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RIS Discussion Papers

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National Innovation Systems and India's IT Capability: Are there any lessons for ASEAN Newcomers?

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Abstract: This paper traces the factors that have led to the build-up of substantial IT capability by India. It is shown that the National System of Innovation evolved overtime as an outcome of the policies initiated by the government, has been instrumental in facilitating India's IT success. These included, but not limited to, development of a system of higher education in engineering and technical disciplines, creation of an institutional infrastructure for S&T policy making and implementation, building centres of excellence and numerous other institutions for technology development. In addition, the institutional interventions like the setting up of the software technology parks were highly helpful for IT exports. Thus India's IT success is a typical case of proactive state intervention wherein the Government laid the foundation and created the facilitating environment and the industry took off with greater participation by the private sector and increased world demand in the 1990s *inter alia* on account of the Y2K problem. The paper then draws lessons from the Indian experience for the new members of ASEAN viz. Cambodia, Laos, Myanmar and Vietnam in their attempt in harnessing the potential of ICTs. The paper argues that though the road ahead is long as well as rocky, much could be learned from India in to facilitate their leapfrogging. The paper also underscores the need for cooperating with India in developing their IT capabilities.

Introduction

The Information and Communication Technologies (ICTs) and the associated innovations are considered to be instrumental in bringing about wide ranging socio economic transformation of the developing world during the 21st century. No wonder today there is hardly any country in the developing world, which

An earlier version of this paper was presented in the First Asialics International Conference on Innovation Systems and Clusters in Asia: Challenges and Regional Integration, organized by NISTDA, JICA & Globalics, Bangkok 1-2 April 2004. We are thankful to the participants of the conference, and the discussant Prof. Henry Yeung. Special thanks to Prof. Ashok Parthasarthi for his helpful comments on an earlier draft. The usual disclaimers follow.

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has not initiated policy measures and institutional interventions to harness the powers of new technology for development. The focus of these initiatives involved, among other things, developing a domestic ICT production base on the one hand and facilitating the diffusion of the new technology to different sector of the economy and society including governance. The new ASEAN countries like Cambodia, Laos, Myanmar and Vietnam, though lagging behind their counterparts in ASEAN, have not been left behind as manifested in the series of policy measures initiated by them during the last decade. One of the distinguishing characteristics of the new general-purpose technology, unlike its predecessors is that a developing country like India is acclaimed for her competence. Hence an obvious issue before the new ASEAN aiming at harnessing the new technology for development arises; are there any lessons for these countries from India that is known for its IT success? The present paper seeks an answer to this question.

India's ICT capabilities and its presence in the world market for ICT software and services is well documented (D'Costa, 2003, Heeks 1996, Arora etal 2001, Arora and Athreya 2002, Joseph 2002, Joseph and Harilal 2001, Kumar 2001). The ICT software and service sector has sustained an annual compound growth rate of over 45 per cent during the last decade, which has been unprecedented in any of the sectors of the Indian economy since independence. As a result this sector today contributes about one-fifth of India's total export earning and provides employment to over 0.6 million. India exports ICT software and services to about 133 countries and over 300 fortune companies outsource ICT services from Indian companies[1]. What is more, majority of the ICT firms in the world with CMM- level 5 certification are from India. While some studies have shown that Indian firms, by and large operate at low end of the value chain (Arora *et al.,* 2001) and lagged behind in innovative affect, Parthasarathi and Joseph 2002), another study (Joseph and Abraham 2002) estimating firm level technological competence index has shown that Indian firms are building up technological competence. Similar conclusions were drawn by Kumar (2001) that explored the issue by analyzing the value added per employee, profitability and net foreign exchange outflow. On could add more to the list of achievements that the Indian ICT sector deserves. But to draw lessons from India for other countries like new ASEAN, one needs to have a better understanding of the underlying forces that brought about India's IT success. There are a number of studies (Arora *et al.,* 2001, Singh 2003), which tend to argue that India's ICT success has been an outcome of

the free play of the market and of benign state neglect. Such conclusions not only conceal more than what is revealed but are of little relevance for other countries because there are many countries in the developing world that assigned prime role to market yet their success in the IT sector have been limited. Hence the present study makes an attempt towards exploring the underlying forces of India's ICT success using the framework of national system of innovation.

