India's Software Industry[1]

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Introduction

The objective of this study is to understand *how* the Indian software industry has been able to catch up—successfully access, learn, and develop—to the technological standards of global leaders while others in the developing world lag behind. The focus of this study is on explaining factors that contributed to the phenomenal growth of software exports from India, including the role of institutions and government policy.

The Indian software industry has been a remarkable success story. It has grown more than 30 percent annually for 20 years, with 2008 exports projected at close to $60 billion. India exports software services to more than 60 countries, with two-thirds to the United States, including half of all Fortune 500.

Economic policy has undergone substantial revision driven by this sector, and India began to open up. Foreign exchange reserves are high, markets greatly influence policy, and a string of coalition governments have not deviated from economic liberalization. Benefits are uneven, though, as the very poor have been little affected. High unemployment continues, and huge bureaucracies still yield to corruption. While problems remain, India is an emerging economy fueled by techno-savvy manpower and a world-class information technology (IT) industry.

Indian software firms quickly moved up the value chain, from performing low cost programming abroad to providing comprehensive software development services from India for overseas clients. An abundant pool of Indian technical manpower, due to early government investment in technical education, created a series of elite technical and management institutes that responded to a severe global shortage of technical manpower. English-speaking, trainable and hungry for higher wages, Indian firms sent staff to onsite client facilities in the United States.

Indian professionals in Silicon Valley built personal networks and valuable reputations and used their growing influence within US companies to help Indian companies get a foot in the door of the expanding opportunity of outsourced IT work. Once the potential of software exports was demonstrated, Indian Government helped build a high-speed data communication infrastructure, which allowed overseas Indians to return home and set up offshore sites for U.S. clients. The Indian "brand" image for affordable speed and quality grew.

Intense quality and productivity improvements built client value and today these Indian companies deliver a wider range of software development tasks, as well as benefits in new service segments such as product design and information science (IS) outsourcing. Many firms have met top certification requirements for quality standards in demand around the world. New frontiers in data protection practices are moving quickly to the top of the agenda.

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[1] Published in Bhatnagar, Subhash, 'India's Software Industry', Technology, Adaptation, and Exports: How Some Developing Countries Got It Right, Vandana Chandra (Ed.), World Bank, 2006, Pp. 95-124.

Some of the meaning of the earlier text has got changed/corrupted because of substantial shortening of the text. Please see the suggestions above for the intended meaning.

A remarkable success story

Even two decades ago, the image of India in the world was one of a country beset with poverty, unrestrained population growth, and substandard competitiveness. Today, due largely to the dramatic growth in the Indian software industry India is an emerging economy with techno-savvy manpower building an impressive IT industry edifice. Parts of India continue to be beset with problems of poor infrastructure and poverty but such an image has clearly receded into the background.

The industry has grown more than 30 percent annually throughout the last two decades. From about $50 million in exports in the late 1980s, the industry grew at around 30 percent a year to more than $200 million exported by 1993 (table 1). In the boom years of the mid- and late 1990s, software exports grew 50–60 percent annually, reaching $6 billion by 2001. Even during the infamous 'dot com' bust, software exports continued to grow by about 25 percent annually, which significantly outpaced growth in the software industry anywhere in the world. Today India's software industry is back to a healthy 33 percent growth rate with projections for 2008 exports close to $60 billion.

Table 1. Growth rate of Indian software exports

Year	Exports of software (US$ million)	Growth over previous year (percent)
1987–1988	52	NA—
1988–1989	67	29
1989–1990	100	49
1990–1991	128	28
1991–1992	164	28
1992–1993	225	37
1993–1994	330	47
1994–1995	450	36
1995–1996	734	63
1996–1997	1,100	49
1997–1998	1,759	60
1998–1999	2,600	48
1999–2000	3,400	31
2000–2001	5,300	56
2001–2002	6,200	17

2002–2003	7,100	15
2003–2004	9,200	30
2004–2005	12.200	33

— = [[what?]] The figure is not available as the estimates for export in 86-87 are not available.

Source: Compiled from Bhatnagar (1997), NASSCOM (2001, 2002, 2003, 2004, 2005)

In the last seven years, output has grown dramatically, from $1.86 billion in 1996–97 to $16.5 billion in 2004–05. The bulk of growth came in exports: By 2003–04, nearly 85 percent of sales was in the form of exported software services (table 2).

Table 2. Annual turnover of the Indian software industry

Year	Total in $ billion	Exports in $ billion	Domestic in $ billion
1996–97	1.86	1.10	0.76
1997–98	2.94	1.76	1.18
1998–99	4.01	2.60	1.41
1999–2000	5.3	3.4	1.9
2000–01	7.8	5.3	2.5
2001–02	8.7	6.2	2.5
2002–03	9.9	7.1	2.8
2003–04	12.8	9.2	3.6
2004–05E	16.5	12.2	4.3

Compiled from NASSCOM (2004, 2005). Figures may have some variations because of variation in the conversion rate of US$ from one fiscal year to another.

Software exports in the last few years have accounted for 15–20 percent of all exports from India. This share has grown from less than 2 percent in 1995 and is expected to grow to nearly 26 percent of all exports by 2008. This growth is particularly impressive in a period when growth in exports from other sectors such as jewelry, garments, and manufacturing has also been high (NASSCOM 2002, 2004).

The software industry's share of GDP has grown correspondingly. The IT share of overall GDP in 2004–05 is 4.1 percent, which is likely to grow to 7 percent by 2008 (with software and services alone accounting for 2 percentage points).

Software industry exports are primarily information and software services rather than products. While firms export to more than 60 countries, the United States represents nearly half the global market and is the primary destination[2]. The United States (69.4

[2] Table on Indian software exports by country, NASSCOM *Strategic Review*, 2004, p. 29. Also, according to NASSCOM, the number of $1 million plus customers in the IT exports segment increased from 331 in 2002-03 to 442 in 2003-04 (TNN, June 2004).

percent), United Kingdom (14.5 percent), Japan (3.0 percent), Germany (2.8 percent), and Singapore (1.8 percent) account for nearly 91.5 percent of India's software exports.

In 2005 India's share of the global market for outsourced IT services stands at 3.3 percent. It serves nearly half of all the Fortune 500 companies. India's market share has grown rapidly, and in terms of absolute share its position is second only to the United States.

The report begins by briefly characterizing the organization of the industry today. A historical overview of the software industry explains how India's software sector has evolved since the early 1970s. Important explanatory factors are discussed in the following sections, including the role of government investment in technical education, the role of the Indian Diaspora in promoting and facilitating early growth of the industry, the facilitating role of government policies, and the role of the industry association in promoting the Indian software "brand" abroad and in lobbying for favorable policies. Final sections discuss the impact of the industry on the Indian economy, sector strategies for moving up the value chain, and the role of R&D in the industry. A short discussion of the future concludes the paper.

Industry organization

The Indian software industry has a pyramidal structure, with a few large indigenous firms dominating the sector (table 3). Among the 3,000 firms exporting software from India, the three largest firms each have more than $1 billion in annual sales[3]. At the other extreme, the smallest 2,900 firms have annual sales of less than $10 million, with most less than $2 million. The largest five firms account for 32 percent of software exports, while the smallest firms own a 14 percent share.

