INDIAN SOFTWARE INDUSTRY: INNOVATION AND GROWTH

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Certificate

This is to certify that the dissertation entitled **"Indian Software Industry: Innovation and Growth"** submitted by Manoj Tirkey in partial fulfilment of the requirements for the award of the degree of **Master of Philosophy** of this University is an original work according to the best of our knowledge and may be placed before the examiners for evaluation.

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Dedicated to

Ma & Baba

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CHAPTER - I

INTRODUCTION

"In ten years, even the mountains move", says a proverb. The radical transformation of the Indian Software Industry[1] over the last decade aptly epitomizes the proverb. The benefits of which are now being realized in wide ranging areas of the economy much beyond the realm of the industry itself.

1.1 Radical Transformation

India's software industry has indeed transformed itself from a position of relative obscurity in the 1980s to a position of eminence today. The rapid growth rates recorded by it are unparalleled in the history of Indian economy. Being export oriented, it has resulted in unprecedented spill over ranging from such intangible benefits as bringing international prestige to the "Made in India" brand to tangible benefits like making huge contributions to the country's foreign exchange reserves. Among its long term effects are: the general improvement in the perception of the country abroad[2]; approval for enterprise and entrepreneurs by the political class at home, both of which were despised earlier; general acceptance of reforms by the political elites and the common people who had only reluctantly accepted it in the early 1990s (Kapur 2002); accumulation of technological competence in software design and development, which is comparable to the best in the world; and emergence of India as a major hardware design and software &

[1] Software Industry includes firms involved in the business of selling software services, IT Enabled services, software products and manpower support for client site operations.
[2] See Business World (2004), 'Made in India: a paradigm shift', Vol. 24, No. 7, 6-12 July, p. 56.

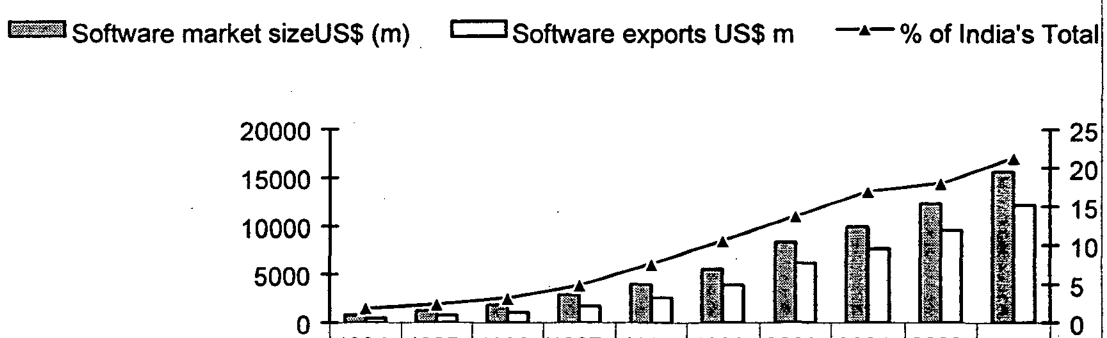
services destination in the world, which has prompted many top global companies to set up their Research & Development (R&D) and software development centres in India[3].

The Software Industry has been experiencing a phenomenal growth rate of about 50% since 1991 (Krishnan & Prabhu, 2002). From meagre revenue of $ 787 million in 1994-95, it has grown to an astounding $ 12.3 billion in 2002-03 and it is expected to touch $ 15.5 billion in 2003-04 (NASSCOM 2002, 2004). In the last decade, software and services exports have recorded an annual compound growth rate of 60% in rupee terms and around 45% in dollar terms (Parthasarathi & Joseph, 2002). From modest exports revenue of $105 million in 1989-90 it has grown to $9.5 billion in 2002-03 and is expected to grow to $12.2 billion in 2003-04. Whereas software constituted only 1.9% of exports in 1994-95 by 2002-03 it had shot up to 18%[4].

Software industry has also emerged as the prime driver of the overall foreign exchange reserves. While its contribution to overall invisible earnings was less than 18 percent in 1997-98, it increased to 59 percent in 2002-03 and the contribution is expected to go up to 73 percent in 2003-04 (NASSCOM, 2004.).

[3] For example, GE, Texas Instruments, CISCO Systems, LG, Philips, et al have either set up R&D centres or software development centres in India.
[4] See Nasscom (2002) & Nasscom (2004) report for a detailed report on the Indian Software Industry's performance.

Fig. 1.1 **Indian Software Industry's Performance**
Source: NASSCOM (2004)



	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04E
Software market sizeUS$ (m)	787	1253	1895	2936	4011	5539	8298	9958	12314	15574
Software exports US$ m	489	754	1100	1759	2600	3962	6217	7647	9545	12200
% of India's Total Exports	1.9	2.4	3.2	4.9	7.6	10.6	13.8	17	18	21.3

Potentially the most important long-term benefit from the success of the software exports sector is the global recognition of the nation's intellectual prowess and its ability to deliver quality products. The spill over of India's IT expertise can be exemplified by the fact that where as a decade earlier, foreign importers of Indian goods were wary of making known the source of those products, today the 'Made in India' brand is not only accepted abroad, but also helps in realizing a premium[5].

Success of first generation entrepreneurs like Sabeer Bhatia, Vinod Khosla, Narayana Murthy and his co-founders of Infosys, and numerous others, has not only built confidence among the political class on Indian enterprise and entrepreneurs but also

[5] Jindal Vijatnagar Steel, for example, has been exporting steel ingots, but unlike in the past when the importers prevented the embossment of the 'Made in India' mark, today it is readily accepted (Businessworld 2004). Similar other examples include vehicle exports by Indian auto companies.

inspired the younger generation from non-business backgrounds into looking at enterprise as a career option. Perhaps for the first time in Indian history, enterprise was being celebrated as opposed to being derided. The business culture and commitment to society and nation building of the new generation of IT entrepreneurs has become the mode for emulation. The fact that one need not face a choice between making money and making it "cleanly" is a revolutionary idea for most young Indians and indeed it has the potential to give rise to a new breed of entrepreneurs (Kapur 2002).

A relatively faster pace of economic advancement of states[6] that have promoted the development of software industry has prompted the laggards to follow suit by taking appropriate reformist measures to attract investments. Even Marxist Bengal, a state that disdained Capitalism, has been wooing the IT sector for making investments there. Thus even the worst critics of reforms of the early 1990s, when they were first being implemented, have legitimised it.

Over 60 percent of the software revenue is generated from the highly competitive exports market (NASSCOM, 2004). To be competitive in this market, software companies are required to adhere to the exacting standards of the customer, both in terms of the development of the software as well as its timely delivery. Most of the projects that are undertaken involve onshore and offshore operations requiring a certain number of members of the project team to be located either at or near the client site. This proximity

[6] Karnataka, Maharashtra, and Delhi National Capital Territory are among the first states to build infrastructure and attract investments in IT. However, Tamil Nadu and Andhra Pradesh too have been providing good competition. Laggards like West Bengal, Punjab, Kerela, et al, have also attempted to emulate the successes of former states, but with limited success.

to the client as well as the exposure of having to work in the world's largest[7] and most competitive software market, the US, serves well in honing the skills of Indian programmers resulting in significant enhancement in the technological capability of software companies.

The increased competence of the Indian software professionals has not only enabled domestic software companies to foray into high-end consulting, product development, and R&D services but also attracted transnational corporations to India. Many global high-tech companies, attracted by the abundance of highly skilled software professionals, have set up their own Development Centres in India to carry out R&D and support services for the parent company. The potential for spill over of 'know how' from foreign owned units are immense for the domestic industry.

1.2 Innovation and Learning

Software industry being a knowledge intensive industry is often referred as hi-tech industry and India's success in this industry has prompted some observers to argue that latecomers can do well in hi-tech industries.

However, going by the R&D expenditure of Indian software firms it would be difficult to categorize them as 'high technology firms'. Infosys Technologies, one of the

[7] US is the world's largest software market with an IT spending that is about 50 percent of the world's total IT spending and it is also the most competitive with a well developed software industry (NASSCOM, 2004).

leaders in the industry, spends about 0.38 percent of its sales on R&D[8]. Similar is the story for other software firms in India.

Some observers argue that given the customized nature of the tasks undertaken by Indian firms, every new project is a new learning experience and may involve a fresh understanding of the problem apart from deployment of new technology and approaches for solving it. Therefore, they argue, R&D expenditures in such firms are understated. The ambiguity in the firms' real R&D expenditure and the corresponding learning notwithstanding, there is some evidence of business specific knowledge creation in the software industry through the execution of these projects[9].

Therefore, our attempt to understand the innovation orientation of software firms will include a broader definition of the term 'innovation' which will include technological, managerial, and organizational innovation in the software industry. A detailed conceptualisation of the term has been done in the third chapter. By this broader definition even the idea of offshore development through a 'dedicated offshore centre' is an innovation.

Since its inception, the industry has acquired various technological capabilities as well as domain knowledge in its effort to upgrade the organization's knowledge base. Some examples include the industries ability to quickly master the UNIX platform during

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[8] See Infosys Technologies Ltd. *Annual Report 2002-03*.
[9] Development of solutions for customized projects often require a team to be located at the client site for understanding the client's business. This exposure to the client's business procedures results in significant enhancement in domain knowledge of the deployed software professionals and consequently their firms.

the early phase and then adoption of the Java platform and the parallel .NET framework when the Internet market exploded. Another prominent example is the industry's swiftness in providing Y2k solutions for legacy systems in the US and European markets. Yet another area where the industry has demonstrated its fast learning ability is in adopting quality systems. Starting with ISO 9000 certifications Indian firms have moved up to acquiring SEI Capability Maturity Model (CMM) Level 5 certifications[10]. NASSCOM estimates that 65 Indian firms had acquired CMM Level 5 certification by the end of 2003, accounting for more than 50 percent of the total strength (NASSCOM 2004). Many of these firms are now seeking People-CMM certification[11].

Several innovative measures aimed at improving profitability and increasing competitiveness have been taken by software firms at various stages of their evolution. A detailed representation of these initiatives has been made in the fourth chapter. A summary of those initiatives would include the traversal of software firms from being providers of software labour ('body shopping'), to custom software development, to high-end work like IT consulting, product development, and Research & Development services for global software and hardware companies.

[10] SEI is the abbreviation for Software Engineering Institute of the Carnegie Mellon University, which has developed the Capability Maturity Model frameworks for quality assessment of software companies. The assessment is done at various levels, Level 5 being the highest.

[11] People-CMM is a process at managing and developing an organization's work force. It comprises of five maturity levels that lay successive foundations for continuously improving talent, developing effective teams, and successfully managing the people assets of the organization.

1.3 Driving Forces

In the process of evolution of the software industry from its rudimentary state during the 1970s and 1980s to its present day towering status in the Indian economy, several factors have been identified as the enablers of rapid growth of the industry. While some factors can be attributed to the government for its policy initiatives and some as a matter of serendipity, some others can be termed as idiosyncratic to the country.

Since independence the policies in this country have been driven by the primary objective of technological self-reliance (Forbes 1999). It was this desire to become self-reliant which prompted successive governments to make heavy investments in the key strategic sectors like atomic energy and space and the public sector. The government also created a massive R&D infrastructure of laboratories under the aegis of Council for Scientific and Industrial Research (CSIR) and the Defence Research & Development Organization (DRDO). Some of these institutions became the source of skilled staff for the use of software industry during its nascent phase[12].

Starting in the 1950s the central government has been establishing prestigious institutions like the Indian Institute of Technology (IIT) and Regional Engineering Colleges (REC). Likewise, state governments and some private players have also been establishing engineering colleges. These are the institutions that provided the skilled

[12] Since the government laboratories and some public sector units had the most modern computers in the country they also possessed the manpower who were skilled to operate them. The private sector software startups used this manpower to get a head start in the industry (Heeks, 1996).

manpower to the software industry when the software market exploded in the late 1980s and 1990s and they continue to do so till today.

Apart from the above-mentioned long-term measures, the government also initiated policy measures to promote the software sector through out its growth trajectory. A detailed analysis of all the policy measures taken by the government has been provided in the fourth chapter. However, some of the important measures that may be mentioned here are: the institution of Software Technology Parks of India for establishing software processing zones and furnishing them with the required infrastructure like high speed data links and continuous power supply; establishment of Indian Institutes of Technology (IIT) and Indian Institutes of Information Technology (IIIT); and 100 percent tax exemption on profits from software exports [Parthasarathi & Joseph (2002) and Kumar, N. & Joseph, K.J. (2004)].

Serendipity and idiosyncrasy also had some role in the software industry's growth. By 1980s India was clearly lagging behind some East Asian countries in manufacturing (Kapur 2002). With the shift of the high technology manufacturing capacities to some of these East Asian countries like Taiwan and Korea, hardware got commoditised, bringing down their prices substantially. The decline in price of the Personal Computer accelerated its adoption among the masses, thus providing a boost to the software market, especially in the US where diffusion of computers was fastest. This created the demand for software programmers and India with its massive infrastructure for higher technical education was aptly placed to serve this demand. Another factor particular to this country that gave competitive advantage to Indian firms was its location in a time zone, which ensured a virtual 24-hour workday for its principal market, the US. Yet another idiosyncratic factor that made India the favourite source for software as well as manpower was this nations proficiency in the English language.

Lastly, a lot of the success has to be attributed to the adroitness of software firms who have been swift in adapting to the fast changing technological requirements of the industry. The most notable characteristic of Indian firms towards this end has been their strong customer focus and quality consciousness in execution of their clients' projects.

1.4 Some caveats to the euphoria

Rapid growth of the industry and its success in the export sector notwithstanding, experts suggest that if India is to maintain its lead in the software sector it must 'move up the value chain'. Orlando Ayala, former group Vice President of Microsoft, emphasizes this need for the Indian software companies to upgrade from providing low cost services to high value services that are not available elsewhere. He further emphasizes the need for Indian companies to invest in long term R&D and develop innovative solutions for the next generation platform - the Internet[13].

[13] See, 'It's now or never', *The Economic Times,* May 10, 2001

A new set of problems has arisen because of the rapid growth of the software industry. Today we have 'cybermarts'[14] and bullock carts operating simultaneously in the economy. There is widespread disparity in the growth rate clocked by the traditional sectors of the economy. Agricultural and other industrial sectors, which constitute a major portion of the GDP, are lagging far behind. The agglomeration of software industries in some big cities and towns has further aggravated the regional economic disparities. The ability of the software industry to attract engineering talent from other disciplines has the potential to debilitate other traditional sectors (Joseph & Harilal, 2001).

This unprecedented but unbalanced growth of the software industry vis-à-vis other industrial sectors has raised many questions in the spheres of policy-making, the academia, and in the software industry itself. How have the Indian firms and the software industry evolved over the last decade? What factors have contributed to the industry's rapid growth? What role has innovation played in its growth? What do R&D and innovation mean in the software industry sector? Are Indian firms moving up the value chain (becoming more innovative)? These are some of the questions that need to be explored.

[14]'Cybermart' symbolizes the existence of hi-tech world comprising of a complex network of high-speed fibber optic communication lines, cable lines, the telecommunication infrastructure, and Internet service providers, enabling the convergence of telecommunication and the Internet.

1.5 Specific objectives of the study:

1. To evaluate the process of innovation and learning in Indian software firms.
2. To study and analyse the role of the State in fostering or inhibiting innovation and growth of software firms in India.
3. To study and analyse the various innovative measures taken by the software firms.

1.6 Research Methodology

1.6.1 Data sources

The data for the project has been sourced from various studies undertaken on India's Information Technology Industry in general and software industry in particular. The data has been derived from published works comprising of books and articles.

The articles have been extracted from –

- Newspapers
- Magazines
- Journals
- Internet

Alternative documentary sources include statements on policies, policy resolutions, press notes, and Government of India notifications and publications. National Association of Software and Services Companies (NASSCOM) is the main source of data for studying the global markets and evaluating the growth of the industry. NASSCOM's reports on industry-wide data have also been used to study the quality initiatives of Indian firms and the various innovative measures taken by them to remain competitive.

1.6.2 Method of Analysis

The method of analysis adopted for the study is a mix of qualitative and quantitative techniques. The aim through out the study has been to maintain a balance between the two techniques. While the first part of the dissertation comprising of the first three chapters has been overwhelmingly theoretical involving qualitative analysis, chapter four involves some quantitative analysis. However, quantitative analysis in this study has been limited to the use of data tables, line graphs, and bar graphs.

1.7 Chapter scheme

Following the introduction, a theoretical framework for reviewing various studies conducted on the Indian software industry is provided in the second chapter. The literature review is done under four headings: genesis of the growth of software industry; export orientation: causes and consequences; brain drain Vs brain circulation; and India's competitors: what are there chances? The third chapter provides the analytical framework for the study. The key concepts of Research & Development and innovation are conceptualised in this chapter. Additionally, several frameworks or models are explored to understand the process of learning and innovation in software firms. The first part of the fourth chapter comprises of a detailed analysis of the policy frameworks since the inception of the software industry. In the midsection of the chapter a brief history of the industry and its growth has been outlined. In the concluding section, the process of innovation in India's software industry is evaluated and the various innovative measures taken by software firms have been delineated. The last chapter provides the conclusions of the study.

CHAPTER - II

LITERATURE REVIEW

The approach we take to develop the theoretical framework for the study is to briefly review various studies conducted on the Software Industry. We have categorized the review of literature under four headings. In the first part we explore the genesis of the growth of today's software industry. In the second, we examine the export orientation of the software industry, its causes and consequences. The third part is about the generic issue of 'brain drain[1]' and the more recent phenomenon of reverse brain drain leading to 'brain circulation[2]'. Finally in the last part we take a look at India's competitors and their chances in the software export market. A short conclusion follows the last section to end the chapter.

2.1 Genesis of the growth of software industry

The genesis of today's rapidly growing software industry occurred during the late 1960s and 1970s. In the early phase a number of companies, such as the Computer Maintenance Corporation (CMC) (1978), Tata Consultancy Systems (TCS) (1968) and Hindustan Computers Limited (HCL) (1976) were established (Evans, 1995; Heeks, 1996). Some of these companies started as hardware producers, but in the course of time they either spawned software units or evolved into software companies themselves.

[1] It is a common malaise faced by many developing countries. It implies the flight of Human Capital to locations in advanced countries because of better opportunities there.
[2] 'Brain circulation' is a more recent phenomenon and is characterized by the reversal of brain drain. The term encapsulates the return of Human Capital to the home country and creation of trans national networks of scientists and engineers to facilitate transfer of technology and knowledge.

However, it was only after a shift in the government's policy from a protectionist to a promotional one in 1984 that software production got a boost (Evans, 1995). Further, the establishment of other firms like Wipro, and Infosys bolstered the growth of the software industry.

However, the state's role in building higher education and R&D institutions cannot be underestimated. The government's heavy investment in tertiary education and R&D laboratories, which is sometimes maligned, helped create the Human Capital and 'infrastructural clusters' that formed the starting point for the growth of the software industry (Kapur 2002).

By the late 1980s, India had become a clear laggard in manufacturing, even as East Asia was marching ahead. At this juncture, as Kapur (2002) points out, two events occurred simultaneously and serendipitously: the software industry boom accelerated with its locus in the US as value addition shifted from hardware to software[3], and India began to liberalize its economy. Another factor that helped was Indians English language skills – a result of a 'historical comprise[4]'. With East Asia locked into manufacturing, India's under-utilised abundance of human capital assets suddenly found a booming demand for which alternative suppliers were not easily available. Some local

[3] As the manufacture of computer hardware got commoditised and shifted to East Asia the cost of computers declined sharply. With increase in adoption of computers the market for software applications that run on them exploded and signaled the shift of value addition to software.

