

# Innovation Systems in India's IT Industry

## An Empirical Investigation

*The stellar performance of India's information technology sector has been acclaimed worldwide. Although India's export success in IT is widely attributed to its human capital, it is not clear whether this has also been accompanied by industry-wide innovation. This paper explores the innovative behaviour of firms in the IT sector. Although substantial efforts have been made over the past 50 years by the government in implementing various policy measures, building institutions, and putting strong emphasis on higher education, there has been a systemic failure to promote the emergence of networks of innovation. This, in turn, has impeded the innovation performance of the IT industry. There is a need to direct policy to address this systemic failure and bring in industry-wide innovation.*

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### I Introduction

The software and services exports of India posted an impressive average yearly growth of 42 per cent from 1995-96 to 2004-05 and has been the envy of other hi-tech industries in India. The Indian software and services export sector in particular, which today employs more than a million software professionals, has zoomed from a mere US \$ 12 million in the 1980s to a whopping US \$ 17 billion in 2004-05 (Table 1). The software and services export segment (including ITES/BPO sector) has emerged as a significant export earner for the country contributing 34 per cent of total services exports and accounts to 64 per cent of the total information technology (IT) industry.

The Indian software industry has grown at a phenomenal rate over the second-half of the 1990s. Earning around 80 per cent of its revenue from exports, the annual growth rate of software exports has been more than 45 per cent, except for the years 1999-2000, and the succeeding years from 2001-02 to 2004-05. The slowdown in export activity due to the worldwide recession and technological downturn has now abated, as the IT industry maintains its growth momentum and consolidates its partnership with overseas customers.

India's export-oriented software services industry not only recorded high growth rates but has also undergone some movement up the value chain, from code writing and software testing activities to systems integration, project management, high-end consulting, and packaged software exports. Effectively, India's software mix is a balance between on-site and offshore software services. It is said that the industry has perfected the global delivery model. The software and services sector is traditionally composed of customised software, largely driven by legacy applications management, maintenance, development of small applications and enhancement for existing systems, migrations to client-server systems and customs application development segment.

The ITES/BPO sector is the fastest growing segment within the software services sector. Within five years since its emergence in 1999-2000, its size grew to almost 10 times from US \$ 565 million in 1999-2000 to US \$ 5.2 billion in 2004-05. Within ITES

services lines, customer care and finance have been the fastest growing segments. In terms of outsourcing of IT services, proficiency in the English language provides a comparative advantage to India's exports vis-a-vis those of competitors such as China and Mexico. At present, India's BPO has captured 44 per cent of total worldwide outsourcing.

Presently, India's software and services exports are oriented towards western countries, primarily the US. Around 62.7 per cent of India's IT services export revenues are realised from the north American market alone. In north America and western Europe, Indian software has been servicing significantly the banking, insurance, and financial services, manufacturing, communications and media, and government sectors.

A study by Nasscom and McKinsey on Indian IT strategies estimates that India can become an important global player in IT and can reach exports between US \$ 57-65 billion by 2008 – a manifold increase from US \$ 4 billion in 1999-2000, from which IT services exports will take US \$ 28.30 billion, ITES/BPO exports US \$ 21-24 billion and product and technology services US \$ 8.11 billion. Presently, India has evidently become a destination of choice not only for low-end work like ITES/BPO but also high-end development work like application design and implementation. More and more global companies are opting for offshore outsourcing combined with technological competence with lower cost, flexibility, quality and efficiency.

Indian companies have emerged as the most competitive suppliers of a large number of computer software in the world. The comparative advantages of India as a software exporter have been identified in its early growth years [Schware 1992; Heeks 1998 and 1996]; recent studies [Arora et al 1999; Kumar 2000a and 2000b; Krishna et al 2000; Arora and Suma 2001; Arora et al 2001; Kumar 2001a; Tschang 2001] have presented a wide range of critical factors that explain India's IT competitiveness. Its success is now known to have resulted from a combination of abundant human resource endowments, linkages to the main export market, good timing, and the basic facilitation of infrastructure for communication and trading by the government. Moreover, government policies in building local technological capability and promoting enterprise level technological effort have met with success on a number of fronts. These include

building up one of the largest stock of scientific and technical manpower in the world. Indian talent has been widely sought by the IT industry worldwide.

Although India's success in the IT sector has been phenomenal and its software development is widely attributed to its human capital, it is not clear whether the growth has led to an industry-wide innovation. Parthasarathi and Joseph (2001) argued that the innovative behaviour of firms under export orientation has been one wherein firms have depended heavily on collaboration with their foreign counterparts. Foreign firms, which possess the property rights for new technologies, usually assign specific tasks to Indian firms that do not require any serious research and development (R&D) efforts. Thus, R&D intensity in the industry has been negligible and has not recorded any marked increase. On the other hand, Hagel and Brown (2001) found that Indian companies have also been able to export technology-intensive goods as well as technology itself to a number of countries. However, with the increasing need for many firms in the developed countries to outsource their IT operation, most of India's IT industry appears to have followed the path of export services rather than develop its own brand products. In fact, from the R&D point of view, the nature of the IT industry was found to be "applied", "service-oriented", or "incremental" in its innovation [Tschang et al 2003].

