, preference for any skill or qualification in the applicant pool, their firm-level training and career development initiatives and their employee retention programs. The interviewees were also asked to provide their insights into the future of the software industry as a whole and their recommendations for policy change.

This study also relies heavily on secondary data sources such as publications and survey findings by NASSCOM, IDC and the World Bank that assess the industry trends and human capital development efforts at the firm level. National Association of Software Companies (NASSCOM) is the primary body in India that conducts annual surveys and compiles aggregate information relating to the software sector, although the number of variables on which data is collected and the sampling techniques employed are limited (Kambhampati, 2002). For macro-economic data on India, I have drawn upon most recent surveys reported by the Government of India. Data have also been adapted from other scholarly publications whenever deemed necessary.

III. TECHNOLOGY-BASED ECONOMIC DEVELOPMENT: THE CASE OF INDIAN INFORMATION TECHNOLOGY INDUSTRY

In this section, I take a look at the structure and the growth trajectory of India's information technology industry. I analyze the sector's contribution to India's overall economic development to understand why the case of India merits such sudden and high degree of academic discourse as has been recently seen.

An Overview of India's Information Technology Industry

India's information industry started off in the 1970s as a mere resource base for developed economies that were beginning to feel the need for additional technology workers who could aid in automation and software production. A few Indian firms benefiting from the lack of significant competitive barriers to entry and India's endowment of highly educated workforce responded positively by supplying engineers and scientists. By the 1980s, India was graduating nearly 150,000 engineers, with a limited demand for their services from the Indian economy. Some of these scientists began to relocate to the US and other countries to work at the clients' premises, a process that came to be commonly known as 'body-shopping' (Lakha, 1994).

The Computer Policy announced by the Government of India in 1984 recognized software as an industry for the first time in India, making it eligible for investment allowance and other incentives (Saxenian, 2000). Since then a series of policy actions from an otherwise intrusive government simplified the process of obtaining clearances and permits, and eased the tariff structures and exports restrictions encouraging the development of the information technology industry (Arora et al, 2000).

In addition to the policy shift at home, business paradigms were shifting around the world by the late 1980s. Most notably, outsourcing of business functions emerged as a strategic management tool (Klepper and Jones, 1997). Information systems were increasingly outsourced in parts or in entirety for various strategic reasons, most significant being the cost advantages offered by the outsourcing service providers. Other important conditions

supporting the argument for information systems outsourcing were when information technology did not make a firm's core competency, when the firm encountered a skills gap between the need for specific skills for a job and available resources (Gerston, 1997), and when firms wished to leverage the technical expertise of software vendors in a rapidly changing technological environment (Klepper and Jones, 1997). India's information industry adopted the outsourcing application software model and grew along the trend. The liberalization of India's economy in the early 1990s, reforms in the telecommunications sector, removal of import licenses and formation of Software Technology Parks as export processing zones bolstered the trend toward outsourced software development (Saxenian, 2000).

Before examining the growth in the information technology industry in India in more quantitative detail, it is important to understand the structure of this industry. The information technology industry has three main components: 1) the computer hardware segment that includes computing and communications products and devices; 2) the computer software segment that comprises computer programs, algorithms, user interfaces and applications; and 3) the information technology enabled services segment that enhance other business functionalities with the use of computer hardware and software. The software segment may be further categorized into two types: a) generic off-the-shelf software products that may target a vertical business segment or multiple segments or b) customized software or application developed to suit the need of a particular user in the context of a specific technology or business need. In some cases, large software packages such as ERP or CRM products designed to serve multiple vertical segments on multiple technological platforms require a lot of tailoring and customization before operating under a set of specific business needs.

The Indian IT industry has weighed heavily on the software segment rather than the hardware segment (NASSCOM, 1999). The hardware and manufacturing segment suffered from poor quality, technological backlash and the inability to gain scale economies in a highly capital-intensive industry (Saxenian, 2000). Facing similar obstacles, the Indian software industry has lagged behind in exploring the products and

package development possibilities primarily because of the absence of a sizeable domestic market (Khan, 1998). It has also been argued that weak intellectual property rights, the lack of design and marketing experience, and the absence of more proactive government-facilitation of the IT sector (Bajpai and Radjou, 1999) have restricted Indian software companies to venture into the product market. Within the domestic market, lower willingness to pay for software products on the part of Indian users also discourages firms from engaging in indigenous research and development (Arora et al., 2000). Since the early 1990s, firms focusing on product development have been lured into adding export oriented services and consulting practices to their offerings, primarily to fund product development (Udell, 1993).

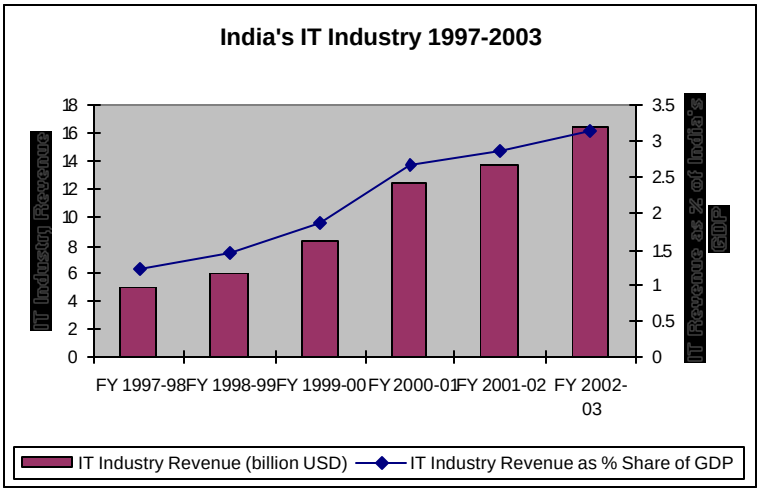
While the hardware and the software products segments have been historically weak and mostly import-dependent, India has emerged to be a leader among the developing countries in supplying cutting edge customized software. This is evidenced by the steep growth trajectory experienced by those Indian software companies that engaged in customized software and services in the last decade. The Indian software industry has grown at an unprecedented rate of 40- 50% in the last decade (NASSCOM, 1999). The information technology (IT) industry recorded US$ 8.26 billion in revenue in 2000-01, signifying a 55% growth over the 1999-2000 revenues. When the recent economic downturn hit India's software industry, the annual growth rate slowed down a bit, settling at 26% for 2002-03. The

The Indian IT services industry continues to be fundamentally reshaped by the emergence of new service opportunities, customers and competitors. The most recent development in this aspect is the emergence of the IT-enabled services sector. NASSCOM estimates indicate that during 2002-03, the IT-enabled services segment grew by a phenomenal 65 percent. Revenues from this sector rose from approximately $1.6 billion in 2001-02 to approximately $2.4 billion in 2002-03. Compared to other competing ITES nations such as Ireland, the Philippines and China, India drew the most of the global business on account of its unmatched price, performance and quality proposition.