Smaller firms play a more significant role in the domestic market where they supply software services to small and medium sized domestic firms in different sectors. For their export contracts, the smaller firms have primarily entered into a variety of linkages with individuals and small companies abroad for marketing access. There are few horizontal partnerships between small and large vendors. Some early efforts by established firms to subcontract to smaller ones failed because the smaller partner tried to make direct contact with overseas clients. In recent years a few small firms have developed products for the domestic market with some success but exports[3] have been very limited.

Table 3. Structure of Indian IT services and software exports industry (2002–2004)

	Number of companies		
Annual sales volume (US$ Million)	2001–02	2002–03	2003–04
> 210	5	7	9
105 – 210	5	5	8
52.5 – 105	15	15	24
21 – 52.5	27	41	53
10.5 – 21	55	71	56

[3] Infosys and Wipro fourth quarter results announced in April 2004. TCS crossed the $1 billion mark in 2003.

2.1 – 10.5	220	244	367
< 2.1*	2483	2644	2,653
Total	2,810	3,027	3,170

Compiled from NASSCOM (2005, p.74).

Multinational companies arrived in India relatively late and account for only about a quarter of exports. Multinational firms use their Indian operations primarily as export platforms. Increasingly multinationals are setting up shop in India to conduct sophisticated software development activities and as a captive source of R&D, utilizing India's pool of highly trained engineers.

Many Indian firms have been started by entrepreneurs who acquired some wealth and experience working in larger established firms and then set up new companies. Many of the corporate leaders did their graduate study in the United States and/or worked in Silicon Valley, so they have a keen understanding of the software development process. The high profitability and relatively low risk of the industry has attracted a large number of professionals. Also, entry costs are relatively low. To start software company does not require huge investments in land, plant, or machinery. Most of the assets can be acquired on lease without a high upfront investment. The lead time for generating revenues is also much shorter than in many other industries.

Industry growth

Beginnings in bodyshopping

The birth of the software industry in India began in 1970 with the entry of Tata Consulting Services (TCS) into the domain of outsourced application migration work. In the late 1960s, the Tatas (name of a large conglomerate of companies) [[several individuals named Tata?]] created TCS as a central service center for Tata Group companies. A few young MIT-trained Indian professionals were recruited, and a large computer system was imported. With IBM having been thrown out of India, the concept of outsourcing application development work had become a necessity for Indian companies. Utilizing its excess computer capacity, TCS began doing outsourced application work for organizations such as Central Bank of India and Bombay Telephones. Within a few years TCS began sending young Indian engineers to a joint venture partner in the United States, Burroughs, for training. The trainee engineers excelled at doing platform conversions, and TCS started earning conversion assignments for its engineers in Germany and elsewhere[4].

Later a new company named Tata-Burroughs was formed. Tata was keen to exploit the personnel placement or "bodyshopping" opportunities whereas Burroughs was interested in selling hardware to the Indian market. After a few successful years the partnership was broken at the behest of Unisys which had by then acquired Burroughs in the United States and the company was rechristened as Tata Information System Limited. A U.S.-trained Indian electrical engineer took over management of TCS in 1969. He used his influence in the Institute of Electrical and Electronics Engineers to further promote TCS and founded the Computer Society of India with fellow scientists and professionals from the Tata Institute of Fundamental Research. Many of these professionals later moved to government and became very influential policymakers. These early networks played a very

[4] Information for the above section was obtained in a conversation with Dr. Nitin Patel, CEO Cytel Corporation, Boston. He was one of the first few employees hired by TCS.

useful role in overcoming severe administrative and procedural constraints in India's otherwise closed economy during the 1970s and 1980s. Following the success of TCS, many other companies were set up in India.

Beginning in the 1970s, a growing shortage of engineers for the expanding computer industry in the United States and Europe, an oversupply of Indian engineers relative to domestic demand, and a growing international reputation for the skills of Indian engineers, provided an opportunity for *bodyshopping* in which Indian firms such as TCS sent Indian engineers overseas to do software programming onsite, mostly in American firms for limited, billable projects.

During the first phase (1968–84) of exports, four types of companies interlinked in direct and indirect ways to facilitate bodyshopping (Xiang Biao 2002). 1) There were established companies in India such as TCS and Infosys Technologies which supplied programmers to large multinationals in IT and non-IT sectors primarily in the United States. These multinationals also recruited programmers through local U.S. companies such as Mastech (now iGate) and Information Management Resource established by Indians living in the United States. Such companies in turn recruited manpower through local search agents (small companies run by Indians in the United States). These agents, from several states in the United States, would contact local agents in India from a multitude of small companies and operators. The responsibility of collecting resumes, forwarding them to U.S. placement agents, preparing visa and contract finalization with the programmers was done by the agents in India. The programmers were paid low wages. Commissions were charged by different members of the supply chain. Sometimes there were subagents spread in different towns and cities in India. There was an interesting network among revolving players. Programmers who returned to India after a stint overseas would join the pool of software engineers who could be hired by the established companies in India. Often, programmers sent onsite by large Indian companies would move laterally to another assignment in the United States through a local U.S. agent to prolong their U.S. experience. Later they would return to India and be in the market for local Indian agents to hire them. The Indian Diaspora had played a key role in the bodyshopping exports. Arora *and others* (2001) also report several instances where Indian immigrants in the United States helped U.S. buyers to locate Indian suppliers. Field interviews with U.S. customers reported that the impetus for outsourcing to India came from employees of Indian origin.

The development of bodyshopping links between firms in the United States and India was due mainly to the large Indian Diaspora in the United States, many of whom worked as professionals in the American IT industry. They promoted and facilitated connections between U.S. firms and firms or agents in India who could supply programmers for onsite work in the United States. The successful growth of bodyshopping was due to the skills of Indian entrepreneurs and the steady supply of low cost and trainable Indian engineers. Bodyshopping was and continues to be an attractive strategy for new entrants into the industry, requiring nothing more than knowledge and established relations with a few potential clients.

The severe shortages in skilled technical labor for the growing IT industry in the West and the liberal immigration policies of the United States fueled the emergence of bodyshopping. For example, in the 1990s annual growth of IT expenditures on equipment in the United States was 24 percent and in Germany and Britain just under 20 percent. At the end of the 1990s the shortage of programmers, systems analysts, and computer engineers was estimated at about 346,000 in the United States and 30,000 in Canada.

The era of outsourcing

While initial development of India's software industry was based primarily on bodyshopping work onsite at U.S. firms, in recent years the trend has been increasingly for Indian firms to conduct software development for U.S. clients "offshore" in India. This shift was the result of a maturing of India's software industry and its international reputation in the last 15 years, and the development of necessary infrastructure and communications technologies in India that has made offshore work possible.