Recent studies about innovation in the industry however point to the study of factors underlying innovation that go beyond skills, organisations, and in-house R&D to include knowledge spill overs, the broader innovation system, and linkages within a system of innovation.<sup>1</sup> In the case of the hi-tech knowledge intensive sector, innovation is the key to competitive success, knowledge is a key asset and learning is a key process. Innovation as a key factor in competitiveness is particularly important in a knowledge-based economy since hi-tech firms may more readily exchange tacit creative knowledge with each other and with university research laboratories and public or private research institutes as well as with the local or regional innovation support infrastructure [Smith 1997].

Kumar (2001a) specified the elements of India's system of innovation to include government policies to create infrastructure for development of human resource, institutional framework and infrastructure for technological development, government's direct participation in scientific and technological development, incentives for promotion of in-house R&D activity in industry, enactment of the new Patent Act, and encouragement to utilisation of indigenous technology. He argued that the substantial investments made by the government in building the national system of innovation (NSI) over the past 50 years helped in improving the overall competitiveness of the industry. In a later study, Kumar and Joseph (2004) pointed out that the NSI which evolved as an outcome of government policies, has been instrumental in facilitating India's IT success.

Furthermore, Kaul (2002) in his study on innovative clusters and implications for public policy argues that new types of policies are needed to address systemic failures, particularly policies directed to networking and improving "firm absorptive capacities". Enhancing the absorptive capacities of firms is another policy priority. Technology policies should seek not just to diffuse equipment and technologies to firms but also to upgrade their ability to find and adopt technology themselves. Technology policies should aim not only on technology-based firms but also at firms with lesser technological

capabilities in traditional and mature industries, and in services sectors.

In spite of the build-up of these elements of the innovation system, there is some evidence leading to a systemic failure, which impedes the innovation performance of the IT industry. The lack of interaction between the actors in the system, mismatches between basic research in the public sector and more applied research in industry, malfunctioning of technology transfer institutions, and information and absorptive deficiencies on the part of the enterprises, all contributed to the poor innovative performance of the IT industry. Therefore, there is a need to direct the attention of policy-makers to this systemic failure to address the specific issues and apply the necessary remedy.

This paper is an exploratory study focusing on the strategies of firms in the Indian IT industry and their innovative behaviour from the point of view of the innovation system. The specific question that this paper attempts to address is: what type of innovation system exists in the Indian IT sector? In other words, the paper will determine the elements which define Indian IT sector's system of innovation and will examine the extent of interaction among the firms and innovation support organisations to measure the effectiveness of the system of innovation.

The rest of the paper is organised in the following manner. The section that follows examines the different elements of the system of innovation existing in the Indian IT industry in general. The third section presents the results of the survey examining the internal functioning and innovation of respondent-firms, their innovation and cooperation with other firms, academe, and technology support institutions, and the diffusion of knowledge and technology within the firms. And finally, the fourth section concludes the study by integrating the research output and the major findings of the survey. An attempt is made to identify the gaps in policy-making and implementation to improve the IT industry's system of innovation.

## I Innovation System in India's IT Industry

Gaining and sustaining competitive advantage in a knowledge-intensive industry like IT means that enterprises need to focus on dynamic improvements and innovation. Innovation is fundamentally a learning process. Such learning – by "doing", by "using", by observing from, and sharing with others – depends

**Table 1: Indian Services and Software Exports**  
(In US\$ million)

Year	IT Services Exports 1	Annual Growth (Per Cent)	ITES-BPO Exports 2	Annual Growth (Per Cent)	Total Software and Services Exports 3(1+2)	Annual Growth (Per Cent)
1995-96	754		–	–	754	
1996-97	1,100	45.9	–	–	1,100	45.9
1997-98	1,759	59.9	–	–	1,759	59.9
1998-99	2,600	47.8	–	–	2,600	47.8
1999-00	3,397	30.6	565	–	3,962	52.4
2000-01	5,287	55.6	930	64.6	6,217	56.9
2001-02	6,152	16.4	1,495	60.7	7,647	23.0
2002-03	7,045	14.5	2,500	67.2	9,545	24.8
2003-04	9,200	30.6	3,600	44.0	12,800	34.1
2004-05	12,000	30.4	5,200	44.4	17,200	34.4

Note: ITES: IT enabled services. BPO: Business Process Outsourcing.

Source: NASSCOM, Reserve Bank of India Annual Report 2003-04 and 2004-05.

upon the accumulation and development of relevant knowledge of a very wide variety. The recent literature on innovation systems [Nelson 1993; Lundvall 1992] stresses the fact that national specificity of patterns of interaction between users and producers of innovations are at the very core of what defines a national innovation system. More recently, there has been a growing interest in innovation systems at the regional level. At this level, clustering of innovative firms, their emergence, and promotion are becoming the focus of study. The innovation system can also be defined and studied at the sectoral level. A sectoral system of innovation and production encompasses new and established products for specific uses and the set of agents carrying out market and non-market interactions for the creation, production, and sale of their products [Malerba 2002].