Contribution to India's Economy – Output, Exports and Employment

Output: India's information technology industry recorded US$8.26 billion in revenue in 2000-01 and rose to nearly $16.5 billion in 2002-03. The domestic IT market touched revenues of $6.4 billion during 2002-03, of which software and services accounted for around $2.9 billion. At this level, the IT industry contributed more than 2.87% to India's GDP. As per a recent McKinsey Study, the Indian software industry will account for 7.7% of India's GDP by 2008, growing to more than $87 billion with software and services exports accounting for 35% of India's total exports. The following chart captures the growth trends for the Indian IT industry and its contribution to India's GDP.

Chart 1: Growth Trends for India's IT Industry 1997 - 2003

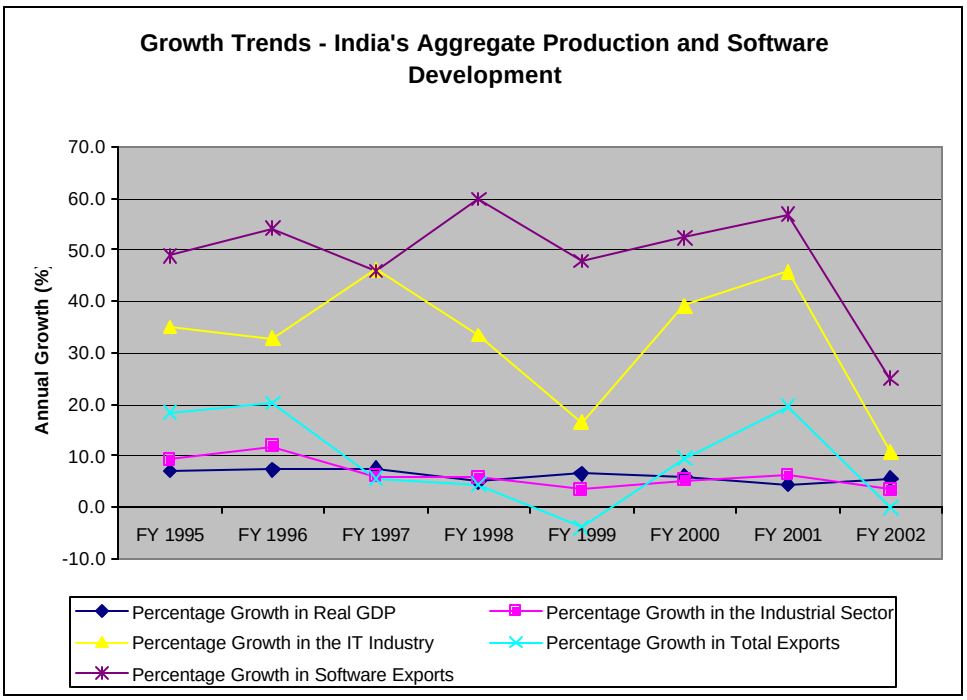


Source: NASSCOM (2003)

Exports: Following the economic liberalization of India in 1991 riding the wave of globalization, India's software exports grew rapidly, recording $131.2 million in turnover in 1990 to over $7.8 billion in 2001-02 (NASSCOM, 2002). Currently, this accounts for 16.3% of India's total export, rising from a mere 1.9% in 1995. Software exports in 1998-99 at $3.01 billion were almost half the value of agricultural exports ($6.2 billion) and almost one third that of the textile sector (Kambhampati, 2002). The National Task Force estimates software exports to grow to $50 billion by 2008, even if the recessionary trend holds in the short-run (National Informatics Center New Delhi, 2001). At the international level, India's software exports comprise of 1.9% of the approximately $300 – 500 billion world IT market. This ratio may not look very impressive at first glance,

however, when compared with the software services segment and especially the global outsourced software segment, India has captured a significant share (Saxenian, 2000). The following chart indicates the growth trends over time evident within the IT sector, as compared to other national economic indicators.

Chart 2: Contribution of the Software Sector to India's Economy



Source: NASSCOM (2003) and Ministry of Finance, Government of India Economic Survey (2002-03)

Entrepreneurship: The growth in production has brought in a flurry of entrepreneurial activities within this sector in the last decade. A number of new companies have been founded. While most of these new firms have been started locally, the convincing success in software outsourcing has encouraged many foreign multinational software companies to set-up their own India offices in the last few years. The primary multinational employers in India in the software sector include Microsoft, Oracle, IBM, Intel, HP, Accenture, KPMG and others. Many of these firms not only conduct product design and development and client servicing from remote Indian offices, some have even converted these offices into their global centers for research and development (example, Oracle, Intel etc.). Another interesting trend is that many multinationals and Fortune 500 firms not engaged in software development and sales (example GE) have also established satellite offices in India to take advantage of the expansive IT labor pool. Despite the

adverse economic conditions worldwide, the VC disbursements in India increased, albeit marginally, from $ 1.1 billion during 2001-02 to $ 1.2 billion during 2002-03.

Employment: As the table below shows, the aggregate impact on these trends on India's IT employment has been phenomenal. In 1985, the software sector employed only about 6,800 people. The employment numbers grew to 280,000 in 1997 and rose to 650,000 by the end of 2002 (NASSCOM). The demand for IT professionals is estimated to go up to 1.1 million in the next five years if the current growth trends hold (NASSCOM, 2003).

Table 2: Software Sector Employment

Year	Number of Software Professionals	Total Private Sector Employment	Software Sector Employment as % of Total Private Sector Employment
1985	6,800	7,312,000	0.09%
1990	56,000	7,582,000	0.74%
1996	160,000	8,512,000	1.88%
2000	430,000	8,646,000	4.97%
2001	522,000	8,652,000	6.03%

Sources: NASSCOM – Indian IT Sector: Knowledge Professionals Employed and Government of India – Economic Survey (2002-03)

Distributional Aspects of the Growing Industry

In spite of the spectacular contribution of the Indian IT industry in general, and the software sector in particular, to India's economic output, exports and employment, the sector is not free from criticism. India's software sector has been argued to have represented an embodiment of a market model within a social-welfare focused economic structure. This market model may have led to combined economic development at the aggregate level, but when analyzed at the micro-level taking regional, sectoral or knowledge-content indicators into account, this development appears uneven and disconcerted at best. However, scholarly literature suggests that the uneven economic development that has resulted from the rapid evolution of one particular sector in the

world's fifth largest economy,[1] is rooted in the differential innovative capability and infrastructure, the uneven diffusion of technical education and the varying policy entrepreneurship underlying India's overall socio-economic and political structure (D'Costa, 2003).

