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ABSTRACT

This study examines the situation that produced a high-tech industry (software development) despite the generally deprived conditions in the country. The authors examine the legacy of colonialism, the ensuing democracy with a socialist bent, and how the global software industry emerged. Clearly the education system and the prevailing infrastructure in a small southern region of the country were contributory factors. There are some warning sings of dangers ahead.

Keywords: India, software, outsourcing software.

INTRODUCTION

As the British prepared to leave India in 1947 there were many obstacles for the ancient country which was being born anew. However there were some advantages as well, in that there was a functioning infrastructure that the British left behind that would transcend the trauma of their supervisory absence. India's struggle for freedom has its origins in the 1920s (16) when Gandhi was a lawyer in Durban, South Africa. He saw the injustice and harsh treatment of Indians there, and returned to India determined to rid his country of the foreign rulers. He did so vowing to adhere to nonviolent means, which were eventually successful though it took over twenty years (14).

A Constituent Assembly was convened and using the British Parliamentary system as a model produced a document that became the Indian Constitution. It became law in 1950. The Central Government shared its powers provincially, but retained responsibility for defense, foreign affairs, railways, airways, shipping, post and telegraph, and currency (14). The smooth transition from British to "home rule" was testimony to the freedom fighters who understood their roles and the change in those roles as the new country emerged.

The Nehru era (1947-1964) gave way to the next Nehru generation as his daughter Indira Gandhi became Prime Minister (1966-1984). They both had strong socialistic tendencies with the Central Government controlling all decision making, even industrial production. However the stature of Nehru and the aura of leadership were not entirely transferred to Indira whose autocratic leanings led to outright authoritarianism (14). What is important about this era however is that since the Central Government reserved so much power to itself in some critical areas, it was possible to impose programs on the provincial governments. Therefore the infrastructure decisions including transportation, communications, and education all flowed from the center. Through a series of five-year plans Nehru addressed the needs of the private and public sector and dealt with the perceived needs of different sectors of the economy. Thus his planning resulted not in socialism, but in promoting capitalist enterprise in both industry and

agriculture (5). India thus represents the anomaly of a centralized socialist government giving birth to entrepreneurial activity.

There has been continuing speculation about the reasons for the ascendancy of the software industry in India. The preceding discussion describes the socialistic tendencies of the early governments in democratic India, which would seem to discourage entrepreneurial activity, and thus the development of private companies specializing in software. However, a significant factor in software development was the level of education of the population. Once again there was a contradictory situation of statistical information in terms of the literacy rates in India. In this study the authors reviewed some of the paradoxes relating to entrepreneurship and socialism, high technology and illiteracy, export quality software and inadequacy of basic services.

Education as the foundation

The World Education Report 1998 indicated that while India spent 3.8 % of its Gross National Product (GNP) on education, the illiteracy was still around 46% of people over 15 years of age. In comparison China spent only 2.6 % of its GNP on education but had an illiteracy rate of 22 percent (4). This study did not seek to explain the relative illiteracy rates between the two most populated countries in the world. In fact with India's population of over 1 billion people, whose rural population was three times higher than its urban population, the rate of illiteracy has defied central government efforts to reduce it. It was perhaps the challenging state of the infrastructure that inhibited attempts to solve the problem. The rate of illiteracy was much higher for women than men. In 1991 64% of the men were literate whereas only 39% of the women were, and by 1997 men were still 73% literate against 50% of the women (4). Despite the gap in female literacy evidenced by the statistical data, the female literacy rate was growing, particularly in urban areas. Of particular interest in this report was that when literacy was examined regionally, the southern states showed a literacy rate of over 90% compared to 22% for most other states (3). That India has understood the value of higher education is clearly evident in the growth of colleges from 600 in 1950 to 9,400 in 1997, not including 450 engineering colleges and over 1,000 technical institutions (4). Keith Bradhser (2) reported that in 2002 Hyderabad alone graduated 65,000 engineers.

Those engineers also had an advantage that attracted the attention of many U.S. and European firms in need of software development. Engineering students in India were educated in English and had staffed software departments in many parts of the world. India's software entrepreneurs point to some factors in their development: despite a low level of general education, there was a highly educated middle class; the top institutions were world class, and English was the working language (6). Quosol's Fernandez said that "if all the Indian programmers left the country, many IT projects in Malaysia would grind to a halt" (8). However that "brain drain" would soon be lessened with the development of software organizations in India. India's early reputation was "the most regulated economy in the non-communist world" characterized by restrictive licensing regulations, production quotas, and substantial checks on large organizations and foreign investment (10). That reputation would not foster the kind of entrepreneurship that the IT industry needed. Interestingly, Schumpeter (11) argued that restrictive anti-competitive measures may temporarily be necessary in the creation of new industries that require large capital investments. He argued that the risk would be too high for private investors to absorb (11).