The sectoral system of innovation in the IT sector of India can be characterised by the early development of a system of higher education in engineering and technical disciplines; creation of an institutional infrastructure for science and technology (S&T) policy-making and implementation; building centres of excellence; investments in public-funded R&D institutes and support for their projects, which crowds in private sector investments; and a unique socio-cultural environment that supports the sustainability of these elements of the innovation system.

Since the early 1960s, the government of India has recognised the critical importance of the electronic and computing industries for national development. In view of their pervasive applications, the government has consciously strived to build local institutional infrastructure for development of local capabilities. These early initiatives have provided a base for the rapid development of the IT industry in the 1980s and 1990s.

The Indian strategy of the 1970s until mid-1980s was aimed at the autonomous, national and state-led development of the computer and software industries.<sup>2</sup> Planning was used to direct investment to particular sectors. Expenditure on R&D, high tariffs on imports, limitations on foreign direct investment, the licensing of production capacity, and legislated monopolies for certain public enterprises were all examples of intervention designed to pursue specific national objectives in the IT sector. It was in this policy thrust that publicly owned and managed companies like Electronics Corporation of India (ECIL), Electronics Trade and Technology Development Corporation (ETTDC), Bharat Electronics (BEL) and Computer Maintenance Corporation (CMC) were created.

The computer policy of 1984, for the first time, acknowledged the importance of software development and underlined the needs for institutional and policy support. Policy shift towards the market mechanism began in 1986 that gradually reduced government control and a larger role was given to Indian private corporations. Accordingly, an explicit software policy was announced underlining the importance of an integrated development of software for the domestic and export markets giving more incentives for the industry to grow, such as tax holidays, tax exemption on income from software exports, export subsidies, and duty-free import of hardware and software.

With economic reforms beginning 1991, a number of other policy initiatives have facilitated the growth of IT. The new policy included the provision to finance software development through equity and venture capital, measures to make available faster and cheaper data communication facilities, removal of entry barriers for foreign companies and reduction and rationalisation of taxes, duties and tariffs [Narayana Murthy 2000]. Likewise, the central

government intensified its support for research and development activities, giving rise to institutions such as Centre for Development of Advanced Computing (C-DAC) and Electronics Research and Development Corporation (ERDC). But it was the creation of a series of software technology parks under the aegis of the Software Technology Park of India (STPI) that soon revolutionised the development of the software industry, which led to the mushrooming of several local IT companies. As of now there are 18 software technology parks in the country and they play a significant role in the software export.

Humanpower development particularly in the field of S&T has been India's core policy since 1958. As a result, a large number of institutions training S and T personnel were set up in the country. Premier institutions such as the six Indian Institute of Technology (IIT) and the Indian Institute of Science (IISc) which institutionalised engineering education in the country, led to the introduction of computer science degrees both in the undergraduate and graduate levels. Soon after, several local engineering colleges emerged owing to the demand of highly skilled humanpower in the IT industry. To this, government has quickly responded by facilitating the entry of the private sector in the training of software personnel by putting up an accreditation scheme based on certain objective criteria. As a result, a large number of private organisations were set up that provide short-term training programmes catering to the middle- and lower-level manpower requirements of the IT industry.<sup>3</sup> To a certain extent, the National Centre for Software Technology (NCST) – a government agency that was created primarily to undertake R&D activities related to computer technology and software design – contributes as well to the supply of skilled humanpower requirements via its short-term courses. Besides these, seven Indian Institutes of Information Technology (IIIT) were set up to train humanpower on par with the academic standards of the IITs, coupled with strong support from the industry.

Since the early 1970s, the Department of Electronics (DoE), now transformed to the Ministry of Information Technology (MIT), has put heavy emphasis on R&D activity relating to the development of computer software by supplying R&D activity being done by different institutions such as Tata Institute of Fundamental Research (TIFR), IITs, IISc, ERDC and the Council of Scientific and Industrial Research (CSIR). These centres of excellence have been proven instrumental for the development of technology in computer, electronic, and software and have even provided high-end expertise and manpower for the IT industry. The government has also stimulated and supported the R&D activity of industry through tax incentives and direct funding on a limited scale. A large number of academic institutions, industries and research labs with geographical distribution spread all over the country have implemented projects and programmes supported by the MIT.

Other support institutions also played a very important role in the sectoral system of innovation. For one, venture capital companies that became operational in India since the 1990s provided greater access to capital and encouraged professional business practices from their beneficiaries. Both the public and private sectors have developed venture capital funds for the software and IT companies, giving rise to software exports coming from several start-up software companies. Moreover, the software movement gathered momentum ever since the National Association of Software and Services Companies (Nasscom) came into existence in 1988. Presently, with more than 860 IT

software and services member companies constituting almost 95 per cent of the revenue of the software industry in India, Nasscom has earned its place as India's apex body and umbrella organisation, which assiduously promotes and catalyses the growth of all IT companies in and outside India.