The Knowledge Gulf, Regional Concentration, and Gender Divide: The export oriented software sector has been criticized to contain very little forward and backward linkages to the regional economies, leading to less likelihood of providing as many growth points as the manufacturing sector (Balasubramaniam and Balasubramaniam, 1997a). Although the software industry has grown out of the software processing zones of the 1980s, it has till date remained concentrated in a handful of cities. Whereas many researchers attribute this development to the concentration of science and engineering institutes and telecom infrastructure in a limited number of cities, the impact of the regional policy entrepreneurs can not be overstated. The states of Andhra Pradesh, Karnataka and Maharashtra are cases in example where the state governments have proactively engaged in structural reforms. As per the study reported by Kambhampati, by 1997 a major proportion of firms were headquartered in Mumbai (96 of 302), followed by Delhi (61/302), and Bangalore (51 of 302). Most recently, the industry has spread to other smaller cities, albeit the concentration of firms in the southern and western region has not altered significantly.

Software development is seen to be gender neutral from an employment standpoint (Kambhampati, 2002), providing a more conducive and less discriminatory work environment from women (Jayanthi and Madhavan, 1985). Approximately 10% of the software employees were women by mid 1990s (Heeks, 1996), the proportion is believed to have grown to 18 –20 % in the last five years.

Impact on Other Industries – Governance and Compensation: Some of the information technology service providers in India such as Infosys Technologies have championed good corporate governance (Palepu and Khanna, 2001). These champions are

[1] India is the fifth largest economy in the world in terms of purchasing power parity (2001) Economist.

propagating the culture of corporate citizenry, transparent management, good financial practices and risk disclosures within and outside the information technology industry. Although not yet fully realized, these processes are leading to increased productivity as well as better compensation of the competitive science and technology workforce in other industries.

As we see from the above discussion, the information technology industry in India has not only had tremendous growth in the last decade, but has contributed enormously to India's economic development. As an engine of technology-based economic development, the software sector justifies serious academic and policy discourse. However, for the sector to sustain its growth and contribution to the national development, it is necessary to set aside the accolades of the past for a moment and carefully consider future challenges that may hinder the upward movement witnessed so far. As we proceed to consider the challenges, it is necessary to first understand the competitive advantages on which the sector has based its progress. The next section intends to take a look at the key success factors and sources of competitive advantages for India's information technology industry.

IV. WHAT MAKES INDIA'S IT INDUSTRY COMPETITIVE?

Why seek competitive advantage?

Competitive advantage may be described as the unique position an organization or region develops vis-à-vis its competitors (Hofer and Schendel, 1978). It draws upon the basics of comparative advantage, but moves beyond the boundaries of factor endowments, the fundamental notion of the comparative advantage theory, to include the dynamics of competition and the continuous evolution of markets, products, technologies and socio-economic structures around the entities under study. The competitive advantage theory not only considers the factor endowments such as human resources, physical resources, knowledge resources, capital resources or the infrastructure inherited by organizations, industries or regions, but also emphasizes how these factors are created and upgraded consistently (Porter, 1990). A competitive advantage becomes sustainable when it resists erosion by competitive behavior (Porter, 1985) and when the resources and capabilities creating that advantage are durable (Colgate, 1998).

What are the sustainable competitive advantages in the Indian IT industry and why should they be analyzed? Scholarly literature suggests that economic performance can be upheld in the long run through sustainable competitive advantages that contribute to economic activity (Porter, 1985, Bharadwaj and Varadarajan, 1993). Hence, without fully understanding the inherent strengths and weaknesses of the Indian IT industry and the durability of the resources and capabilities existing within the sector, it is difficult to predict if the sector's growth trends and its contributions to the nation's economy witnessed thus far can be held in the long run.

To be able to better analyze the competitive advantages, we must first understand the competitive landscape prevailing around the industry. I begin this exercise with a comparative assessment of the software sectors in three emerging software powerhouses: Israel, Ireland and India. These three countries show a lot of commonalities in their evolution and growth, and are often considered as parallel success stories while being competitors in the global software industry. Such a comparison therefore merits a

discussion despite the appearance of China, South Africa, Philippines and Russia as the next breed of software service providers (Arora et al, 2000).

Comparative Assessment of Israel, Ireland and India

The Israeli software industry developed based on an export orientation. In 1990, software exports from Israel amounted to $90 million. Increasing steadily over the next decade, it reached more than $2.6 billion by 2000. The Israeli Association of Software Houses estimated that exports surpassed $3 billion by the end of 2001. Domestic sales grew by 10% per annum and overall sales for the industry were expected to top $4.2 billion in 2001 (ISHA, 2002). Analysts attribute this exceptional success to the high caliber of its human resources and high degree of research and innovation. There were about 15,000 highly educated scientists and engineers employed in this sector by the end of 2001.

The Irish software sector started with a dependence on software services, and a low-exports, low-profit approach. However, a switch in strategy took place in the 1990s, from services to software products, and from domestic to export markets catering to the European countries. The National Software Directorate of Ireland estimated that the Irish software sector had more than €10.15 billion in revenues and exported over €8.5bn worth of products and services at the end of 2000. It was also estimated that by the same time the industry consisted of more than 900 companies, 130 of them foreign, employing 30,000 people with employment in the industry growing at an average annual rate of 20%.

The commonalities in these three countries are that their software sectors have evolved over the same time period, have experienced similar high growth trends, and have contributed enormously to their economies. All the three countries have relied heavily on the endowment of a highly skilled technology workforce and a supportive higher education system. Along with these commonalities, there also exist striking differences among these three cases. India built its reputation through providing quality, custom-made software for clients mostly in the US and Europe. Ireland on the other hand, engaged in developing and selling software products and packages while not directly

competing with the big software products companies like Microsoft and Oracle. The Israeli software companies have also relied heavily on software products catering to mainly scientific, aviation, defense and telecommunications sectors within and outside Israel, but constrained by a small domestic market, the Israeli industry focused on software product exports without laying much focus on localizing products and packages. Ireland has served the local market of the European Union by becoming a 'gateway' to the local market for the global software giants. Another important distinction among these three competitors that is relevant to this study is that relating to the labor productivity. The following table shows the marked difference in productivity in these three countries.

Table 3: Software Sector Productivity in Israel, Ireland and India

Year	Software Sector Productivity - Revenue per Employee in USD		
	Israel	Ireland	India
1997	$178,000	$315,000	$27,000
1998	$204,000	$306,000	$26,000
1999	$227,000	$306,000	$29,000
2000	$255,000	$255,000	$29,000

Sources: Computed from data reported by the Israel Association of Software Houses, Ireland National Software Directorate, and NASSCOM India respectively

It is in this context of competition that I examine the interesting set of advantages for India's information technology industry. Below is a short list of those advantages that emerge from literature review and my field interviews.

