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Software Technology Parks: India's Economic Powerhouse

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Introduction

The emergence of science parks after World War II in the United States (U.S.) and the success of Silicon Valley in California for high technology (high-tech) industries, especially information technology and software development has set the benchmark for high-tech parks throughout the world. In India's case high-tech parks has the potential to catapault India into the twenty-first century through the process of "leap frogging". The computer software sector has become India's leading services export industry. At the beginning of 2004, export of software services in India had reached over US $ 12.5 billion and forecast to be worth around US $ 50 billion by 2008. To facilitate the growth of software development, in 1992, a satellite earth station was established in the southern city of Bangalore in the state of Karnataka for high speed communication services to facilitate software exports. Thereafter, India's first international gateway and network operations for Information Technology (IT) was established at the Software Technology Parks of India (STPI) in Bangalore's Electronic City. The STPI is an autonomous society that was established by the government under the Ministry of Information Technology for the purpose of promoting export of computer software[1].

The Software Technology Park (STP) scheme introduced by the Indian Department of Electronics (DOE) in the early 1990s also ensured that India had areas where IT companies could be "hothoused" and nurtured regardless of the condition of the state infrastructure in general[2]. Companies registered under the STP category also obtain

[1] The STPI is also a licensed International Communications service provider and a Category A Internet Service Provider (ISP). The STPI has carrier relations with major telcos in the world including Concer, Worldcom, KDD, Teleglobe, C&W and others.
[2] AnnaLee Saxenian, "Bangalore, The Silicon Valley of Asia?" in Anne O' Krueger (ed), *Economic Policy Reforms and the Indian Economy*, Oxford University Press, 2002.

several benefits that includes; single window government clearance for permits, 100 percent foreign equity ownership, complete duty free for imported equipment, up to 90 percent exemption for corporate tax, a dedicated data communication links and single point certification for export and custom bonding. The STPI also facilitates links with leading international telecom providers and has operations across more than 25 states. Besides Bangalore, other cities such as Hyderabad (Andhra Pradesh) and Chennai (Tamil Nadu) have also developed their own STPs to compete with Bangalore and attract companies involved in the IT business. However, Bangalore is still considered to be India's leading IT hub for software exports. Since its inception in 1999, the original STP concept had evolved from a physical entity in which companies had to hire space and export their software from these STPs. Rapidly changing technology and business conditions dictates that a virtual STP could react faster to changing business trends. In this regard, companies could acquire STP status in their chosen locations and the STPI will grant them upon approval of their status, the STP benefits.

Across India, the share of software exports in comparsion to total exports has risen from 2.5 percent in the mid-1990s to 10.5 percent at the end of 1999. The aim of this paper will be to examine the growth of the software industry and its transformation of Bangalore from a relaxing destination for penshioners and "honeymooners" to a high technology hub. The sustainability of the IT sector in Bangalore will also be discussed in view of its impact on overall economic development such as its revenue generating capacity but having the need for huge investments in infrastructure such as telecommunications and electricity generation. Apart from the economic aspect of Bangalore's evolution as an IT hub, the paper will also examine the socioeconomic impact of the IT industry in Bangalore. The paper assumes that the trend for IT expansion in Bangalore will depend on specialised IT parks that are self-contained to act as "islands" or "pockets" of first world amenities. However, beyond these pockets of world class facilities, the digital divide is ever increasing between those that are benefiting from the IT boom and those that are hardly touched by the IT phenomenon. The paper will also argue that IT centres in India as in the case of Bangalore have no alternative but to depend on the clustering approach to "leapfrog" and compete globally in the IT industry.

Innovative Clusters

Michael Porter[3] had used the concept of clusters to explain how knowledged based economies could use linked industries to create critical masses in order to expand economic activities. According to Porter, clusters affect competition which increases a firm's competitive advantage and is overall beneficial to economic development[4]. Balasubramanyam et al had also used the cluster approach to account for the expansion of the Information Technology (IT) sector in Bangalore[5]. John Streamlau had also written on the transformation of Bangalore into India's Silicon City and how this will affect economic development throughout India but pointed out that there are adverse impacts to Bangalore's expansion of its software industry[6]. India's low cost but large and skilled IT human resource pool is the main attraction for IT MNCs in Bangalore. In this context, AnnaLee Saxenian had written a number of papers on the "brain drain and brain gain" aspect of the IT sector with specific reference to the loss of software talent from developing countries such as India to Silicon Valley in the United States. Saxenian had also examined whether Bangalore could be considered the Asian equivalent to Silicon Valley in the United States (US)[7]. In a more recent article, Ambika Patni reported on the progress of Bangalore in specific areas such as software development[8]. In contrast, geographers such as Mark Holstrom[9] had used the spatial approach to examine Bangalore

[3] Michael E. Porter, "Clusters and the New Economics of Competition," *Harvard Business Review*, Nov/dec 98, Vol.76, Issue. 6.