Besides institutions and other support infrastructures, some socio-cultural factors have contributed to the Indian IT success. It is argued that the management practices and organisational modes that have emerged in the software industry are in convergence with the Indian socio-cultural ethos. Factors like value for intellectual activity, affinity and strength for maths and sciences, view of work as duty to family, and open communication across levels in corporate and strategic decision-making that stimulate new ideas, have attracted a large number of young workers to the software industry.

Despite the early structuring of the system of innovation, it seems however that the software industry has not benefited much from it in terms of its innovative behaviour. The Indian software industry has revealed little thrust on R&D so far compared to the knowledge intensity and its international orientation. Government support for R&D in the IT sector increased only marginally from Rs 316 crore in 1994-95 to Rs 318 crore in 1999-2000 [Chandrashekar and Basvarajappa 2001]. The IT sector is ranked third with respect to value addition, but is ranked eight in terms of R&D support. Innovation activities have remained largely internal, especially among the large corporate firms. Though R&D spending by companies increased from Rs 97 crore (US \$ 32 million) in 1994-95 to Rs 203 crore (US \$ 45 million) in 1999-2000, their R&D expenditure has been rather low compared to international standards.

A bigger R&D thrust will be necessary for Indian software enterprises to upgrade their export profile to higher value adding services and products, and establish themselves as innovators and developers of new products and technologies rather than just providers of coding and programming services [Kumar 2001b]. Experts also believe that in terms of implementing R&D projects between the IT sector and other areas like space technology, while coordination takes place on a need basis, organisations involved in projects as well as policy continue to function largely as islands with very little networking [Chandrashekar and Basvarajappa 2001].

### III Results of the Survey

With the aim to examine and understand the innovative behaviour of Indian IT sector using the concept of a sectoral innovation system, a survey was conducted. A cluster sampling methodology was used to identify companies located in Delhi, Mumbai, and Bangalore. These three locations have the highest concentration of IT companies accounting for 60 per cent of IT companies as per Nasscom's survey. Within these clusters, we selected 300 companies from Nasscom's list of member-companies available in their website. A questionnaire was developed to collect information from these companies.<sup>4</sup>

A letter was sent to all the selected companies along with a copy of the questionnaire by post. At the second stage, all the selected companies were called by phone and requested to participate in the study. A personal visit to Mumbai and Bangalore was undertaken to follow-up. However, in spite of the intensive and extensive efforts to get the questionnaires filled up by the

prospective respondent firms, only 35 companies have responded affirmatively.<sup>5</sup>

A large majority of the respondents belong to the software services sector as their primary activity, even though some of them, to some extent, are into software product manufacturing. From among them, only one is exclusively into hardware manufacturing, one a BPO company and one into training and education. Apart from being service-oriented, the sampled firms are predominantly export-oriented. On the basis of size, 18 per cent of the total are small units, 35 per cent are medium-sized firms and 47 per cent are large firms, which also follows the pattern of distribution according to the age of firms. Most of the respondents were Indian companies, 17 per cent of which were 100 per cent foreign-owned.

Responses collected from these companies have been analysed. To get a further insight into the innovative behaviour of IT companies, an in-depth study of three companies was undertaken.<sup>6</sup>

The results of all these analyses are given below.

### Innovation Behaviour of IT Firms

As far as the innovation behaviour of IT firms is concerned, Table 2 shows that a larger proportion of the respondent firms are aiming at incremental innovations. Ninety-four per cent of them have improved, from a technological point of view, their productive processes. Not far behind, 89 per cent of them have improved their existing product and/or service.

With respect to radical innovations, 80 per cent claim that they have introduced new productive processes and a little less than three-quarter of the respondents have introduced into the market new or technologically innovative products and/or services. These figures may be an overestimation from what they really are. The fact is that since firms in the software and services sector are engaged into customised application development and maintenance, it requires principally an adoption of a particular leading edge technology as per the client's specification rather than the creation of an entirely new technology.

Nevertheless, on the basis of these results, it is still evident that IT firms are more inclined towards the improvement of their existing products, services or processes rather than introducing entirely new products, services or processes.

ISO 9000, benchmarking, flat hierarchies, and networking are among the most widely used organisational innovations by the IT firms in India. These organisational practices are inextricably linked to the firms' objective to produce high quality products or services within the required period of time.

### Internal Functioning and Innovation

The pressures of globalisation and the heightening of competition have forced firms to become more innovative. Because of competitive factors like the rapid changes in technology and at

**Table 2: Type of Innovation in IT Firms**

Type of Innovation	Number	Per Cent
<i>Incremental</i>		
Improved product/service	31	89
Improved productive process	33	94
<i>Radical</i>		
Introduced new product/service	26	74
Introduced new productive process	28	80

the same time an increasing demand for better quality at reasonable costs from sophisticated markets, companies have to choose from very limited strategic choices.