[4] After independence there was considerable pressure from the north Indian nationalists to promote Hindi as the national language and dispose of the imperialist English, however the government had to persist with English as the unifying force amidst opposition from the southern states, chiefly Tamil Nadu, against the imposition of Hindi.

entrepreneurs grabbed the opportunity and set up software services companies and others who shifted to the US made huge fortunes for themselves few years later.

During this phase a number of foreign hi-tech companies set up units in India, particularly Bangalore. The stimulant for the influx of these companies was an improvement in the Foreign Direct Investment climate and the creation of special software technology parks (managed by the Software Technology Parks of India [STPIs]) (Tschang 2001). One notable MNC investment was by Texas Instruments (TI), which set up a design facility in Bangalore in 1985. The chief attractions were - easy availability of skilled manpower at low cost, STPI's provision of a one-stop window for government approvals, and a satellite link and other facilities that ensured TI's smooth operations. TI thereafter became a referral example for other MNCs to invest in India.

Unlike other sectors, government intervention in the software sector has been limited. In the early phase its role was merely to reduce state intervention rather than promotion (Dedrick & Kraemer 1993). Kapur (2002) contends that the industry's success has largely been a private initiative. A former IT minister, Pramod Mahajan, has testified this notion. He once remarked that India is a leader in "IT and beauty contests, the two areas that the government has stayed out of." Though the statement appears to have been said in jest, there is some merit in it. The Indian software industry is driven by private sector firms who compete in the global market with limited role of the government as a facilitator or producer.

[Parthasarathi & Joseph (2002), Kumar & Joseph (2004)], however, disagree with this view. They point out that there has been a significant contribution of the government by way of promotional measures ranging from the setting up of the STPIs from where 70 percent of India's software exports originate, to providing high speed data links, to numerous fiscal measures of which the most notable is the 100 percent income tax exemption on profits from software exports, to the establishment of IIITs (Indian Institute of Information Technology). They also draw the attention to the many contributions of public sector companies in major IT-based systems. These contracts for both the domestic and export markets have been in frontier areas of IT applications, for example, computerization of railway ticketing and freight handling, major port automation, airport automation, automation and management of international games and telecommunications - both switching and transmission. The public sector firms involved in these services CMC[5], RITES, TCIL, Bharat Electronics, and Electronics Corporations of India Ltd (ECIL).

2.2 Export Orientation: Causes and Consequences

The 1980s saw the software industry confront a set of hardware policies, which denied them access to necessary tools[6], except for developing software for export. Given this situation, the industry had at its disposal an abundant supply of human resources and a poor infrastructure[7]. The two combined to create a software industry with a strong export

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[5] Computer Maintenance Company has now been acquired by the Tata group the owners of India's largest software company Tata Consultancy Services.

[6] During those years of scarcity the government maintained a tight control of foreign exchange and hence for importing any hard ware the Indian companies had to guarantee exports.

[7] The telecom and power infrastructure was relatively underdeveloped in the early phase of the industry.

bias, and has since lagged in production for the domestic market (Dedrick & Kraemer 1993). The circumstances seemed appropriate for 'body shopping' i.e. sending software workers abroad for executing projects rather than exporting software developed at home.

The empirical evidence shows overwhelming dependence of the industry on software services and the U. S. market while the contribution of software products and domestic market were negligible[8]. Approximately 70% of export services consisted of onsite work, while only about 30% were of offshore type (Chakraborty & Jayachandran 1999). This overbearing imbalance has been attributed to the Software Company managers' apprehensiveness about the direction of Government policy changes, at least until recently. Frequent changes in government and in political ideologies have encouraged Indian firms to undertake business activities free of bureaucratic control at home and focus on short term, low risk activities available abroad. In the initial phase, this apprehensive psyche of the software manager was responsible for the promotion of 'body shopping' as a model for servicing foreign clients. However, some observers have accused Indian entrepreneurs of a 'trader mentality' for their use of 'body shopping'

Heeks (1998) illustrates some other incentives for the firms to resort to body shopping. He argues that onsite work meant savings for the company, as it was not required to purchase any hardware or software. Likewise, it also implied that the company was not required to make big investments in setting up technological infrastructure in the home country. Additionally, since this form of export relies on links

[8] More than 60% of revenue for this industry is generated in the U.S. market. The domestic market explains only 17.5% of the total software revenue. [Source : survey of Chakraborty et al (1999)]

with foreign collaborators, it does not require such a level of marketing and financing as competition within the open market would. Thus the Indian firms enjoyed an almost 'inputless' export that required only a contact overseas, a little finance, and the names of some local programmers who can be hired if a contract is forthcoming.

Given the nature of onsite work requiring only programming skills, Indian firms continued to export software workers who were good programmers but lacked higher software and management skills. Besides, most of these firms have the practice of promoting software workers to management positions based on seniority rather than potential. Quite predictably, the combination of these two practices has created such an image of Indian firms among the clients, which could potentially inhibit their future growth. The foreign clients based in the US perceive Indian vendors as "good and willing learners, receptive to new ideas, and flexible in terms of the software and hardware platforms for which they provided services". However, they have the impression that Indian firms lack domain knowledge and possess poor management skills Arora, et al (1999b). They believe that Indian firms cannot work on high level specifications or project definition stages of a project, although for the most part, this belief remains untested.

Export orientation of the software industry has also affected the very character of the corporate system of Indian software firms. Lema & Bjarke (2003), for example, suggest that the software industry's corporate culture is, for the most part, a result of the adjustment to the client firms in the US and elsewhere. The yearning among Indian firms for SEI-CMM certifications, for instance[9], has resulted in evolution of a system in the software industry, which is quite distinct from other sectors of the economy. Therefore, it may not appear as an exaggeration to argue that 'quality standards, management styles, and ideas of corporate governance owe more to western, especially US, models than to traditions of Indian firms' within the sector[10].

Lema & Bjarke conclude that, unlike the Silicon Valley, which is a dense network of firms, a typicality of 'technology clusters', the agglomeration of software firms in Bangalore is more like an 'operational cluster' based on the success of customer-centric business models[11]. Firms here have succeeded individually, not as parts of a thickly interlinked collective of firms. It may not appear all too far fetched to argue that this individuality is as a result of the Indian firms adjustment towards the requirements of the customers, who are often afraid of information leakage and fear the loss of intellectual property. This fear is demonstrated by the fact that often sub-tasks of the same project are outsourced to several firms in such a manner that local firms need not interact with each other. The integration of sub-projects remains the prerogative of the client.

D Costa (2002) attributes the rapid growth of the Industry to export of low-end manpower-intensive software services. He argues that growth dependent on export may

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[9] In 2002, of the 55 software firms in the world that had reached level five in the globally acknowledged quality certification, Capability Maturity Model for software (CMM), 22 are located in Bangalore (Naidu 2002:7)

[10] See *The Economist* (2001). 'A Survey of India's Economy', The Economist, 2, June, 2001.

[11] 'Technology cluster' is an agglomeration of innovation lead firms that focus on product development, relying to a large extent on tacit knowledge and face-to-face interaction. 'Operational cluster' on the other hand is an agglomeration of firms focused on generic manufacturing, assembling, and logistics. For a detailed exposition see McKendrick, Doner & Haggard (2000)

perpetuate a lower innovative trajectory because of a 'lock in'[12] effect that may be caused by servicing of non-mission critical[13] tasks outsourced to the Indian software firms. He further argues that the sector's excessive export dependence and a weak domestic orientation eliminates the possibility of finding IT solutions to local problems. Thus giving rise to dualism: a scenario in which the economy will have a vibrant software sector amidst other lagging sectors. It has been observed that while the software sector has grown at around 50% other sectors like agriculture, which is the occupation of 70% of the population and contributes about 27% of GNP, and manufacturing industry have witnessed slow growth rate (D Costa 2003). This, according to him, has made the development process 'convoluted'[14]. He warns against an over-dependence on a software export strategy and calls for policies and measures to address the deep-rooted issues responsible for uneven development.

Yet another consequence spotted by Joseph and Harilal (2001) is that the booming software export sector with its ability to attract professionals from other disciplines can adversely affect the growth of other sectors, which compete for skilled manpower. In the short run these sectors may suffer and in the long run the growth of the IT sector itself may be inhibited, they contend.

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[12] 'Lock in' effect implies - firstly, the over dependence of Indian software industry on the US and secondly, the industry's getting hooked to executing low value technologically inferior tasks. See, D Costa (2002) for a detailed exposition.

[13] Most of the tasks outsourced to Indian companies are not core to the software projects handled by the companies of importing countries. Such tasks have been referred to as non-mission critical tasks.

[14] For a detailed exposition on the issue of 'uneven and combined' development and how it has convoluted the whole process of economic development see D' Costa (2003).

They go on to join the band of critics of India's export oriented strategy by claiming that in its preoccupation to solve the problems of developed countries India is leaving its own problems unresolved[15]. Accelerating the pace of IT diffusion in different sectors of the economy, including governance, they reckon, can solve this problem. They claim only such a strategy could help in achieving the twin objectives of enhanced productivity, international competitiveness, and growth of other sectors on the one hand and sustained growth of the IT export sector on the other.

Tessler and Barr (2003) suggest that overwhelming export orientation of the software industry is undesirable. In order to achieve any reasonable goals on a sustainable basis, a strategy must be balanced. Directing the deployment of software capacity towards social and governmental applications at home, as opposed to export-focused strategies, should be part of that balance (Hanna, 1991, 1994). Moreover, opportunities to manage local software projects and serve local users are often essential to gain experience in software project management and advanced technologies (Schware, 1992). This experience, he argues, can be used for taking up more complex projects both at home and abroad.

While there is some element of truth in the argument that domestic markets provide far more challenging projects, Arora, et al (1999a, 1999b) are sceptical about the links between the domestic market and exports. There is little evidence for the idea that

[15] There is school of thought, which feels that by providing solutions to firms of various sectors in the US and other developed nations, India is only making them more competitive while firms in India remain backward.

experience with complex domestic projects has a high payoff in the export market or that the "learning to walk on two legs entry strategy"(Schware, 1992) was being practiced by Indian firms. Indeed, many firms that began with a domestic market focus seem to have moved away towards less challenging but more lucrative export tasks.

There have also been some noticeably positive outcomes of export orientation of the industry. Carmel (2003) examines the impact of a software export sector on the broader national economy. Economic and social impacts include: impact on labour, impact on new organizational forms, stimulation of infrastructure and other industries, economic impacts, and political impacts. The most noticeable impacts are the *secular* rise in wages of software workers and the wealth of software equity holders. Since export orientation of the industry calls for global competitiveness various progressive forms of organizational structures, quality standards, and Human Resource practices become essential. The evidence also suggests that demand for software spurs investment in communication infrastructure, which stimulates the growth of related industries such as IT – Enabled Services. Economic impacts include improvement of the national trade balance, strengthening of the currency, and sharp increase in contribution of the industry to the Gross Domestic Product (GDP). However, possibilities of political backlash increases if the government does not take measures to bridge the 'digital divide'[16].

[16] A situation where one section of the populace is exposed to computers while the other remains computer illiterate. In a broader definition it may imply the division of people in terms those who have benefited from new technology and those who haven't.

The most significant effect of the success of the export-oriented industry is the emergence of first generation IT entrepreneurs in the US and at home, which has served to legitimise capitalism to Indian political and intellectual elites who had only grudgingly accepted the reforms of the 1990s (Kapur 2002). Entrepreneurs, rather than bureaucrats, have become the new role models, spreading the message that one could make substantial wealth, but without the manifest corruption associated with business. Reforms have since then become acceptable to most Indians and it can be manifested in the intense competition among state governments to attract investments.

2.3 Brain Drain Vs Brain Circulation

A number of studies have been conducted to study the issue of 'brain drain' as also 'brain circulation'. But before we review these studies it would be appropriate to briefly understand the nature of work of software workers and their remuneration patterns that may have caused brain drain. Kattuman and Iyer (2001) indicate that the typical projects undertaken by Indian software companies are - low level design, coding, and maintenance. Often extremely simple tasks like the mere digitising of raw data is also undertaken, for example, digitising medical records. Such tasks are considered least value adding and are in the lowest end of the 'waterfall model'[17]. This combined with the differential in wage rates of India and the US and other major competing countries has resulted in very low revenue per employee. The **revenue** per employee of the conventional private sector IT exporters was US$ 20,000 and even the established firms

[17] The 'Waterfall Model' involves several stages between Post Production Support at the lowest level and Requirement analysis at the highest level. Testing, Coding, Low level design, and High-level design are the intermediate stages.

earned a little over US$ 30,000 where as the comparable figures in Israel and Ireland were US$ 150,000 and US$ 60-800,000[18] respectively (Arora et al. 2001a). However, when it comes to the **cost,** Indian salaries were 20-42 per cent of US levels and at 38.53 per cent of Irish levels in 1995 (Kumar, 2001). Arora, et al (2001a) suggest that after factoring in all costs the cost of software development is only half of that in the US even though the estimated wage costs in India were about 1/3rd to 1/5th of the corresponding US levels for comparable work.

The wage differential between India and the US has resulted in flight of skilled manpower from Indian companies to their counterparts based in the US. Many of the software workers who are sent there to execute projects at the client site quit their Indian employers in the lure of greener pastures. Often these are the experienced professionals with the potential to take up jobs at the higher end of the waterfall model. Fernandes, et al (2003) suggest that it is at this experienced[19] project leader and project manager level that shortage is most acute, thus leading to many undesirable consequences. One possible consequence is that projects may be forsaken due to a shortage of qualified project leaders or managers. Such a contingency may compel companies to depute software developers with inadequate experience to handle these tasks with job quality and employee motivational consequences. Additionally, firms may be unable to undertake new tasks and move up the value chain, thus inhibiting growth, productivity, and

[18] Arora et. Al. (2001) point out that the foreign firms in Ireland have revenue per employee in excess of US $ 400,000. However, these firms may be induced to book revenues of products and services sold all over Europe in Ireland because of tax incentives. Therefore, the true productivity may be substantially lower.

[19] A higher estimate of this number in 1999 is around 71,000 software developers (Arya, 1999) although current estimates are that nearly 50% of last year's quota of 115,000 H1-B visas went to Indians.

profitability. Employee attrition may also act as a disincentive for software firms to invest on training and development of software workers.

Another critic of brain drain Parthasarathi (2002) observes that since the downturn in the US economy in the late 90s and early 2000 there has been a "reversal of brain drain but in catastrophic and unplanned ways". He recommends that it is the imperative of the government and the industry to create the challenge in the jobs offered in India to staunch the brain drain. This, he insinuates, can be done by initiation of appropriate "government policy and company strategies to address the numerous domestic applications and to use these domestic-oriented ICT systems as a launch pad for a different kind of export drive". What he perhaps implies is that Indian firms should shift to value added services i.e., complete solutions involving software, hardware, and domain knowledge.

Though the majority of the returnees, as pointed out by Parthasarathi (2002), are those that have been 'benched'[20] by their US employers, there is some evidence of senior software professionals also returning to India by the lure of high value technologically superior assignments. NASSCOM estimates that of the 35,000 IT professionals who have come back to India since 2000, about 10-15% have lived in the US for more than 10 years and these are the category of returnees who have taken up technologically complex assignments that are now being outsourced to India. However, the 'India Development Centres' of the US based multinationals are doing most of this high value software

[20] 'benched' is an industry jargon that refers to the software employees who have been laid off.

development[21]. A similar trend has been observed in the reversal of brain drain in the IITs. Foreign returnees have filled a significant portion of the faculty positions at IIT Bombay, IIT Madras, IIT Delhi, and IIT Kanpur[22].

The return of these software professionals and entrepreneurs has a potentially beneficial 'spill over'[23] effect for the home industry. This reversal of brain drain has resulted in informal technical links between the home country and the US. Some analysts are now labeling this phenomenon as 'brain circulation', which implies networks of scientists and engineers transferring technology, skill and know-how between regional economies faster and more flexibly than most corporations (Saxenian 2002). Such networks in conjunction with 'home clusters' create 'return entrepreneurship' and promote high technology development in the home country. China and Taiwan have been able to create such networks by taking suitable policy measures. However, Indian engineers and entrepreneurs in Silicon Valley have been slow in forming such networks.

Bajpai & Radjou (1999) too recognize the importance of such networks. They recommend creation of an institutional infrastructure that supports the establishment and growth of a local IT industry. Creation of such an infrastructure would involve development of a strong local entrepreneurial base, massive investments in human resource development and the promotion of local centres of innovation. However, the

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[21] See Business World (2003), 'Homeward Bound', Vol. 23, No. 24, 4-10 November, pp. 30-37.
[22] In 2002-03, at IIT Bombay, half the new faculty positions filled were recruited from abroad. At IIT Madras, about one third were returning expatriates while the corresponding figures at IIT Kanpur are more than 50%. See the The Economic Times, 12th Nov. 2003, p.10 for the full report.
[23] 'spillover' here means that the return of these professionals and entrepreneurs has open the door to transfer and development of new technology in India, which may be acquired by the local firms by poaching such professionals.

centres of innovation need to be integrated to the rest of the economy to build linkages with the local economy and thus transfer capital, knowledge and technology to the rest of the society. Therefore, the government must ensure that as it expands the number of Export Processing Zones (EPZs) and Software Technology Parks (STPs) it also facilitates formation of 'clusters' to tap into additional knowledge spillovers[24].

2.4 India's competitors: what are their chances?

The last decade or so has witnessed a rapid growth of the software industry globally. Continuing growth of the industry has attracted several countries to take advantage of the opportunities at hand. However, the major players in the software export market that have emerged from among them are India, Ireland, and Israel. Others like Malaysia, China, Russia, Korea, and Singapore, are still struggling to crack the export industry (Tessler and Barr 2003).

All the three major software exporting countries have evolved into industries that are distinct from each other, shaped by there own resources, the prevailing conditions, and the global opportunities present at the time. For example, Japan exports mostly software games, India exports primarily software services to large software development shops, Ireland exports software products (created by MNCs located in the country as well as by a growing number of indigenous companies), and Israel mostly exports software technology which is subsequently 'productized' by firms in the US and Europe (Tessler and Barr 2003).

[24] See Porter, Michael (1998), Clusters and the New Economics of Competition, Harvard Business Review.

The difference in the industries of these countries may also be attributed to the difference in their National Software Strategies. Ireland's strategy of creating jobs in software industry was driven by the fact that it was environmentally friendly and required low capitalization when compared to the manufacturing industry. India's goal, on the other hand, was to create an export industry for job creation, which would serve the dual purpose of foreign exchange earnings and technological self-reliance. Israel's strategy however, was driven by its desire to commercialise military technology, create an export industry, and employ tens of thousands of immigrant programmers from Russia. Correspondingly, the nature of products / services of their industries also differ. While Indian software industry is predominantly based on software services, Israel, and Ireland's industry is predominantly based of software products and software technology respectively.

Given the fundamental differences in the industry and the wage differential among these nations it appears unlikely that these nations will affect each other's fortunes in near future. As regards the competition from other countries, if Tschang's[25] findings are any indication, it would require a tremendous effort on their part to dethrone India from the services that it specializes in.