[4] Clusters affect competition in three main ways; first, by increasing the productivity of companies located in a specific area. Second, by driving the direction and pace of innovation. Third, by stimulating the formation of new businesses within the cluster. Clusters within a certain geographic area benefit from greater flexibility, closer relationships, better information and powerful incentives. Porter Michael E., "Clusters and the New Economics of Competition," *Harvard Business Review*, Nov/Dec 98, Vol.76, Issue 6.

[5] Balasubramanyam et al, "The Software Cluster in Bangalore," in John H. Dunning (ed), *Regions, Globalization, and the Knowledge Based Economy*, Oxford University Press, Britain, 2000.

[6] John Stremlau, "Bangalore: India's silicon city," *Monthly Labor Review*, November 1996 and John Streamlau, "Dateline Bangalore: Third World Technopolis,"

[7] AnnaLee Saxenian, Bangalore: The Silicon Valley of Asia?" in Anne O. Krueger (ed), Economic Policy Reforms and the Indian Economy, Oxford University Press, New Delhi, India, 2002.

[8] Ambika Patni, "Silicon Valley of the East," *Harvard Business Review*, Cambridge, Fall 1999.

[9] Mark Holmstrom, "Bangalore as an industrial district: Flexible specialisation in a labour surplus economy," in *Decentralized Production in India*, Phiip Cadene and Nark Holstrom (eds), Sage Publications, New Delhi, 1998.

as an industrial district with specific reference to the engineering and electronic industries.

To analyse the capabilities of innovative clusters in expanding IT development, David Rosenberg had examined six locations world wide including Silicon Valley and Bangalore to examine the benefits of a technology cluster[10]. Rosenberg had outlined several key features of software technology parks such as geography, company culture, venture capital, stock market capitalization, universities as talent pools and government policies to foster IT growth[11]. In relation to Bangalore, Rosenberg had described this IT hub as a "silicon island, third world sea." The chairman of Infosys, Narayanan Murthy made a similar observation when he commented that Indian IT workers in Bangalore had to made the mental adjustment from living in a third world to working in a first world environment on a daily basis. This paper will use Rosenberg's framework for analysis to examine Bangalore's IT sector but with some adjustments. Instead of examining IT talent merely from tertiary institutions, Indian talent will be linked to the "brain drain and brain gain" (brain circulation) phenomenon. The paper will also look at the funding for the growth of the IT industry from sources like venture capital (VC) and stock market capitalisation. While Bangalore could be considered an IT pioneer in Indian terms, the plan that the Karnataka state government had adopted to transform the state into an IT hub is more accurately categorised as "latecomer" strategy in global terms.

Being a latecomer to international competition in the global IT industry, the Indian government has to sustain its software exports through innovation by linkages, leverage and learning[12]. The assumption being made here is that due to the weak domestic demand for personal computers (PC) in India, the domestic market alone could not have sustained the growth of the Indian IT industry. In 2000, it was estimated that there were less than a million PCs in the whole of India. Table 1 provides a brief historical outline of the

[10] David Rosenberg, *Cloning Silicon Valley, the next generation high-tech hotspots*, Reuters, Pearson Education, London, New York, Singapore, 2002.
[11] Ibid, pp.32-37
[12] John A. Mathews, *Dragon Multinational. A New Model for Global Growth*, Oxford University Press, 2002, p. 109.

development of Bangalore as an IT hub with the discovery by MNC Texas Instruments that Bangalore has a skilled and large IT talent pool.