Sources of Competitive Advantages for India's IT Industry

English-speaking educated workforce: The two factor endowments commonly claimed by researchers as necessary ingredients in India's success are the availability of a large English-speaking educated workforce and the time difference between India, the software service provider and the US and Europe, the service recipients (Heeks, 1996, Saxenian, 2000). India's English-speaking labor pool with a strong quantitative aptitude provided an early advantage in learning and reproducing programming languages that are written in English.

Time difference: At the same time the operational time difference between the clients and the service providers added a round-the-clock proposition to the business and reduced total cycle time. With the advancement of telecommunications infrastructure in India, the software developers in the US and Europe could send application specifications to India at the close of their business, the Indian programmers then started working on the same program on the other side of the world and delivered the code before the US developers could resume work the next day.

Emergence of outsourcing as a business model undoubtedly translated a business niche into an advantage for India. A survey conducted by Sobol and Apte in 1995, much before the year 2000 data migration, commonly known as the "Y2K bug" or the 'Millennium remedy' catalyzed global information system outsourcing, revealed that a significant proportion of the US companies had outsourced at least one of their information system function to a domestic provider. A relatively smaller percentage (16.7%) of the responding companies agreed that they had engaged global software outsourcing and two thirds of the respondents were considering global outsourcing as a valid option. The cost advantages of outsourcing appear to be the most commonly cited rationale behind outsourcing development and maintenance functions of information technologies (Powell, 1990).

Labor cost advantages appear to be the most convincing factor endowment that worked in favor of India's software companies. In spite of the development of many design tools and quality processes and standardization of software development in the recent past, software development still remains highly labor-intensive, relying much on the knowledge and skills of the developers. Some estimates suggest that labor costs accounted for over 70% of all software costs in the 90s (Lakha, 1994). It was natural then that corporate managers seeking cost reduction and efficiency after the 1991 economic recession favored engaging Indian programmers at significantly low rates. It has been documented in earlier studies that the an offshore Indian programmer cost only 1/3rd to

$1/5^{th}$ as much as a programmer in the US or the UK cost in the 1990s for comparable work (Arora et al, 2000).

Brain Circulation: India also benefited in great deals from immigrants of Indian origin who had pursued technological careers in developed economies. This reversal of brain drain of the 1970s and 1980s, also termed as brain circulation, not only helped in transfer of technology through movement of the skilled personnel or through the companies they helped start, has proved to be a unique factor in the development of the sector (Saxenian, 2000)

High quality strategy: Another critical success factor in the case of India's software industry is the industry's adherence to high-quality and software development standards. India's exports sector had suffered from the world perception of India as a manufacturer of poor quality, undifferentiated products (Lall, 1999). To overcome this perceptual barrier, the early mover software companies laid emphasis on quality certification of software products and processes to comply with global standards. Today, most Indians companies have got their software development processes qualified per ISO 9001 standards or per SEI Capability Maturity Models (CMM). In fact, over half of the CMM level 5 firms in the world are in India (Arora et al, 2000). By the end of 2002, there were 42 firms that had attained CMM 5 – the highest level in the software quality model, and 316 firms had attained some form of quality certification (NASSCOM, 2003).

The senior executives I interviewed unanimously agreed on the fact that high quality was a compelling advantage for their companies, although the degree of corporate investment in quality improvement techniques, training and education varied widely. Some small firm interviewees admitted that their motivation for getting certified comes from the necessity to signal their capabilities to potential clients rather than actually reengineering or improving the development methodology. Whatever be the underlying motivation, my observation is that quality certification has indeed broadened the share of India's software firms in the global market.

Abundant supply of knowledge workers: Low-cost, highly skilled software professionals are widely believed to be the key to India's success story. The Arora et al study, 2000 reported that factors that influenced most US managers decision in favor of Indian companies include the availability good programming and testing skills, the ability of Indian companies to quickly put together a cross-functional teams of engineers at short notice, and their ability to scale up teams and add members whenever needed. Although many managers downplayed the associated cost advantages while emphasizing availability of an abundant pool of developers, the extensive price competition among Indian software companies serving clients through similar operational models emphasizes the close interaction of abundance of labor and cost advantages. Indian companies increased their exports on an average of 40-50% per year in the 1990s, with the big firms growing nearly 100% per annum over some years. Employment in the sector grew proportionally, increasing almost ten-fold between 1995 and 2000. The fact that the firms' growth was volume driven supported by engagement of larger labor units without improvement in per unit productivity, it is reasonable to argue that the size and supply of labor pool played the most significant role in the growth of India's software industry.

While the discussion above compiles a list of comparative advantages for India's software industry, it is intriguing to note those factors that have not, at least thus far, provided any competitive advantage to India.

R&D and Product Development: The weakness in the sector's commitment to pursue fundamental research in information and communications technologies is particularly disappointing when compared with the sector's overall growth in the last two decades. For example, the Indian software industry's research and development spending was a meager 4% of their total spending in 2000-01 (NASSCOM). Apart from the arguments of lack of domestic market, weak intellectual property rights and lack of intervention from the government, another interesting reason appears to have been crucial in leading R&D commitment within the IT sector to low levels. That critical factor is the risk aversion of the software firms in pursuing domestic product related research. Some of the interviewees provided interesting insights in this regard: export dependence of early

movers straightened a lot of bureaucratic tangles as regards exports, export projects earned higher returns than domestic projects and products, high growth standards set by the bigger firms restricted smaller firms to invest in slow-growth, high risk ventures. The end result of lack of R&D portfolio is that the Indian software industry has shown abysmally low labor productivity (refer to table) in the most knowledge intensive industry.

Domain knowledge, project management and communications skills: Most of the Indian software companies, especially the medium-sized and big firms, are generalists in the sense that they cater to multiple vertical markets. The Arora et al survey of US managers study revealed that a majority of US managers thought that Indian software professionals had poor domain knowledge in the client's business and had difficulty relating to the business requirements. In the case of understanding business and technology trends specific to any particular industry such as the financial, banking, insurance or telecommunications sectors, Indian firms were lacking in business expertise. They also believed that owing to poor project management skills in these technology professionals, the US managers had to assign more people to a task than they would otherwise do. Many were critical of the Indian system of promoting software programmers to managers basef on seniority rather than on proven managerial ability (Arora et al, 2000).