Tschang (2001) contends that while there is much that other countries can learn from India 's experience, but "replication of India's success will not be easy, as it

[25] See Tschang (2002) for the detailed analyses of the reasons why the competing countries will find it tough to beat India in software services.

involves both hard factors (education and infrastructure) and soft factors (culture and social networks)". Even if competing nations implement the enabling policies, hard infrastructure, and labour pool still they may not succeed, since "soft and social infrastructure" may end up being a prime determinant of success. These may include the workforces' proficiency with the English language, social networks between the developing economy and advanced countries (through which contracts and advanced technological knowledge are obtained), and "customer-focused mentality" (something thought to be missing from most Russian programmers). Further India is blessed to be in a time zone, which ensures a virtual 24-hour workday for its largest market US[26]. It may also be difficult for newer firms to win new contracts in the face of competition from the established Indian firms who have built strong relationships with their clients in the developed countries.

However, Arora, et al (1999b) warn that India's low cost labour advantage is not sustainable in the long run and suggest that Indian firms have to 'move up the value chain' by climbing the clients 'trust curve'[27]. There is some evidence that the more established firms are willing to acquire domain knowledge by utilizing their links with the clients. Thus engage in upper level activities of the 'water fall model' of software development such as conceptualisation, requirement analysis, and design services. With growing maturity Indian firms may also attempt at 'productization' of their services by

[26] The time difference of 12 hours between India and US enables a virtually 24-hour work shared between onsite and offshore workers.

[27] The US based clients do not want to outsource complex projects to Indian vendors because they doubt Indian companies ability to execute such projects. Therefore, Arora, et al suggest that Indian companies should persevere to win over their US clients' confidence to win more complex contracts and thus climb the 'trust curve'.

creating proprietary tools, methods and reusable software code that can be customized according to the clients' needs. Nevertheless, such efforts of up gradation would require the Indian firms to get rid of their trader mentality and invest in R&D and "create linkages to encourage career prospects for researchers in engineering" (Kumar 2002).

2.5 Conclusion

As is evident, much of the extant literature deliberates on the nature of success of the industry. The earliest such studies in its nascent years were by Schware, (1992), Dedrick & Kraemer (1993), Heeks, (1996) and later by Arora et al (1999a, 1999b), Arora et al (2001), Arora and Athreya (2001), Tschang (2001) among others mentioned above. They have all deliberated on India's comparative advantage in software. Some have discussed the various coincidental causes of the success of the Indian IT Industry, for example, combination of abundant human resource endowments, linkages to the main export market, good timing[28], convenient time zone[29], and the basic facilitation of infrastructure for communications and trading by the government Arora et al (2001); Tschang (2001). Schware, (1992); Heeks, (1996); Parthasarathy & Joseph (2002) have deliberated at length on the desirability of export orientation. Arora & Asundi, (1999a) have studied the industry from the perspective of quality certification and its forbearance on the firms' growth. However, a comprehensive study of the innovation trajectory of Indian software firms is yet unexplored. The current proposal is to explore this aspect of the industry along its growth path.

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[28] Good timing here refers to the ability of the software industry to recognize the export markets at the opportune moments.

[29] India is fortuitously located in a time zone that has a time difference of 12 hours with that of its main export market, the US. This virtually ensures a 24-hour workday between the onsite team in America and the offshore team at home.

CHAPTER - III

ANALYTICAL FRAMEWORK

Understanding and mapping innovation and growth trajectory of software firms is no mean task. Nevertheless, an attempt is made in this chapter to understand the concept and the role of innovation in the context of the software industry. The chapter begins with the conceptualisation of Research & Development (R&D) and Innovation in the Schumpeterian and the National Systems of Innovation context. Further, several frameworks or models are explored to provide an understanding of the process of technological learning, innovation capability building, and analysing the growth trajectories of firms.

3.1 A theoretical perspective of R&D and innovation

Innovation and knowledge creation have for long been acknowledged as the primary fuel for continued firm growth in most high technology industries (Nonaka and Takeuchi, 1995). In many hi-tech firms continued innovation and creativity are vital not only for their growth but also for their survival. Indeed, the nature and the rate of innovation achieved by a firm often shape its evolutionary path as well as its future growth. Prior studies that have examined firm evolution from an innovation perspective have shown several intra firm factors as well as external factors influence a firms innovation capability and hence its growth. Internal innovation-related factors like product architecture, development process, management team structure, and organizational culture have significant impact on a firm's future growth potential (Cusumano and Yoffie, 1998; Brown and Eisenhardt, 1998; Utterback, 1994). Similarly, several external factors such as the macroeconomic environment comprising of the Industrial Policy, Science & Technology Policy, Trade

Policy, Education Policy, and Monetary Policy have an influence on the innovation orientation and growth of firms.

3.1.1 Conceptualising Research & Development

Research & Development, which is an important component of innovation, is also an important parameter for the innovation orientation of firms, industries, and nations. Indeed R&D is an activity that precedes innovation and may result in invention, which may then be developed for the market. According to the extant literature - Ames (1961), Machlup (1962), Freeman & Soete (1997), R&D may be referred to as any activity that results in new and improved materials, products, processes, and systems. It includes dissemination of knowledge through the education system, industrial training, information services, and even the mass media. The extant literature also highlights the importance of application of existing stock of knowledge and feedback from production and from markets to the process of R&D[1]. All such R&D activities may be broadly categorized as: a) 'basic' or 'fundamental' research - resulting in a flow of new knowledge in the form of research papers and memoranda, which is essentially, of general nature, e.g. research into the properties of materials; b) 'applied' research, which is directed at a particular objective and results in flow of new knowledge relating to specific applications, e.g. searching for new materials for a product; c) 'experimental development' which may give rise to models, sketches, designs, manuals, and prototypes for new products, or pilot plants and experimental rigs for new processes. All the three types of R&D may be carried out by government research laboratories, universities, research institutes, and company's research departments.

[1] For a detailed exposition on R&D systems, inputs and outputs in research, invention, development and innovation see the introduction in Freeman & Soete (1997).

3.1.2 Conceptualising Innovation in the Schumpeterian perspective

In purely Schumpeterian terms innovation may be defined as the commercial exploitation of an invention. His pioneering work on innovation established the distinction between inventions and innovations. An invention may be an idea, a sketch or model for a new or improved device, product, process or system. However, such inventions, which may also be patented, do not necessarily lead to technological innovations. An innovation in the economic sense is accomplished only with the first instance of commercial exploitation of the new product, process system or device (Freeman & Soete, 1997, p.6). Therefore, innovation includes the whole process of research, development, invention, and its commercial exploitation.

Schumpeter's original notion of innovation though, is closely related to development in the context of his theory of economic development wherein he postulates that economic development is driven by the discontinuous emergence of new combinations (innovations) that are economically more viable than the old way of doing things (Schumpeter 1934). The role of innovations in creating development is expressed in the paradigm shifts that they produce, "which is replete with vitality, motivated by a small circle of personalities, and which does not consist in continuous adaptation" (Schumpeter 1912/2002, p. 103). The underlying emphasis is on the motivated "small circle of personalities" or entrepreneurs who, according to him, are the primary drivers of innovation.

The concept of innovation as theorized by Schumpeter covers five areas: (i) the introduction of a new good or a new quality of a good (product innovation); (ii) the introduction of a new method of production, including a new way of handling a commodity commercially (process innovation); (iii) the opening of a new market (market innovation); (iv) the acquisition of a new source of supply of raw material or intermediate input (input innovation); and (v) the carrying out of a new organization of industry (organizational innovation) (Schumpeter 1934, p. 66).

However, in his later work, Schumpeter (1942), in a significant departure from his earlier work, redefines innovation as an activity, which need not be radical and unpredictable. He also diminishes the role of the individual entrepreneur in the process of innovation - perhaps in keeping with the changing times - as doing things outside the familiar routine in business had become much easier. Indeed, Schumpeter (1942) sees innovation itself being reduced to routine in the sense that technological progress has become the business of trained specialists. Therefore, one may conclude that Schumpeter in his new *avtar*[2] sees the innovation process as being increasingly institutionalised, depersonalised and automatized, which implies that innovation itself has seized being a break with 'business-as-usual'. Schumpeter (1942, p. 83) thus describes innovation as a "process of industrial mutation (....) that incessantly revolutionizes the economic structure from within". The incessant character of innovation should not be taken too literally, as the actual revolutions occur in discrete rushes – it is the process as a whole that works incessantly (Schumpeter 1942, p. 83, footnote 2).

[2] This view of Schumpeter is popularly known among economists as Mark II where as his earlier view is referred to as Mark I.

With the institutionalisation of innovation and its recognition as a continuous activity experts have broadly categorized innovation into two types - a) *incremental innovation* and b) *radical innovation.* Incremental innovation involves *exploitation* of an existing technology in a manner, which involves several small improvements resulting in refinement or expansion of existing products or processes. These improvements merely make the product or process a little better, faster or cheaper. Therefore, incremental innovations essentially emphasize on cost reductions or feature improvements of products and processes. Radical Innovations are more *exploratory* in nature. They require fundamentally different technologies and approaches and enable the performance of functions that were previously not possible, or the performance of presently possible functions in a manner that is strikingly superior to the old. They beget several incremental innovations. Thus, radical innovations may involve development of new businesses or product lines - based on new ideas or technologies or substantial cost reductions that transform the economics of a business.

Hauknes (1998), an advocate of Schumpeterian notion of innovation, suggests that any characterization of innovation as technological or non-technological, product or process innovations etc. is subordinate to the basic aspect of innovation. According to him Innovation is a market phenomenon, where its nature and dimensions are shaped by the perceived structure of competition on the markets where the innovating firm operates. Innovation from the firm point of view is primarily a response to the firm's competitive environment. By innovating, the firm contributes to changing the 'data' of the business environment of customers, competitors and other related firms. He further states that there are three characteristics that implicitly underlie the concept of innovation; that innovations are *deliberate* implementations of 'new ways of doing things', that innovations are 'new' or *novel*; they exceed some minimal novelty 'height', and they are at least partially *codified.*

Schumpeter believed that monopoly favoured innovative development because research & development (R&D) required large resources and large markets. This view can no longer be sustained, more so in the software industry sector, where more often the smaller firms are the most aggressive innovators and often the larger firms are mere imitators. Studies show that small businesses account for a disproportionate share of innovations (disproportionate to their share in output or R&D expenditure, although the latter may not be fully captured in the statistics).

The twin Schumpeterian hypothesis namely, firm size is positively correlated with innovative activity, and monopolistic market structure is more conducive to innovative activity were subjected to rigorous empirical verification by various scholars such as Scherer (1980), Kamien and Schwartz (1982), Baldwin and Scott (1987). The studies of these scholars have gone beyond the Schumpeterian tradition of research on innovative activity spanning firm characteristics, industry characteristics like demand, and technological opportunity.

By the 1980s, because of the pioneering work of Freeman (1974, 1987), Rosenberg (1976, 1994), Nelson (1981), Nelson and Winter (1982) and others, innovation began to be studied in a broader context with its determinants being recognized as more complicated than the earlier Schumpeterian notion of innovation. Their studies laid the foundation for the, now in vogue, National Systems of Innovation[3] (NSI) perspective for studying innovation.

3.1.3 Innovation in the National Systems of Innovation Perspective

While the Schumpeterian perspective of innovation is important for understanding the concept from the development perspective, various scholars such as Freeman (1987), Lundvall (1992), Nelson (1993), Metcalfe (1995a, b, c,), et al have emphasized on a broader understanding of the process of innovation from the 'National Systems of Innovation' (NSI) perspective. The NSI perspective encapsulates a strong belief that technological capabilities of a nation's firms are a key source of their competitive process, that these capabilities are in a sense national, and that they can be built by 'national action'.

Freeman (1987) defined NSI "as the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies". A more refined definition was stated by Lundvall (1992) who defined NSI as "the elements and relationships, which interact in the production, diffusion and use of new, economically useful, knowledge ... and are either located within or rooted inside the borders of a nation state".

A more specific role of NSI in promoting innovative activity especially in the industrial sector was emphasized by Nelson (1993) who defined NSI as "a set of institutions whose interaction determine the innovative performance of ... national firms". However, the most exhaustive definition of NSI was proposed by Metcalfe (1995) who conceptualised

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[3] The term 'innovation system' is perhaps misleading because its operations are not planned or systematic and it has three main elements: government, higher educational and research establishments, and business.

NSI as "... set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which the governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer knowledge, skills and artefacts which define technologies".

Therefore, one may conclude that the emerging theoretical paradigm of the 'National Systems of Innovation' argues and advocates that technological advance can be compartmentalized at the 'nation' level, as innovation depends not only on the complex inter-linkages between the government, private and academic sectors that define the focus of research and development, but also on the social, political and economic environments within the country that create the demand for and also control the direction of technological advance.

Though traditionally the notion of innovation has been excessively skewed towards the manufacturing sector, with the emergence of NSI perspective and other generalized conceptions of innovation, the concept itself has got diffused into various sectors and functions. Innovation today is perceived to be multifaceted covering not only technological innovation but also institutional, organizational, and managerial innovation, and their attitudinal and cultural support systems (Sridharan, 2002). This broader definition of innovation is all pervasive irrespective of the size of the firm and the nature of industry it is in. We use this broader definition to study the innovation led growth of the software industry.

3.2 Innovation in software industry

Innovation in software has also been described in the extant literature as being consistent with the existing definitions of R&D and innovation. Within the technological innovation framework 'technology integration' has emerged as an important method of innovation in software. If we look at the Personal Computer (PC) software industry, for instance, one of the biggest innovations of Microsoft, the Windows 95 operating system, is an example of technology integration. Launched in the mid 1990s, it included several new features unseen in its previous product,– the MS DOS. However none of the extra features were inventions of Microsoft. It had merely integrated the disparately existing technologies to create a new product[4]. According to Iansiti (1998), technology integration is a way to innovate in which the innovating firm chooses among already existing technologies to build innovative products. The 'technology integration' model is especially suitable for software, where communication between different systems and programs usually requires some level of integration. The model is essentially about problem solving and product building on the basis of existing technologies or technology paradigms[5].

Another significant approach to innovations in software industry is through product platforms[6] (Meyer and Seliger, 1998). Therefore, it has been observed that innovating firms tend to produce platforms rather than single product innovations. Although many start-up

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[4]The Windows 95 OS encapsulated within itself several new features, which were disparately existent. The concepts of multi-threading, multi-tasking, and file system organization were well known by 1965. The idea of window based user interface, mouse interaction, pop-up & drag drop menus had all been invented by the late 1970s.

[5]For example, a product may involve integration of two different components. One of which may be developed in the C language (of the ***structured programming*** paradigm) while the other component may be developed in Java language (of the ***objected oriented programming*** paradigm).

[6] Microsoft, for example, initially introduced the *Windows* operating system, which it used as a platform for launching the MS Office suite of products among others.

firms are dependent on a single innovation, they often move forward to build a product platform. By building, sustaining, and further developing the platform, a software firm reduces its dependency on single products. The platform mode, in turn, affects the innovation management in the firm because the innovations that are to be integrated into the platform come from R&D other than the R&D carried out with regard to the actual platform.

Within the technological innovations framework various types of innovations that may take place in a software product/services firm are listed in *Table 3.1*.

Table 3.1. ***Modes of innovation in software firms***

Type of Innovation	*Product / Service characteristics*	*Example*
Customized Innovation	Products are tailor made to meet specific clients' requirements and needs; products are produced from 'scratch'.	Customized solutions provided by Infosys, TCS, et al.
Ad hoc Innovation	Implementation of service products requires an adaptation or translation to client specificities. In such 'problem solving' provision the implemented 'product' is essentially co produced with the client, as an interactive problem solving process, geared to the contexts of a specific client. These innovations are augmented by formalizations of implementation experiences through 'appreciative theorizing' to enhance repertoires of implementation towards new users.	ERP implementations provided by companies like Oracle, Peoplesoft, SAP.
Technology Integration	New products /services are essentially obtained by dissociation and new combinations of more or less standardized service elements or products.	End to end solutions provided by IBM.
Differentiation Or adjunct Innovation	New products are obtained through addition of new or amended peripheral services.	Newer and / or several versions of Windows Operating System launched by Microsoft.
Delivery Innovation	While retaining the basic function and characteristics of the 'service product', the mode of delivery or interaction with the client is changed.	Offshore development & technical support.

SOURCE: Some of the ideas in the table are borrowed from Sundbo and Gallouj (1998)

The various types of innovation mentioned in the *Table 3.1* above do satisfy the Schumpeterian notions of innovation. For example, they give rise to some new or novel software like creation of new product platforms that may involve developing new software code or making drastic changes to the existing source code[7] (*product innovation*). Further, the fruits of innovation give rise to a new market for the software product or service (*market innovation*). Technology integration, for instance, may involve a new way of doing things such as integration of new or existing algorithms or programs or products rather than making improvements on a single product (*process innovation*). Lastly, the new way of doing things may also call for *organizational innovation*.

Therefore, from the above discussion it may be concluded that innovation in software may include alterations or novelty in software code i.e. lines of instructions dictating the operation of a computer. It could also be a new algorithm or a solution enabling the integration of existing computer programs; it might be a product suite or just a single product. Software innovations may also be in the form of embedded applications or software solutions that may cater to diverse market segments such as network & internet security software, enterprise resource solutions, 3D modelling software, databases and customized software solutions.

However, for the purpose of our study we take a broader Schumpeterian definition of innovation comprising of new products and processes, new materials, new markets and new

[7] Source code is commonly referred to the *programming language* instructions that are subsequently compiled through a compiler into binary code that dictates the operations of a computer.

forms of organization. Therefore our definition of innovation would include technological, managerial, and organizational innovation in the software industry.

All the modes of innovation discussed earlier are only possible if firms build the required technological capabilities. Firms can develop their technological capability through in-house efforts augmented by interactions with domestic and foreign institutions, constrained by regulations, and simulated by government incentives in the dynamically changing global technology environment (Kim, L. 1997).

3.2.1 Innovation capability building by firms

A firms' innovation capability can be built only through the process of technological learning[8], which takes place at two different levels: individual and organizational. At the individual level, employees of the firm become the prime actors of organizational learning. However, at the organizational level, learning is a synergistic process of creation and diffusion of knowledge across the organization. The implications are that the knowledge created is communicable among members, has consensual validity, and is integrated into the strategy and management of the organization (Duncan and Weiss, 1978).

In the process of technological learning and building innovation capability a firm has to create new knowledge which is of two dimensions: explicit and tacit. *Explicit knowledge* "refers to knowledge that is codified and transmittable in formal, systematic language. Thus explicit knowledge may be acquired from books, technical specifications, designs, and

[8] The discussion on theoretical learning and innovation capability building by firms is drawn heavily from Kim, L. (1997).

material embodied in machines. *Tacit knowledge*, on the other hand, is so deeply rooted in the human mind and body that it is hard to codify and communicate and can be expressed only through action, commitment, and involvement in a specific context. Tacit knowledge can be acquired only through experience such as observation, imitation, and practice" (Kim, L. (1997).