The paper is organized in following sections: The first section analyses the role of different actors in India's National Innovation System that contributed towards the growth of India's ICT sector. The second section examines present state of ICT production and use as well as the present state of human capital availability in the new ASEAN countries (Cambodia, Laos, Myanmar and Vietnam) followed by the last section wherein certain concluding observations along with lessons for the new ASEAN from India towards developing an ICT base are presented.

National Innovation System and India's IT Development

The concept of System of Innovation introduced by Lundvall (1985) has been further articulated analytically and empirically into the national system of innovation (NIS) in the hands of Freeman (1987). With further contributions by Freeman (1988), Nelson (1988) and Lundvall (1988, 1992) and Nelson (1993) the NIS has emerged as framework for the growing body of literature that addresses the process on innovation both at the national, regional and even sectoral level. While the earlier literature has been focusing mostly the developed countries with limited empirical content, of late there has been a number studies focusing on developing countries and providing empirical content. In its broad sense, the NIS refers to the national network of institutions, both public and private, and the policy initiatives for the development and diffusion of various technologies (Freeman 1987[2], Nelson 1993, Lundvall 1992). The NSI in India evolved over time has been instrumental in the creation of an extensive infrastructure base for the development of innovative and skill intensive activities like ICT. This *interalia*, includes one of the largest and expanding mass of technically trained manpower, a network of centres of international reputation, in specific sciences such as Indian Institute of Science, Indian Institute of Technologies (IITs), and national laboratories and a number of Software Technology Parks to facilitate the export of ICT software and services. What follows is a brief account of the various state initiatives towards the development of ICT and software sector in India.

Institutional Infrastructure and Policy Initiatives[3]

As early as in the mid 1960s' the government recognized the critical importance of electronics industry and computing for national development in view of their 'pervasive' applications and has consciously strived to build local institutional infrastructure for development of local capabilities. (India, Electronics Commission, 1975). As will be seen below these early initiatives have provided a base for rapid development of IT software industry in the 1980s and 1990s.

In contrast to the general perceptions, the importance of promoting software development, particularly for export, had been recognized by the erstwhile Department of Electronics and suitable policies and programs were put in place as far back as 1972 (Parthasarathi & Joseph 2002). In a period when very high tariff and non tariff barriers were the rule, import of computer systems on a custom duty free basis and with out reference to indigenous angle clearance was permitted for software export. Moreover, in a period when there were a series of restrictions on FDI, 100 per cent foreign owned companies were permitted to set up software export operations provided they locate in the Santacruz Electronics Export Processing Zone. (India, Department of Electronic1972).

A series of government committees and policy measures (see Table 1) have contributed to the evolution of the NIS in the IT sector. The early initiatives include Bhabha Committee of 1963, Electronics Committee Chaired by Dr V.A. Sarabhai in 1966, and the National Conference on Electronics of March 1970. Significantly, the National Conference had recognized the potential of India to emerge as a force in software exports. As a follow up of their recommendations, a separate Department of Electronics (DoE) was set up to coordinate and implement policies for development of electronics industries including computer software in 1970. In 1971, the government constituted the Electronics Commission as a policy formulation body with a heavy emphasis on R&D and technology development. In 1973, the Technology Development Council was set up to assist the Electronics Commission on the recommendation of the National Seminar on R&D Policy in Electronics. (India, Electronics Commission, 1975). DoE spearheaded a number of programmes of human resource development for software engineers, technological and communication infrastructure for software development and other facilitating measures over the past three decades in tune with the recommendations of the Electronics Commission's perspective plan.

Table 1: Milestones in Electronics Policy

Mile stones	Remarks
1. Bhabha Committee (1966) Report	Recommended development of an integrated electronics sector to achieve self reliance with minimal recourse to foreign capital and dominant role to public and small scale sector.
2. Formation Department of Electronics (1970)	The department was endowed with the responsibility for developing Electronics industry in the Country
3. Formation of Electronics Commission (1971)	This was mainly the policy formulating body relating Electronics industry in the country.
4. Sondhi Committee (1979)	Recommended dismantling of controls in general and MRTP and FERA in particular.
5. Menon Committee (1979)	Recommended liberalization of import of foreign capital and technology and duty free import of capital equipment.
6. Components Policy (1981)	De-licensing of component manufacture except for MRTP and FERA companies. Provision of 74 per cent foreign equity to FERA companies in high tech. areas. No clearance required under section 21 and 22 of MRTP Act except for LSI and VLSI circuits. General reduction in duty on components and liberal import of capital goods for component manufacture.
7. Telecommunication Policy (1984)	Telecommunication equipment manufacture was opened to private sector.
8. Computer Policy (1984)	All Indian companies, including FERA, were allowed to enter all segments of companies the computer industry with no restriction on capacity. Most of the components needed were put under OGL to facilitate import.
9. Integrated Policy (1985)	De-reserved certain components of small scale sector. Introduced broad-banding and liberal approach towards foreign companies even with more than 40 per cent equity in high technology areas.
10. Computer Software Policy (1986)	Reduction in the import duty on all imports meant for software exports and no duty for hundred per cent export. Provision of special financing schemes and permission for foreign companies (with more than 40 per cent equity) in hundred percent export projects.