As the Indian software industry matured, increasing client confidence in Indian capabilities and quality standards enabled Indian firms to move their work offshore. With maturity has come a goal to move up the value chain. Many new companies were set up in the 1980s by entrepreneurs with ambitions of creating world-class software development centers. Firms which had started primarily as subcontractors for technical manpower gradually shifted to managing complete parts or phases of projects, and then to delivering complete solutions from India. During this phase, most companies made significant efforts to assimilate good practices in project management and quality and to acquire internationally recognized quality standards certification. NASSCOM played an aggressive role in promoting the India brand abroad. In some ways, during this period, India was building a launching pad for the eventual take off of its software service industry.

In this period the Indian government played a facilitating role in advancing the industry and enabling offshore work in India. Recognizing the growth potential of the software industry, the government in the 1980s took key policy actions to open up the sector. Further policy reforms enacted since the late 1990s have facilitated development of telecommunications and other infrastructure required for offshore work. A policy change in 1998 that effectively ended a monopoly on internet service provider (ISP) gateways, allowed India's private sector to offer needed bandwidth to the growing industry. Two years ahead of the World Trade Organization (WTO) commitment, India liberalized international long distance in 2002. In 1990 the government created software technology parks (STPs) in 39 locations across India to provide software companies with access to high speed data communications and single-window clearance for regulatory compliance. While few of the larger firms have made use of the STP's, they have provided opportunities for new firms to launch, and smaller firms to grow, with little investment.

Table 4 shows the shift in the last 15 years from client sites overseas to "offshore" business in India. The revenue from services provided in India increased from only 10 percent in 1988, to 33 percent in 1995, to more than 60 percent by 2003–04.

Table 4. Comparison of Indian software export revenue by delivery location (percent)

Type	1988	1995	1998–99	1999–00	2000–01	2001–02	2002–03	2003–04	2004–05
Delivered at overseas client site	90	66	54.4	57.4	56.0	45.2	43	36	29
Delivered in India	10	33	44.4	43.6	44.0	55	57.3	64	71

Compiled from Kumar (2001: 4,280) [[page 4,280 YES?]] and NASSCOM (2005: 58)

The Indian software industry is now in its third phase – that of take off. Today, most leading companies are operating in the high-end software services business and are also making efforts to enter the products segment. A new breed of companies, led by second generation software entrepreneurs, are setting up product-oriented companies. The industry has weathered ups and downs in the global market, maintaining a high rate of growth. The industry moved center stage in the domestic media because of its visibility in the United States, high market capitalization and wealth creation for its employees. It is a source of national pride, and as a consequence continues to attract disproportionate government attention. The government set ambitious software export targets and has provided the policies to enable the industry to achieve those targets. Software companies are increasingly being recognized for their leadership in adopting best practices in management by the media. Indian companies have fine-tuned the "offshore model" and project their brands as service companies. Companies have moved further up the value chain, improving productivity, targeting new geographies, vertical domains and businesses.

Investment in technical education

India's public investments in technical education beginning in the 1960s provided the foundation for growth of the IT industry. Lack of adequate opportunities for Indian engineers in the domestic economy has ensured an abundant supply of high quality and cost effective workers for India's export software industry.

In the 1960s the government created a series of elite institutes for higher education in engineering and management, in collaboration with leading universities in the United States. Five Indian institutes of technology (IIT) and two Indian institutes of management (IIM) were set up in the 1960s. The IITs were set up through technical collaboration with the most industrialized countries of the time. At current prices, the cost of setting up an IIT was perhaps 10 billion Indian rupees (US$200 million). The IIMs were set up with active collaboration from two leading business schools in the United States. The cost of setting up an IIM at current prices would be approximately 1.5 billion rupees (US$30 million). The annual cost of undergraduate education at IIT Delhi is 150,000 rupees per student (US$3,000 excluding the capital investment and depreciation)[5] and that of graduate education at IIMA is 280,000 rupees (US$5600) per student[6]. Both types of institutions attracted a large number of U.S. trained Indian faculty. Subsequently, most state governments set up regional engineering colleges (REC) that attracted students from all parts of the country.

Professional education in India attracts large numbers of applicants. Most of the IIT, REC and IIM admissions programs are able to choose one out of 100 or more applicants. This selectivity and reasonably good training produced the high caliber engineers that formed the backbone of the software industry in its early years. A unique feature of these high-caliber engineers was their willingness to work as programmers, partly due to the shortage of lucrative jobs in a closed economy. IIT engineers who moved to the United States and those who worked for companies in India in the 1970s and 80s built a reputation that helped Indian companies procure software development contracts in the initial years.

Subsequent expansion of technical and management education in India helped fuel the numbers needed for the high growth. India has a large higher education system with about 253 universities and nearly 13,000 colleges producing 2.5 million graduates every year. Nearly 300,000 engineering degree and other graduates enter the workforce every year (table 5). Since engineers from any specialty are willing to work in the software industry, so far supply has kept pace with the demand. Many initiatives by the human resource development (HRD) ministry (discussed later) helped to multiply technical institutions and technically qualified graduates.

Table 5. Indian information technology sector: labor supply (000's)

Number	2002–03	2003–04	2004–05	2005–06	2006–07
Engineering graduates	259	215	284	348	382
Degree (4-year)	129	112	155	210	235
Diploma (3-year)	130	103	129	138	147
IT (computer science, electronics, telecom) professionals	126	141	165	181	193

[5] Jain B. N., Indian Institute of Technology, Delhi. Presentation available online at: www.iitd.ac.in/cgi-bin/nph-p/http/10.116.2.57/alumni/alumni.ppt

[6] Sustaining Academic Excellence, Position Paper by IIMA Faculty, April 2, 2004. Presentation available online at: http://www.iimahd.ernet.in/download/Presentation.ppt

Engineering IT graduates (degree)	81	95	100	111	117
Engineering IT graduates (diploma)	45	46	65	70	76
IT professionals entering workforce	72	80	94	103	109
Engineering IT graduates (degree)	47	55	58	64	68
Engineering IT graduates (diploma)	25	25	36	39	41
Non-IT engineers entering IT workforce	40	40	40	40	40
Graduates in other disciplines entering IT workforce	35	30	30	30	30
Total fresh IT labor supply	147	150	164	173	180

Source: NASSCOM (2005: 158)

Recently, privatization of technical education produced an ever-increasing technical labor supply to meet demand (table 6). By the end of the last decade, there were an estimated 660 engineering colleges in the country.

Table 6. The India IT and IT enabled services (ITES) sectors: professionals employed (000's)

Number	1999–2000	2000–2001	2001–2002	2002–2003	2003–2004	2004–05E
Software exports sector	110	162	170	205	270	345
Software domestic sector	17	20	22	25	28	30
Software – captive in user organizations	115	178	224	260	290	322
ITES – BPO	42	70	106	180	253	348
Total	284	430	522	670	841	1,045

Source: NASSCOM (2005: 156). BPO stands for business processing outsourcing.

Given the estimated demand, manpower will not be a bottleneck. Manpower projections for the software sector in 2008, when India expects to export $60 billion worth of software, also indicate sufficient labor supply. Estimates indicate that there would also be newer activities, such as products and technology services, which would employ 140,000 professionals.