From the above discussion it is clear that most of the success in this industry may be attributed to human resource factors than to innovation capability, national diffusion of technology, physical infrastructure or other factor endowments. Almost all the critical success ingredients, with the exception of the advantages of English speaking abilities and the time difference aspects, highlight the importance of the availability of trained software professionals who could deliver information systems design and programming needs. Any analysis of future opportunities and threats relating to India's software sector, therefore, must emphasize the opportunities and threats facing the supply and demand of information technology workers.

V. THREATS TO INDIA'S COMPETITIVE ADVANTAGES

In this section, I shall discuss the threats, present and emerging, to the factors that have given India an enormous lead among its peer software developing countries. I shall draw on existing literature to include different perspectives on the threats to competitive advantages and India's needs to develop resilience against those.

There is unanimity among researchers that in the emerging global economy, the sustainable competitive advantage of nations will reside not in the availability of cheap labor force, but in their ability to harness their countries intellectual assets (Bajpai and Radjou, 1999). Evidence from the Indian software industry however, does not show enough indication of any movement toward building those assets.

The Dilemma on Building Innovation Capabilities

Researchers argue that even today, India's software industry is heavily dependent upon routine, relatively simple programming, low-level design and maintenance of existing software rather than creating new code. Basing their research on surveys of Indian software firms and US- based firms that outsourced software development to India, Arora et al. note that although the situation has improved in a number of ways since 1998, bulk of outsourcing still pertains to system maintenance and enhancement. Recently, in order to step up the value chain, Indian firms have begun to take distinct strategies such as the acquisition of domain knowledge, adoption of high quality standards and development methodologies. However research and development as a value adding strategy has only appeared to a limited extent. The Indian suppliers are competent (by and large) at providing a limited range of services but have not moved to where the suppliers offer solutions to client problems (Arora et al, 2000).

My interviews in 2001-02 did not reveal any change in this position. While new start-ups have been initiated most recently to engage in product development and MNCs have increased their R&D service outsourcing to India, the majority of Indian firms engaged in software services, especially the big firms contributing most to software exports, have not

changed their strategy to any visible extent. While many senior executives felt that there is a lot of business opportunities in software services that remain to be tapped globally, one senior manager heading the research and development wing of Infosys Technologies, India's second largest software exporter, raised issue on the definition of R&D and innovation. According to him, for most Indian companies, going beyond software development to advise the customer select various system components, charting out a map for technology investment and returns, and enhancement of the software development and delivery process itself constituted innovation and that there was no need for every company to develop products. While this view may be acceptable in the strict definition of the scope of work currently covered by most companies, it can be challenged from two angles:

First, even if we agree that innovating toward adding more value to the customer's software and system requirements and deployment, there hasn't been much corporate-level emphasis by many companies on this. For example, while Indian firms have done very well in qualifying their software development process to be certified for top SEI CMM levels, these companies have mostly remained strict followers or consumers of such certification issuers as SEI specifically to win credibility from US clients. Even the CMM level-5 companies have had no effort to go beyond these certification models or innovate a new or improved delivery model by themselves. Second, the rate and ease with which software firms in India have pursued and qualified for these CMM level protocols irrespective of size of firm, it appears that any new entrant to the software service market from any other developing country may be able to replicate the standards and reach where Indian firms are at this point of time.

The relative sluggishness on the part of Indian software outsourcers to develop high-end capabilities leads to the question if this inertia is due to the usual delay in the sequential development cycle that technology commonly passes through. Or could it be a characteristic offshoot of the outsourced software model itself?

According to the opinion commonly held by economists, technological development, especially in the early-developing countries, concentrates on importing existing technologies and slowly progresses toward attracting inward investment through multinational companies. At a later stage of development, those countries engage in improving existing technologies and ultimately in innovation activities that lead to new products and technologies (Castelles and Hall, 1994). This development cycle may be mapped on to Indian software industry to establish a value chain that start with low level data entry and coding activities and passes through offshore development and customized solution provision to culminate in indigenous technology and product development activities. However, empirical evidence does not support this natural progression of the value chain in the Indian software industry when compared with other rival countries such as Israel and Ireland. While Israel and Ireland shifted their strategies to innovation and product development and thus realized very high labor productivity, India's software industry has been slow and less responsive to acquiring the innovation model. It does not mean that India does not have any software product to boast, but the aggregate trends indicate that Indian firms have remained much more focused on volume-driven growth rather than value-adding propositions.

The answer to why India pursued the volume growth model may remain in some characteristics of the outsourcing model of software development. Research reveals that the multinational corporations encouraging outsourcing, typically, process the value-added services at home and outsource those with high labor content to low cost international service providers (Bajpai and Radjou, 1999). Thus Indian firms engage in small-scale projects involving maintenance, porting and application enhancement. Therefore, the export orientation of Indian software firms offers limited potential for developing human capital (Heeks, 1996).

Issues that expand or obstruct an industry's innovation based development are unique in their own ways. How India plays out its product development options and what portion of resources is allocated to product R&D in future remains to be seen. However in this paper, I focus on the threats that emerge against Indian software industry's most

prominent competitive advantage – its knowledge workforce. First, I consider the cost advantages related to India's IT labor-pool. The second, and most important consideration in the remaining part of this paper is the set of supply and demand dynamics that concern the knowledge workers.

The diminishing labor cost advantage

India has played the cost differentiation game and its advantage of a large English speaking labor force for long to gain its current competitive position in the outsourced application software arena. But those advantages appear to be waning in the face of competition from a growing number of developing countries such as China, Philippines and South Africa. Two of the frequently cited reasons for the weakening sustainability of the present outsourcing model are the rising wage costs for Indian software developers (Arora et al, 2000) and the acquisition of the critical intellectual assets by the rival developing countries that present similar labor cost structures (Saxenian, 2000).

Competition is stiff among Indian software firms to attract and retain quality software talent. This is reflected in the average 20% increase per annum in wages that occurred in the 1990s in this sector (Arora et al, 2000). Currently, a software programmer in India may be earning only a fraction of the salary of his or her international counter part yet, it is about 20 times the national average (Arora and Athreye, 2002). Suffering from high vulnerability to employee attrition, software companies have not only steadily increased salaries, they have introduced other creative compensation mechanisms including employee stock option plans, bonuses, and other employee privileges. When these benefits are factored in, the over all cost per employee no longer remains the 1/3rd level, but moves up to over half of the per employee cost in the developed markets.