Table 1 continued

Table 1 continued

Mile stones	Remarks
11. National Taskforce on ICT(1998)	Made 104 recommendations on Software and 87 on Hardware development in the Country.
12. Telecommunication Policy (1994, 1999)	Opening up the Telecommunication Services for the private sector
13 Formation of MIT (1999)	Brought Together different actors involved in IT to form a separate Ministry of Information Technology.

Adapted from Joseph (1997).

The Computer Policy of 1984, gave a thrust to software development by underlining the need for institutional and policy support on a number of fronts. The policy, for example, called for the setting up of a separate Software Development Promotion Agency (SDPA) under the Department of Electronics (DoE). Imports of inputs needed for software development were made more liberal. However, the policy also emphasized that

> "Effective software export promotion on a sustained basis can be effective in the long run only if it is planned as a part of an overall software promotion scheme covering both export and internal requirements including import substitution. Also, planning for software development is integrally connected with the plan for hardware development and system engineering" (India, Department of Electronics , 1985).

This accelerated growth of computer industry following the above policy posed numerous problems for the software activities calling for a rationalization of the policy for import and manufacture of software and using this base for promoting software exports. At the same time, world trade in computers was expected to be of the order of US $100 billion by 1990 where in more than half was estimated as software. The Seventh Plan (1985-90) had a software export target of US $ 300 million accounting for about 0.6 per cent of the world trade in software. Against this background, there was the felt need for more concrete policies towards the promotion of software development and export. Accordingly in 1986 an explicit software policy was announced and software was identified as one of the key sectors in India's agenda for export promotion. The policy underlined the importance of an integrated development of software for the domestic and export markets (India, Department of Electronics, 1986). The policy had the following specific objectives;

- To promote software exports to a take a quantum jump and capture sizeable share in international software market
- To promote the integrated development of software in the country for domestic as well as export markets.
- To simplify the existing procedures to enable the software industry to grow to a faster pace.
- To establish a strong base of software industry in the country.
- To promote the use of computer as a tool for decision making and to increase work efficiency and to promote appropriate applications which are of development catalyzing nature with due regard to long term benefit of computerization to the country as a whole.

To facilitate the stated objectives, the policy emphasized the need for simplifying the existing procedures pertaining to all the aspects of software development and production for both domestic and export markets and provided various commercial incentives to software firms like tax holidays, tax exemption on the income from software exports, export subsidies, and duty free import of hardware and software for 100 per cent export purposes.

With the initiation of economic reforms in the early 1990s an assessment was made by the finance ministry that apart from the general orientation of all industries towards export markets, India's comparative advantage was in software and not in hardware. Therefore, a major thrust was consciously given to software exports. Accordingly, new policy measures have been initiated which *interalia* included; removal of entry barriers for foreign companies, removal of restrictions on foreign technology transfers, participation of the private sector in policy making, provisions to finance software development through equity and venture capital, measures to make available faster and cheaper data communication facilities, and reduction and rationalization of taxes, duties and tariffs etc[4] (Narayana Murthy 2000).

Along with the policy measures initiated by the National Government, various state governments also enacted IT policies with a view to promote ICT growth in the respective states. As of now, 18 state governments have enacted such policies. These policies, generally focusing on the key issues of infrastructure, electronic governance, IT education and providing a facilitating environment for increasing IT proliferation in the respective states[5].