Much of this manpower supply is due to the privatization of technical education. In 1999, output from private institutions outstripped the state output (table 7). Even though the number of engineers has increased , quality has not deteriorated significantly. In 1969, the IITs produced around 1,350 engineers[7].

The private cost to start an engineering college that produces 500 students per year is currently about 500 million Indian rupees. The private institutions receive no government funding.

Table 7. Number and capacity of engineering colleges in India 1998–99

Region	Number of colleges	Sanctioned students*	Capacity in self-financed colleges as a proportion of total capacity
Central	50	9,470	0.52
East	25	4,812	0.26
North	140	25,449	0.42
West	140	34,165	0.74
South	308	82,597	0.79
Total	663	156,493	0.69

* Maximum number of students.

Source: Arora and others (2001)

One reason for the concentration of software companies in the south is the proximity of the locations to a very large number of engineering colleges.

The HRD Ministry played a facilitating role in ensuring adequate supply and quality of the technical labor force. Ministry policies encouraged creation of private engineering colleges and industry IT training institutions. With the proliferation of new private colleges and IT training institutions, the HRD Ministry developed mechanisms to assure quality control, including the establishment of an All India Council for Technical Education to regulate technical education, and an accreditation system run by professional societies such as the Computer Society of India to monitor private training institutions.

Additionally, the introduction of a master of computer applications (MCA) degree in many universities in the late 1980s was aimed at producing graduates with the combination of technical and management skills required for the expanding IT industry. While the pool of MCA graduates became a primary source of recruitment, the programs tended to be stronger in technical rather than management skills. Recognizing that raw technical recruits are generally unprepared to work immediately as software engineers, most large companies rely on extensive training divisions.

Since engineers were willing to work as programmers in a domestic environment with few job opportunities, growth was also driven by larger salaries in the IT industry abroad.

[7] Compiled from Out-turn of Undergraduates from all IITs. Available online at:http://shikshanic.nic.in/cd50years/f/G/J/0G0J0D01.htm

Tackling the manpower issue: firm-level efforts

Human resource development is critical in software companies where 95 percent have formal training divisions and learning needs analysis programs. Minimum training per employee is 40 hours. This covers both technical and behavioral training and the proportions vary between managerial and technical positions.

A 2003 survey by Hewitt Associates and NASSCOM provides insights into recruitment and training practices (NASSCOM 2004: 189–191). A large proportion of companies spend about seven percent of total employee costs on recruitment. Nearly 26 percent of the total manpower requirement is met through campus recruitment of fresh graduates. In fact, nearly 44 percent of such companies source campus recruits from engineering institutions only. Nearly 17 percent of the companies also recruit from management campuses. Most companies run large lateral hire programs which are based on written aptitude and technical tests followed by interviews.

Statistics reveal that among innovations in the software industry, the most significant interventions have taken place in human resources. For example, nearly 60 percent of companies have formal employee suggestion systems from which 28 percent of suggestions are actually implemented. Another study (Bhatnagar and Dixit 2004) of two large organizations reports how special attention is paid to organizational innovations that meet the challenges of external and internal imbalances. They suggest that current software service activity has built-in incentives to innovate up the value chain toward more complex services, software products and hardware-software integrated products.

In terms of rewards and recognition, a majority of companies uses market data to determine basic pay. Employment and wages in the software sector have increased over the last decade but not enough to erode India's competitive advantage. The differential between client countries and India remains very high (table 8). In terms of competition, countries comparable to India in overall cost/quality/delivery metrics have significantly higher wages than India. Moreover, expanded capacity of Indian engineering colleges will ensure that the supply is adequate for the likely demand in the next five years.

With the entry of many multinationals in the Indian market, there is competition for the best talent. The top 10 companies reportedly have retention rates over 90 percent indicating a fairly stable environment. It is interesting that Indian companies are neck-and-neck with multinationals in these surveys (Dataquest, August 31, 2003), indicating the highly professional nature of the HRD function in the industry.

Table 8. India and her competitors compared

Parameter	India	Canada	Ireland	Israel	Philippines	China	Russia
Export Industry Size (US$ million)	9,500	3,780	1,920	900	640	1,040	165
Export focused professionals	195,000	45,000	21,000	15,000	20,000	26,000	5,500
IT employee costs (US$ per year)	5–12,000	36,000	25–35,000	25,000	7,000	9,600	7,000
Number of CMM-5 certified companies	60	NA	0	0	NA	2	3

Quality of IT labor force	High	High	High to Moderate	High	Moderate	Low quality	High quality
Infrastructure	Average	Good	Good	Good	Good	Average	Poor
Unique positives	Abundant and skilled (English, highly qualified, exposed to clients) workforce, robust project management experience	Near shore, highly compatible culture with the United States and United Kingdom	Large MNC presence, early start	Large product development (shrink wrapped) experience	English skills and cultural compatibility	Large IT workforce	High quality engineers
Main negatives	Ordinary infrastructure	High costs	High costs	Regional unrest	Lacks project managers	Lacks project managers	Unstable economy

n.a. = data not available. [or do you mean "not applicable"?

Source: NASSCOM (2004)

Nearly 87 percent of the companies reported a routine performance management process in which managers and employees together set performance goals and 30 percent of the organizations had 360° feedback system. A key measure of employee satisfaction is the attrition rate. Most large companies have created work environments which contain attrition to low levels. This is a significant benefit to assure clients that disgruntled employees are not distributing confidential information. To date, hardly any cases of this crime have been reported.

The role of the Indian Diaspora

The success of Indian IT professionals in the United States was a significant factor in development of the software sector in India. The stream of U.S.-educated Indian professionals who joined the IT industry in Silicon Valley and met technical, managerial, and entrepreneurial success, created a positive image of the capabilities of Indian professionals. By the year 2000, Indians headed 972 Silicon Valley technology companies, accounting for $50 billion in sales and nearly 26,000 jobs. Indians headed up 3 percent of technology companies started between 1980–85; ten years later, they headed up 10 percent of the companies.

The Indian Diaspora also expedited bodyshopping, by showcasing the value of Indian programmers and fostering connections between software firms in the United States and India. Some have returned to work for multinationals which have established Indian subsidiaries, while others have launched firms in India. A few straddle both countries, able to speed the transfer of know-how about emerging markets and technologies, and willing to nurture long-term relationships across borders.

In spite of the large English-speaking, technically educated, Indian population, the number of doctorates awarded in the United States to scholars from India has been far fewer than China and Taiwan during the 15-year period from 1985 to 2000. Whereas

the number for India varied between 500–1000 per year, the number for China has varied between 2000–3000 in the last 10 years. Interestingly Taiwan, as a small country, has had more U.S. doctorates awarded than India.

Government's facilitating role

Although the story of the Indian software industry is a story of private initiative, the government played a supporting role with public funding of a large, well trained pool of engineers and management personnel who could forge the Indian IT industry into a world class treasure in a short time. Early government support came from a few visionary civil servants who championed the cause and helped the industry find its way through a labyrinth of regulations, making exemptions wherever possible. Later, policies that encouraged local firms and direct foreign investments were introduced.