Table 1: Historical Overview of IT Industry in Bangalore

1984	Texas Instruments (US MNC) enters India for offshore development
1986	DOE announces software policy
1991	Software Technology Parks of India (STPI) is set up
1992	Exclusive satellite international gateway for export industry is set up
1997	Karnataka becomes the first state in India to announce an IT Policy
1998	Number of IT companies increases to 253, total project worth US $ 840 million
1999	Indian Institute of Information Technology, Bangalore (IIITB) and the KITVEN FUND are established
2000	Number of IT companies increases to 782 with total projects worth US $ 1.1 billion
2001	Number of IT companies grows to 928 with total projects worth US $ 1.6 Billion
2002	Number of IT software companies under STPI increases to 1038, total projects worth US $ 2.06 Billion, IT companies number 1038.

Source: STPI Karnataka, India.

Bangalore IT Industry

If one side of the Bangalore "coin" was as a sedate and laid back city, the flip side of the coin was a Bangalore that has a history of being a research and development (R&D) hub and the government had poured considerable resources towards developing its scientific talent and infrastructure. After India's independence in 1947, the government established several large public sector companies and institutions in Bangalore. They included Indian Telecommunications Companies, Hindustan Machine Tools, Indian Space Research Organisations (ISRO) and others. Together with the presence of automotive and electronics companies, Bangalore was provided with a suitable environment for the take off of the IT industry in the mid 1980s.

The international benchmark of excellence for software development could be gauged using the ISO 900 certification and of the 300 leading IT companies with this certification, more than 170 are based in India. Another often used IT benchmark is the SEI-CMM standard developed by the Carnegie Mellon Institute in the US. The SEI-CMM standard ranges from a scale of 1 to 5 for excellence. There are over 50 companies

worldwide with SEI-CMM Level 5 status, India has about 40 companies with CMM Level 5 and more than half of them are found in Bangalore. Table 2 shows the type of IT activities undertaken by various IT firms in Bangalore. The trend indicate that the majority of Indian companies are still providing services but a few are into integrated circuit design, the first step towards innovation and R & D.

Table 2: Type of Activities for STP Companies in Bangalore

Number of STP Companies	Type of Activity
46	Integrated Circuit Design
108	Communication software
166	Systems software
293	Application software
303	Service Companies

Source: *Government of Karnataka*

Table 3 indicates that the Bangalore IT industry is dominated by about 13 companies that are valued between US $ 20 to 200 million each. Besides the dominance of a handful of Indian companies, software companies in Bangalore are also confronted with other challenges thereatening their sustainability. The sustainability of the Bangalore software phenomenon rested upon three distinct type of IT activities, these are dealing with targeted domains, differentiated activity and synergistic innovation of Indian software firms[13]. Software production in Bangalore has become capital intensive raising the cost of entry and participation in overseas markets in terms of technology access, software development tools, techniques and methods.

Table 3: Number and Value of IT Companies in Bangalore from 1999 to 2002

	Number of Companies		
Value of Companies in US $ Million	**1999-2000**	**2000-2001**	**2001-2002**
Above 200	Nil	2	2
Between 20 and 200	6	13	13
Between 2 and 20	51	66	95
Less than 2	100	189	246
Less than 0.5	277	212	326

Source: Government of Karnataka

[13] Jane Millar, "Software Teletrade in Bangalore: the case study for sustainability", United Nations University, Mumbai, November 1999.

Infrastructure

Bangalore suffers from a power deficit and "brown-outs" are quite common, prompting the need for businesses to have their own captive electricity generators which increases the costs of their operations but there is no alternative for the foreseable future. The transportation networks in Bangalore could also be improved, especially its roads which were not designed to accommodate the huge increase in volume of motorised vehicles. Bangalore's image as an IT hub from the point of view of foreign investors also suffered when it was shown that the state government was poorly equipped to handle the massive floods which inundated the state in early June 2004.

Table 4: Information and Power Network in Karnataka 2002

Infrastructure	**Unit of Measurement**
Power Deficit	4000 million Kwh
Plant Load Factor	64.9%
Installed captive capacity	15.5%
Projected power deficit	-20.8%
Tariff Industrial	Rs 1.77 / kwh
Number of phones	560 733
People per phone	80.25
Phone services	DOT, Hughes Ispat
Cellular Services	Modi Communications
Radio Paging	Arya, Hutchison Max

Source: *Government of Karnataka*

Table 4 illustrates the information and electricity generating network in Karnataka. Table 5 shows the transportation networks and export processing zones (EPZs) in Karnataka. Although Karnataka has some 134 000 kilometres of road network, they need to be expanded and upgraded to attract more MNCs and foreign investment. Potholes along main roads, crumbling pavements and badly maintained drains and storm sewers seems to be a common sight in the city centre. The long drawn out tender and selection process

to construct a new international airport in Bangalore is also reflective of the slow process of decision making that discourages MNCs and foreign investment[14].