More recently, recognizing the potential of IT-related industries and software for India's development, the Prime Minister appointed a National Taskforce on Information Technology and Software Development (NTITSD) in May 1998 under the chairmanship of the Deputy Chairman, Planning Commission. NTITSD submitted its report outlining a National IT Plan comprising 108 recommendations for software and 87 recommendations for hardware (India, NTITSD, 1998). These recommendations have since been notified by the Government in the Gazette of India dated 25 July 1998. NTITSD has set before the country an ambitious target of $ 50 billion software export by 2008. DoE was upgraded into a full-fledged Ministry of Information Technology (MIT) in October 1999 to coordinate the promotional role of the government in the industry.[6]

Supply of Trained Manpower for Software Development

The National Conference on Electronics in 1970 had estimated the need for about 300 M.Techs and 50 PhDs in computer science and technology and had recommended launching of specialized Masters level programmes at the IITs and other major institutions besides making proficiency in computer programming mandatory for undergraduates of IITs and science post graduates of all major universities in the country (India, Electronics Commission, 1975). As a follow up of these recommendations, M.Tech (2 year post graduate) and B.Tech (4 years graduate) courses in computer science were started in 1974 and 1977 respectively with DoE support at the IITs. In 1982, two new courses viz. a three year Master of Computer Applications and a Diploma of Computer Applications were started besides expansion of M.Tech/ B.Tech courses as a follow up of the Rajaraman Committee of 1978. These facilities were further expanded and new polytechnic diplomas were started in 1984 further to Computer Manpower Development Programme launched in 1983. In 1984, Sampath Committee reviewed the training needs and in 1985 a Standing Committee on Computer Education was set up to plan further actions. The new courses introduced under the Computer Manpower Development Programme supported by DoE at about 400 institutions had produced some 15000 software personnel by 1996 (Heeks, 1996). The DoE's support has not only been restricted to financial grants but has also involved curricula development. Besides the courses started at the educational institutions, a number of enterprises and other institutions promoted by DoE have also been providing training in software development. These include NCST and C-DAC running advanced software engineering courses and CMC Ltd., ETTDC, NIC running routine software application training.

Besides these, the government permitted private investment in IT training since the early 1980s.[7] These privately run centres offer diplomas of various duration ranging from short-term specialized courses to longer-term basic courses. However, the quality of the training imparted by these institutions had been uneven. DoE has stepped in to provide accreditation of their courses as a step towards standardization of these courses. A scheme called DOEACC was started in 1990 jointly with the All India Council of Technical Education (AICTE) to provide accreditation to specified level of courses viz., O-foundation course, A-Advanced Diploma, B-MCA Level, C-M.Tech Level. By January 2004, a total of 850 institutes had been accredited by DOEACC Society. The Society conducts examinations for all the four levels twice a year and grants certificates /diplomas (India, Department of Information Technology, 2004).

The demand for software personnel especially engineering graduates has grown rapidly since the mid 1990s due to the expansion of the software development activity in India as well as the growing brain drain. In view of this, easing the supply of IT professionals has been one of the challenges faced by the country. In a survey conducted during the late 1990s, 57 per cent of the firms interviewed indicated manpower and skills shortage as the major problem (Arora *et al*. 2001). The NTITSD has made a number of recommendations dealing with augmenting the quality and quality of trained manpower for software industry. In tune with these recommendations, the capacity of the higher education system in engineering in the country has been expanded besides setting up of new institutions.[8]

Infrastructure for Technology Development in Software

DoE, as the government arm has played an instrumental role in creating necessary infrastructure for the development of software industry development. In the 1970s, the DoE was setting up Regional Computer Centres run like public utilities, attached to educational institutions that were following the recommendations of the National Conference on Electronics of 1970. These centres were set up at Bombay, Delhi, Bangalore, Calcutta, Kanpur, and Hyderabad. A Computer Maintenance Corporation (CMC) was set up in 1976 for maintaining these and other computer centres. Over time CMC has grown into a full fledged software company with strong R&D capability. National Informatics Centre (NIC) was set up to facilitate automation and networking of government offices at the centre, state and district levels.

Since the late 1980s, the DoE has concentrated on providing data communication and networking infrastructure to the educational and research community and to the software industry. This infrastructure has played a critical role in the development of the industry in the 1990s. The Education and Research Network (ERNET) project was initiated in 1986 with participation of NCST Mumbai, IISc Bangalore, five IITs, and support of DoE and the UNDP with the objective of enhancing national capability in the area of computer communication by progressively setting up a nation-wide computer network for the education and research community. ERNET has evolved into a separate institution now providing networking services to over 80,000 users in 750 academic and research institutions with its dedicated satellite data transfer backbone.