Government targeted software exports once the market identified the industry's potential and created the necessary institutions. As early as 1972, the Department of Electronics introduced a policy to permit duty-free imports of computer systems, if importers would promise to export software and services worth twice the value of the imported computers within a specified time. This policy helped a number of leading companies in their inception stage. In the 1980s the Department gave software developers a further boost by initiating software export friendly policies. It formed a software export promotion council and liberalized import rules for materials needed for the industry. Software was explicitly targeted as a key sector for export promotion. In the late 1990s, the government created four major taskforces comprising chief executives of leading software companies to study the sector and recommend actions, and then acted on most of the recommendations.[8] At that time the Department of Electronics became the Ministry of Communication and Information Technology. This was followed by the IT Act to address a large number of issues. In addition to these federal interventions, many states promoted local software industry by improving infrastructure, IT education, and provision of more facilitating environments.

With the beginning of economic reforms in the early 1990s, efforts were , made to attract foreign as well as domestic investment. Foreign companies were permitted to establish fully owned subsidiaries in the electronics export processing zones. Within the Ministry of Finance there was greater recognition of India's comparative advantage in the sector, as it abolished entry barriers for foreign companies, made available fast, low-cost data connection facilities, and reduced and rationalized duties, taxes, and tariffs.

The Reserve Bank of India adopted several measures to support the IT industry. These included: simplification of the filing of Software Export Declaration Form (SOFTEX); acquisition of overseas parent company shares by employees of the Indian company; companies whose software sales were over 80 percent could grant stock options to nonresident and permanent resident employees; foreign exchange could be freely remitted for buying services; and companies which executed contracts in "computer software" abroad could use income up to 70 percent of contract value to meet contract-related expenses abroad.

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[8] The prime minister's task force on IT, formed May 22, 1998, submitted 108 recommendations in an IT action plan aimed at increasing software exports to US$50 billion by 2008 and creating 1 million new jobs over five years. Recommendations included: blanket approval for overseas acquisitions from export earnings; zero duty on all IT products by 2002 by advancing International Trade Administration (ITA) schedules; broadening definition of software to include entire range of IT software as per WTO-ITA norms; exemption for software developers and exporters from physical and customs bonding at software technology parks (STPs), engineering development units (EDUs) and export processing zones (EPZs).

Source: IT taskforce suggests ways to turn India into a IT super power, *Information Technology Review*, June 1998. Available online at: http://www.ipan.com/reviews/archives/0798it.htm

Tax holidays were given on company profits, although the government is progressively phasing out these deductions. Tax breaks from corporate income and tax on profits was available to units in any free trade zone, any software technology park, or any special economic zone to the extent of 100 percent of the profits derived from the business. These deductions will not available from Financial Year 2009–2010 onwards.

Indian direct investment in joint venture (JV)/wholly owned subsidiaries (WOS) abroad was simplified and a fast track window is available for large investments. IT software and services companies in India can acquire companies overseas through American Depositary Receipt/ Global Depository Receipt stock swaps without prior approval for up to $100 million or ten times the export earnings of the previous year.

While the government has enacted significant reforms in the area of intellectual property rights (IPRs), and has joined the World Trade Organization and Trade-Related Aspects of IPRs, the reforms have so far not led to a surge in patents in the Indian software industry, nor have IPRs been perceived as effective in protecting innovations in the Indian software industry (Gupta 2004).

Several policy reforms in the telecom sector helped accelerate the domestic and export industry. In 1998, a national telecom policy was announced to clarify the role of the regulator, transition from license fee to a revenue sharing model and open domestic long distance to private operators. The ISP gateway monopoly ended in 2000 and permitted private companies to set up international gateways. In 2002, international long distance was liberalized two years ahead of WTO commitments and competition increased in cellular markets. As a result, India's teledensity, the number of phones per 100 people, increased to five and cellular penetration overtook the land line penetration.

Recognizing the growing need for manpower in the software industry the Ministry of Human Resources Development took the following actions:

- Helped create and expand computer science departments in existing engineering colleges.
- Eased policies in order to enable private sectors to open educational institutions without public funding. A large number of engineering colleges were opened in the private sector.
- Introduced quality control systems for engineering colleges and other IT training institutions, such as the All India Council for Technical Education and an accreditation system run by professional bodies such as the Computer Society of India to monitor private training institutions.
- Encouraged the private sector to open training institutions. At its peak nearly one million Indians were being trained in a year with the IT training industry earning over nearly 10 billion rupees in 1998 with no government subsidy.

Software technology parks

Creation of NASSCOM in 1988 and later establishment of STPs in 1990 represented a fundamental approach to policy making for the software industry. An important institutional intervention was the establishment of STPs to provide infrastructure for private companies to export software. Established in 39 locations, including most major towns, they provided ready-to-plug IT and telecom infrastructure. STPs also allowed single-window clearance for all regulatory matters. The benefits and approvals for STPs are similar to those of Export Oriented Units. Incentives provided in the Export–Import Policy are also applicable to STP members.

The companies registered with these parks account for about 68 percent of software exporters. Many of these companies have not benefited from the actual STP infrastructure in any significant way. Perhaps, the major contribution of these STPs was to

enable new enterprises to launch, and small and medium enterprises to grow. Already established companies merely registered with these parks but did not use the infrastructure that was created.

The performance of STPs has been variable. Where the environment was right the STPs enabled small and medium enterprises (SMEs) to set up and grow. On the other hand in Gujarat, total sales from 60–70 SMEs was Indian Rs. 1,000 million (US$22 million), miniscule in comparison with industry norms. The Gandhinagar STP had a membership of 300 companies, many of which may have been attracted because of the incentives. However, only 60–70 are active. Out of the 5 Mbps (megabits per second) bandwidth available for use, hardly 2 Mbps is being utilized.

One of the STPs' key contributions is providing high-speed data communication services to the industry. The Software Technology Parks of India (STPI) had international gateways at 39 locations (2003). For the last mile users can connect through point-to-point and point-to-multipoint microwave links, and terrestrial fiber/copper cables were used (where feasible). The up time of STPI connections is 99.9 percent. STPI works with major international telecom operators such as AT&T, Sprint, MCI, Intelsat and British Telecom. STPI offers two main services: Softpoint service, secure and exclusive digital circuits for data and voice transmission; and SoftLink, Internet access on a shared basis.

Cluster development

The software industry in India has been concentrated in six to seven cities such as Bangalore, Hyderabad, Chennai, Mumbai, Delhi and Pune. Well-researched reasons to explain why these locations have become fertile centers have not been propounded. Many centers do not necessarily have the best infrastructure. The one reason often suggested is the availability of a large pool of locally trained manpower as the distribution of engineering colleges closely mirrors the distribution of the software industry. The other significant reason may be the attractiveness of these locations for young and upwardly mobile professionals (Meine Pieter van Dijk 2002). Most have a strong cosmopolitan character. Other authors (Srinavas 1998) have reported the importance of a lower cost of living and favorable climate as important reasons for choosing a location lending support to this argument. For example, Bangalore perhaps boasts of the best education system in India and, therefore, is very attractive as a place for educational professionals.