Table 5: Infrastructure Network in Karnataka 2002

Infrastructure	Unit of Measurement
Railway track length	3089 km
Domestic airports	6
International airports	1
Cities linked	Ahmedabad, Calcutta, Delhi, Mumbai, Thiruvananthapuram
Road length	133 987
National Highway Length	1968
Ports	2 (New Mangalore, Port Karwar)
Industrial zones and parks	23
Export processing zones	1
State-identified priority sectors	Electronics, Informatics, Pharmaceuticals, Telecoms, leather and leather products.

Source: Government of Karnataka

To prevent and mitigate for potential adverse impacts of power shortages, power protection firms such as US MNC APC have an established presence in Bangalore and are expanding their client base. These captive power generating plants are also the norm in IT "hotspots" in Bangalore such as the International Technology Park Limited (ITPL) and Electronics City. The Bangalore ITPL was built as a self contained facility with its own captive power supply and satellite links. Built to international standards it supports high-tech and non-polluting industries such as software development, electronocs, communications, research and development (R & D) and financial services. The ITPL represented a successful model of a joint venture in IT between India and its foreign partners. The ITPL was a joint venture between the Karnataka state government, Tata corporation and a consortium of Singapore companies. Initiated in 1997, the first stage of ITPL was completed in 1999 at a cost of US $ 480 million and officially launched in January 2000 and stage 2 was launched in November the same year[15]. Stage I of ITPL is fully occupied with 91 companies, while 37 tenants have leased premises in stage 2. This encouraging demand for IT facilities has enabled ITPL to initiate phase 3 of its

[14] Rajendra Bajpai, "Tata – led group pulls out of Indian airport project", *Business Times*, Singapore, 17 July 1998 and "Tatas pull –out from airport proect", *The Statesman*, India, 16 July 1998.
[15] *Ascent*, The Ascendas Magazine, Ascendas Land Pte Ltd, Singapore, Issue One, May 2001.

expansion. The ITPL remains the benchmark for IT parks in India with its world class infrastructure and it has the highest number of occupants compared to other Indian IT parks.

The Electronic City in Bangalore also houses a number of established IT multinational companies (MNCs) such as Texas Instruments, Hewlett Packard and IBM. Billion dollar Indian companies such as Infosys and Wipro are also located at Electronic City. The anchor tenant at electronic city is Infosys Technologies, one of the largest IT employers in Bangalore. The success of these IT parks also depended on the speed of satellite communications . Companies with microwave antennae could be connected by satellite uplinks to clients anywhere in the world. Video conferencing is also a norm for Indian IT teams to confer and discuss problem solving with their overseas counterparts dispensing the need for physical presence.

Government Role

In October 1999, Indian Prime Minister Vajpayee announced the formation of the Ministry of Information Technology (MIT) to transform India into a global IT superpower[16]. MIT was tasked to be the nodal institutional mechanism to facilitate IT initiatives from various sources such as the Central Government, the State Governments, Academia and the private sector for the overall growth of the IT sector. MIT's main target was to implement a comprehensive plan to achieve a target of US $ 50 billion in software exports for India by 2008. In October 2000, India's Information Technology Act came into force making India one of the few countries in the world and the second after Singapore to have an IT Law. Regional governments in the various states also began to attract direct foreign investments in the IT industry. The various state governments took its cue from the federal government on IT matters and implemented their own IT strategies. In late 1999, S.M. Krishna took over as Chief Minister in Karnataka and continued the state's development as an IT hub[17]. Krishna introduced several incentives

[16] Tony Allison, "Software-the arrowhead of India's IT weaponry", *Asia Times*, 7 December 2000.
[17] "Survey – India: Information Technology", *Financial Times*, London, 1 December 1999.

to attract more investments like cyber parks, one – stop IT unit of approval, a convention centre built to international standards and fiscal measures. The fiscal measures included incentives such as exemption from stamp duty, 100 percent exemption from entry tax on computer hardware and other inputs which proved popular with multinational corporations (MNCs). By the end of 2001, there were more than 100 MNCs in Karnataka and the cumulative investment in the software[18] industry amounted to some US $ 1.3 billion.