The current industry demand and supply dynamics

The demand drivers – *IT Services*: Despite the global economic down turn of the last two years, the demand for Indian information technology workers has grown, boosted by some positive trends in the domestic market as well as in the exports sector. On the domestic front, IDC predicts that India will emerge as the fastest growing domestic

market, providing growth opportunities to companies servicing this market. In 1999-2000 alone the domestic IT industry was expected to grow 23% (IDC, 1999). Technology upgrades within the private sector and privatization of the public sector companies have induced technology demand locally in the last couple of years. This trend is expected to continue in the future. Another significant catalyst that is expected to stir up the local market is the government sector. The need to improve governance has led the central and state governments to initiate e-governance programs, encourage ecommerce and promote development of vernacular software applications to engage communities. The growing IT training and education industry is expected to absorb a larger share of the information workforce as the education service providers such as NIIT and APTECH expand their operations locally and abroad.

In the exports sector, the opportunity to reduce cost of operation in a recessionary economy is increasingly leading the global companies to either expand strategic outsourcing or offshore system development and maintenance activities to the offshore development centers in India. Large global systems integration majors such as IBM Global services and Accenture are expanding their presence in India to take advantage of the country's cost and manpower strengths. These developments have presented significant opportunity for Indian companies in existing services lines such as application outsourcing and custom application development where the country has a 14-16 percent market share (NASSCOM, 2003). Non traditional service lines such as packaged software installation and support, IS/R&D outsourcing, etc. are now been sent to India. Companies such as Patni, Wipro, Satyam, among others are getting into some of these hitherto unexplored segments (NASSCOM, 2003). A recent McKinsey/ NASSCOM study predicts that with the current of absorption in the IT industry, the growth of software and hardware segments, the sector's employment will go up to 1.1 million by 2008.

Emergence of ITES: International Data Corporation (IDC) has predicted that the IT-enabled services market globally will account for revenues of US$ 1.2 trillion by 2006.

With growth projected at 11 percent annually, the ITES/BPO segment will be one of the most significant business opportunities for the Indian software and services industry.

Table 4: Growth of IT Enabled Services Sector

Year	Increasing Contribution of the IT Enabled Services Sector to Total Exports	
	IT Enabled Services	IT Service
1999-2000	14%	86%
2000-2001	14.50%	85.50%
2001-2002	19%	81%
2002-2003	24%	76%

Source: NASSCOM, 2003

While the growth of an associated sector is welcome news for India's over all economic development, the emerging sector stands to cannibalize potential growth opportunities for the IT services sector. NASSCOM predicts that the employment in ITES sector itself may grow to 1.1 million if current trends hold. Given that most of the ITES ventures source quality staff for technical and managerial positions from the same labor pool as the software services sector, this may further pressure the IT sector. One of the executives we interviewed cited an example of a senior colleague of hers who left the firm in 2002 to start an ITES venture. Along with him, he took five key employees who were experienced in project management as well as software design and coding.

Table 5: ITES Sector Employment

IT Enabled Services	Sector Employment	
	1998	2008 (projections)
Back office operations/ Revenue accounting	9,700	260,000
Remote maintenance and support	1,600	180,000
Medical transcription/ insurance claim	3,800	160,000
Call centers	1,400	100,000
Database services	1,000	100,000
Content development	5,500	300,000
Total	23,000	1,100,000

Sources: NASSCOM, The Software Industry in India: A Strategic Review, 1999

Emergence of the Engineering R&D Services: This newly emerging sector is increasingly boosting the R&D extension services by India's leading manufacturing companies. Leading Indian engineering firms like Larsen & Toubro and the Indian subsidiaries top global manufacturers (example GE), appliance makers (example Samsung) and automobile companies (example Toyota) are beginning to receive major shares of design work from abroad. Although precise quantitative estimates of future employment have not been made in this area, it is expected to put substantial strain on the IT labor pool as the manufacturing firms tap into India's engineering graduates.

Emergence of the Equity and Financial Research Services: A survey 100 major American banks, brokerage firms and insurance companies released by the management consulting firm A.T. Kearney earlier this year indicates that the US financial sector including the top performers like the Citigroup, JP Morgan Chase and the Goldman Sachs group will outsource 500,000 jobs over the next five years. India ranked as the best overall destination for business processing in this survey. The jobs outsourced will cover very high-end functions including financial research, regulatory reporting and equity research for which the outsourcers will tap into the Indian MBA pool. A.T. Kearny itself has begun outsourcing much of its research tasks to its Indian office.

Outward Migration: Opportunities appearing in other countries for India's technology workers should not be ignored in the face of the recent slump in technology spending. India has earlier experienced tremendous pressure from the immigrant IT workers fleeing to the US for better compensation and quality of life. Countries like Germany, Ireland, the UK and Singapore have extended invitation to India's technology workers. Similar opportunities appear from developing countries like China, Malaysia and Philippines that are trying to replicate India's success in IT outsourcing. The slump in the global high tech sector is expected to end soon and IDC forecasts that IT spending in the US will come back to, if not exceed, the FY 2000 level by 2006.

The supply factors: As the demand side dynamics continue to exert pressure on India's IT workforce, the supply side factors present an equally important set of constraints that should be carefully considered.

Formal Education Sector: The most important source of India's IT workforce is the formal education system. A survey conducted by Arora et al in 2000 reported that 80% of the software professionals employed in the industry had engineering degrees while 12% had diplomas (equivalent to post-secondary technical associate degrees in the US).

The All India Council for Technical Education governs the approval curriculum and capacity of technical degree granting institutions in India. The number of AICTE approved technical colleges grew at an average annual growth rate of 9% in the 1990s and student enrollment grew at an average rate of 11.5 % per annum. In recent years more than 160,000 engineers and 1.54 million non-engineering students graduated from Indian institutions. NASSCOM estimates that nearly 55,000 engineers and 20,000 non-engineering graduates join the IT labor pool each year. These numbers may seem like a lot given the fact that the 2002 employment in the sector was 650,000. However, the intense competition in wage increases and high attrition rates indicate that demand for IT professionals is higher than supply (Fernandes and Arora, 2000)

Non-formal Education Sector: India has a reasonably strong private training and education sector that trains students in software development specific courses. NASSCOM sources estimated that there were 3,800 such training firms in 1998,although NIIT and Aptech, the two largest training firms, had approximately 70% of the software training market. While many of the courses offered by these training firms are short programming language training for developers, some of them also have graduate programs (GNIIT from NIIT), and certification programs (example Microsoft Certified Systems Engineers or IBM net commerce by Asset International).