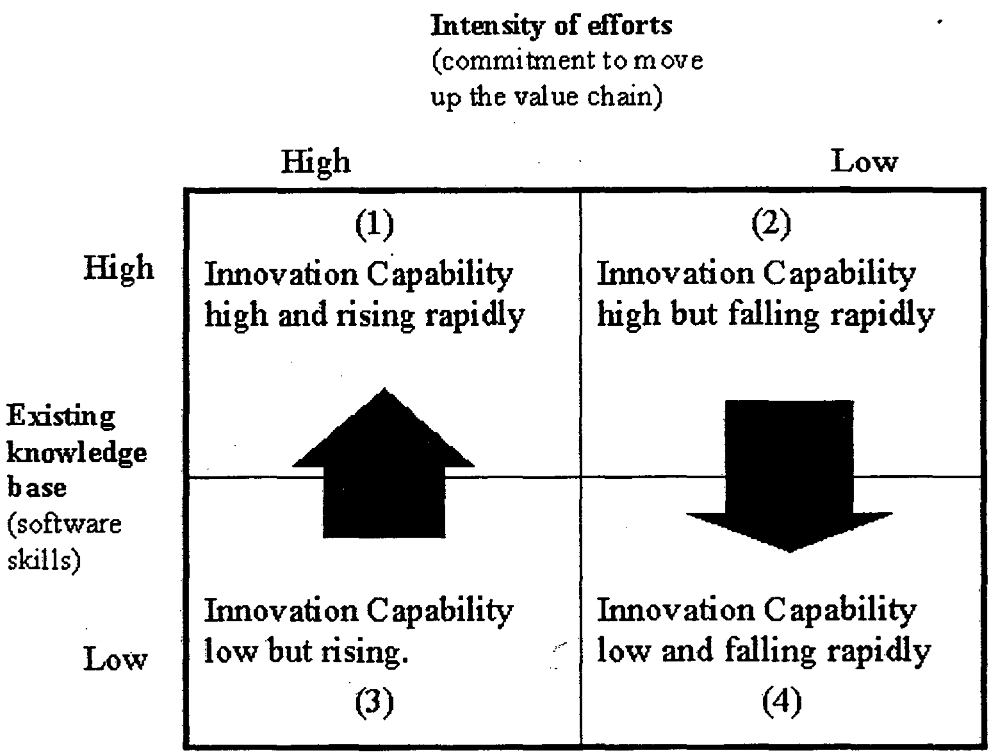
Nonaka (1994) postulates that firms create new knowledge by building both explicit and tacit knowledge and more so by conversion between these two dimensions of knowledge: tacit to tacit, explicit to explicit, tacit to explicit, and explicit to tacit. Tacit to tacit conversion takes place when an individual shares the knowledge embodied in him to another through training. Conversion from explicit to explicit takes place when an individual combines discrete pieces of explicit knowledge into a new whole. When an individual articulates the foundations of her tacit knowledge, conversion from tacit to explicit takes place, whereas conversion from explicit to tacit takes place when new explicit knowledge is shared through out the firm and other members begin to use it to broaden, extend, and reframe their own tacit knowledge. Such conversions become faster and larger in scale as more and more individuals get involved in knowledge conversions (Kim, L. 1997).

Linsu Kim contends that Technological or Innovation capability of a firm is not a collection of explicit knowledge; rather, it is largely a collection of tacit knowledge. All the proprietary explicit knowledge of firms is of use only if its members have the tacit knowledge to utilize them.

Knowledge conversions are indispensable for technological learning and building innovation capability. However, effective knowledge conversions are dependent on two important elements: *existing knowledge base*, which should largely comprise of tacit knowledge, and the *intensity of efforts* or the commitment to move up the value chain.

These two variables, 'existing knowledge base' and the 'intensity of effort' constitute a two by two matrix that indicates the dynamics of Innovation or technological capability (see ***Fig 3.1***). When both existing knowledge base and the intensity of efforts are high (quadrant 1), innovation capability of the firm is high and rapidly rising. If the firm has high existing knowledge base but its intensity of efforts is low (quadrant 2), its innovation capability is high but falling. It may be observed that high existing knowledge to be sustained needs high intensity of efforts on a continuous basis since advancement in technology renders the existing knowledge obsolete. Such organizations, because of their lack of efforts, may gradually move to quadrant 4. When existing knowledge base is low but intensity of efforts is high (quadrant 3), innovation capability is low but rising. Such firms because of their sustained efforts enhance their knowledge base and gradually move up to quadrant 1. Finally, when the existing knowledge base is low and the intensity of efforts is also low (quadrant 4), innovation capability of the firm is low and falling rapidly. Therefore it may be concluded that intensity of effort or the commitment to move up the value chain is more crucial than existing knowledge base for a long-term learning and competitiveness.

Fig 3.1. Innovation Capability building by firms

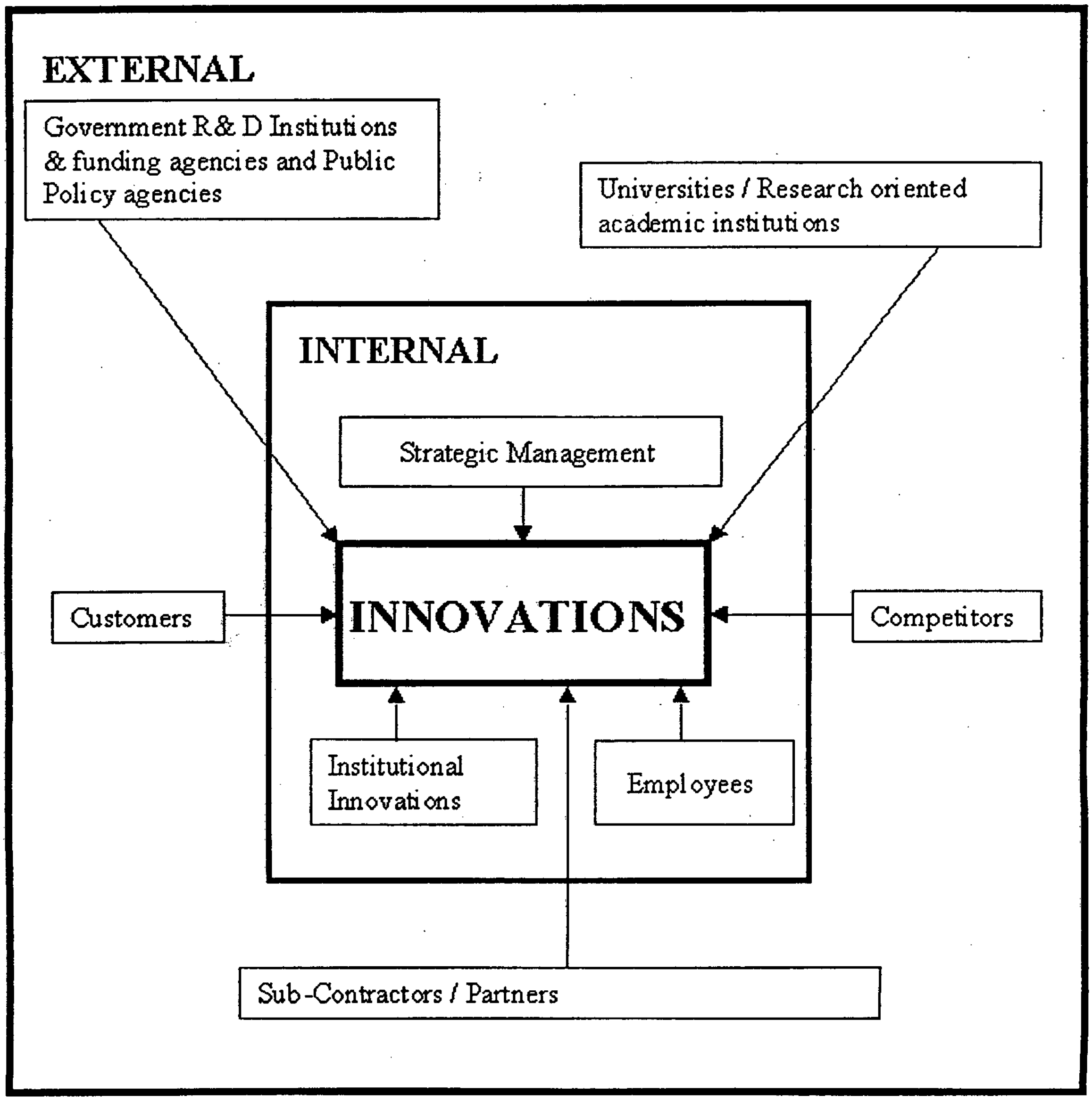


Adapted from Kim, L. (1997)

3.2.2 Drivers of Innovation

To understand the process of innovation in software products & services industry, we have outlined a model of drivers of innovation (see ***Fig 3.2***). The driving forces depicted in the model are persons, firms or organizations whose behaviour is important to the firm's capacity for selling products & services and for its innovation activities. According to the model, the external environment comprises of several drivers that not only define the firm's market possibilities but also affect its process of innovation. The driving forces have been broadly categorized as external and internal.

Fig 3.2 Driving forces of innovation



Internal driving forces comprise of intra-firm drivers formulated by the firm itself as a response to market opportunities. There are three internal drivers identified in the model: strategic management, employees, and institutionalised innovation efforts in the form of formalized innovation in R&D units.

Five sets of external drivers, noted in the diagram are: *Customers, Competitors, Sub-Contractors & Partners, Government R&D institutions & funding agencies & Public Policy agencies, and Universities & Research oriented academic institutions*. While *Customers and Competitors* are major drivers of innovation *Sub-Contractors and Partners* are important sources of innovation as well. *Government R&D institutions & funding agencies and public policy* agents are a diverse set, playing a multiplicity of roles. Besides being a source of technology transfer, *Government R&D institutions* also partner firms for joint R&D programmes. Its *funding agencies* finance firms' R&D and innovation initiatives. Through S&T policies *public policy agencies* provide advisory services, conduct seminars, and training & education programmes. *Universities and other academic research institutions* not only provide skilled human resource for the needs of the industry but often they are the source of new technology. They also partner firms in carrying out R&D and innovation initiatives.

Having conceptualised the concept of innovation and explored the dynamics of technological learning and innovation capability building by firms, in the next section of this chapter, we explore and present various models of innovation in the context of the software industry and attempt to capture the nuances of the process of innovation and growth of software firms.

3.2.3 A *Multiple Stage Innovations Model* for software services firms

Bhatnagar & Dixit (2004), based on their case study of Infosys and NIIT, have proposed a model for software innovations. The key terms in the model are: *triggers of innovation*; "those aspects within and outside the organization that prompt the innovations" and *enablers of innovation* "that may lie within or outside the organization and that enable innovations to take place".

The authors define ***internal enablers*** as "the leadership style of the top management, the culture of experimentation and tolerance and failure, the ambience of learning and sharing, recognition of innovation as a part of the mission of the enterprise, the appraisal and recognition systems of the management". ***External enablers*** are "developmental financial institutions, R&D laboratories, the community of investors and their confidence, customers and their feedback, and public policy makers".

They identify strategic imbalances as triggers of innovation. Imbalances may be internal or external. *Internal balance* is the gap between what the organization wants to be (its articulated vision) and what it is. The imbalance is in what it wants to accomplish, the kind of customers it wants to serve and the products and services it wants to offer, the competencies it desires to build – and its current realities. It is this gap that may spur both product and process innovation.

Bhatnagar & Dixit identify external imbalances of two types; *external imbalance - type I* and *external imbalance - type II.*

External imbalance - type I is defined as a "gap between what is required by the vision or dream of the founders and what is readily available in the environment to realize it". For example the articulated vision may call for skilled workforce in whose absence the firms may have to train the hired workers to bring them up to the required level.

External imbalance - type II is defined as the "imbalance between what the external environment expects the organization to do and what the organization is immediately capable of doing". For instance, the high expectations of the clients could challenge the organization into innovative product and process measures to meet their needs.

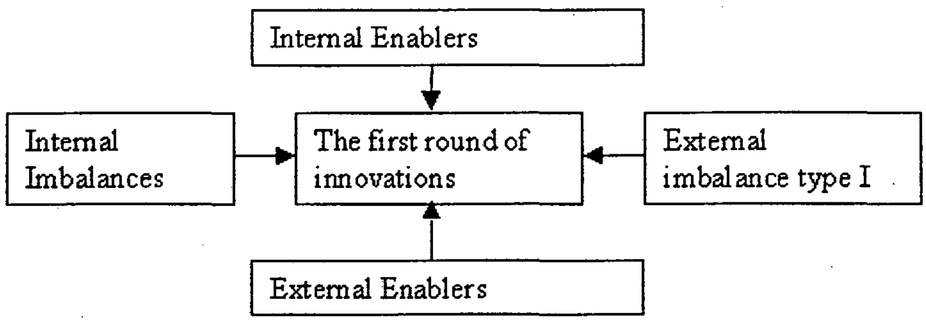
3.2.3.1 The Multiple Innovations Model of stages

The authors provide a multiple stage model for innovations. The model captures a dynamic interaction among the imbalances and enablers leading to innovations in three stages.

Multiple innovations: stage I

In the first stage (***see Fig.3.3***), the first round of innovations are carried out by innovating organizations "to creatively build internal resources and capabilities so as to neutralize or surmount the industry environment's many handicaps". This involves bridging the gap between what the firm wants to be and what it is, i.e. (internal imbalance) and bridging the gap between what is required by the firm to fulfil the vision of its founders and what is readily available in the environment, i.e. (external imbalance – type I). The process of bridging these gaps may involve developing the human resources' skills and creating the desired organizational culture with the help of internal and external enablers defined above.

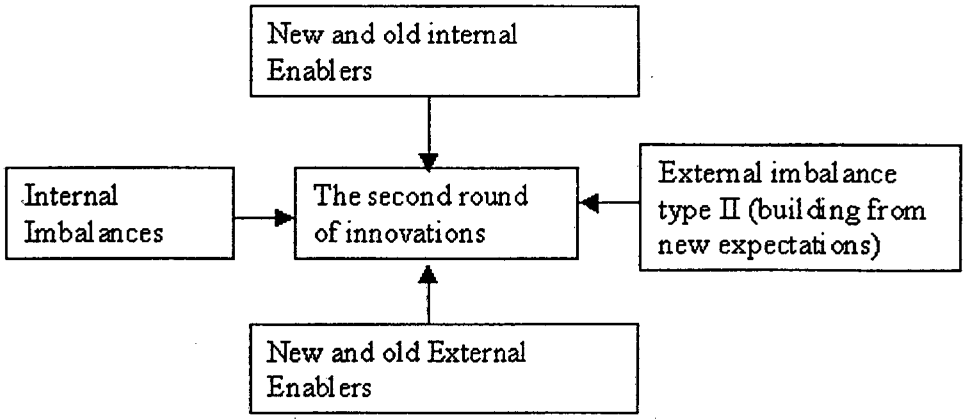
Fig. 3.3. Multiple Innovations: stage I *[SOURCE: Bhatnagar and Dixit (2004)]*



Multiple innovations: stage II

If the stakeholders receive the innovations in the first stage favourably, the organization is encouraged to innovate further. Success in the first stage "generates new expectations from the environment and also new external enablers. For example customers may take notice of the organizations capabilities to meet their exacting standards and entrust it with repeat orders. As the reputation of the organization gets enhanced, more and more customers approach it. Existing customers expectations also gets enhanced and when these expectations are beyond what the organization can readily deliver, an external imbalance of type II occurs. The organizations are challenged to innovate again. A combination of both new and old enablers spurs the second round of innovations. The new set of enablers may be in the form of cultivation of a culture of experimentation, articulation of a more distinct vision, and enhancement of the organization's overall image. This stage is captured in ***Fig 3.4.***

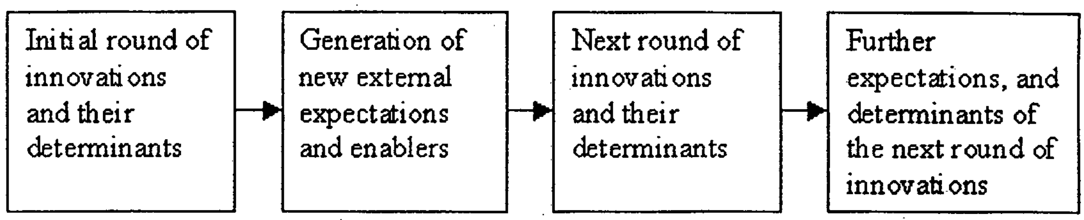
Fig. 3.4. Multiple Innovations: stage II *[SOURCE: Bhatnagar and Dixit (2004)]*



Multiple innovations: stage III

The next phase is dependent on the response of the clients. If the innovations were well received, there would be another round of expectations and development of enablers. This would lead to new imbalances and another round of innovations. Further, the organization may have to revise or enlarge its vision in the light of the changed business scenario. In the process a culture of innovation may be instituted. The multiple stages can be visualized as in ***Fig 3.5.***

Fig. 3.5 Multiple Innovations: stage III *[SOURCE: Bhatnagar and Dixit (2004)]*



Bhatnagar & Dixit warn that the linear representations as shown in ***Fig. 3.5*** should not be construed as one development strictly following the other. It may also happen that an organization may return to the earlier stage of development and get stuck or move forward.

The linear model captures the process of innovation in the software service firms quite well but being linear it appears incomplete, as the next stage of development and the regression of the firm to a previous stage are not reflected. Further, the model fails to capture the trajectories that a firm might take and the nature of software development activities it might engage in along its evolutionary path. Therefore, we would explore another model to plug these gaps.

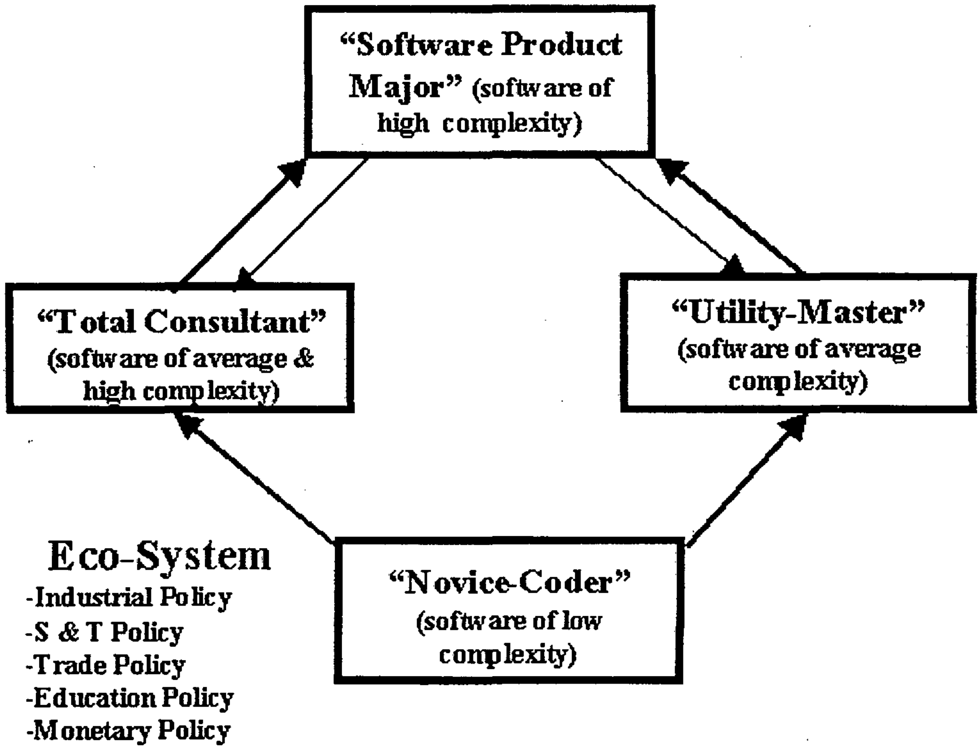
3.2.4 Alternative framework: a model for evolution of software firms:

The basic premise on which this framework[9] is built is that the firms' primary objective is to maximize economic gains (*see **Fig. 3.6***). Therefore, they would innovate and try to move up the value chain. The framework has an innovation bias and hence it captures the innovative orientation of software firms along their evolution trajectories. Evolution may be defined on the basis of: *(a) the nature of software product developed and (b) the range of activities*

[9] Ideas for the framework have been heavily drawn from Nambisan (2002)

undertaken in the process of new software development. These two dimensions have been used to map the evolution of firms directly in terms of the nature and process of innovation.