Presence of progressive chief ministers and special state government benefits to attract firms may explain the growth of the Hyderabad center but other locations thrived without such political support.

Because of the high degree of professionalism in most exporting companies there is consistency in the quality of experienced manpower that sometimes moves laterally from one company to the other. Other than this movement, there is not enough evidence of horizontal linkages between IT firms located in the clusters. Even though five to six centers account for more than 90 percent software exports the typical clustering effect associated with Silicon Valley does not seem to exist in these centers. Perhaps a lack of informal knowledge exchange exists because many companies view other companies as close competitors. Most Indian companies operate in a narrow market space such as in the U.S. market in 2–3 verticals which essentially account for just five percent of the total global outsourced market. Some researchers have corroborated the absence of these linkages in the domestic market (Basant and Chandra 2004) and found very little evidence of horizontal interaction in a case where there were four Indian sub contractors in Bangalore working for the same multinational.

The role of the industry organization

The National Association of Service and Software Companies (NASSCOM), India's software industry association, was founded in 1988 and has been a vocal and potent force in lobbying for policy reforms, including rules limiting access to capital markets, issuance of stock options, easing rules on foreign currency transactions, and improving telecom infrastructure.

NASSCOM played a significant role in establishing a brand image for India in the global software services markets by participating in global trade fairs and events and organizing learning events in India that feature prominent experts from major markets. Through its annual reports, NASSCOM has became the most reliable source of data and information about the Indian software industry. NASSCOM activities were influenced by the dominant software players, who share a great commonality of interest in terms of policy recommendations and the Indian brand. NASSCOM also had a very dynamic leader (in Dewang Mehta) whose contribution was widely acknowledged by Indian media.

NASSCOM's membership grew from 38 members in 1988 to over 1000 firms in 2005. It was most effective in policy concerns and brand promotion abroad. NASSCOM was less effective in representing small and medium scale enterprises or domestic rather than export firms.

Impact of the industry on the Indian economy

The success of the Indian software industry has had wide-ranging effects across the Indian economy. Policy changes to enhance exports are facilitating rapid development of a domestic IT market, offering efficiency gains through adoption of information technologies. In sharp contrast to even a decade ago, Indian business, government, and consumers have ready access to the newest software products and imported hardware.

The very high standards of management practiced in Indian IT firms and the tremendous employment opportunities offered by the industry have had significant effects on the confidence, aspirations, and work ethic of young professionals in India. The leading software firms have pioneered a movement to modernize Indian management practices, adopting practices of creative organizations with less hierarchical structures and strong work ethics. In order to comply with international norms to participate in international capital markets, IT firms have set new standards in accounting and corporate governance. They have offered unprecedented high-paying employment opportunities for the young and educated labor force, particularly for women professionals.

Moving up the value chain

The leading firms have moved up the value chain in software services, developing organizational and managerial capabilities that enable them to offer more comprehensive services than merely low cost programming. One sign of maturity is that the industry increasingly procures fixed price contracts, rather than the time-and-materials contracts of earlier years. With the greater risk of fixed price contracts comes flexibility in organizing work, greater management control, and an opportunity to earn higher returns as efficiency improves.

Revenue per worker is increased, indicating a move up the value chain – from an average of $9,000 in 1995–96 to $20,500 in 2000–01 – but revenues are still lower than what they are in product-based companies.

In order to build client value, companies have expanded their capacity to service a wider range of software development tasks, as well as to move into new services such as product design and Information Services outsourcing. Software development

includes analysis and specification of requirements, software design, writing and testing of software, and delivery and installation. Indian companies are trying to move beyond only writing and testing, which require the least skill and account for only a small portion of the overall project costs, to higher skill levels that require deeper business knowledge of the industry for which software solutions are being developed.

In their quest to climb the value chain, India's software firms ensured product quality and reliability by adopting internationally recognized standardized work processes. An increasing number of firms have met international certification requirements for key quality standards. For many, this was an exercise in brand building, but the processes and procedures put in place left their hallmark on the quality of software products and services.

Firms seek certification from various sources, beginning with quality management practices that meet ISO 9000 standards to ensure consistent and orderly execution of orders. The next stage focuses on software engineering and certification under the CMM framework of the Software Engineering Institute (SEI) at increasing levels of process maturity. Another stage focuses on aligning internal practices with the People Capability Maturity Model (CMM), which is a framework to guide attracting, motivating, and retaining a talented technical staff. The Six Sigma methodology assures "end-to-end" quality across all company operations and focuses on improved customer satisfaction by reducing defects, with a target of virtually defect-free processes and products. As of December 2003, India has 65 companies at SEI CMM Maturity Level 5. In October 2002, the SEI of Carnegie Mellon University published a list of high-maturity organizations as part of its Survey of High Maturity Organizations and High Maturity Workshop research[9]. A country list compiled from the original list is presented in table 9. The full set of 146 high-maturity organizations includes 72 Level 4 organizations and 74 Level 5 organizations. Of the 87 high-maturity organizations assessed outside the United States, 77 are in India.

Table 9. Comparison of India's quality standards with other countries

Country	Level 4 organizations	Level 5 organizations
Australia	2	—
Canada	—	1
China	—	2
France	1	—
India	27	50
Ireland	1	—
Israel	1	—
Russia	—	1
Singapore	1	—
United StatesA	39	20

— = [[what? zero? not available?]] Pl leave them as blanks as this is not an exhaustive table , represents partial data as explained in the paragraph just above the table

[9] It should be noted that the SEI does not certify companies at maturity levels nor does it confirm the accuracy of the maturity levels reported by the Lead Assessors or organizations. The list of Level 4 and 5 organizations is by no means exhaustive.

Source: NASSCOM (2004: 211)

Because most Indian software firms are export-oriented and serve clients around the world, meeting globally acceptable frameworks and standards has been critical to validating their credentials to new clients, who often demand that vendors adopt ISO and CMM standards.

The reasons for the success of the quality improvements can be grouped in three categories –people based, business related, and management related (Jalote 2001). The Indian software industry primarily delivers services, which globally has embraced software process improvement (SPI) more than those who deliver products. As Indian companies serve worldwide clients who demand that their vendors adopt standards such as ISO and CMM, companies were motivated to certify their credentials and used these frameworks to also deliver real software process improvement. As companies moved to an offshore model, SPI became a necessity to succeed. Managing subcontracted work typically requires monitoring structures to contain risk. This imposes a degree of formality at the interface between the users and developers – something that is generally hard to achieve with in-house development.

For most organizations software development is their core competency which must be continually improved. Their high growth trajectory required the infusion of a large number of new engineers every year. Without tightly controlled processes, it would have been impossible to absorb new recruits into the development process quickly. Since the cost of manpower was not very high in India, it was possible for most companies to dedicate a team for its SPI effort. A survey of high-maturity organizations in India indicated that most companies had dedicated manpower for SPI equal to about 1–2 percent of their engineering manpower (Jalote 2001).