In this study these factors were classified into four groups: (1) competitive challenges perceived by the company; (2) corporate response to the perceived challenges; (3) factors contributing to competitive edge; and (4) factors sustaining competitive edge. The specific factors were identified for the respondent-firms to rate them on a scale of 0 to 7. Unanswered items were given the value of 0. Using the ratings, the number of respondents was determined under three divisions: (a) those who rated the variable below 4 (that is the midpoint from a scale of 0 to 7); (b) those who rated the variable exactly at 4; and (c) those who rated the variable more than 4.

Table 3 shows the frequency analysis for the competitive challenges. Most of the companies have perceived a very fast rate of change of technology in the industry, very frequent introduction of new products, very intense promotion, advertising, and selling, very intense competition in quality and variety of products or services, as well as price. Also, there is a fairly high degree of difficulty in hiring skilled personnel as well as their increasing remuneration. On the other hand, most of them do not find difficulty in obtaining supplies. Moreover, results show that there is genuine difficulty in obtaining finance from venture funds, consumer demand is almost predictable, and government policy for human resource availability, taxation, promoting R&D and the like are generally favourable.

In terms of corporate response to these perceived competitive challenges, Table 4 shows very interesting results. A fairly high number of the respondents resort to cost cutting, organisation restructuring, increasing speed of product development, intensifying internal R&D, intensifying marketing cooperation, increasing market share in their existing product-mix or market, and developing internally a new product and service in response to rapid technological changes and increasing market competition in the global IT industry. On an average, some have resorted to subcontracting and outsourcing as a way to cut cost and also ventured into technological cooperation to be abreast in the latest technologies and to penetrate new markets. Acquiring other businesses and having joint ventures with other firms are less adhered to as a response to the perceived challenges.

From the standpoint of the factors that contribute and sustain the firm's competitive advantage, Tables 5 and 6 give the results of the respondents' perception as to the relative importance of the factors specified. A large majority of the respondents rated very highly customer-oriented factors: personal attention to customer needs, product/service quality or design, after sales service or maintenance, ability to quickly adapt to clients needs, quick and timely delivery, and price of products and services. For some of the respondents, regularly introducing new and unique product or service is another way to achieve customer satisfaction. Surprisingly, technology-oriented factors such as copyright or patent of new products, regular modernising and replacement of capital equipment and regular purchase of the latest technology do not seem to be as important as the factors directly related to the customer.

As to the factors that sustain competitive advantage, skilled and capable employees, specialised expertise or products, top management, and improving continuously operational efficiency and financial strength of the company are perceived by most firms as the most important ones. Also to a certain extent, the range

and variety of expertise or products, continuous resource allocation for R&D capabilities, geographic proximity to customers, information system and networking, capability of entering and managing technological alliances, reward system and compensation package, capability of combining different technologies, and established a marketing channel for distribution are important factors. Respondents are neutral in taking aggressive promotion and marketing and knowledge about regulations as factors for sustaining competitive advantage. On the other hand, geographic proximity to suppliers and use of joint ventures for R&D are seen as less important factors to sustain competitive advantage.

## Innovation and Cooperation

The survey also covers an examination of the linkage between innovation and the extent of collaboration between the firms and the innovation infrastructure in the IT industry of India. To highlight this, some questions were asked about the company's sources of information for innovation, the extent of cooperation in innovation, partners in innovation process, the collaboration of IT firms with other firms, and the extent of their collaboration with universities and higher institutes of learning.

### Sources of Information.

The survey reveals that more than half of the firms say that they acquire information useful for their innovation efforts mainly from their access to media and the Internet, by their regular

**Table 3: Respondent Firms' Rating of Competitive Challenges**  
(Per Cent of Total Respondents)

Variable	Less than 4	Score of 4	More than 4
Rate of change of technology	3	6	91
Frequency of new product in the industry	14	9	77
Promotion, advertising and selling in the industry	14	6	80
Competition in quality and variety of products/services	6	6	89
Price competition	17	0	83
Difficulty in obtaining supplies	83	11	6
Difficulty in obtaining finances from venture funds	40	17	43
Difficulties in hiring skilled personnel	17	9	74
Increasing cost of skilled personnel	14	11	74
Changes in consumer demand and preferences	29	23	49
Government policies	23	31	46

Note: The competitive factors were rated on a scale of 0 to 7.

**Table 4: Corporate Response to Competitive Challenges**  
(Per Cent of Total Respondents)

Variables	Less than 4	Score of 4	More than 4
Cutting costs	23	11	66
Organisation restructuring	14	14	71
Increasing speed of product development	34	11	54
Intensify internal R&D	31	9	60
Subcontracting	49	14	37
Outsourcing	46	14	40
Technological cooperation	34	23	43
Marketing cooperation	23	20	57
Increased market share in existing product/market	17	14	69
Internal development of new product/service	29	9	63
Acquisition of businesses in industries	60	6	34
Joint venture with other firms	54	11	34

Note: Firms' responses to competitive challenges were rated on a scale of 0 to 7.

dealings with their clients and customers, by attending various conferences and workshops, by consulting professional journals and other publications, through interaction with other colleagues within the firm as well as other firms in the industry, and to a certain extent, information gathered from competitors. The survey results also indicate that overall, firms seldom use information gathered from suppliers, much less from university and other higher education institutes, government R&D labs, and consultants towards innovation.