A notable institutional intervention has been the establishment of Software Technology Parks[9] (STP) to provide the necessary infrastructure for software export. The first ones to come into being were those at Bangalore, Pune and Bhubaneshwar in August, October and December 1990 respectively. In 1991, four more STPs were set up by the DoE at Noida, Gandhinagar, Trivandrum and Hyderabad[10]. As of now there are 39 Software Technology Parks set up in different parts of the country and they play a significant role in the export of software from the country. The total number of units registered with the STPs increased from 164 in 1991 to 5582 in 1999 and accounted for about 68 per cent of India's IT exports (see Table 2). By 2002-03 the number of units increased to 7000 and they accounted for 80 per cent of the software exports (India, Department of Information and Technology, 2004).

The infrastructure facilities available in these STPs included, among other things, modern computers and communication network which are beyond the reach of individual firms. The STPs also envisage a transparent policy environment and a package of concessions, which include among others;

- Approvals are given under the "single window clearance" mechanism and permission of 100 per cent foreign equity.
- The STP authorities themselves issue approvals for projects costing Rs.30 millions or less with no foreign equity participation.
- Units are eligible for 5 years tax holiday with no value addition norms.
- All the imports are completely duty free while the domestic purchases are eligible for benefit of deemed exports.
- Sub contracting of software development activity by STPs is permitted and sales in DTA is permissible up to 25 percent of the export (Oberoi 1991).

Table 2: Trend in IT export from units registered with STPs

Year	No. of units Registered with STPs	Total Exports From India ($ Million)	Share of STP units in Total Export
1991-92	164	164	NA
1992-93	227	225	8
1993-94	269	330	12
1994-95	364	485	16
1995-96	521	734	29
1996-97	667	1085	46
1997-98	844	1750	54
1998-99	1196	2650	58
1999-00	5582	3900	68

Source: Joseph (2002).

In June 2000, a new STP was set up in Silicon Valley, composed of a Business Support Centre and an India Infotech Centre, with a view to facilitate software export by small and medium firms to US[11]. The center also fosters business relationships by providing access to financial institutions in the US, Venture capital funds and specialized trade bodies to promote partnerships and strategic alliances between the US and Indian ICT software and service companies.

R&D Capability Building

DoE has put heavy emphasis on R&D activity relating to, among other fields, development of computer software by supporting R&D activity in the area at different institutions such as TIFR, IITs, IISc, select universities (such as Jadavpur University), ISI, and CSIR Laboratories since the early 1970s. The Technology Development Council has been supporting R&D projects since its inception in 1973 (India, MIT, 2000a). These programmes of technology development have led to building up of capabilities and have provided experienced manpower for the rapid development of the industry. For instance, the capabilities built in the process of early work on data communication at TIFR started in the late 1970s and anchored at the DoE supported National Centre for Software Technology (NCST), set up in Bombay in 1984, proved instrumental for the development of country wide networks and for Internet in the country in the 1990s. The National Aeronautical Laboratory (NAL) also developed a super computer Flosolver. The government S&T agencies have set up a parallel Super-computer Education and Research Centre (SERC) and Department of Computer Science and Automation at IISc, which provided high end expertise and manpower to the

industry in software. Besides NCST, DoE has also set up another institution for technology development in the 1980s viz. Centre for Development of Advanced Computing (C-DAC). C-DAC has developed India's first super computer-Param and has developed software for Indian languages' script. Electronics Research and Development Centre (ER&DC) is another new R&D institution set up by DoE. ER&DC has research facilities at Thiruvanathapuram, Calcutta and Noida near Delhi. The government has also stimulated and supported R&D activity of industry through tax incentives and direct funding by DoE.

Procurement Policies and Other Promotional Measures

The government has also helped in development of software industry by generating large and complex assignments that have given confidence and railway freight management to the local industry firms. These include automation of railways reservation, bank automation, among others (Heeks, 1996 and Parthasarathi and Joseph, 2002). The government has also assisted firms in standardization and quality control, for instance in their effort to obtain ISO 9000 certification. The small and medium enterprises have been assisted in their overseas expansion by subsidies for their participation in industry fairs such as CebIT, venture capital and tax breaks for export activity.