Most of the software companies in India are very young. Being followers in the software development process, they could exploit the collective knowledge and experience of organizations the world over in implementing SPI. Most companies introduced quality systems very soon after they were formed. This ensured that the company had work standards to which each new entrant had to conform. After that, the company, people and quality systems all matured together. As the people in the company have contributed actively to the SPI movements from the early days, it induced among the practitioners a sense of ownership for the quality system.

Software companies attract the best of talent from engineering schools. Some of the CMM lead assessors have observed that the scores on the Myers-Briggs personality tests conducted as part of the capability appraisals often indicate that Indian engineers are different from their counterparts in the United States. Indian employees are ambitious and look for improvement in the way the organization works, which creates a need for process orientation. The average age of the Indian engineers is in 20s and that of managers is late 20s to early 30s. Younger professionals are more receptive to change, as they have not invested in traditions and indeed want changes.

Indian culture is more family-oriented rather than individualistic. This prompts people to conform to established frameworks and systems. Professionals do not mind being measured. There are fewer privacy concerns and in-house surveys have indicated that most engineers are more concerned about the nature of work and the overall work environment, and not so much about being measured. The software background of top managers helps to secure backing from senior management for SPI initiatives.

Most of the facilitating factors are based in more general and societal context. Such factors are hard to emulate once the context changes. Government had little role to play in this movement. India does not have centers along the lines of the U.S. or European Software Engineering Institutes. The Ministry of Information Technology in India did bring in the world's best Software Testing and Assessment of Software Maturity through licensing arrangements with Software Engineering Institute at Carnegie Mellon University. Under this agreement, the Indian Standardization, Testing, and Quality Certification (STQC)

Directorate of the Ministry of Information Technology undertook the job of Certification, Testing and Training of Trainers and assessors in India.

The increasing importance of outsourced IT services from developed countries prompted many clients to voice concerns about data protection practices of service providers. Issues of data confidentiality, integrity and availability have come to fore. The latest EU data protection laws are designed to ensure that personal data of EU citizens is not sent to a country that has less stringent legal protection. Clients are also demanding adherence to security standards to ensure information security.

The Government of India and NASSCOM are working closely to respond to these concerns. The government introduced clauses in its IT Act of 2000 — covering privacy, digital signatures, and cyber crime— to meet EU requirements. More generally, the government strengthened software testing and assessment capabilities in India, in association with some of the leading organizations internationally. The Ministry of Information Technology set up the STQC directorate to train assessors and implement security standards. An Information Security Technology Development Council has also been set up to promote research in the area of information security.

Research and development

R&D expenditure amounts have been and continue to be small (table 10) with some increase in recent years. Low R&D expenditures can partly be explained by the service instead of product focus which would require greater investment in R&D.

Table 10. Profile R&D effort in India's IT and software service sector

Year	Sample size	Firms reporting R&D (numbers)	R&D spending (Rs. million)	R&D intensity*
1997–98	115	9	213.44	2.03
1998–99	155	14	244.28	2.82
1999–00	238	16	703.29	6.82
2000–01	217	17	763.19	4.91

*R&D expenditure as a proportion of sales.

Source: Parthasarathi and Joseph 2004, p. 97.

The bulk of R&D occurs in subsidiaries set up by multinationals. As a cost-reduction strategy, a number of large and medium sized product companies started captive development centers in India. Other companies have partnered with Indian firms to set up product development centers, and still others are outsourcing to India functions such as requirement specification, design, testing and maintenance. The availability of capable and low-cost Indian technical expertise, coupled with the deep financial resources of the multinationals, provide for cost-effective R&D. However, as multinationals increasingly distribute R&D or product development operations globally, they become less likely to develop whole products in a single place such as India.

Indian firms were reluctant to invest in product development because they lacked resources and expertise, and more importantly, because of the difficulties in designing products for distant and unfamiliar markets. Even when firms have the resources, they

find it hard to justify the high risks of product development. The risks are much lower in providing services than in selling product, in part because of the lower level of skill and financial risk.

In the software industry, product development is a small component of the overall costs of developing and promoting software products. Software firms may spend as much as 50 percent of revenues on advertising and marketing and as little as 10–15 percent on product development.

There are few examples of successful product development by Indian software companies. For the industry as a whole, only 1–5 percent of the software packages typically succeed in the market. Only recently have Indian companies reached a size and maturity to consider investing in R&D and marketing. One successful example to date are products developed by Indian companies for the banking sector.

Indian software companies as learning organizations

Tschang, Amsden, and Sadagopan (2001) examined the different ways with which upgrading takes place in the Indian software industry. They used the R&D classification of pure, basic[10], and applied research[11] to differentiate different firms' technological abilities and functions. They found sufficient evidence of firms upgrading to the applied research stage – itself an achievement, since it involves more conceptual work or longer term efforts at research. The two highest levels of research— pure science and basic research— are almost nonexistent in India, especially in domestic firms. This shows that the nature of the industry is "applied", "service-oriented", or "incremental" in its innovation. The technologies developed are typically not breakthroughs, but are rather first implementations, involving "transforming, variating [[is "variating" a term of art? Or do you mean "varying"? It is a term used by the authors and is used in literature]] and reapplying" known techniques to the software product under design.

The model of upgrading into products is perhaps the most difficult task, given the many reasons for failure. There is a paucity of success stories. The leaders of domestic firms who went into products, including those who left Wipro, Satyam, and other service companies to build their new enterprises, all noted that they had a different mentality and business objective in mind. Their goal was to build products, or to create a fundamentally new service. Their plans would not have materialized if they remained in their former software service firms. Each new startup may have also been trying to find a defensible or competitive niche within the Indian software industry.

Many firms are discouraged from trying the product market because of the distance from the final market and lack of sufficient resources or expertise at the outset. Service companies have resources, but find it hard to justify risk taking when they have such nice returns. Ultimately, even firms that break into the product market can stumble and fall. Ramco was an example. The shortage of this risk-taking attitude across the broader industry, coupled with resource and distance-from-market constraints,

[10] The category of pure science will include the development of mathematical algorithms, languages, or other computer science theory. Typically, only the freshest startups in regions like the United States or the main labs of the most established companies like Microsoft will base their products on in-house basic research or university research into the pure sciences. Typical examples of the latter are the Web search engine companies like Lycos and Google.

[11] For example, the implementation of a communications protocol stack (i.e., part of a computer communications system) in a particular language or for a particular environment (with all its interface standards) requires knowledge of the standards, how to create a logical model that meets the standard (applied research), and how to develop the model in a particular programming language, in preliminary prototype form along the way to its final developed form.

will make it difficult for more product firms to emerge. Unless all these factors change, it is unlikely that the Indian industry as a whole will change its complexion to one with more diverse models of upgrading.

The Indian service companies are clearly following a trajectory laid out by their original competencies, continuing to dominate the larger part of the services value chain all the way back to the requirements analysis and consulting stages.

The emergence of the specialized services model such as Mindtree's contract R&D service shows that the Indian industry does have its own style of promising entrepreneurial capabilities and the resourcefulness to develop a wider variety of areas.