Human Resource Pool

Indian produces about 80 000 skilled IT workers every year but the majority of them prefer to work overseas especially in the US. The remaining IT workers from across India usually shift to where the IT hubs are like in Bangalore. Out of the over 1000 software companies in India, more than a quarter are located in Bangalore. In addition to their English speaking skills, Indian software engineers and other skilled IT workers have excellent skills in hardware programmes like IBM Main Frame, MAC, Novell LAN, AS-400 and others. Indian software companies also have competency in project management to develop software but ensuring overall cost effectiveness, quality and timely delivery. To publicise their competency, Indian software companies had achieved ISO 9000 certification and SEI CMM Levels 2 to 5. However, the main draw about software development in Indian IT hubs like Bangalore is that on average an Indian software engineer is paid four to five times less than their US or European counterparts. This enables MNCs and Indian IT firms to employ more skilled IT labour to work on a project thus reducing development time. While high "turnover" of IT employees are becoming a real challenge in continuity, IT companies have managed to reduce the problem with attractive perks such providing company stock options for staying with the company and the attraction of working on value added projects such as product development.

[18] Software is a term used to refer to the instructions that direct the operation of computer equipment and information content that computers manipulate.

Human resource talent in Bangalore and India as a whole has also improved because the dominant business model in the Indian IT sector has changed from one focusing on Unix computer platform services to one focused on the growing number of Internet related services. Indian software engineers are realising that their capabilities are suitable for a wide range of internet based activities such as e-commerce, data centres, application hosting and medical transcription[19]. While, Indian software engineers had in the past undertaken most of the low cost work and activities for IT MNCs such as coding, this trend is changing. Multinationals in India had mentioned that the training imparted to India IT workers is in tune with industry needs and a large number of these firms also undertake to train those IT workers whom they recruit. Infosys Technologies in Bangalore employs some 4000 people about half of its total work force worldwide. Increasingly, more technology design is being undertaken in India and by Indian entrepreneurs in India. Indian IT firms that had initially started as consulting firms are now developing new technologies and products. Well known IT MNCs such as Texas Instruments, employs over 600 software professionals at their large complex in Bangalore to develop software for digital signal processing to operate many of the gadgets we need such as cellular phones, CD-ROMs, multimedia etc. In terms of salaries and gender disparities, the IT sector in Bangalore seems to be battling the trend of male dominance by having equitable salaries and hiring the best qualified talent regardless of their gender.

The role of the Indian IT diaspora has a significant impact on India. Indian immigrants in Silicon Valley managed approximately 9 percent of all new start ups in the late 1990s. In early 2000, one third of all IT companies in Silicon Valley were either managed by Indians or employed skilled Indian IT workers within its ranks. In 1999, Indian IT workers were issued 165 000 out of the 200 000 H1B visas offered to foreign IT workers in the US[20]. Besides the US, European countries such as the United Kingdom (UK) and Germany have also offered visas to attract Indian IT workers. Even Japan has joined the fray to recruit Indian IT workers when it announced multi-entry visas valid for up to 3 years for Indian IT professionals working in Japan. The downturn of the IT market in

[19] Tony Allison, "Software – the arrowhead of India's IT weaponry", *Asia Times*, 7 December 2000.
[20] Ibid..

early 2001 increased the flow of returning Indian internet veterans from Silicon Valley. These IT veterans brought back with them precious management expertise and knowledge of cutting edge technology which they are using to establish their own start ups in Indian IT hubs like Bangalore[21].

The positive spillover effects of mature IT talent are their abilities to act as mentors to the aspiring fresh IT talent emerging from tertiary institutions in India. Some of those heading back to India will also be entrepreneurs with the ideas and initiatives to establish high-tech companies that will be able to compete internationally[22] According to the Head of Nasscom in Bangalore, Poornima Shenoy, the Indian IT companies in Bangalore are showing promising signs of maturing and the Indian brand name for software services and BPO work is widely recognised. In addition, there is the emergence of well – focused product companies emerging with the correct blend of promoters – marketing, technology teams and management. For India to realise its ambition to be an IT superpower it has to move up the value added chain and be involved in strategic consulting, R & D and providing more web-based and e-commerce interactive services.