### *Extent of Cooperation in Innovation*

More than half of the respondents claim that they have cooperated to some extent with institutes, customers or competitors. However, a significant 43 per cent of the firms say that they do not have any cooperation and that their innovation efforts are exclusively internal. Primarily, the medium-sized firms are the ones less cooperative than small and large size firms in terms of their innovative efforts. A significant number of small firms have some cooperation, while a third of the large firms claim intensive cooperation with institutes, customer, or competitor.

### *Partners in Innovation Process*

There is strong evidence that a region-based innovation system exists as a significant percentage of respondents have identified local customers, local technology transfer agencies, local venture capital firms, and local training institutions as major partners for innovation. On the other hand, suppliers, competitors and consultants may vary from place to place within India. As for the support institutions abroad, virtually all of them collaborate with those, which are located in the US. This is expected, as the US remains the largest export market.

### *Collaboration of IT Firms with Other Firms*

Our survey results also show that most of the firms have more intensive collaboration with foreign companies than Indian companies. The majority of those who have collaboration with Indian companies say that their collaboration with them has not changed compared to foreign ones. This result is expected, as Indian IT firms would prefer to undertake technological and marketing collaboration more with hi-tech firms existing in the developed countries. Besides, being export-oriented, the IT firms would invest more of their resources to acquire knowledge from innovative companies that will strengthen their competitive position in the international market.

The most common way of collaboration, which the firms undertake together with other firms, is through informal links. Around 38 per cent of the respondents say that their informal links can be a combination of professional, commercial and friendship networking. Thirty-five per cent says that their link is purely professional, 15 per cent through commercial links and 12 per cent via friendship networks. A significant number of respondents collaborate with other firms by forming some kind of strategic alliance with other firms.

Asked about their motives why they collaborate with other firms, a significant number of firms gave a number of reasons, namely their desire to forge long-term business with the respective firm, to gain access to new markets, to enhance their image and reputation, to increase their market share, to use the

knowhow of the partner firms, and to increase their turnover. The collaboration seems to be effective as 63 per cent of the respondents say that they do not have any problem whatsoever in their collaboration with other firms.

### *Extent of Collaboration with Universities*

As far as the university and other higher educational institutes (HEIs) are concerned, we have already seen that these institutions as a source of information for innovation are seldom used. Some of the respondents who claim that they collaborate with universities were asked to specify which type of collaboration they are undertaking with universities or other HEIs. Forty per cent of them have informal contacts with academics, 34 per cent look at universities as source of manpower, 26 per cent sponsor research trials or projects, and 23 per cent conduct student projects. The informal contact with academics is very significant to the system of innovation as information and knowledge flow from university to industry and vice versa through intensive interaction between industry representatives and the academic community with respect to the firm's innovative endeavours.

## **Diffusion of Knowledge and Technology**

As we have already seen, local firms tend to collaborate with their foreign partners especially when it comes to undertaking initiatives that will require technological innovation. It is also

**Table 5: Factors Contributing to Firms' Competitive Advantage**  
(Per Cent of Total Respondents)

Variables	Less than 4	Score of 4	More than 4
Regularly introducing new and unique product/service	37	6	57
Personal attention to customer/client needs	0	3	97
Price of products and services	6	11	83
Product/service quality or design	0	6	94
After sales service or maintenance	6	3	91
Ability to quickly adapt to clients needs	0	9	91
Quick and timely delivery of products/services	11	9	80
Copyright/patent of new products/services and processes	60	9	31
Regular modernising and replacement of capital equipment	46	20	34
Regular purchase of latest technology, designs or copyright	37	17	46

Notes: Firms' responses are rated as a scale of 0 to 7.

**Table 6: Factors Sustaining Firms' Competitive Advantage**  
(Per Cent of Total Respondents)

Variables	Less than 4	Score of 4	More than 4
Specialised expertise or products	6	0	94
Range and variety of expertise or products	9	14	77
Skilled and capable employees	3	0	97
Continuous resource allocation for R&D capabilities	29	17	54
Geographic proximity of suppliers	60	17	23
Geographic proximity to customers	11	11	77
Information system and networking	9	20	71
Capability of entering and managing technological alliances	11	17	71
Reward system/compensation package	14	11	74
Use of joint ventures for R&D	60	11	29
Improving continuously operational efficiency	9	6	86
Capability of combining different technologies	14	11	74
Aggressive promotion and marketing	34	14	51
Established marketing channel for distribution	34	9	57
Knowledge about regulations	43	11	46
Financial strength of the company	11	9	80
Top management	6	3	91

Note: Firms' responses are rated on a scale of 0 to 7.

the objective of the survey to evaluate the absorbing capacity of the firms with respect to technological capabilities. In other words, to what extent companies are able to adapt to the fast changing pace of technology in the IT industry. Our survey shows that almost an equal number of the respondents implement new technologies once or twice a year. Close to 60 per cent of the respondents source their technologies from different places. It can be from India, the US, the UK, Germany or Japan, wherever a particular technology is available and cost competitive. Twenty one per cent source their technology exclusively from the US while another 20 per cent source their technology only from India.