Ultimately, the running of multinational subsidiaries on a cost center basis (and the continued tradition of defining product requirements elsewhere) will constrain these subsidiaries from promoting new ideas or products locally. This pattern is different from domestic firms, which run as profit centers, giving them both heavier responsibility and greater scope for doing challenging work. In summary, both domestic firms and multinationals appear to be able to upgrade to applied research, but the business models themselves suggest that the domestic firms have broader scope to do products, if they so choose. Those local firms may engage in a broader range of R&D, though not necessarily the most advanced technologies.

The Indian product company, Sassken built a large R&D arm to research technologies for making the "first implementation" of a communication standard (i.e., high level and detailed design) can be considered to involve both (a) the "learning" in applied research and (b) the implementation in models of applied research.

The same kind of learning and concept modeling in applied research has been done at the CMC, one of India's earliest software companies set up by the national government. CMC had to design systems from scratch, many of which had social objectives, such as India's first railway reservations system, perhaps the most complicated systems endeavor ever undertaken in India.

Learning through alliances and partnerships

Although a number of alliances have taken place between Indian firms and multinationals (table 11 for examples), India's firms have not benefited greatly in direct knowledge transfer from them. In a study by Gupta (2004), the perceived benefit of alliances in knowledge development and products skill is lower compared to the benefits of marketing know-how. Although IT firms have entered a large number of technology partnerships with foreign firms, they were primarily straightforward in nature (Gupta and Basant 2001).

Basant and Chandra (2004) offer an interesting insight into different strategies used by alliance partners in India and China. They characterize an alliance in India with Nortel, a Canadian telecommunications equipment manufacturer, as having yielded limited benefits of knowledge transfer to Indian companies which resulted in more Indian contracts in the telecom sector. Nortel's alliance with five Indian subcontractors was focused on short-term export revenues by each company. On the other hand Nortel's alliance in China was with a university for research that would benefit the Chinese domestic telecom market; its impact was more long-term.

Table 11. Variety of alliances entered into by Indian IT firms – some examples

Types of alliances	Examples
Services	
Staff augmentation	Aditi-Microsoft
Application development	GE-Satyam (JV)
Package implémentation	TCS-SAP
Migrations	Compaq India—Persistant Systems
Remote maintenance	TIS-Silverline Technologies
ASP	Satyam-Computer Associates (JV)
IT enabled services	Wipro-Spectramind (Equity)
Non service industries	
Computer hardware	IBM-Wipro
Biotechnology	Satyam-CCMB
Verticals	
Engineering services	Van Dorn Demag – Infosys
Telecom & Internetworking	Nortel Networks – Infosys
Finance	Nordstorm – Infosys
Aviation	Swiss Air –TCS
Embedded systems & chip design	DCM Datasystems – Intel
Manufacturing	Oncourse-Geometric Software
Systems integration	Wipro-HP
CRM	Siebel-Infosys
Technology consulting	Answerthink-HCL
Alliance categories	
Marketing alliance, market access, new area	JASDIC-Infosys (Japan)
Marketing alliance, new domain	Wipro – Spectramind
Technology alliance implementation	SAP-Infosys
Technology alliance product development	Microsoft-Infosys (Hailstorm Technology Development
Technology alliance IP	Synopsis -HCL Technologies
Joint product development alliance	Tata Infotech Ltd-WFS
Product marketing alliance	Vision Compass – Oasis

Product technology compatibility alliance	Servion –Infosys
Standards	TCS (Internet Security Alliance)

Source: Basant 2003.

D'Costa and Sridharan (2003) found what they term the creeping innovation capacity in a wide range of Indian firms of various sizes. Contributing to innovation are firm-level learning strategies that include systemization of knowledge, use of tools, and efforts at partnerships with research institutions. Many forms were incubated unwittingly in the import substitution regime, contributing to their strength in the post-liberalized era. Domain expertise, process standards and short time to market have been pursued by all firms. Most large firms have begun small-scale partnerships for exploratory research with academia.

The future

India, compared to its competitors, ranks high on several critical parameters, including level of government support, strong track record of quality and delivery, early-mover advantage of brand recognition, quality of labor pool, English language skills, project management skills, strong focus on processes, and a favorable time zone difference with the United States that permits 24/7 internal operations. Some of the weaknesses that persist are slow growth in the domestic market and a lack of innovation and product orientation in the bulk of small and medium sized companies. Infrastructure needs improvement in many areas such as roads, electricity, venture capital and airports. Markets continue to be concentrated in North America and are therefore subject to nontariff barriers such as visa denials. There has been some domestic political backlash against outsourcing in the United States and Europe. However, a comparison of India with competitors in software exports on strengths and weaknesses seems to suggest that India's current position is quite sustainable in the near future (table 8).

It is difficult to say whether India's success can be replicated in other countries. Any country hoping to emulate India's example would have to define a strategy that matches local capability to global opportunity and discover niches that can be exploited. The niche could very well be in terms of the market to be served on the basis of language competency. Late movers can take advantage of the demonstrated success of the offshore model and how it works. There is only one necessary condition, which is the existence of high quality, trainable manpower and strong entrepreneurial and managerial talent. If countries cannot wait for a high quality technical education system, it may still be possible to mount focused training and certification programs in targeted niche areas[12]. This would of course require a foundation of a good university education system that is producing easily trainable manpower. Key infrastructure for offshore services such as telecom could be created selectively through technology parks. Policy support and incentives can also be provided selectively. Since trust is a key issue in offshore work, the country's Diaspora and intermediaries can play a critical role in the beginning.

Key factors that explain success of India's software industry

- Software industry can be built entirely on human capital. Requires limited infrastructure and upfront investment. Has good cash flows and is highly profitable.
- India had an early-mover advantage: repeated positive experience built trust in outsourcing and validated the Indian brand.
- Role of human capital, including software engineers, project managers and corporate leaders.

[12] For example Infosys Technologies is setting up a center in Mysore (a city in south India) to train 12,000 software engineers per year. The center will be set up in one year. [Source: Times News Network, Infy plans biggest training centre, *The Economic Times*, New Delhi, June 18, 2004. Available at: http://economictimes.indiatimes.com/articleshow/744132.cms

- Early investments in engineering education and privatization of education created a large talent pool.
- Bodyshopping exposed a large population to new ways of working.
- Professionally trained entrepreneurs.
- Vigorous efforts at assimilating new technology and good management practices helped companies offer competitive costs for high quality and delivery performance. ***
- Selective support to industry in an otherwise constraining environment by a few enlightened bureaucrats and the role of NASSCOM in influencing policy.
- Lack of effective implementation of restrictive policies allowed market forces a significant play in the early phase. The economy was liberalized in later years.
- Highly entrepreneurial IT training and private education industry. Responded quickly to fill skill gaps and opportunities. Positive government policies and lack of regulation meant few barriers.
- Large population created competition for engineering seats and jobs. Software industry faced no internal competition for technical talent. Competition from MNCs came when indigenous firms were prepared.

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