Venture Capital and Stock Market Capitalization

The importance of venture capital for the development of the IT industry was reflected by the MIT's decision to establish a National Venture Fund for software and IT development with the assistance of the Small Industries Development Bank of India (SIDBI) and the Industrial Development Bank of India (IDBI). The objective of the fund is to provide venture capital for software professionals to nurture their small scale start–up companies. In relation Venture Capital funds in India, they will only be taxed in the hand of investors but will not be taxed on the amount of distributed or undistributed income[23]. In its efforts to attract foreign investments to India, the Ministry of Finance has also given the approval to source for funding overseas[24]. Under the liberalised scheme, Indian companies that are keen to issue American Depository Receipts (ADR) or Global

[21] Madanmohan Rao, "Silicon Plateau of India: Hope and Hype in Bangalore", *Bandwidth*, November/December 2003.
[22] Greg Gretsch, "Valley diaspora set to rock India", *Economic Times*, India, 22 March 2004.
[23] "India: Market Strategy", *Merrill Lynch*, Sub-continent Snapshot, 17 April 2000.
[24] "India firms now free to tap funds overseas", *Business Times*, Singapore, 21 January 2000.

Depository Receipts (GDR) could go ahead after appointing a mechnat banker that is registered with the capaital markets regulator. Firms raising money in this way would need to inform the Finance Ministry and the RBI 30 days after the issues[25]. This benefited well known Indian IT companies like Infosys Technologies which has seen its ADRs rise nine times its original value to US $ 308. The liberalised foreign investment regulations would enable ADR and GDR to function as domestic issue shares. Companies could also sell their shares directly to investors is the isdue is managed by an investment banker registered with the US Securities and Exchange Commission, under the UK Financial Services Act, or other appropriate regulatory authority in Europe, Singapore or Japan.

IT hubs like Bangalore have gone further to attract venture capital firms to establish a base in their respective states. The state government of Karnataka together with the Confederation of Indian Industries (CII) have even organised a Global Investors Meeting in June 2000 in Bangalore to attract investors to Bangalore and India as a whole[26]. Encouraged by the initiatives to attract foreign capital to India and concerned over the after effects of the global IT crash with the failures of dotcom companies, venture capital firms in India have become more discerning in investing their money in India. Venture capital firms are concentrating their focus on tech start ups with strong revenue models rather than firms backed by little more than internet ideas. However, this may be beneficial to IT hubs like Bangalore because venture capital firms are interested in areas such as software services, IT services that drive or speed up the internet, wireless applications, computer networking and telecommunications[27]. Leading global venture firms such as Walden, Draper and Intel Capital have established operations in India. The potential for Indian companies to develop cutting edge technology solutions has been enhanced with the clustering initiatives and interaction between private industry, tertiary institutions and government backing. Westbridge capital had observed that investments are shifting into pure technology companies that could create more revenue and a clearer path to profitability. Westbridge capital had launched a US $ 140 million fund for Indain tech companies with a focus on start ups in information technology (IT) and IT enabled

[25] Ibid.
[26] "Global investors meet in Bangalore", *The Hindu*, 7 May 2000.
[27] "Venture capital funds embrace India's tech toddlers", *Business Times*, 21 November 2000.

products and services[28]. Other venture capital firms like Accordiant ventures a US based fund had announced plans to invest US $ 250 million in Indian IT firms working on semi-conductors, internet infrastructure and wireless telecommunications.

Venture capital firms are also drawn to Bangalore because of the increasing joint ventures (JVs) between Indian corporations such as Tata and global IT firms like IBM. The JV company is TISL. TISL was conceived in 1992 and indicated IBM's official return to the Indian IT scene after its exit from India in 1972. IBM and Tata are compatable business partners as they viewed the IT business in similar terms. Bangalore was an ideal location for TISL because of its creative talent and innovative dynamism. According to a TISL executive, Bangalore has the same conditions for innovation as the aerospace boom in Southern California, the US in the 1960s. Part of the culture of innovation came from IBM's departure in 1972. India's IT isolation until the mid 1980s compelled India to leapfrog over obsolete technology. Without IBM to dictate computers and programming languages, there was no prorrietary software base, every software base became transparent and India became a Unix power. The vacuum created by IBM's departure also forced Indian companies to source indigenously for software creating the skilled talent pool that attracted the MNCs back to India to places likeBangalore.