Fig.3.6 *A Framework for evolution of innovative firms*



Adapted from Nambisan (2002)

3.2.4.1 Nature of the software product

Software products may be broadly classified into two categories based on product scope and degree of innovation. ***Software products of low or average complexity*** are generally built on established software products. They involve incremental innovation and are value adding in nature. Examples include numerous utility tools like WinZip (a compression software), Audio players like WinAmp or they may also be 'add-ons' for popular software packages like MS-Word, MS-Excel and merely enhance their features. ***Software products of high complexity*** on the other hand, involve radical innovation. Such software are much more comprehensive in their scope and may serve multiple tasks. They are often stand-alone products. Examples include Enterprise Resource Planning (ERP) solutions, Office Suites, and customized software suites developed as part of turnkey projects.

3.2.4.2 Nature of tasks undertaken in New Product Development

Typical tasks undertaken in New Product Development in software industry include product concept generation and evaluation, project planning, product design, coding and testing, and commercialisation (Cusumano and Shelby, 1995). Firms may be operating at any of these stages of software development process. At one end of the spectrum a firm may be engaged only in design & coding, further along, firms may have their own product concept and development but may leave the commercialisation to other firms. At the other end of the spectrum are the firms that may carry out the entire range of activities involved in new product development.

From the two dimensions discussed above we depict the evolution of software firms in our framework into four stages: "Novice-Coder", "Utility-Master", "Total Consultant", and "Software Product Major". We further propose the trajectories firms may take to move up the value chain. In the process, we also discuss briefly the ways in which the "Eco-System" may influence the trajectories of firms.

"Novice-Coders" are the firms that are involved in design & coding of low complexity software packages. Typically, they are small units with limited financial resources or product vision to develop and market own products. They lack large product development experience. Therefore, they do not attract contract jobs from larger software firms. Rather, their forte remains judicious management of human resource and product coding and testing. Such firms are found more in countries where manpower costs are relatively low, (e.g. India, Russia, Philippines), which reduces the entry barrier (Micklethwait, 1997).

"Utility-Masters" develop and market their own software products of average complexity. They may have considerable product development experience, but they have a narrow technology focus and lack a coherent product vision. Since their products involve incremental innovation, which has minimal competitive advantage, they generally operate in a market crowded with competitors. Hence, they focus on marketing their product at minimum cost often involving non-traditional channels (e.g. shareware over the Internet). For example, WinZip Computing, Inc. of the US.

"Total Consultants" are involved in the design and coding of software products of high complexity on contract basis. They are generally large units with experience on a wide variety of hardware & software platforms. These firms may possess well-established, mature, and dependable software development processes. However, they do not have the financial resources or capability to market or source their own products. With time they may graduate to product development, including, in certain cases, product conceptualisation (Micklethwait, 1997). They focus primarily on software engineering and managing their human resources. Their clientele includes large software firms like IBM, Oracle, Informix, SAP, and other *Fortune 500* companies. India, Ireland, and Hungary are countries that have a large proportion of such software firms (Anderson, 1996).

"Software Product Majors" (SPM) are mature companies with huge financial resources. They have significant experience in developing and marketing innovative products and they tend to enjoy a good margin of profit over their products. They leverage the economies of scale and tend to dominate their respective product markets. Examples include major software producers like Microsoft, SAP, and Oracle.

The **"Eco-System"** forms an important feature of our framework because it can potentially determine the trajectory of firms' growth in an economy. The "Eco-System" is referred to here as the Macroeconomic Environment, which would typically comprise of the existing industrial policy, Science & Technology Policy, Trade Policy, Education Policy, and Monetary Policy. All of these, either directly or indirectly, have a bearing on the firms' growth and innovativeness. For example, a favourable trade policy coupled with strong Intellectual Property Rights and anti-piracy laws would encourage firms to take up software product development. A sound Science & Technology policy can provide financial support to innovative firms. It can provide the infrastructure for public sector R&D and innovation that can spill over to the private sector firms. A favourable education policy with large investments on higher education can provide skilled human resource to the industry. Friendly industrial & labour policies too have a positive effect on firms' innovation orientation. Favourable monetary policies like tax incentives for R&D spending by firms can accelerate innovation.

The framework assumes that firms' primary objective is to maximize their economic gains and hence they would like to move up the value chain and become a 'SPM'. Although, 'Utility-Masters' hold the intellectual rights to their products and control all product development tasks, they have marginal competitive advantage in the market and can rarely demand premium for their products. On the other hand, the Total Consultants can maximize their economic gains only by increasing their software development efficiency, as they rarely hold intellectual rights to the products they develop. Thus, from both economic and market perspectives, software firms can maximize their gains only if they evolve into a 'SPM'.

However, firms rarely start as 'Software Product Majors' because it is extremely difficult for a 'Novice-Coder' to develop an innovative and comprehensive product and at the same time establish a large customer base. Thus, the natural evolutionary process involves software firms being born as "Novice-Coders" and evolving into either "Utility-Masters" or "Total Consultants", with some eventually becoming "SPM". Firms may take two alternative trajectories to evolve into a `SPM'. The first trajectory involves moving up from 'Novice-Coder' to 'Total Consultant' to 'SPM', while the second trajectory involves moving up from 'Novice-Coder' to 'Utility-Master' to 'SPM'. Software firms in countries where the 'Eco-System' provides an abundant supply of low-cost programmer talent tend to take the first path—"Novice-Coder" to "Total Consultant" to "SPM". Initially they concentrate on enhancing their technological capability by undertaking contracts of major software products and in the process build reliable human resource assets. Having established their reputation in the industry and attained sufficient human and financial resources, they attempt to develop and market their own software products. Tata Consultancy Services (TCS), for example, has launched several products notably the EX accounting software targeted at the mass market and Mastercraft, and BankOn, among others, targeted at the industrial sector.

Some firms that are able to come up with one or two good utility software may succeed in taking the other route to 'SPM' moving from 'Novice-Coder' to 'Utility-Master' to 'SPM'. This route is riskier and failures could be fatal for firms. Such firms need to invest in building brand image and maintain a coherent product strategy otherwise their evolution to 'SPM' will be difficult. An example of a firm that has successfully taken this path is VDOnet. Started in Israel in the early 1990s, as a producer of minor Internet related utility software, VDOnet is now the market leader and developer of Internet video broadcasting software.

Of the two routes presented in the framework, evidence suggests that most major Indian firms like Infosys Technologies, Wipro Technologies, TCS, and Satyam Computers have taken the 'Novice Coder' to 'Total Consultant' to 'SPM' route. The evidence also suggests that some of these firms operate at both these levels, for example, TCS, which operates both as 'Total Consultant' and 'SPM'. There are others who are at the 'Total Consultant' level, for example, Satyam Computers, a software services major. Ramco Systems[10], an ERP vendor with 156 customers and a presence in 11 countries, may be categorized as a 'SPM'. Unlike the generic growth stages defined in the existing literature – start-up, growth or expansion, maturity, and decline (Hanks et al., 1993) this framework

[10] For details on the Company and its product see Krishnan, R. T. & Prabhu, G. N.,(2002).

does not show the decline stage, but given the dynamic nature of the industry, companies may regress back to either 'Total Consultant' or 'Utility-Master'. For example, Infosys Technologies, had initially forayed into several software products, but all those initiatives have been spun off and the company now concentrates in software services (Krishnan, R. T. & Prabhu, G. N., 2002) (see the regress arrows pointing downwards from SPM to 'Total Consultant' and 'Utility-Master stages in ***Fig. 3.6***).

3.3 Summary

The chapter begins by briefly discussing the concepts of R&D and innovation. Gradually the focus shifts to the *operation* of the concept in the software industry. Thereafter, the chapter explores several frameworks or models to study various aspects of innovation in software firms and the industry.

The first model presents the dynamics of technological learning and innovation capability building by the firms. The emphasis being on the two important elements: 'existing knowledge base' of the firm and its 'intensity of efforts' towards building innovation capability. The four quadrants of the model show four different levels of innovation capability of firms *(see **Fig. 3.1**)*.

The second model depicts the driving forces of innovation at the firm level. It depicts the various internal and external factors that drive innovation in a firm.

The third model proposed by Bhatnagar & Dixit (2004) shows the process of innovation in multiple stages for software services firms. The Mutiple Stage Innovations Model demonstrates how a firm innovates by overcoming the external and internal imbalances with the help of external and internal enablers.

Lastly, a general model for studying the innovation orientation and evolution trajectory of software firms is presented. The model delineates the evolution of software products firms as well as software services firms.

CHAPTER - IV

THE SOFTWARE INDUSTRY: POLICY FRAMEWORK, GROWTH AND INNOVATION

In the second chapter we discussed various notions of innovation and conceptualised our definition of innovation for the software industry. We also explored and analysed several models of technological learning, innovation capability building, and growth trajectories of software firms. In this chapter we use some of those conceptions and propose our own innovation model to map the innovation orientation and growth trajectory of Indian software firms and the industry.

The chapter is organized in three parts. In the first part, we analyse the policy framework and its role in the innovation orientation and growth of the industry. The second part of the chapter is composed of a brief history of the industry and its pattern of growth since its inception in the 1970s. In the last section, we analyse the innovation orientation of the software industry and delineate various innovative measures taken by it.

4.1 POLICY FRAMEWORK

During the early days of the software industry in the 1970s and 1980s the formulation and implementation of government IT policies suffered from the hangover of overriding ideology of import substitution, self-sufficiency, and protectionism manifested by regulation, licensing, and quota which had become pervasive in all government policies since independence. The effect of which could be felt when liberalization policies for the software industries were initiated in the 1980s.

The implementation of policies in the initial years was considerably conservative, tending to attenuate the policy changes and thus moderate the extent of liberalization. For example, in 1986 it was promised that there would be 'single point clearance' for hardware import applications and that decisions would be made 'within six weeks'[1]. The reality however was very different; the whole process required visits to at least two departments and took three months (Heeks 1996). Similarly, despite the de-licensing of the software industry, companies were required to register with the Secretariat for Industrial Approvals, and there were such other complaints from the industry about procedural realities underlying theoretical liberalizations[2].

However, despite the differences in practice from theory, the policies taken as a measure of liberalization had the desired effect, implying that they were by and large successfully implemented and that the alterations in implementation were mere aberrations.

4.1.2 Pre-1980:

The Department of Electronics (DoE) was created in 1970. In 1972 one of its earliest major initiatives was the 'Software Export Scheme', which eased the import of hardware for use in software exports. The primary criteria was a commitment from the importing

[1] See Government of India (1986), 'Policy on Computer Software Export, Software development and Training, Department of Electronics', New Delhi.

[2] See India Today (1992), 'Stopping short', 15 January, pp. 70-72.

company to export and earn at least an amount of foreign exchange which was equivalent to the import price. This was to be earned within the following five years. The export obligation was later raised to twice the import price.

Other notable initiatives of DoE were investment in public sector R&D projects, an unwritten policy of the government and the public sector to procure customized software from Indian companies, and encouragement and initiation of computing and software related courses in universities.

Another important initiative was the setting up of the Santacruz Electronics Export Processing Zone where 100 percent foreign owned companies could be set up for software export operations[3].

4.1.3 1980 -1990

The new policy guidelines of 1981 emphasized the generation and export of software. Measures like higher import duties and tighter government inspection controls were established to ensure that the imported computers were used for export of software. The DoE reserved the right to confiscate computers from the importers who failed to meet their export obligations. However, the importers were allowed to use two thirds of the computer time for domestic use as it was envisaged that software export related work would not require the whole of the computer time.

[3]See Government of India (1972), Annual report, Department of Electronics, New Delhi.

The training investment efforts of the DoE continued during this phase. The Engineering Export Promotion Council and the Trade Development Authority began offering export marketing assistance to software companies during this period (Heeks 1996).

4.1.3.1 The New Computer Policy of 1984

A new computer policy was announced by the Department of Electronics in 1984, just a few days after Rajiv Gandhi was appointed the Prime Minister[4]. The thrust of this policy was towards hardware, aimed at promoting the manufacture of computers based on the latest technology, at prices comparable to international levels and with progressively increased indigenisation. It also had some major policy liberalizations for the software industry.

An important policy change was the liberalization of imports to foster domestic hardware production. Duty levels were lowered on components needed by computer manufacturers from 135 percent to 60 percent and on software from 100 percent to 60 percent, with an allowance of duty-free import for source code on paper. Companies producing CPUs, peripherals and subsystems on an OEM basis were permitted liberal imports of "know-how" with a low excise duty. Existing licensing requirements for the manufacture of micro- and minicomputers were removed for all Indian companies.

[4] See *Electronics Information & Planning* (1984), "New Computer Policy," Vol.12, No. 2, 1984.

Another policy change was the elimination of maximum capacity restrictions, which had limited computer production to uneconomical levels. These were replaced by minimum capacity requirements, which actually promoted economies of scale in production.

The new policy recognized software as an industry and entry into it was de-licensed thus providing a boost to the industry. As with hardware, companies with up to 40 percent foreign equity holdings (covered by FERA) and very large companies (covered by MRTP Act) were allowed to become software producers.

A number of other measures were planned to promote the software industry. A Software Development Promotion Agency (SDPA) was planned. Half of the foreign exchange earnings from export of software over and above the obligation were allowed to be used for purchase of more hardware. To prevent piracy software was placed under the Copyright Act, bringing the threat of fines or imprisonment on defaulters.

4.1.3.2 1986 Software Policy & other initiatives

Following up on the 1984 hardware policy, the DoE announced the 1986 Policy on Computer Software Export, Software Development and Training[5]. The objectives of this policy were:

• To promote the integrated development of software in the country for domestic as well as export markets.

[5] See Government of India (1986), 'Policy on Computer Software Export, Software development and Training, Department of Electronics', New Delhi.

• To promote the use of the computer as a tool for decision-making and to promote appropriate applications, which will catalyse economic development.

The software policy was dubbed by DoE's N. Seshagiri as a "flood-in, flood-out strategy," i.e. allowing an initial flood in of imports to achieve a greater flood out of exports[6]. It was based on the belief that India has intrinsic economic advantages in the field of software, in the form of human resources, and that promoting software production could provide a source of economic growth, foreign exchange earnings, and jobs. The software policy was a tacit admission that policies to protect domestic hardware producers were stunting the development of the software industry by denying the programmers access to necessary hardware and software development tools.

The software policy made import of hardware and software easier and quicker through some procedural changes. Software imports were de-licensed (changed from quota to tariff protection) and the duty was reduced to 60 percent. This was reduced in 1990 to 25% for computers and software used by software producers[7]. Previously, most popular software packages had not been allowed in the country at all. Also, firms setting up export-oriented software operations were allowed access to foreign exchange for the import of hardware and/or software in return for meeting export targets. In order to facilitate training of computer professionals, imports of hardware and software designed

[6] See *Dataquest*, (1987), "The New Software Policy: Dr. Seshagiri Clarifies, January 1987, pp. 82-95.
[7]See *Computers Today*, (1991) "Let Us Look at Electronics as a Means of Tackling Crises," January 1991, p. 63

for computer-aided instruction were allowed with a 60% duty. Foreign exchange was also made available for hosting foreign experts and importing training equipment.

To boost export of software the government increased export obligations by 50 percent, which was to be achieved in four years rather than five years as earlier. To ensure strict adherence to export obligations the government stipulated the companies to issue bonds and bank guarantees. Further, the export earnings had to be earned from net rather than gross export earnings.

In another policy initiative the government allowed establishment of wholly foreign-owned software companies as long as their entire output was exported.

In 1990, a 100% income tax exemption was extended to profits from software exports and the double taxation of software imports (income and customs taxes) was eliminated. Also, it was decided to develop 12 additional software technology parks.

The software policies have largely been impartial without any attempt to promote any particular company. The policy did not even promote establishment of any state enterprise. As Seshagiri once mentioned, the policy is based on the idea that "there should be a free-wheeling condition ... because we cannot anticipate ... what kind of software is going to be dominant in the world two years hence." The software policy may have been considered very liberal when compared to the past standards, but by international standards, a 60% import duty was hardly liberal, especially with export requirements attached. While this liberalization helped software exporters, it did little for companies developing products for the domestic market. Also, penetration of foreign markets was then perceived to be an expensive and risky proposition and the policy provided little direct support to exporters (e.g., market intelligence, export finance facilities).

4.1.4 Government's Policy Initiatives during the 1990s

The broad based policies of industrial liberalization in 1991 had a profound effect on the software policy. This period witnessed the reduction in telecommunication charges for satellite links. Import of telecommunications equipment into Export Processing Zones and Software Technology Parks was made duty free and obligation-free. Reconfirmation of export tax and excise duty exemption was made annual, with the former's confirmation being changed to 'open-ended' rather than annual in 1995 (Heeks, 1996). Yet another confirmation provided that the export obligations could be met from earnings of staff sent to work overseas at the client's site.

Import duties on software (both applications and systems) were progressively reduced from 122 percent in 1991 to 10 percent in 1995. In 1993, duplication of software was permitted in India. For the first time Indian companies were allowed to enter into agreements with an overseas software package producer to import a single master copy of the package at normal import duty and then pay a taxable royalty on each copy made and sold in India. No permission was required for such deals where the royalty was less than 30 percent of the software's Indian price.

In a major policy initiative the National Task Force on Information Technology and Software Development was instituted by the Prime Minister in May 1998 with the mandate to formulate a draft for the long term National IT Policy for the country. The Task Forces role was to advise the government about the immediate initiatives that the Government should take to remove bottlenecks and boost the growth of the IT industry in general and the software industry in particular. Three important reports[8] were submitted during the period between July 1998 and April 1999. In its first report – the 'Information Technology Action Plan: Part-I' the Task Force has stipulated 108 recommendations focused on the development of the software industry.

The major recommendations of the Task Force in this report include opening of Internet gateway access; allocation of 1-3 per cent of Budget of every Ministry/Department for IT applications; zero customs and excise duty on IT software; income tax exemption to software and services exports; allowing US Dollar linked stock options to employees of Indian software companies; encouragement to set up venture capital funds; encouragement for private sector Software Technology Parks (STPs); networking of all Universities and research institutions; new schemes for students including attractive package for buying computers, etc[9]. The Government has accepted almost all the recommendations and has directed all concerned departments to implement recommendations. Meanwhile, the Government has set up a new Ministry of Information Technology (MIT) in October 1999, as the nodal agency for facilitating all the initiatives

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[8] The three reports are *Information Technology Action Plan- Part I* (July 4, 1998), *Information Technology Action Plan- Part II* (October 26, 1998), and *Information Technology Action Plan- Part III* (April 16, 1999). While the first two reports are on software and hardware industries respectively, the third one is on long-term national IT policy.
[9] See *Economic Survey: 1998-99*, p. 109.

in the Central Government, the State Governments, academia, the private sector and successful Indian IT professionals abroad[10].

The focus of the Task Force's third report is on the long-term (strategic) national IT policy. Among its major policy recommendations are the following:

- De-licensing and de-regulating the import of software productivity tools to continuously upgrade productivity of the Indian Software Industry.
- The high quality of Indian software products and software services exported to be sustained by compulsory insistence of ISO- 9000/SEI CMM Level-5 Standards or equivalent, certified by one or more competent certification agencies in India.
- For keeping pace with the fast changing trends in the software technology, companies and software development organizations to be progressively encouraged to spend at least one-fifth of their total software budget for the purchase of software productivity and quality tools and emerging software related to the latest software technology trends.
- In their drive to increase international credibility, the software companies shall be allowed to utilize a part of their export earnings for putting in place all necessary means for meeting strict delivery schedules and customer satisfaction.