The majority of the companies offer a wide array of services based on leading edge knowledge. For companies to be competitive and to stay in business, being technologically up-to-date is the order of the day. Our survey reveals that very few of the respondents venture into knowledge new to India. Again, this is clear evidence that most of the innovation being done in the IT companies are related to R&D that focuses on adaptation of the latest technology available in the world market to improve existing products and processes rather than to general an altogether new technology. This approach makes sense, as R&D work to develop entirely new products and processes requires a lot of time and financial resources, which IT firms in India generally cannot afford.

Lastly, to effectively diffuse knowledge and technology, a good number of scientists and engineers have to be employed by the companies. Our survey results show that in 76 per cent of the companies, scientists and engineers comprise around 50 to 100 per cent of their workforce. Among the total number of scientists and engineers, very few have personnel at the doctorate level, a good percentage have masteral degrees, and 90 per cent have an engineering degree. Most of the companies have their own in-house training programmes, which prepare recruits to conform to the technical and managerial functioning of the firms. Those having a higher degree of learning may not be much of an additional asset. Although their role is perceived to be very critical to the firm's thrust towards innovation, ironically, scientists and engineers in most cases do not dominate the composition of the board of directors of IT companies.

### Case Studies of IT Companies

As for the case studies of the three companies, namely NIIT, I-flex Solutions, and Infosys Technologies, some general observations have been derived. These are as follows:

First, as the three companies have established themselves as global companies, the importance of connectivity and adequacy of physical and human infrastructure in a location becomes critical. Delhi, Mumbai, and Bangalore, being major urban centres, are logical choices of operation.

Second, these companies have resorted to strategic alliances with the best global technology partners to ensure that solutions are built around the latest technology. Also, they acquired counterpart firms abroad to be able to expand to new markets.

Third, innovative capability in the case of all three companies presented has depended largely on information and knowledge sharing within the firm through their in-house R&D centres as well as feedback directly from customers through offshore development centres (ODCs) or marketing outlets abroad.

Fourth, even with core competencies well defined, the three companies' business model is distinctly characterised by a highly

diversified business model. This underlines the importance given by these companies to quick adaptability to the needs of the market.

Fifth, the three companies have substantial investments in human resource development in the form of attractive packages, considering the need for highly skilled and experienced manpower in the midst of competition in the labour market. The software services segment of each of these companies, aside from generating most of the revenues, has been their window to the latest technologies and put pressure on their IT personnel to acquire more domain knowledge on specific industries.

Finally, except for NIIT, which is an education and training company, the collaboration of other companies in terms of linkages with universities is very limited. This is indicative of the wide disparity of interest between industry and academe in terms of R&D efforts for the IT industry and that local universities are seen no more than suppliers of manpower by these companies.

Our three case studies further confirm some of the results of our survey. In their quest to establish their brand name globally, these companies have achieved the highest level of quality in their software development process (SEI-CMM Level 5). Meeting customer requirements and satisfaction has been the most influencing factor in their competitive strategy so much so that they acquire foreign-based firms and even employ non-Indians to be closer to the target market. In these companies, knowledge management has been the key to the effective application and diffusion of the latest technology and the stimulation of more innovative products and processes within the company. Definitely, government policy, particularly the trade and industrial reforms, have contributed to the growth and competitiveness of these firms. However, innovation has yet been an entirely company effort. Innovation is largely internal and collaborative efforts with other institutions are quite minimal to establish a systemic innovation.

## IV Conclusion and Recommendations

On the basis of the results of the survey, the study concludes that although India's software sector is internationally competitive, the system of innovation has generally been weak to spur innovation within the industry. However, we would like to mention here that in view of the limitation of the sample, the generalisations we make about the innovative behaviour of firms in the IT industry in India are not on firm ground and can at best only be tentative. There is a need to do more in depth analysis on these dimensions by taking a larger sample.<sup>7</sup>

The following are some of our observations based on the results:

- As the majority of software firms are in the services sector offering customised software and consultancy services, most of the innovation activities are incremental rather than radical in nature. Innovation by firms is limited to the successful absorption, adaptation and effective deployment of new technology and resources to meet technological challenges.

- The rate of change of technology, frequency of new product introduction in the industry and accent on quality competition have led to organisational restructuring and intensifying of in-house R&D activities of most firms. Price competition and challenges in increasing market share push firms to cut costs and put emphasis on marketing cooperation.

– Most firms have acknowledged competitive advantages directly related to customer service and satisfaction. The pattern of innovation is market driven rather than based on fundamental technological research. To sustain this advantage, skilled and capable employees are the key factor. This underlines the primary importance of knowledge and learning for IT innovation.

– Internet and media are the main sources of information for innovation. The latest trends in technology and market information are also gathered from customers, colleagues within the firm, and other firms in the industry that reinforce the collaboration that exists among firms.

– Overall, the degree of interdependence among firms, which is a vital element in a system of innovation is not strong enough to effect innovation among firms. Most medium-sized firms tend to be exclusively internal in their innovation efforts.