Challenges

The government driven National Task Force on Information Technology and Software Development aimed at attracting foreign investments into the software sector came with a massive price tag. Heavy investments in the form of STPs was a necessity with their earth stations, gateway switches, high-tech data communications, professional training, marketing and support services. These heavy investments in infrastructure, transportation, education and environmental improvement are needed to develop these areas compete in the international software trade. For education alone, the state government is trying to use IT to provide computer training facilities in schools, universities and other tertiary institution. The policy initiatives implemented in Karnataka state might entail some problems. For example, government policy might be held captive to the needs of

[28] Ibid.

dominant IT firms in Bangalore and scarce government resources might not be allocated efficiently.

India's main software export market is the United States (US) followed by Europe which is highly vulnerable to the volatility of the international IT industry. The revenue earned by Indian IT companies could also be improved from the low-end customised packages to those involving coding and testing of software conceptualised by their foreign clients[29]. Apart from inadequate infrastructure and cultural differences, Indian software firms need to consider the geo political situations that will affect their global delivery capabililities[30]. Indian IT companies with a local presences have to develop and market credibility such as building a reliable brand together with a decentralized off shore decision making structure. Indian firms have to specialise and not generalise its expertise because their competition will adapt to offering offshore services and exploit specific market niches. However, Indian IT companies even large ones such as Infosys are subjected to customer "churn", that is, as Indian companies gain new customers they are also loosing their existing ones. While the Indian companies may have overall added to their number of clients, the have to gather more new clients as to offset increasing loses of existing clients.

Bangalore land and rental prices have increased sharply with the expansion of the IT industry. This and the lack of infrastructure to meet growing demand for services has companies looking at other emerging IT hubs in alternative cities such as Chennai, Hyderabad and Pune. The inflow of IT talent from across India are flowing to Bangalore, indicating that Bangaloreans are not reaping the full benefits of the IT reveolution. Other challenges includes the digital divide will also have a strong influence on the trends of IT development in Bangalore and India as a whole. The recent general elections suggests that the benefits from IT and outsourcing business that has created thousands of jobs in India for the middle class has not had much impact on the rural population of India. Following the ouster of Chief Minister Chandrababu Naidu of Andhra Pradesh, Chief

[29] Amit Roy Choudhury, "Is India's IT Just a Bubble"? *Business Times*, 23 August 2000.
[30] "Indian IT firms not quite there yet", *Economic Times*, India, 26 September 2002

Minister S.M. Krisha of Karnataka appeared to have been unseated by the rural voters. Reportedly, the rural voters felt that he had paid little attention to the poverty, illiteracy and lack of amenities that they had to face on a daily basis[31]. The objective of spreading the use of IT for e-commerce and e-governance to bridge the digital divide.

Whether this would have larger implications for the IT sector in India's high-tech hubs such as Bangalore remains to be seen as MNCs, foreign investors and Indian companies involved in IT work take stock of the election results. The elections does indicate that the euphoria of job and business creation due to the IT boom and especially outsourcing of IT enabled services has not had much impact for the majority of Indian voters especially those in the rural areas. In relation to gender, less than 10 percent of all skilled IT workers in India are women because of the type of training required and the frequent travelling which it involves[32]. While Bangalore deservedly receives accolades for being able to attract over 1000 MNCs and Indian firms into India that employs over 120 000 people, the paradox is that Bangalore also has the highest suicide rates among all the other states in India. The alarming suicide rates which are 35 per 100 000 compared to the national average of 11 per 100 000 are many and interlinked. More disturbing the age group most affected by suicides are in the 15 to 45 years range, the most productive years for most people. The transformation that has taken place in Bangalore over a short period of 10 years or so since the mid-1990s is seen as a major contributing factor to the high rates of suicide[33].

The change of life-style and values -back city favoured by penshioners and "honey mooners" has led to increasing in migration from other regions in India. The socio-economic result has been increasing alienation as supporting family networks have broken down or simply non-existent. Bangalore is also known for its pub scene with 3500 outlets selling alcohol and 27 percent of attempted suicide has been under the influence of alcohol. Academic pressures to succeed in education especially in private schools has increased the pressures on student's expectations.