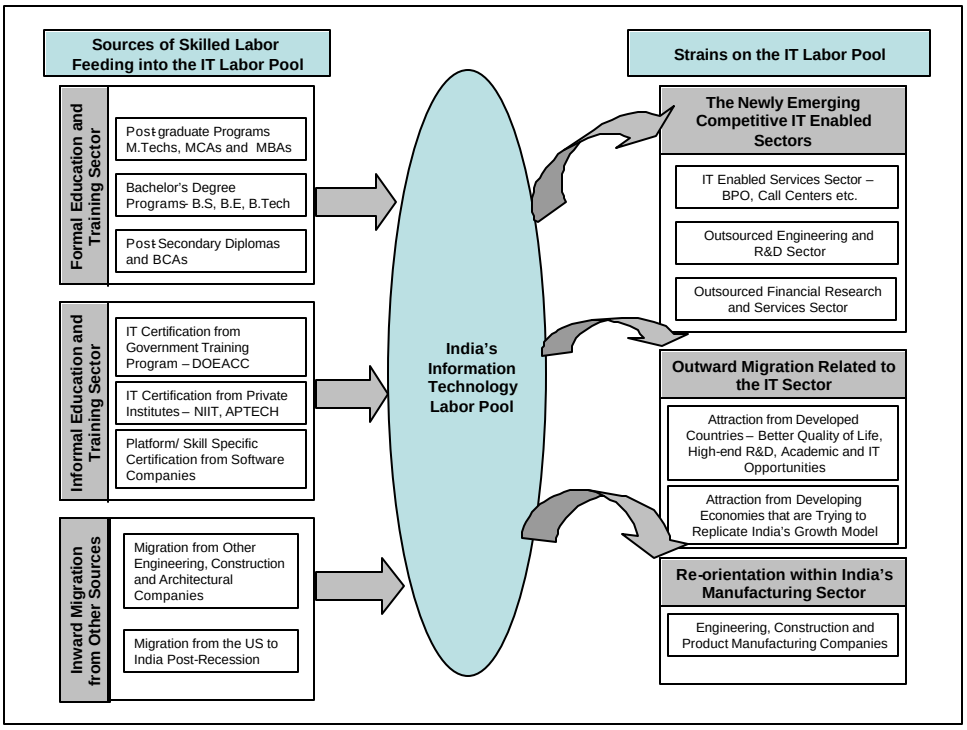
Many training institutes are accredited by the Department of Electronics through the Department of Electronics Accreditation of Computer Courses (DOEACC) to establish

credibility in the training market. Large software vendors like Oracle, IBM have also set-up their own training arms to share in the growing IT training market.

Migration from other sectors and the US: The IT sector has also lured many engineers from unrelated disciplines and unrelated industries like manufacturing and construction. Since many firms specifically targeted the already employed engineers in non-IT firms to quickly expand their workforce with people having corporate experience, these majors are having serious implications for other sectors. A recent report from the AICTE highlighted the acute shortage in engineering disciplines caused by an exodus of students from various engineering disciplines outside Computer Engineering, Electrical Engineering and Electronics Engineering that are closely associated with the IT sector.

The recent economic down turn led many large software firms to drastically cut their labor pool. Indian programmers serving in the US on H1 visa suffered in most part. The labor mobility restriction in the US has not helped in retention of the knowledge professionals during this turmoil. Many professionals were forced to return to India, and this trend has to some extent worked in favor for the sector. There have been many cases where restriction on the issuance of US green card has forced Indian IT professionals to leave their jobs and return home.

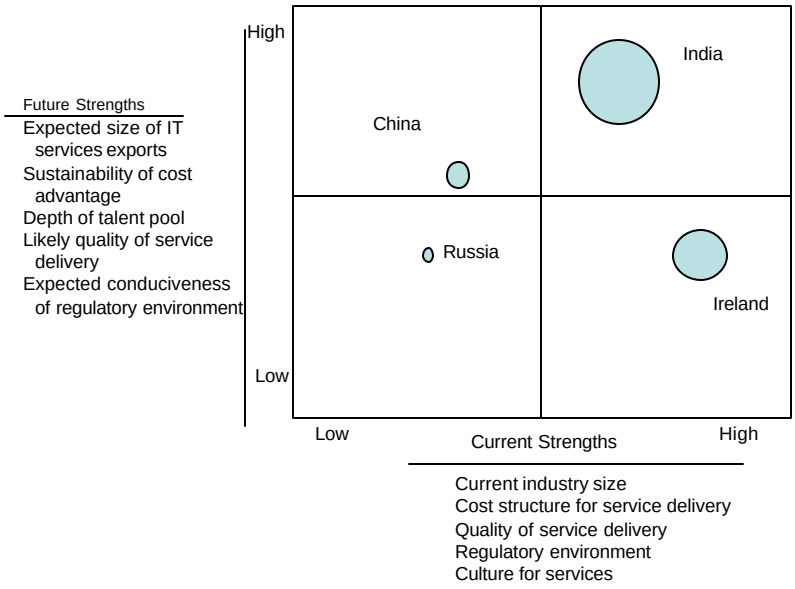
Chart 3: The IT Workforce Inflow – Outflow Schematic



Emergence of China, Philippines and Russia

Emergence of China, Philippines, Russia, Brazil, and South Africa among others as developing market alternative to India's IT workforce has endangered India's pre-eminence in this area. China has maintained its lead over India in the manufacturing sector for decades. And now China has emerged a potential threat to India's dominance in the IT services sector. A McKinsey study examined China's advantages in detail and concluded that the country has all the resources and capabilities to develop its IT services and IT enabled services sector rapidly. The country not only has the scientific workforce but also has been very aggressive in pursuing training programs specifically targeting their English deficiency. The Chinese premier has also been seeking India's help in technology transfer and business cooperation in this regard. Some researchers argue that the benefit for Indian firms to tap into the huge Chinese market can only come at the cost of developing the intellectual asset of China by Indian companies.

Chart 4: Emergence of China as a Competitive Threat



Country Competitiveness Assessment
Source: McKinsey/ NASSCOM, 2003

VI. THE HUMAN RESOURCE CHALLENGE

The supply and demand dynamics emerging within the sector and the threats coming from rival developing economies compel a deeper understanding of the challenges facing the IT workforce. The human resource projections estimated by the Ministry of Information Technology has taken into account the emergence of the IT enabled services, however, the other newly emerging opportunities delineated in the earlier section of this study have not received any mention in the strategic reviews conducted thus far by the government or NASSCOM. From that point of view, both NASSCOM and government estimates may need to be revised upwards. The purpose of this section is not to get into the details of specific estimates, but to find out gaps in assumptions, perceptions and remedial actions taken to develop the country's competitive advantage. In this section, I shall discuss some of those challenges perceived by the industry sector and the government interventions to remedy those concerns.