Developing countries pursue high-tech development despite high cost in order to avoid "technological colonialism" (10). India is still socially complex. Governing over 1 billion people is a daunting task especially when they are religiously, ethnically, culturally, and regionally diverse. It is comparable to a central government in London governing all of Europe (10).

The embryonic software industry

India's foray into "informatics" was a predictable outcome of the affinity between state-society and demiurge (10). In 1966 the Bhabha Committee outlined goals for an informatics sector in India with a goal of computer self-sufficiency within 10 years (10). In 1970-71 the Department of Electronics (DOE) and the Electronics Commission were founded. The star in the field was the Electronics Corporation of India Ltd. (ECIL). Britain's ICL used ECIL to manufacture computers in India. DOE was unable to meet the growing demand for computer services in India. In the early 1980s Rajiv Gandhi son of Indira, became politically active. He supported the liberalization of the computer industry. When he became Prime Minister in 1984 he pushed joint ventures with foreign partners where local firms were inadequate. Technically oriented managers enhanced computerization. ECIL became responsive when private competition entered the market, and aggressively sought software contracts in various parts of the world. Between 1984 and 1989 the growth of the industry was noticeable. By 1990 the three top firms in India were software firms (10).

Bharat Electronics Ltd (BEL) started as a state run enterprise to supply the military with electronic equipment. Located in Bangalore it employed almost 20,000 people in the mid 1980s, and became India's "silicon plateau" thanks to its pool of engineers (10). However its technological success in wafer production did not translate into profits due to manufacturing inefficiencies. They designed and produced indigenous minicomputers and operating systems, but apart from being overpriced these computers lacked applications, and failed to sell in Europe. Its failure as a consumer commodities manufacturer was contrasted by spectacular success in software integration, designing and developing large-scale custom systems with high social returns.

The Computer Maintenance Corporation (CMC) won a contract in 1987 to computerize an international athletic event in Syria. They completed a system in three months on hardware that was unfamiliar to the development team, and parlayed that success into opening an office in London. They earned a contract with the London subway system, and then tried to acquire a US software firm in order to establish a foothold in the US (10). They wrote a ticketing system for the Indian Railways (second largest in the world) on Digital Equipment Corporation (DEC) hardware and software, and did so as winners of the bid over several countries.

India had a poor IT infrastructure, yet the software industry emerged. Despite a generally low level of education, the middle class was well educated especially in engineering. Private entrepreneurs experienced only rhetoric but weak institutional support. They leveraged their legacy of English from the British, and as Thirtle and Ruttan (14) suggest in their three stages of technology transfer, "a nation must go beyond reliance on simple technology transfer and invest in the capacity to adapt the technology for its own resources and institutional environment." The irony of India's overinvestment in education is that the US corporations benefited from the

Indian émigré population that was well educated but unable to find employment in India (6). The paradoxes continue into the current time, but it became clear that the benefits of this technology transfer were limited to a small percentage of the population in India, and to a small region in the southern part of India. The prosperity associated with Hyderabad and Bangalore should not be generalized to India as a whole. India is still overpopulated and impoverished particularly in the north. A few citizens work in high technology, but the vast majority in low technology (1).

India's industrial sector was kept separate from the electronics industry and its known fast-paced change. However in 1968 the Tata Consultancy Services Ltd was created and became the leading software exporter. The Tata group was already a major industrial conglomerate. As DOE began promoting IT, its growth between 1984 and 1989 was startling: computer production and hardware exports quintupled and software exports tripled. By 1990, the three top firms in India were software firms (10). In 1981 WIPRO was set up and hired away ECIL engineers. In 1989, INTEL designated WIPRO as the official 'beta-test site', and had the first chip implementation in the world.

One company (HCL) started offering replacement applications for old IBM programs. IBM had left India leaving its customers with no support. Applications were developed in UNIX and other technically difficult environments. In 1981 the National Institute of Information Technology was formed to train management personnel. Shiv Nadar a founder of HCL indicated that low cost engineering was India's most important comparative advantage, whereby projects could be completed at a tenth of the cost in the US. Indian subcontractors usually charged 70% of western rates for onsite work and 40% for offshore work. There was a gap between supply and demand for software developers in western countries. US firms looked favorably at India's English-speaking well-educated programmers to close that gap (6).

The growth of the Industry

As the reputation of the industry spread, Indian graduates of prestigious schools around the world returned to India to explore the new entrepreneurial environment and many software ventures emerged. With low cost engineering, these firms were able to compete internationally and produced code that was well respected and well designed (10). The Capability Maturity Model developed by the Software Engineering Institute (SEI) at Carnegie Mellon University evaluated hundreds of companies worldwide. Software teams received rating of 1-5, 5 being highest. Very few companies achieved a score of 5 but Motorola in Bangalore did.