[31] "Bangalore leader ousted", *Straits Times*, Singapore, 14 May 2004.
[32] Tony Allison, "Software-the arrowhead of India's IT weaponry", *Asia Times*, 7 December 2000.
[33] Meenu Shekar, "High-tech Bangalore also leads in suicides", *Straits Times*, Singapore. 11 January 2002.

Conclusion

India's establishment of high-tech parks to expand its IT sector using innovative clusters as its main approach is producing positive results. These high-tech parks like those in Bangalore overcomes the impediments caused by India's inadequate overall infrastructure. Despite frequent power failures or "brown – outs", high – tech parks in Bangalore are a huge attraction for MNCs looking to reduce their operational costs by establishing a subsidiary or joint –venture in India. The outsourcing of offshore IT enabled services has strengthen India's role as an outsourcing hub. In terms of human resource, India has an abundance of human talent which are proving their competency among the world's leading IT companies. The Indian Institute of Technology (IIIT) has become known throughout the world. While Bangalore does not have an IIT, it does host the Indian Institute of Science and the Indian Institute of Management including a number of leading colleges in India. The steady flow of skilled IT workers that "migrate" to Bangalore from other parts of India ensures there is no shortage of IT talent in Bangalore. However, competition for more experienced IT professionals of between 2 to 5 years experience to lead development projects is becoming tougher. Skilled IT workers are also also demanding higer pay in Bangalore, hence undermining one of the key factors that has promoted India as an IT hub, that is, low labour sosts. While internal migration towards Bangalore sustains its IT creativity and talent pool, these IT professionals are the new elites of Bangalore. Increasing IT wages also widen the socio-economic disparities between the IT elites and non-IT elites.

Indian companies are achieving international recognition as leading IT players as reflected by their ISO 9000 and CMM Level 5 standings. Indian IT companies in Bangalore are now trying to achieve the six sigma standard of excellence. While high staff turnover is a major problem with the average attrition rate at around 20 percent of total staff strength, company loyalty are usually rewarded and this has reduced the turnover rates. Some companies reported that they have between 12 to 15 percent attrition rate. Furthermore, the contraction of the international IT market has increased the exodus

of returning Indian IT professionals to India to supplement the existing pool and IT companies have various adjustment programmes that include accomodation, schooling for children and adjustment allowances for these workers. Some IT companies have tie-ups with prestigious tertiary institutions and exchange programmes.

Social costs as a result of the IT boom also comes in the form of increasing rates of asthma and lung infection among Bangalore's population especially among the very young. The increasing volume of traffic and the state's apparent inabilility to regulate the number of vehicles and set a minimum emission standard of vehicles will magnify the air pollution problem in the near future. The public transport system in Bangalore consists of buses that are around 20 years old or more and the system of roads are unable to accommodate this increase in the volume of road traffic. Large IT firms prefer to locate away from the congested city and have their business concentrated om sprawling campuses on the city's outskirts, that are between 45 minutes to an hour's drive from the city centre. In most cases, funding for the expansion of Indian IT companies are not derived from venture capital firms but from "internal" sources or the stock market. These factors will have a great impact on the sustainability of Bangalore to continue being the Silicon Valley of India. Power shortages and increasing land prices will add to the costs of product development and the state government has to resolve these emerging problems. For the majority of IT elite group, the digital divide and digital disparity are furthest from their minds and hardly a concern.

The rural poor seemed to bear the heaviest toll of the IT industry as the "gap" between them and the IT elites becomes wider. While some IT companies such as Infosys, Wipro, Tata and Infosys have a community based programme to assist the poor in Bangalore, the majority of IT firms do not take such an interest. While it could be argued that the Indian paradox of rich and poor has been a part of Indian life, the IT sector seems to magnify the disparity. The state governments that are pro high-tech and IT such as those in Karnataka have been replaced but would an alternative state government seriously disrupt or impede a US $ 12.5 billion revenue exporting industry. Using a latecomer strategy to leapfrog competitors and develop Indian IT hubs such as Bangalore, compels India to leverage on

MNCs and foreign investors to expand its IT industry. It will be demaging if IT hubs like Bangalore severs its linkages with MNCs and shifts its emphasis totally towards rural development. A compromise strategy for the government will be to develop the IT sector and the agrarian sector. IT programmes could also be used to educate the rural poor and help farmers to develop a better understanding for market crop prices.

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