The government, NASSCOM, and other organizations have taken various initiatives to promote quality consciousness among Indian firms in the software industry. While some of these initiatives are in the form of incentives and grants, others include

[10] See Economic Survey: 1999-2000, p. 125.

promotion and Memorandum of Understandings (MoU). Some of these initiatives as listed by NASSCOM are[11]:

- Software developers who have acquired the quality status of ISO 9000(Series), SEI CMM (Software Engineering Institute Capability Maturity Model) Level 2 and above or equivalent certification[12] are eligible for a grant of Special Import Licenses (SIL) by the Directorate General of Foreign Trade (DGFT), Ministry of Commerce. The entitlement is calculated at 5 percent of the FOB[13] value of export of product or services made during the preceding licensing year. SIL can be sold in the open market at a premium.
- Exim Bank has announced a scheme whereby the bank could subsidize software-exporting companies with up to 50 percent of the cost for acquiring the quality certification. Towards this end, NASSCOM and Exim Bank have already signed a MoU.
- Ministry of Information Technology has taken the initiative in bringing the best in the world in the area of Software Testing and Assessment of Software Maturity through licensing arrangements with Software Engineering Institute, Carnegie Mellon University, USA. Under this scheme, STQC Directorate of Ministry of

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[11] These are taken from *www.nasscom.org/template/Quality.htm.*

[12] In India, quality certification is provided by many agencies. However, there is a list of organizations recognized under the Exim Policy of the Ministry of Commerce. The Government of India has also published a list of SEI CMM Level 2 and above certificate issuing authorities, which includes Software Engineering Institute, Carneige Mellon University; TeraQuest Metrics Inc., USA; Process Transition International Inc., USA; Global Systems Technology, USA; Software Technology Transition, USA; John Ryskowski Consulting, USA; The Process Group, USA; ChangeBridge Inc., USA; Theta Information Systems Inc., USA; and PRT Corporation of America, West Indies. The Government of India constantly updates this list.

[13] FOB or 'Free on Board' is a term of Economics used in international trade. Here it means 5 percent of the value of software exported by the firm in the previous year.

Information Technology is undertaking the job of Certification, Testing and Training of trainers and assessors in India.

In a recent initiative the government has set up an IT venture capital fund of Rs. 100 crore for software companies. Further, it has enacted the Information Technology (IT) Act, 2000, which came into force on 17th October 2000. The Act, apart from providing a legal framework for e-commerce and prevention of computer crimes, also recognizes electronic contracts, electronic documentation, digital signature, etc. These provisions of the act are meant to lay the foundation for the growth of e-commerce in India.

While the Indian state combined restrictive regulation with attempts to substitute state-owned production for private production during the 1960s and 1970s, conscious attempts have been made by the central government regulatory agencies and state-owned enterprises in the high technology industry to increase state actions aimed at complementing and promoting private entrepreneurship during the 1980s (Evans, P. 1992). This change in the orientation of the Indian state has been reinforced more strongly since the adoption of liberalized economic policy in July 1991 and more so since May 1998 as the above analysis suggests.

4.2 BRIEF HISTORY OF THE SOFTWARE INDUSTRY

4.2.1 1970s to 1980: Software Industry's origin and the birth of the export industry

During the early phase of 1970s, government and academic computer users were partly dependent on the imported software bundled with the hardware and partly on their own in-house software developed by the software developers. However, as more and more commercial organizations adopted computers a new market for software emerged and such software development work began to be contracted out to management consultancies. Thus the software services industry was born.

The growth of India's hardware industry in this early phase had a benign consequence for the software industry. As the indigenous hardware manufacturers began developing an increasing range of operating systems, compilers, and application packages, they significantly enhanced their own technological capability and those of their human resources.

Since procurement of hardware continued to be difficult and expensive due to the existing policy regime, companies who had acquired computers often operated as computer Bureaux and resorted to selling computer time to other firms to recover their costs. Typically, the computers used for these purposes were imported and only those firms that agreed to undertake exports were allowed to acquire a computer at lower costs with simpler import process (Heeks, 1996).

The first firm to agree to export in return for permission to import hardware was Tata Consultancy Services (TCS) in 1974 (ibid.). Thus the Indian software export industry was born.

TCS's initial software services were based on its foreign collaboration. Initially it entered into a collaboration with Burroughs and later floated a separate company Tata Burroughs Ltd and shifted all its Burroughs oriented workers into it. TCS and TBL (later Tata Unisys Ltd) were then the largest software export companies in India. TCS still remains the largest software exporter from India.

Some other companies that were set up in the 1970s are Computer Maintenance Corporation (CMC) (1978), and Hindustan Computers Limited (HCL) (1976) (Evans, 1995). Though some of these companies started as hardware producers, but in the course of time they either spawned software units or evolved into software companies themselves.

During this phase the Information Systems departments of companies also started selling their in-house software. Some of the more successful ones were hived off into separate departments.

The departure of IBM from the country in 1978 gave the industry an added boost, as several of its ex-employees set up small software companies, which often started as computer bureaux and then graduated into software development houses. Thus the number of computer bureaux, and software services companies slowly increased.

4.2.2 1981 to 1990: Software industry strengthened

Post 1981, aided by the increasing export awareness and increasing availability of skills in India, government initiatives to encourage fulfilment of export obligations, and external factors such as boom in demand for software in the US, software exports escalated. Small and medium sized companies whose operations were hither-to domestic oriented entered the export market as the computer bureaux market stagnated.

The advent of the 1984 hardware policy further boosted the growth of software industry as import of computers became easier. Many companies were incorporated to take advantage of the change in policies and thousands of computers were imported. Most of these companies were a result of hiving off of erstwhile software departments of existing IT companies. Many others were started by ex-employees of existing software or hardware organizations or software departments of companies of other industries (Heeks, 1996).

The 1980s marked the arrival of international hi-tech companies like the Citicorp Overseas Software Ltd (COSL) and Texas Instruments (TI). Other notable firms that were established are Infosys Technologies, Wipro Technologies, and Satyam Computers.

4.2.3 Post 1991: Liberalization and spurt in growth of the industry

July 1991 heralded the era of massive liberalization. Aided by the benefits accruing from the general liberalization policies and several promotional measures of the government, India emerged as a major software development centre in the world.

By the mid-1990s, even those firms, which had initially focused on hardware, were pushing into software exports, compounding the export obsession[14]. Additionally, with India's reputation in software having been firmly entrenched, the influx of MNCs into the country proliferated. Oracle, Microsoft, and SAP, among numerous others, set up their Development Centres in India. Their main attraction being the availability of cheap and technically sound labour pool. All these firms have shifted substantial portion of their software development to India thus bolstering exports.

The proliferation of Graphical User Interface (GUI) based software in mid 1990s accelerated the diffusion of computers among the masses as it became possible to interact with the computer simply by clicking graphical icons as opposed the earlier system of interacting through commands which had to be memorized. Further, the rapid diffusion of Internet and the Y2k paranoia towards the end of the decade created a big export market for software.

4.3 MEASURING THE GROWTH OF THE SOFTWARE INDUSTRY

There are no reliable government statistics on overall software production within India for the early years of the industry. Heeks suggests that the most inaccurate figures for the early years of the industry are those presented by IDC (e.g., IDC 1992, IDC 1993, IDC 1994) and Dataquest (e.g., Dataquest 1993, Dataquest 1994, Dataquest 1995a) (see ***Table 4.1***. From the compilation of data Heeks concludes that overall software production has

[14] By 1996, all but two of India's top ten IT firms were significant software exporters, as were all but three of the top 10 hardware companies. In the largest hardware firms, software exports grew by 170 percent between 1992-93 and 1994-95 (Dataquest surveys).

grown slower than exports, and that software exports probably grew from something like one-half of overall production in mid-1980s to roughly three-quarters of overall production in the mid-1990s.

Table 4.1 INDIAN SOFTWARE EXPORTS

Year	**Exports (Rs. M)**	**Exports (US $m)**
1973	0	-
1974	2	-
1975	9	-
1976	20	-
1977	25	-
1978	30	-
1979	35	-
1980	31	4
1981	59	6.8
1982	128	13.5
1983	186	18.2
1984	291	25.3
1985	337	27.7
1986	490	38.9
1987	698	54.1
1988-89	1010	69.7
1989-90	1750	105.4
1990-91	2350	131.2
1991-92	4260	173.9
1992-93	6700	219.8
1993-94	9860	314

SOURCE: Heeks (1996)

The bias towards exports was evident in the earnings of the top twenty-five software producers by mid-1990s[15]. Fifteen of these earned more than 80 percent of the revenue from exports and the remaining revenue that was contributed by the domestic market was accounted for by imported packages. Only five firms earned more than half their software revenue domestically. However, except for CMC and ECIL, all these firms earned well over 90 percent of the domestic income from package imports. Roughly one-

[15] See *Dataquest*, (1995b), "The DQ Top 20: Volume 2", 1-15 August, 1995, pp. 41-204.

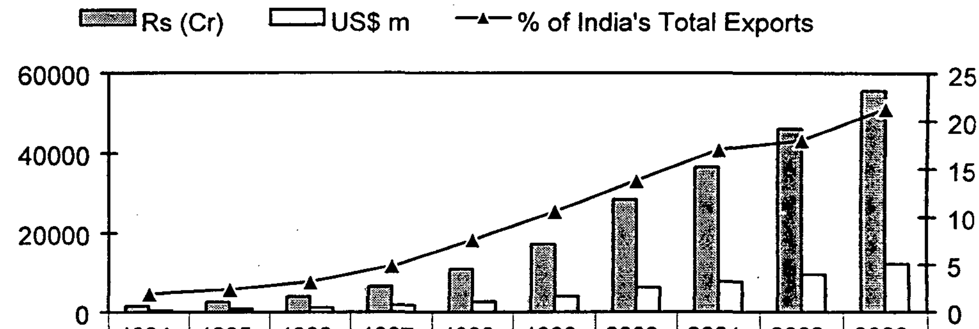
third of India's export earnings came from firms that had no domestic market base for software services sales. The obsession with software exports continues till date and the proportion of revenue from domestic software market remains relatively small.

From meagre export revenue of $ 25 million in 1985, the industry's exports have grown to $ 9.5 billion in 2002-03. Software exports grew at 41 percent annually in the 1980s and about 50 percent in the 1990s [(Heeks, 1996) & (NASSCOM, 2004)].

Software and services exports form bulk of the IT industry and they continue to be the dominating factor in the over all growth of the industry (see ***Fig. 4.1***). The software services exports have grown phenomenally from $489 million in 1994-95 to $9.55 billion in 2002-03, an increase of 26 percent over the previous financial year. This growth is the fastest among the various segments of the IT industry (domestic software and services 23 percent; hardware, peripheral & networking 4.85 percent; IT training (-23 percent). In addition, the contribution of the software and services to the total IT industry increased from 57 percent in 2001-02 to approximately 60 percent in 2002-03 (NASSCOM 2004).

NASSCOM estimates that the robust growth in Software exports are expected to continue and touch $12.2 billion in 2003-04, an increase of 20 percent in Rupee terms and 28 percent in US$ terms.

Fig. 4.1 **India's Software & Services Export** *SOURCE: NASSCOM(2004)*

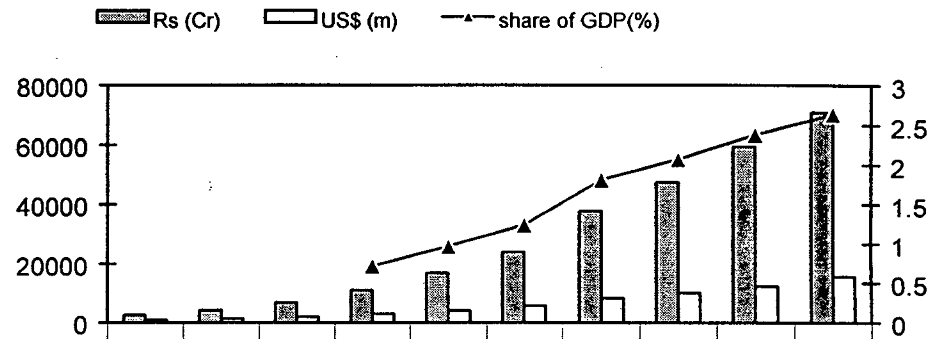


	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04E
Rs (Cr)	1535	2520	3900	6530	10940	17150	28350	36500	46100	55510
US$ m	489	754	1100	1759	2600	3962	6217	7647	9545	12200
% of India's Total Exports	1.9	2.4	3.2	4.9	7.6	10.6	13.8	17	18	21.3

The strength of the software sector as the driver of the overall foreign exchange reserves is reinforced by the continuous increase of the contribution of software and services export to India's total invisible receipts. Whereas its contribution to overall invisible earnings was less than 18 percent in 1997-98, it increased to 59 percent in 2002-03 and in 2003-04 its contribution is expected to go up to 73 percent.

Overall, the IT software and services industry registered a growth of 24 percent in 2002-03, touching $12.3 billion in revenues against $9.95 billion in 2001-02 (NASSCOM, 2004) (see *Fig 4.2*). After a slowdown in the growth rate due to global slowdown in the sector, the industry is expected to grow at about 26 percent in 2003-04 and touch $15.5 billion. Though the growth rate of the industry has declined from what it was in the 1990s, the much higher base will still result in quite respectable outcomes even with the tapered down growth rates.

Fig. 4.2 **India's Software & Services Market** *SOURCE: NASSCOM(2004)*



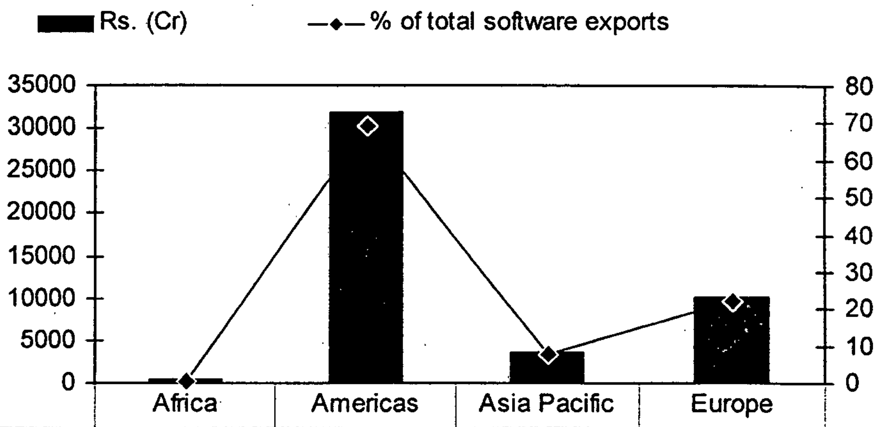
	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04E
Rs (Cr)	2471	4186	6594	10899	16879	23980	37840	47532	59472	70860
US$ (m)	787	1253	1895	2936	4011	5539	8298	9958	12314	15574
share of GDP(%)				0.72	0.97	1.24	1.81	2.07	2.38	2.64

3.3.1 Geographical distribution of exports

Indian software exports are heavily skewed towards North America, which accounted for 69 percent of total exports. Europe was second at 22.25 percent of total exports. All other regions remain under-exploited (see ***Fig. 4.3***).

NASSCOM indicates that this regional disparity in exports could be due to local competition, for example, in the Asian market, emergence of competitors in countries like China, Malaysia, Singapore, et al, could be inhibiting Indian companies' entry into these markets. Yet another factor could be the emergence of near shore locations such as Central and Eastern European countries (for European corporations), and Mexico (for North American corporations), among others.

Fig. 4.3 **India's Major Software Exports Markets** *SOURCE: NASSCOM(2004)*



	Africa	Americas	Asia Pacific	Europe
Rs. (Cr)	356	31833	3657	10255
% of total software exports	0.77	69.05	7.93	22.25

Another reason attributed for the disparity is the possible difficulty for Indian firms in attracting new clients in European countries (except the UK) due to their inadequate knowledge of the local language, business customs and culture.

Yet another reason attributed is the outsourcing inexperience of European and Asia-Pacific corporations. However, this is likely to change, as these companies will be bound to outsource in the future in order to remain globally competitive.

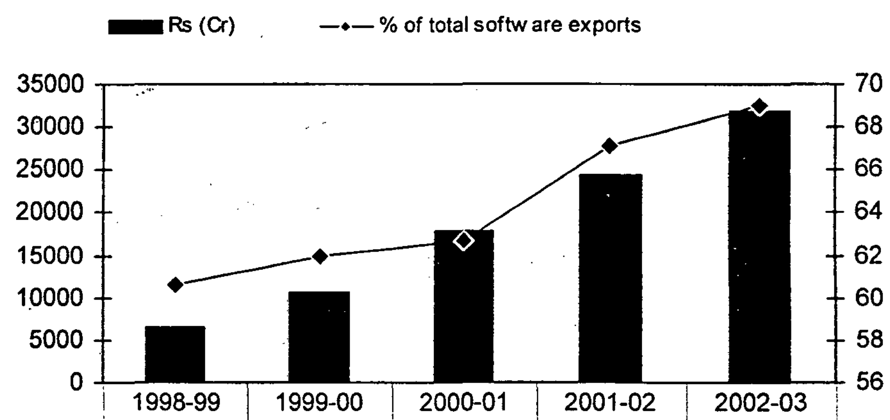
The above-mentioned handicaps notwithstanding Indian companies have been trying to increase their presence in the European, Asian and Australian market. However, North America will continue to be the main feature of Indian software exports simply because of the fact that it accounts for around 50 percent of the global IT spending.

Based on the pattern and volume of software exports India's main software export markets can be categorized as North America, Europe, and Asia Pacific.

4.3.1.1 North America

India's software exports to North America have increased continuously, with its revenue share growing from nearly 60.5 percent in 1998-99 to 67 percent in 2001-02, and 69 percent in 2002-03 (see ***Fig. 4.4***).

Fig. 4.4 **India's Exports to North America** *SOURCE: NASSCOM(2004)*



	1998-99	1999-00	2000-01	2001-02	2002-03
Rs (Cr)	6629	10630	17761	24491	31833
% of total software exports	60.59	62	62.65	67.1	69.05

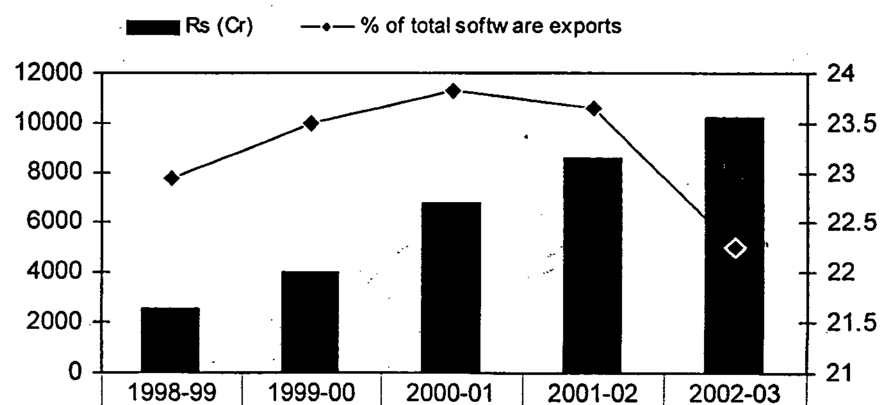
North America is the largest market for software services in the world and it accounted for an estimated 50 percent of the global IT services market in 2002-03. Nearly half of this market is accounted for by the financial and manufacturing industries. Other important industries that have been big spenders in IT are telecom, automobiles, aerospace, and the pharmaceutical industry. Lately, there has been a surge in spending by the federal and state governments in the US.