Until 1980 software exports were not significant, but grew at an annual rate of 40% between 1980 and 1994, going from $4 to 314 million (6), where the work was done offshore in India. 65% of the jobs in India were for coding and testing, making India seem like a haven for low-level coding. Table 1 below provides the details of employment and value of the software industry in India between 1993 and 1999:

IT Export Value and Employment in India

Year	Exports*	Domestic*	Total*	Employment#
93-94	330	228	558	90
94-95	485	341	826	118
95-96	734	515	1249	140

96-97	1085	681	1766	160
97-98	1800	900	2700	n/a
98-99	2600	1223	3823	180

*revenue in millions of dollars; # employment in thousands. Source Nasscom, 2002.

Table 1.

In comparison, employment in the US software industry grew 75 percent between 1992 and 1997, and revenue rose from $95 billion to $231 billion (12).

India's impetus came from a highly trained workforce. Significant numbers of workers had specific knowledge of programming languages, hardware, database concepts, and applications. Most vital – they had fluency in English. The advantages India had were cheap skills, low pay scale, and a favorable exchange rate for most western currencies. India's structural reforms in the late 1990s supported the improved economic performance, but while the worldwide slowdown negatively affected the agricultural and industrial sectors, the IT sector continued its resilience (3).

As they entered the software industry, Indian firms offered to either develop or maintain projects on site for a fixed contract. However, the new trend was for well-defined applications to be developed in India. With the improvement of satellite communications, the ability to continue testing and installing will increase (8). As evidence of this change, India's revenue from the IT industry reached $8.26 billion in 2000-2001, an increase of 55 percent from the year before (7). In 2001, one out of four global corporate giants outsourced their IT development to India, raising its IT exports to 14.1 percent of India's total exports. There were 250 certified software companies in India, of which 27 have attained SEI's level 5 certification (7).

It is no wonder that southern India has gained a reputation for software development. Bangalore has 3 universities, 14 engineering schools, and 47 polytechnic schools. The graduates were eagerly sought by the numerous IT firms in the area. Many stayed in Bangalore, rather than move abroad and contributed $840 million to domestic software industry which grew 53% since 1990 (13).

Bangalore's high-tech emergence can be traced to British rule, and more recently to Delhi's ambitious economic planners. Both the British Colonialists and the pos-independence ruling elite invested in Bangalore, which explains the current success. The Language (English) and the Law were the legacy of the British. The British merely encouraged the already rich traditions of learning in India, in the areas of mathematics and science, and importantly the system of higher education that produced the computer professionals of today. According to the Organization for Economic Cooperation and Development, the British system of Commercial Law was reliable and was noticeably lacking in China. Bangalore reflects decisions made by post-independence governments in New Delhi. Nehru called Bangalore "India's city of the future." His vision was to create an environment where scientists could get away from crowds and distractions, and produce ideas and programs to guide India's goal of achieving economic and military self-reliance. For more than four decades, the central government invested heavily in building Bangalore's infrastructure, and the country's most advanced military and space research facilities (13).

CONCLUSION

India is an ancient country with rich social and religious traditions. Amongst those traditions was the respect for learning, and a history of entrepreneurial activity. During the long period of British colonial rule, India's population while deprived of many freedoms, benefited as well. The British left behind a strong infrastructure including a legal system, a system of government, and English as the medium of instruction. That combination could be potent if leveraged appropriately.

Serendipitous occurrences, in the form of political leaders and relaxing of some critical policies in India, combined to unleash what some would deem unexpected new source revenue for its entrepreneurs and for the nation as a whole. This study has identified a region in India that has developed a reputation for world class software development. It is a well deserved reputation and appears to be impervious to cyclical global economic fluctuation. However, it is important to refrain from generalizing this regional success to the rest of the country.

India remains a poor country with significant poverty, illiteracy, and unemployment and the human consequences thereof. The unparalleled success of the software industry in Bangalore has not generated material benefit to any other part of the country or its citizens. In fact even in the regions of this spectacular success, it is only a small segment of the population that has benefited from the IT phenomenon.

The future of the software industry in India could be challenging. China has eyed the developments with a critical eye. China will undoubtedly respond, and create competition for the available business. In order to do that China will have to make significant changes to its education system and incorporate the instruction of English from an early stage. Indian software firms have already diversified into helpdesk service and software maintenance. If they expect to maintain their lead in the industry over other nations, they will have to continue a proactive approach and avoid being satisfied with the status quo. Another potential issue is a growing debate about the strategic and security exposure of US firms that outsource their software development to foreign contractors. India can ill afford a serious degradation in its flagship export revenue generating industry.

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