– Companies hardly depend on universities and institutes of higher learning as a source of information for innovation. Nonetheless, some evidence of linkage between them is more through informal contacts rather than through an institutionalised R&D collaboration network.

– Generally, IT firms are technologically capable. They can adapt to changes in technology, which are easily accessible.

Despite favourable government policies and institutional intervention, the apparent absence of a systemic innovation system characterised by the lack of interdependence between public companies, public R&D institutions, universities, and the IT companies shows that public policy has failed to stimulate innovation culture within the industry. It can be said further that policy measures and other initiatives taken in the 1990s have been overly export-oriented; the role of the domestic market as a springboard for exports seems to have not received adequate attention.

In summary, the excellence in scientific performance was not matched in the technological and commercial transformation of sufficient scientific knowledge into IT products, processes or services capable of attracting market demand. Barriers weakening the industry response to this challenge included insufficient R&D expenditure and industry involvement in research, lower levels of cooperation among innovation actors, including industry-academia linkages, limited venture capital, and a generally weak enterprise culture.

Therefore, the key challenges for policy aimed at the promotion of innovation involve assisting firms to change by enhancing their learning capabilities, becoming more radically innovative than they have been before in a globalising and highly competitive economic environment. Because innovation is increasingly an interactive process involving more demanding users and specialist technological requirements, much more needs to be done to raise the possibilities for firms to engage in cooperative, trustful interaction in pursuit of innovation while improving their powers of competition both within and beyond India.

Of particular importance here is the process of exploiting “knowledge capital” for commercial gain. Sources of knowledge capital, whether public or private, must be brought closer to business without compromising the essential, scholastic and critical functions of public universities and research institutes.

The following suggestions are made on the basis of the findings and conclusions of the study:

For industry, there is a need to foster interaction between local firms and MNCs. Following the example of the IT industry in Bangalore, there is a wide scope where IT firms can collaborate

with the more technologically competent MNCs. This strategy has been utilised mainly by large firms whereas small and medium-sized firms have to vigorously explore possibilities of collaboration. There is also the need to strengthen R&D collaboration between firms. Indian firms must increase their focus on R&D networking in order to grow and sustain that growth. Strategic and technical alliances have been the key and their role will have increasing importance as challenges in terms of the rate of technological change are coming to the fore.

For government, there is a need to implement policy to strengthen regional innovation systems to support regional clusters. Horizontal as well as vertical small and medium enterprise networks are needed, with knowledge centres centrally involved in diffusing usable knowledge capital. More effort has to be made in promoting the relevance of public R&D institutions. The relatively low use of the enterprise support infrastructure for innovation by the firms is an indication that there is a lack of information about the relevance of public R&D institutions. Public institutes like NCST, for example, must review their existing operational structure and programme schemes to change their role towards helping industry to innovate.

For universities, a review of the current curriculum is necessary to make it more relevant to the needs of the industry. For instance, one way that the IITs can be more effective in providing both talented and experienced engineers is by collaborating with software firms to understand what they need and update their computer technology on a regular basis to keep up with innovation. Research collaboration between industry and academe has to be fostered and further strengthened. Academics must review their potential to facilitate the industry’s innovation efforts by venturing into technological fields that are at the cutting edge. The institutionalisation of technology incubators that are gaining ground in the IITs is an excellent example, which can be replicated by other engineering institutes. [\[EW\]](#)

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## Notes

[The paper is based on the study submitted to University of Delhi for the award of PhD.]

- 1 Technically speaking, this system is otherwise known as the national innovation system. The national innovation system is defined as the network of public and private institutions that funds and performs research and development (R&D) and disseminates and commercialises the results. Nation specific-factors such as interdependence of firms, industry-academe linkages, firm interaction with research laboratories and standard-setting bodies, and specific government policies encouraging firms to play a crucial role in shaping technological change and innovation.
- 2 During this period, there was hardly any specific policy towards software development. In general, software was integrated in computer production and hence was not considered a tradable product.
- 3 As an exception, India-based NIIT and Aptech are world-class private institutes, which now provide high-end skill training programmes among their numerous franchisees located in different countries all over the world.
- 4 The survey questionnaire was patterned after the questionnaire that was used on a survey conducted by Vijay Kumar Kaul among hi-tech companies in Canada as part of a sponsored research project presented at the University of Alberta at Edmonton in 2001.
- 5 Despite the small proportion of respondents (i.e., 12 per cent of the total), we think that the results are valid as 95 per cent of the respondents are service firms and 75 per cent are export-oriented (i.e., at least 50 per cent of their sales revenues come from exports). Moreover, the respondents are divided proportionately among small, medium and large size companies located in Delhi, Mumbai and Bangalore. This, in our opinion, contributes

to the "unbiasedness" of the results.

- 6 Case studies of three particular IT firms, namely NIIT, I-flex Solutions, and Infosys Technologies, were undertaken to examine the firms' strategies towards innovation.
- 7 Authors made a lot of efforts to collect information from a large number of companies. However, a majority of companies were reluctant to participate.

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