With the eminent recovery of the US economy an increase in IT spending in the private sector is likely. According to NASSCOM, IT spending in the US could rise by as much as 8 percent in 2004 if the GDP and corporate profits continue to escalate.

4.3.1.2 Europe

Europe is India's second most important software export market. It accounts for roughly 30 percent of global IT services market. After its worst ever decline in IT spending in 2002 there has been a slight recovery in 2003. NASSCOM estimates that IT spending in Western Europe is likely to improve in 2004, and is expected to grow at 6 percent (see *Fig 4.5*).

Fig. 4.5 **India's Exports to Europe** *SOURCE: NASSCOM(2004)*



	1998-99	1999-00	2000-01	2001-02	2002-03
Rs (Cr)	2510	4030	6754	8634	10255
% of total software exports	22.94	23.5	23.82	23.66	22.25

The share of European market in Indian companies software exports have been increasing gradually. In 2000-01, software exports to the region peaked at 23.82 percent. However, following a slowdown in IT spending in Europe its share in total exports has decreased marginally to 22.25 percent in 2002-03. Software exports to Europe grew by 18 percent in 2002-03 to Rs. 102 billion (US$ 2.1 billion) in 2002-03.

So far, UK has been the main market for India, accounting for nearly 63 percent of Indian software exports to Europe in 2002-03. The UK, Germany and France together contribute to more than 77 percent of Indian software exports to Europe.

The cultural and linguistic challenges posed by the European market notwithstanding, Indian companies have intensified their efforts to penetrate the European market and have resorted to training their employees in various European languages and business culture, especially German and French.

Indian companies have been trying to overcome the inherent barriers by increasingly recruiting local executives in these countries, especially for selling, marketing and other client-facing functions. Further, these companies are exploring the possibility of joint ventures with local European IT services companies for jointly bidding for outsourcing contracts. Indian companies are also familiarizing their existing and prospective clients with the Indian business and social culture.

4.3.1.3 Asia Pacific

In the Asia Pacific region Japan continues to be the most important export market despite the economic turbulence that it has been afflicted with. Other important markets in the area include the Australia-New Zealand region, followed by China-Hong Kong-Taiwan region and South Korea.

IT spending in the region grew by more than 8 percent in the first half of 2003, as compared with the same period in 2002. This is expected to improve further in 2004, and the market is expected to grow by 9 percent. The growth will primarily be driven by the Chinese and Indian markets, followed by South Korea and Australia. However, Japan the largest market in the region is expected to grow slowly.

4.3.5 Exports by service line

There are about 10 major categorizations of IT services but India has a significant presence only in 2 of them. Custom application development and maintenance, and application outsourcing account for about 88 percent of total software exports. NASSCOM indicates that Indian companies have started moving up the value chain by offering services in IT consulting and system integration. Progressive Indian companies are increasingly exploring the untapped potential in network consulting and integration, hardware support and installation, processing services, and IS outsourcing (see ***Table 4.2***).

Table 4.2 **INDIAN SOFTWARE AND SERVICES EXPORTS: KEY SERVICE LINES (2002-03) (figures in billion $)**

KEY SERVICE LINES	2001-02	2002-03
Software & services	**4.95**	**5.53**
IT Consulting	0.05	0.08
System Integration	0.15	0.1
Custom Application Development and maintenance	2.65	3.02
Network consulting & integration	-	0.03
IT Training & Education	-	-
Hardware support & installation	-	0.02
Packaged software support & installation	0.3	0.35
Processing service	-	0.01
IS Outsourcing	-	0.01
Application Outsourcing	1.75	1.85
Network infrastructure management	0.05	0.08
IT Enabled service	**1.49**	**2.39**
R&D Services	**1.21**	**1.66**
Product development & design	0.3	0.56
Embedded software	0.91	1.1
TOTAL	**7.65**	**9.53**

Source: NASSCOM (2004)

4.3.6 Industry Structure

The Indian IT services industry comprises of a diverse group of companies ranging from large billion dollar global companies to small start-up companies and a considerable presence of multinationals (see ***Table 4.3***). Growth rates across companies are quite varied.

NASSCOM has classified the firms into 5 types.

- Tier 1 companies are the top 5 firms of the industry accounting for about 32 percent of total software exports.

- Tier 2 companies with revenues of between Rs. 100 Crore and Rs. 1000 Crore account for about 24 percent of the industry. These companies face the challenge from the tier 1 companies who have resorted to fierce bidding.
- MNC backends accounting for about 26 percent of the industry.
- Focused companies comprise about 3-4 percent of the industry. These are the group of companies that focus on particular domain/service line/products, who are facing the challenge of cutbacks in key markets such as telecom, and have been trying to diversify their offerings.
- The last category is the group of small companies with revenues of less than 100 Crore accounting for about 12-14 percent of the market.

Table 4.3 **Structure of Indian Software Exports Industry**

	No. of Companies	
Annual turnover	**2001-02**	**2002-03**
Above Rs. 1000 Cr		7
Rs. 500 Cr - Rs. 1000 Cr		5
Rs. 250 Cr - Rs. 500 Cr	1	1
Rs. 100 Cr - Rs. 250 Cr	2	4
Rs. 50 Cr - Rs. 100 Cr	5	7
Rs. 10 Cr - Rs. 50 Cr	22	244
Below Rs. 10 Cr	248	2644
	281	**3031**

Source: NASSCOM (2004)

4.4 INNOVATION IN THE SOFTWARE INDUSTRY

4.4.1 Indian Software Industry and the National Innovation System

Any industry in a nation is affected by the existing innovation system. Therefore innovation orientation of the Indian software industry needs to be studied in the light of the existing innovation system.

The Indian Innovation System had a dominant role for the government with the key objective of self-reliance. Towards this end, the government made heavy investments in key infrastructure sectors apart from the important sectors of atomic energy and space. It also dominated Research & Development activity. Over 80% of the R&D done in India was financed by the government of India and conducted within government research laboratories (Forbes, 1999). Most of this was allocated to the strategic sectors of atomic energy and space, resulting in one of the most advanced capabilities in these areas in the developing world. The government also created a network of forty laboratories through its agency – the Council for Scientific & Industrial Research. Research & Development activity in these laboratories has resulted in numerous patents. However, because of lack of coordination with the industry most of these technologies remain commercially unexploited.

Beginning in the late 1950s, under the vision of the then Prime Minister, Jawaharlal Nehru, several institutions of higher technical education like the Indian Institute of Technology (IIT) and Regional Engineering Colleges were established by the central government. The state governments also established and funded several engineering colleges. Private participation in higher education was limited to a few states where engineering education was provided for a 'capitation fee'. The IITs were set up with the famous Massachusetts Institute of Technology as the benchmark. Therefore, these institutes have been provided with world-class infrastructure for research. Typically, the faculty in these institutes comprise of PhDs from reputed American universities. The entrance for the IITs is among the most competitive exams in the world and the quality of students getting admission is also the best in the country. The education provided in the IITs is excellent. Though not outstanding, the research output from its faculty is good but, as in the case of the national research laboratories, IITs had limited interaction with Indian industry. IIT graduates found few opportunities to use their technical knowledge in the industrial sector and tended to emigrate in large numbers, principally to the United States. Those that stayed behind went into the government research establishments or to management positions in the private sector. The graduates of other engineering colleges, however, largely remained underemployed because of the inability of the economy to accommodate them.

By the end of the 1980s, India had developed significant strengths in scientific and technological infrastructure, but little benefit of this was accruing to the industrial production system. The economy was stuck in slow growth of 3.5 percent and India had fallen behind other East Asian countries like Korea and Taiwan.

In the early days of its coming into being, the software industry depended on the public sector infrastructure created by the government for its initial manpower requirements. The main source were the research laboratories of Defence Research & Development Organization and other public sector high technology industries like the Hindustan Aeronautics and Bharat Electronics. The primary reason why these industries became targets was because they possessed the state-of-the art computers and hence they also possessed the skilled manpower that was required to work on computers. However, as the number of computers increased and the software industry expanded, a number of computer based training programmes were introduced in universities and higher technical education institutes to generate the required technically qualified manpower. In cases where the required skills were not available the software companies formulated in-house training programmes.

4.4.2 Innovation orientation of software firms

Since its inception the software industry has been taking various innovative measures for remaining competitive and profitable in the global software industry. The various steps taken by the firms of this industry to move up the value chain along its evolutionary path are discussed below.

4.4.2.1 Shift from 'Body shopping' to value added services

The initial thrust for the industry's growth was provided by the government's policy of export obligations. Firms were allowed to import computers only if they agreed to meet the export commitments (Heeks, 1996). Further, the government issued threats of confiscation of computers if the firms failed to meet their export obligations. The combination of the government pressure and the software firms' survival instincts resulted in 'body shopping' as a means of meeting the export obligations. 'Body shopping' is a pejorative term used to refer to the dispatch of Indian programmers to a foreign destination on a contract basis to write software code for a foreign customer.

Though the software industry's initial start was based on the wage differential between in India and the advanced countries where the required labour was sent, Indian companies have been striving to upgrade themselves to provide value added services. They have been very adept at quickly upgrading themselves from providers of manpower to providers of software solutions. Indian companies, in general, have been quick in learning new programming techniques and diffusing those techniques to the engineers within the company. Some examples of this capability building are: the absorption of the Unix technology in the early days of the industry; the development of solutions for the Y2k problem, Internet and e-commerce technologies few years later; and adoption of some of the new Microsoft technologies such as .NET.

4.4.2.2 Custom application development and application outsourcing

Always on the pursuit of improving their margins and adding value to the customer, Indian software firms have moved up from body shopping to custom application development to application outsourcing. Where as custom application development is about providing customized solutions to the clients' problems. Application outsourcing involves developing either full products or components for MNCs and requires the local firms to work in close coordination with them. These endeavours have considerably enhanced their technological capabilities. In 2002-03 revenue earned from these sources was US$ 4.87 billion (NASSCOM, 2004).

4.4.2.3 Enterprise Application Integration

Lately, Indian companies have forayed into the more profitable business of Enterprise Application Integration (EAI) involving high technology skills to integrate the customers' existing applications for enabling better sharing of data and information, controlling costs, and ensuring better return on previous investments. EAI solutions can be provided at six different levels: platform integration, data integration, component integration, application integration, process integration, and business-to-business (B2B) integration (ibid.). EAI solutions enable companies to exchange data across various enterprise applications, and facilitate easy and reliable access of corporate information.

Indian companies have not only upgraded technologically but lately they have built considerable domain expertise. Most large software firms have formed divisions to cater to various customer domains such as manufacturing, oil and gas, retailing, insurance, and telecom. These firms have built teams of domain experts to help the company develop software solutions in various domains.

4.4.2.4 IT Consulting

The established domain expertise has come in good stead for Indian companies. They are now exploiting the lucrative IT consulting market, a segment in which the industry grew 60 percent to touch US$ 80 million. Top companies such as Wipro, TCS, and Infosys are using their strong brand image to target potential clients. While some of the bigger firms have acquired boutique consulting firms around the world, the smaller ones are entering into collaboration with consulting firms to penetrate the consultancy market.

IT consulting requires an end-to-end approach for developing solutions rather than simply offering different technology solutions for different domains. Besides being more profitable, IT consulting has the added advantage of attracting other works at the lower level of the value chain.

4.4.2.5 Package Implementation and Support

Indian companies have also made considerable progress in the Package Implementation and Support market. This is the market that accounts for about 15 percent of the total global IT spending. In 2002-03, the industry grew 17 percent to touch US$ 350 million in this segment (ibid.). This is a segment that not only requires the companies to develop domain skills and expertise in various industry verticals, but also overcome the competition from large MNCs operating in this space.

Besides the above-mentioned measures of technological and business innovations, one area where Indian firms have demonstrated considerable learning ability is in building quality management systems.

4.4.2.6 Quality Management Systems

Beginning with the ISO 9000 certifications, which ensured a consistent and orderly execution of customer engagements and provided a framework for measurable improvement, Indian companies have graduated to software engineering specific CMM framework for assessment and certification. The importance attached to quality management systems can be gauged from the fact that India now has the largest number of SEI CMM Level 5[16] companies in the world. By December 2003, India had about 65 companies at SEI CMM Level 5 assessment. The quality maturity of the Indian software and ITES-BPO[17] industry can be measured from the fact that already 275 Indian software and ITES-BPO companies have acquired quality certification and about 80 more companies are in pipeline. Not content at having achieved the highest level of certification for software engineering, many Indian software companies have embarked upon the next level of quality consciousness. This level of consciousness is driven by the desire to institute processes, metrics and a framework for improvement in all areas including those relating to sales, billing and collection, people management, and after sales support. Typically, this is characterised by companies aligning their internal practices with the People CMM framework and by the use of the Six Sigma methodology for reducing variation and assuring "end-to-end" quality in all company operations.

Though some cynics have questioned the potential benefits from further efforts to improve quality processes, there is little doubt that the industry or at least the larger companies have internalised strong process orientation. Their ability to continually upgrade their processes has been recognised by their customers in terms of large contracts and a growing business. Obtaining certification has been a powerful signalling device in winning these contracts.

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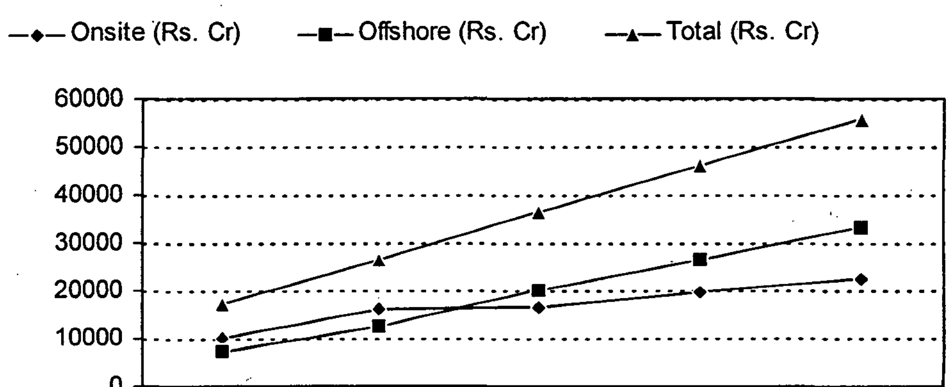
[16] SEI stands for the Software Engineering Institute of the Carnegie Mellon University, which has developed the Capability Maturity Model frameworks for quality assessment of software companies, which is done at various levels, Level 5 being the highest.

[17] ITES stands for Information Technology Enabled Services and BPO stands for Business Process Outsourcing.

4.4.2.7 Global Delivery Model

In their continuous effort to remain competitive and enhance their margins Indian companies have been seeking innovative ways of delivering software and services economically. Their efforts have resulted in a new delivery model in which a considerable portion of the software development is carried out offshore rather than at the client site (see ***Fig. 4.6***). NASSCOM estimates that offshore revenues as a proportion of total revenues have increased from nearly 35 percent in 1999-00 to 56 percent in 2002-03. The proportion of onsite revenues during the same period, on the other hand, has reduced from 57 percent to nearly 43 percent. Further, it is estimated that offshore revenues will increase faster at about 24.4 percent, as compared with 14.20 percent for onsite revenues over 2002-03.

Fig. 4.6 **Indian Software Exports: Delivery models** *SOURCE: NASSCOM(2004)*



	1999-00	2000-01	2001-02	2002-03	2003-04E
Onsite (Rs. Cr)	9850	15900	16500	19700	22500
Offshore (Rs. Cr)	7300	12450	20000	26400	33010
Total (Rs. Cr)	17150	26350	36500	46100	55510

The Global Delivery Model includes several components for delivering software and services. NASSCOM has classified four such components.

- *One Onshore* (same country as client) location for delivering services like account management, consulting assistance by domain experts, high level design, emergency bug fixes, and assessment/estimates.
- *On-site* (client site) for project management, requirement definition, prototyping, user interface design, usability testing, integration testing, acceptance testing, implementation, user training, and warranty maintenance.
- *Nearshore* (country near to client country) for high level design, quick turnaround development, emergency bug fixes, interactive development, prime-time support, testing, risk diversification for onshore/offshore tasks, on line applications management.
- *Offshore* (India) for project management, detailed design, coding, unit testing, preliminary usability testing, documentation, bug fixing, warranty maintenance, and ongoing maintenance.

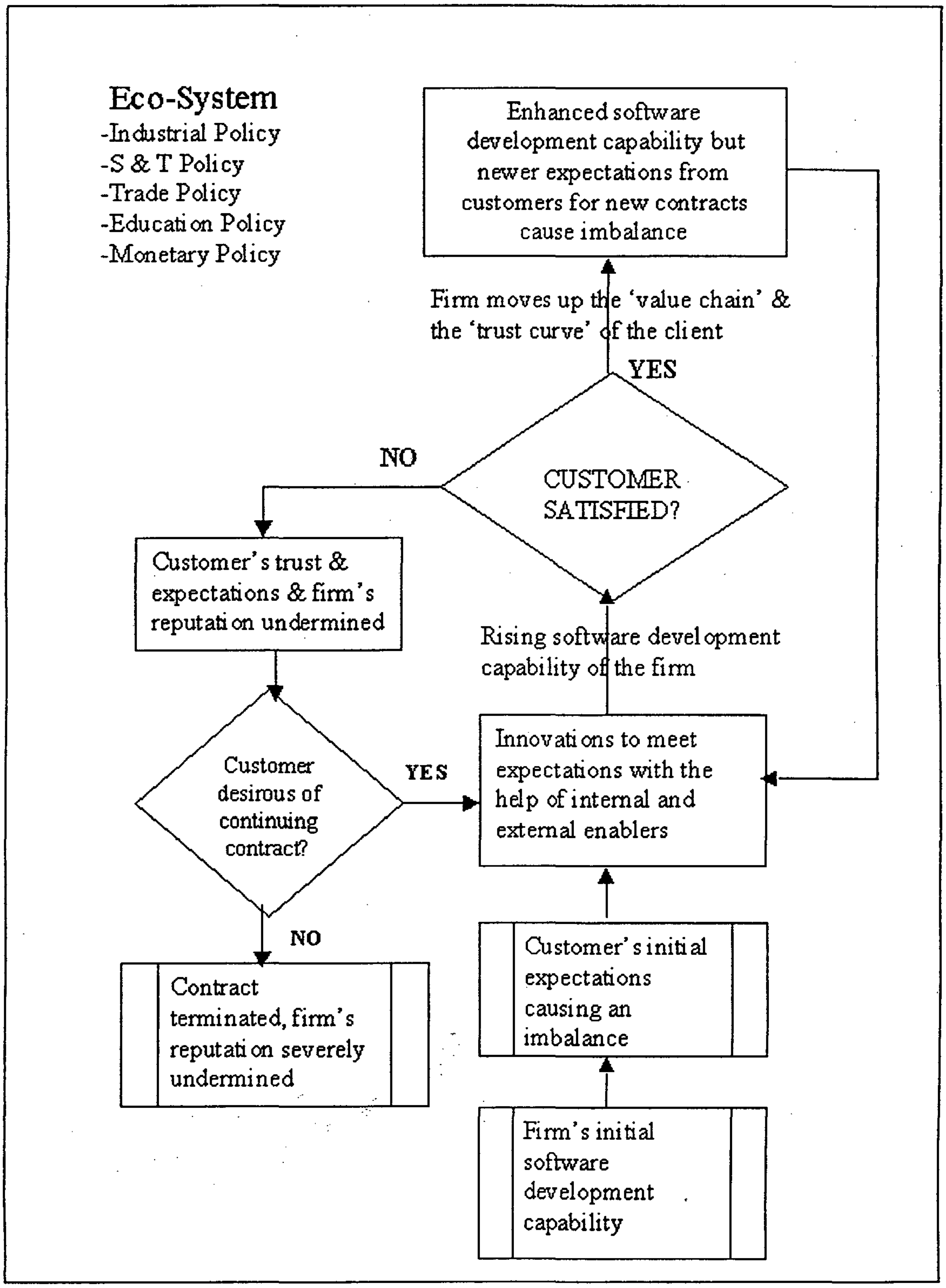
All these up gradations in the software industry, discussed above, can be studied using a general framework. The fact that most of the firms in the industry are software service oriented as opposed to product oriented makes it possible to draw a common framework for studying the innovation orientation and evolution of firms in the industry.