Industry Perception and Policy Response

Preference for engineering: The Arora and Fernandes studies reported that the software industry had a preference for engineers as compared to undergraduate or graduate degree holders in non-engineering fields, with the exception of BCA and MCA candidates who concentrate on computer application and software development specific courses. However, their studies did not find any striking difference in the skill sets acquired by these two categories and how these skills were deployed at the workplace (Fernandes and Arora, 2000). This perception seems to have been shaped by a belief that engineering requires a higher degree of reasoning and quantitative aptitude. It may also have arisen from the fact that engineering students undergo standard screening tests and therefore represent a brighter pool of candidates.

My interviews validated this preference – all interviewees, irrespective of size of the firm, admitted that at least two thirds of their production teams were engineers. However,

when asked how differently these two categories of qualifications contributed to performance in programming, software design or development, the industry participants could not provide any reliable measure. One respondent even said, 'we do not do rocket science here, yet I do not want to fall behind in the talent hunt'. Given the fact that much of the software services refer to routine maintenance or enhancement kind of tasks, this inherent preference in the recruitment process without proven correlation between the nature of work and qualifications seems to have exacerbated the demand and supply equation. Yet, there has been hardly any policy action to tackle this issue at the central or the regional level.

Growing strains on the IT labor pool: It is interesting to note that the same reasons that led to the development of the software services sector, are creating opportunities for allied or other unrelated industries in India. The only difference being that in the case of the newly developing opportunities, the industry is drawing precedence and lessons from the IT services sector and therefore, growing faster than the IT services. Strains are beginning to develop both on the high-end labor categories and the lower-end ones. On the high-end of the pipeline, the financial services sector is targeting the MBA market and the engineering and R&D services sector targeting the M.Techs and IIT undergraduates whereas on the lower end of the pipeline, the IT enables services is tapping mostly the engineering graduates from universities other than IITs, non-engineering undergraduates and diploma holders.

The public policy response to this concern has culminated in the establishment of Indian Institutes of Information Technology, similar to the reputed IITs. The central and state governments have also invested heavily in engineering colleges to expand capacity. While these initiatives are welcome steps to strengthen the supply factors in the long run, they are not likely to have any significant impact in the short term. It should also be noted that the number of post-baccalaureate degrees granted have not grown up substantially, in fact the number of PhDs fell from 675 in 1987 to 375 in 1995. The growth prospects for young engineers in the IT industry seem to have caused this slide. The impact of this trend may be severe, not only because the current sourcing of PhDs in the research

intensive jobs have been stifled, but also because it may have severe impact on academia, and therefore on future preparation of the IT labor pool.

Inflexible curriculum in the formal education sector: The industry has for a long time raised issues with the obsolete curriculum in science and engineering that hinders the direct absorption of graduates into the software developer pool. Almost all big and medium sized companies have devised their own training programs that run for an average of three to four months where new recruits are trained in certain programming languages, database skills and coding standards. Interviewees representing the small firms mentioned that although limited resources at disposal restricts them to provide any structured training to the new recruits, they rely on the self learning abilities of the developers. And often to minimize risk of reduced productivity, the smaller firms look for candidates with 6 to 12 months experience. For example, The Education and Research division of Infosys Technologies trained more than 4,000 of their new recruits through a 3-months long structured training program in 2001 alone. The head of this division claimed, 'we are the largest IT university in Asia', pointing to the resources and expertise accumulated in designing and delivering such large scale in-house training programs.

The Ministry of Information technology is aware of these concerns and the Tenth Five Year Plan Study Team recommended identifying and implementing specific courses under consultation with industry representatives.

Unreliable teaching standards in the non-formal IT training sector: Most industry leaders I interviewed did not see much value in the non-formal education system's contribution to preparing software developers for immediate absorption. However there was some degree of agreement, especially within the small firms, that most of the non-formal training programs are better suited for skills enhancement by software developers already experienced by a few years in other related programming languages and platforms. Besides the quality of training, concerns have been voiced regarding the lack of uniformity in content and structure across training providers. A high level study team

focusing on the development of the non-formal sector recently advised the Government of India to consider creating a mechanism to standardize the course offerings.

Lack of coherence between constantly evolving industry needs and focus of training and education: Interviewees reiterated that the growing irrelevance of the degree and diploma courses and the government accredited certification system to the need of the export market is aggravating the demand and supply gap.

VII. CRAFTING A COMPREHENSIVE IT WORKFORCE STRATEGY

The strengths, weaknesses, opportunities and threats pertaining to India's software industry as discussed in the above sections present a set of complex challenges to the future development of India's IT workforce. It is imperative that if India were to sustain its technology-based economic growth, an opportunity that has come about after decades of waiting, political changes and economic liberalization, it has to identify and eliminate the obstacles to its competitive advantages immediately. Much of India's success in the software sector is attributed to the large pool of qualified IT workers and future opportunities that have emerged in the last few years indicate that growth in future will stay directly correlated to expansion of that labor pool.

This study finds that the public policy response to the human resource challenges so far has been timely, and well articulated. The Ministry of Information Technology within the Government of India is spearheading policy reform at the national level, at the same time technology savvy leadership in some states are supplementing central government efforts with state funds, resources and initiatives. While these policy actions are leading India to retain its competitive advantages through knowledge workforce in the long run, some gaps remain in these debates and strategies. The following recommendations may supplement the recently crafted plans to develop human resources in the information technology industry.

Greater interactions among industry and academia – both formal and non-formal sectors should not only be encouraged, but be institutionalized with great urgency. It is necessary to strengthen the industry feedback loop in the design of science and engineering degrees and diploma curricula. Similarly, the non-formal training programs should be standardized keeping the changing needs for specific skills, both technical and managerial, to aid in direct absorption of graduates from these programs into the productive workforce.

Faculty members in academia should be provided with an expanded set of incentives to encourage their participation in the high-end research and capability building as well as

low-end foundations of the IT workforce. These incentives may include intellectual property ownership, venture creation opportunities, and easy cross over between formal and non-formal sectors.

Leaders in corporate sector training and education should be brought together to share their experiences with the education sector. These leaders, well informed on market needs and expert on training delivery, can collaboratively build an efficient education delivery mechanism. The establishment of a single high-level steering committee to facilitate such collaboration at the national level may help remove inertia from the training and education sectors and induce creativity in curricular design and deployment schemes.

Immediate attention must be drawn to the undue preference for engineers in the recruitment process for IT services company. In view of the large-scale investments required to scale up intake capacity of the accredited engineering institutions, the engineer supply system may be termed as fairly inelastic. It is high time that policy intervention be initiated to direct the private sector recruitment drives toward the large pool of bright non-engineering graduates. This may be attained through a government directed campaign to address this issue at various industry forums, establishment of some sort of standardized scoring program or devising of some incentive structure for companies hiring non-engineering graduates for selected job categories.

These policy interventions, along with the long list already proposed to the Government of India may help reduce the strain on the supply factors relating to India's information technology industry.

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