4.4.3 The Iterative Innovations Model

The proposed *'Iterative Innovation Model' (Fig. 4.7)* is inspired by the multiple stage innovations model discussed in the previous chapter, but unlike the multiple stage innovations model, this one focuses overwhelmingly on the customer. As the name suggests it is an iterative model in which a firm enhances its software development capability by innovating iteratively. Thus moving up the value chain with each iteration. In this model a firm starts with an initial software development capability and tries to fulfil initial customer expectations and subsequent expectations through innovations. As it fulfils the customer's expectations and satisfies it by meeting its exacting standards the firm moves up the value chain or the 'trust curve' of the customer. Every successful execution of a project enhances the customer's trust in the firm's software development capability. The increase in trust results in the award of more complex assignments by the customer to the firm. It also enhances the firm's reputation and its ability to attract more customers.

The *Iterative Innovation Model* predicts that as long as the customer's increasing expectations are met, the relationship between the customer and the firm continues. The whole process of innovations with the help of internal and external enablers to satisfy newer customer expectations also continues iteratively.

Fig. 4.7 Iterative Innovation Model



Internal enablers comprise of the leadership style of the top management, the culture of experimentation and tolerance of failure, the ambience of learning and sharing, recognition of innovation as a part of the mission of the enterprise, and the appraisal and recognition systems of the management. External enablers, on the other hand, comprise of developmental financial institutions, R&D laboratories, the community of investors and their confidence, customers and their feedback, and public policy makers.

All the various stages of technological up gradation and business or process innovations discussed above, for example, custom application development and application outsourcing, application integration, IT consulting, quality certifications, off-shore development, et al, can be conceived in the context of the iterative process of innovation represented in the model.

The external environment in which the external enablers are located also play an important role in a firm's innovation orientation and technological advancement. The environment comprises of the existing universities & research oriented academic institutions, Competitors, Sub-Contractors & Partners, Government R& D Institutions & funding agencies. All of these aspects of the environment and the firms themselves are affected by the existing policy environment which is determined by the prevailing industrial policy, Science & Technology Policy, Trade Policy, Education Policy, and Monetary Policy. These policy frameworks either have direct or indirect bearing on the firms' growth and innovativeness. A favourable trade policy with strong Intellectual Property Rights and anti-piracy laws, for example, may encourage firms to take up software product development. A sound Science & Technology policy can provide financial support to innovative firms. It can provide the infrastructure for public sector R&D and innovation that can spill over to the private sector firms. Favourable monetary policies like tax incentives for R&D spending by firms can accelerate innovation. Friendly industrial & labour policies too have a positive effect on firms' innovation orientation. A favourable education policy with large investments on higher education can provide the skilled human resource required by the industry.

According to this model, at any stage in the process of iterative innovation, if the customer is dissatisfied with the firm's work it may either decide to continue the relationship or terminate the contract. However, even if the customer decides to continue the relationship, it is unlikely that it will out source more complex (value adding) activities to the firm. Thus, in a way, inhibit the technological learning and advancement of the firm. Additionally, termination of the contract can severely affect the firm's reputation in the market and may have a bearing on its ability to attract new high value customers.

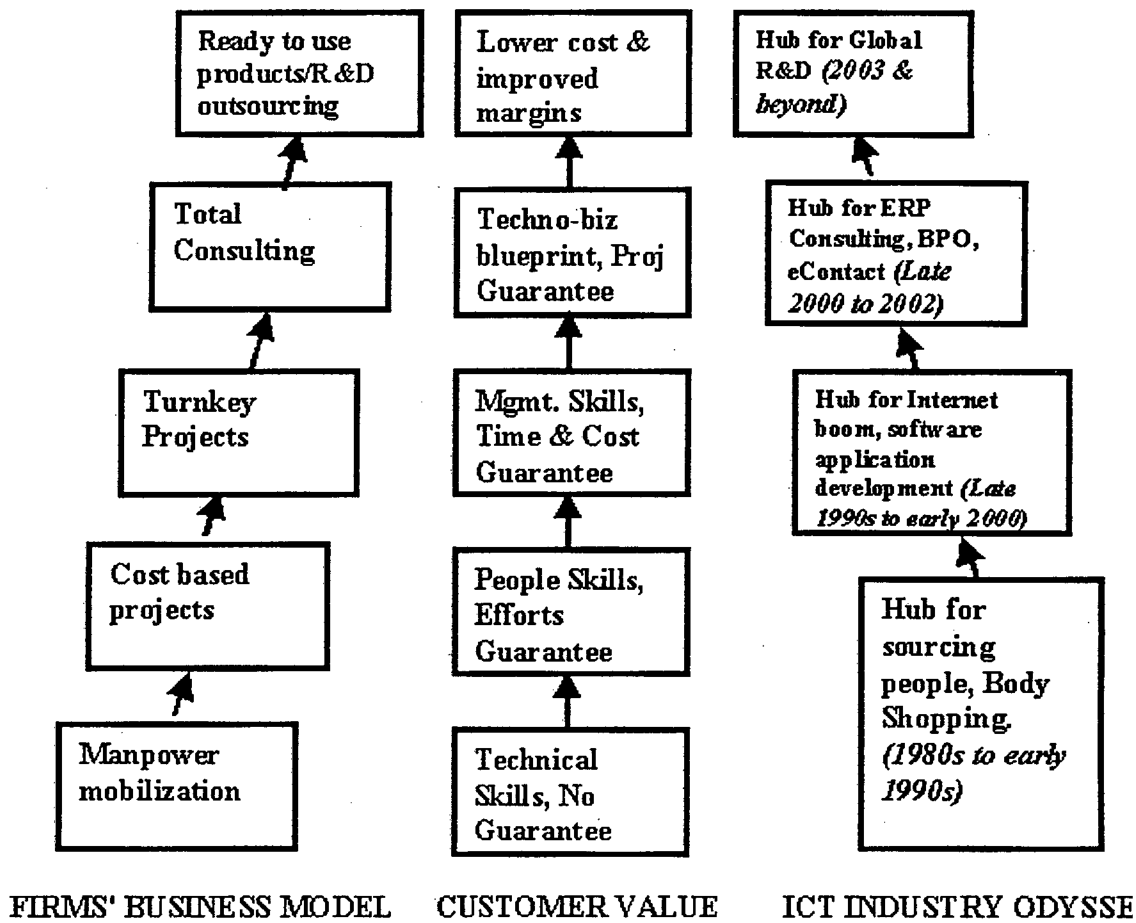
The model depicts the one to one relationship between the customer and the firm and it is likely that the firm may be serving many clients. It may happen that the firm executes projects satisfactorily for most customers but not so satisfactorily for some others. While the dissatisfaction of some customers will definitely have an adverse effect on the future business of the firm, it may not be catastrophic. However, if the number of such dissatisfied customers continues to increase unabatedly the firm may face litigations for not delivering as per the contract (expected) standards. The adverse publicity earned because of these litigations can potentially ruin its reputation and may result in erosion of its customer base. The firm may have to close down for lack of fresh orders and discontinuation of existing contracts by its customers.

The Iterative Innovation Model appears to be adequate for charting the process of innovation capability building by software firms in the Indian context where an overwhelming majority of them specialize in software services as opposed to products. It accurately depicts the one to one relationship between the firm and its customers for whom it provides software solutions. The model provides an understanding of the ways in which the customers affect the behaviour of the innovating firm. However, the model fails to capture the evolutionary trajectories that a firm might take and the range (nature) of software development activities a firm might undertake along its evolutionary path. Therefore, we would explore these issues in the following section.

4.4.4 Trajectory of the Indian Software Industry

In this section an attempt is made to summarize the various stages of evolution of the software industry and the value additions made to the customer in each of these stages. A diagrammatic representation of the trajectory traversed by the industry is made in ***Fig. 4.8.***

Fig. 4.8. Trajectory of the Indian Software Industry (Moving up the Value Chain).



As noted earlier, with the initiation of Government policy measures in the 1980s and the subsequent boom of the Personnel Computer software industry, Indian software firms initially started with mobilization of skilled manpower. In a derogatory Industry jargon this is also referred to as 'Body shopping'. Typically, this involves supplying skilled manpower to the Client Company to be used by it as per its requirement. Then came a stage when Indian firms started servicing 'cost based projects'. If an estimated project of a client required *x* number of people to work for *y* number of hours it was provided. Although, technically, this also amounted to 'body shopping', unlike in previous stage of 'manpower mobilization' where the skills offered were purely technical with no other guarantee, in this case, the Indian firms offered people skills in addition to technical skills and a guarantee of efforts from them, i.e., x number of people working for y number of hours. In the next phase, Indian firms further moved up the value chain to service 'Turnkey Projects'. In this stage, the client was offered management skills and time & cost guarantee for the projects undertaken. Further, up the value chain Indian firms resorted to 'Total Consulting'. The difference between the 'Turnkey Projects' stage and the 'Total Consulting' stage is that while in the former stage the firms were assigned tasks and were expected to deliver on the basis of what they were told to do, in the later stage, the firms partnered the client in identifying problems and developing solutions for them. Most of the large software firms like Infosys, TCS, and Wipro may be categorized to be at this stage of evolution. At this point, the firms not only provide technical consulting but a combined package of techno-business Consultancy. The final phase, which is more of a projection of the future trajectory of the industry, is either to move into the arena of devising, developing, and marketing of innovative software products or to outsource Research & Development activity for major software or hardware producers.

To summarize, from the industry perspective, the various business models adopted by Indian firms at different stages in their endeavour to move up the value chain, we may categorize the first two stages of 'manpower mobilization' and 'cost based projects' as an era when India was the hub for 'body shopping'. The next stage of 'Turnkey Projects' may be classified as an era when India became the hub for Internet boom and software & application development. Further, as the industry moved up to IT consulting, Enterprise Application Integration, and Packaged Software implementation, India became the hub for ERP Consulting and Techno-business consultancy. The corresponding business model of Indian firms in this period was 'Total Consulting'. As the industry tries to maximize its economic gains, from the evidence of the major software & hardware producers setting up their own R&D centres in India, it is projected that India could potentially become an R&D hub for the world in future.

There are two different camps in the software industry propagating two different approaches to move up the value chain in future. One is to evolve into Software Product Majors, which is consistent with the framework provided in the previous chapter (see ***Fig. 3.6 in chapter IV***). The other camp believes that rather than taking the risk of Product development, companies should take advantage of the available abundance of skilled human resource and further enhance their technological capability within the context of 'Total Consulting' by taking R&D activities on behalf of the global IT majors. The coming years will tell us which of the two will be the preferred route. As of the current scenario, the industry seems to be headed to be a major R&D outsourcing destination if not a global R&D hub. Major IT Companies like GE, Microsoft, Sun MicroSystems, IBM, Cisco Systems, Texas Instruments, among others, operating in various high technology segments, have set up their R&D Centres in India bestowing credence to India's claim of becoming a global R&D hub[18].

4.5 Summary

The chapter begins with a discussion of the various policy measures taken by the government since the emergence of the software industry in the 1970s. The existing

[18] Microsoft, Texas Instruments, and Cisco Systems, for instance, have R&D Centres in Bangalore.

software related policies have been analysed in three phases: pre-1980, 1980-1990, and post 1991, the year in which massive liberalisation policies was initiated.

In the second section of the chapter we briefly discuss the history and growth of the software industry. In the first phase – 1970 to 1980, we discuss the evolution of the industry with the focus being its origin and the birth of the export sector. The second phase (1980 to 1990) is about the strengthening of the software industry with establishment of some major international firms like Texas Instruments and Citicorp Overseas Software Ltd (COSL). In the post 1991 phase we discuss the spurt in growth of the industry and exports aided by favourable policies of the liberalized era. This phase also highlights the major technological advancements like growth of Graphical User Interface based software and the Internet.

Next we map the growth of the industry with some empirical data. We provide a detailed analysis of the growth of software industry and exports. We also analyse its major export markets, its various software service lines, and the industry structure.

The concluding section of the chapter is about the innovation orientation of software firms. Various innovative measures adopted by the firms along their growth paths have been discussed in this section. Finally, we put all these innovative measures in the context of our proposed 'Iterative Innovation Model'. We conclude the section by making a diagrammatic representation of a generalized growth trajectory for Indian software firms and the industry.

CHAPTER - V

CONCLUSIONS AND PERSPECTIVES FOR THE FUTURE

Indian software industry's rapid growth has attracted the attention of academics and corporations alike. While the interest of corporations in India is manifested by the increasing number of software units that have been set up by several domestic and transnational corporations in this country, the academics on the other hand, have been studying this rapid transformation of the software industry from various perspectives. This study is an attempt to further enrich the available repository of literature on the Indian software industry. Purely based on secondary sources, this research is an endeavour to shed some light on the process of innovation in software firms and the innovative measures taken by them, and to analyse the role of the state in the transformation of the software industry.

While taking cognisance of the rapid growth of the industry and the role of the government in its growth we have analysed its numerous causes and consequences. In the process, several issues have been identified that either need to be explored or addressed. In this concluding section we highlight some of them.

There appears to be a general agreement among observers that bulk of the software exported from India is dependent on low value work requiring lower level skills of the 'water fall model' of software development [(Arora, et al (1999b), Kattuman and Iyer (2001)]. It has also been observed that the low cost labour advantage of Indian software firms is not sustainable. Therefore, in the light of the emerging competition from East Asian firms, it is advisable for Indian firms to move up the value chain by building the technological capability to take up technologically complex high value assignments and possibly graduate to the more profitable business of development and marketing of software products.

The industry, however, seems to be divided about the trajectory to traverse in the future. While a section advocates venturing into software products, a vast majority of the firms in the industry have preferred to take a more cautious route and continue value-adding activity within their service oriented work. Such caution stems from the fact that some firms like Mastek, Wipro Systems, and Infosys that had initially ventured into software products business have subsequently regressed back to the less risky business of software services (Krishnan & Prabhu, 2002).

The reason for these firms' failure to completely graduate to software products business may be attributed to the difference in the nature of business of a product company and a software company. While the former requires a firm to be a first mover and a rapid innovator and invest heavily in creating a brand image and target a large number of customers with a standard product, the later, on the other hand, has to service a limited number of clients with customized solutions. Such differences in the nature of business warrant completely different organization cultures. Further, for software services firms evolving into software product businesses, balancing resources between software products and services may be difficult. This is an issue typical to the Indian software industry and it needs to be explored further. Other reasons, idiosyncratic to India, which may be attributed to the companies' restraint for moving up the value chain to software products are: the relative under-development of the Indian market, the inherent risk of making big investments in brand building, and the government's inability to prevent software piracy.

So, it appears that in the given scenario, in the short run, Indian firms will continue to provide high value software services rather than jump unto the software product bandwagon. One or two firms may test the waters by launching a product or two but their main source of revenue will continue to be software services. Some firms like I-flex[1] may specialize in enterprise products but even these firms will be dealing in the kind of products that would require high level of customisation. Therefore, in many ways, their style of functioning will be similar to software services firms. However, with the proliferation of many software services firms, profit margins will be under pressure and this may bring together the major software services firms to lobby for creation of appropriate environment in the economy to enable them to enter the software products market. A converse possibility, which is equally likely, is that the intense competition may lead to a consolidation in the industry and the larger firms may gobble up the smaller ones. Thus maintain a status quo, at least till the time the global software services market continues to grow.

Some observers have pointed out that there is a poor perception among the clients abroad about Indian software firms' ability to undertake work on high level specifications or project definition stages. The prevailing impression among them has been that Indian firms lack domain knowledge and possess poor management skills [(Arora, et al (1999a, 1999b), Tschang, (2001)]. The reasons for this negative impression about Indian firms need to be explored. However, it is felt that this notion is likely to change with the establishment of

[1] I-flex specializes in a software product targeted at Banks.

R&D and software development centres by numerous MNCs in India and the inevitable spill over of technical know-how from their high-end activities to the local software firms.

To overcome the negative impression about Indian firms it would require a concerted effort from the industry as well as the government. One possible way in which the government can lend a helping hand is by formulating a new scheme for one time support to software companies to jointly create a marketing system outside India (Krishnan, R. T. & Prabhu, G. N., 2002). This will be a big boost to the software industry considering the limited resources of Indian firms and the massive costs and complexities involved in creating an infrastructure for product marketing in foreign countries.

Another area where the government can play an important role is in creating linkages between centres of innovation and the rest of the economy to ensure diffusion of knowledge and technology to the rest of the society. While increasing the number of Export Processing Zones (EPZ) and Software Technology Parks (STPs) is important, it is also important to facilitate formation of 'clusters' between the firms in these parks and the local economy to tap into additional knowledge spillovers. The Tripple Helix Model espoused by Etzkowitz, et al (1997) may be considered for a reciprocal convergence of public sector, private sector, and academic institutions to facilitate knowledge creation and transfer. Further, the government should aggressively promote formation of informal links between Indian professionals and entrepreneurs abroad with those in India. Such network of scientists and engineers enable the transfer of technology, skill, and know-how between regional economies faster and more flexibly than most corporations (Saxenian 2002). The tremendous technological and entrepreneurial capability built by China and Taiwan proves the effectiveness of such networks.

In the proposed 'Iterative Innovation Model' presented in chapter four it has been observed that Indian software firms, being predominantly in the business of customized software solutions, innovate progressively by moving up the clients 'trust curve'. Every successful execution of a project increases the confidence of the client in the firms' software development capability. This results in award of repeat orders of increasing complexity, requiring fresh approach and initiatives from the software firms to execute the projects according to the clients' expectations. Thus the firms innovate iteratively and build technological capabilities. In this iterative process firms enhance their reputation and win new clients whose fresh orders further increase their scope for learning and innovation.

A set of internal enablers and external enablers[2] play an important role in the process of innovation. Internal enablers include a leadership style that is conducive to risk taking; a culture that promotes experimentation, tolerates failure and provides an ambience of learning, teamwork, and sharing of knowledge. The implication for firms desirous of a strong innovation orientation is to cultivate these characteristics within their organization.

External enablers are of equal importance. These are the external factors that exist in the environment and influence innovation orientation of firms. The external enablers are a result of the existing Industrial Policy, Science & Technology Policy, Trade Policy,

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[2] The idea of internal & external enablers has been borrowed from the Multiple Stage Innovations Model provided by Bhatnagar & Dixit (2004).

Education Policy, and Monetary Policy. A favourable policy regime, for instance, will provide good infrastructure like 'software technology parks' with world-class facilities; establish universities and research oriented academic institutions and government R&D laboratories, which can be a source of skilled manpower and know how. Other enablers like the company's investors can influence compensation and reward mechanisms in ways that facilitate innovation. Employee Stock Option Plans (ESOPs), for instance, have been instrumental in attracting and retaining talented people who form the engine of ongoing innovation in the organization.

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