Financial Support: The role of EXIM Bank of India

The Exim Bank, which is fully owned by the Government of India, has had a number of schemes to help promote the software industry from 1986 onwards. To list a few: Exim bank has entered into a memorandum of understanding in 1998 with NASSCOM for promoting software service export. Under the 1986 software export policy Exim bank operated a special window for export oriented software companies. Exim bank also supported market research quality satisfaction, buyer's visit to India, participation in specialized fairs etc. Exim bank also provided term loans to Indian companies to finance their equity contribution in overseas ventures. To support the industry move up the value chain toward products the bank had a special programme to finance software product development.[12]

Measures to Address Software Piracy

Till recently, the weak copy right regime in the country facilitated the proliferation of software piracy, which in turn acted as a disincentive for firms to develop software products. The magnitude of the problem has been illustrated by an estimate from Lotus Development Corporation, that in the early 1990s 150,000 copies of Lotus 1-2-3, 140,000 were pirated. (Schware 1992). To address

this problem, the government initiated a series of measures. The copy right of computer software has been protected under the provisions of Indian Copy Right Act of 1957. Major changes were made to the Copy Right Law in 1994. Accordingly, it is illegal to make or distribute copies of copy righted software and therefore punishable. Section 63 B of the Act stipulates a minimum jail term of 7 days extendable up to three years. The Act further provides for a fine ranging from Rs 0.05 million to Rs 0.2 million. In addition, the government, in co-operation with the Nasscom, conducts regular anti piracy raids to discourage software piracy. As a result, the piracy rate in the country has come down from 89 per cent in 1993 to 60 per cent in 1997 (NASSCOM 1999a).

Role of Private sector and Industry Associations

It may be myopic to attribute the observed dynamism of the industry entirely to the initiatives made by the state (Joseph 2002). While the state initiatives laid the foundation for faster growth, the industry associations[13], particularly the National Association of Software and Service Companies (Nasscom) played an important role. In addition to lobbying at the Central and State government levels, the Nassscom also played a key role in projecting India's image in the world IT market. For example, in 1993 Nasscom appointed a full time lobbying firm in Washington. It facilitated the participation of Indian firms in a large number of international IT exhibitions and projecting India's capabilities in the sphere of IT. The role that Nasscom played in getting the visa rules relaxed by the developed countries, especially USA, is well known. Also, in 1994 Nasscom initiated anti piracy initiatives in India, when IPR was becoming a major issue in the Indo-US relations. It took up the campaign against software piracy and conducted a number of well-publicised raids.[14]

NIS and Patterns of Spatial Agglomeration of IT sector

IT and Software development in different parts of the world is characterized by a strong tendency of clustering because of agglomeration economies. In India the software industry developed initially in Mumbai (formerly Bombay). Subsequently, especially after the entry of Texas Instruments in the mid-1980s, Bangalore emerged as a centre of software industry development. Besides, Bangalore and Mumbai, Delhi along with its suburbs namely Noida and Gurgaon, has emerged as the third most popular concentration of software units (See Table 3). Hyderabad and Chennai also have emerged as alternative location in the South after the saturation of Bangalore in terms of available infrastructure and scarcity of space. The state government's promotional role has also contributed to the emergence of Hyderabad as the fourth most important centre

Table 3: Patterns of Clustering of Top 600 Software Companies

City	Number of Company Headquarters Located	Percentage share
Mumbai	131	21.83
Bangalore	122	20.33
Delhi and Around	111	18.50
Hyderabad	64	10.67
Chennai	55	9.16
Calcutta	25	4.16
Pune	23	3.83
Thiruvanathapuram	14	2.33
Others	55	9.16

Source: Adapted from Nasscom (2000a).

of concentration of software companies. The top five cities together account for 80.5 per cent of the 600 top companies. But other cities such as Calcutta, Pune, Thiruvanantpuram, Ahmedabad, Bhubaneswar are coming up as increasingly popular locations. One important facilitating factor has been the availability of high speed data communication links and built-up space provided in the Software Technology Parks (STPs).

The patterns of concentration of software development industry in and around select cities does corroborate the key importance of NIS for the activity. Table 4 shows that the cities of high concentration of software development viz., Bombay, Bangalore, Delhi and Hyderabad, have shared a disproportionate share of national innovative infrastructure, skills base, and other resources for technology development. Because of significant agglomeration economies present in skills and knowledge intensive activities such as software development, this disproportionate share of national innovative infrastructure has crowded in the software development activity to these cities.

The presence of higher educational enterprises in engineering and technology thus ensuring the supply of engineering manpower, centres of excellence, a nucleus of local software industry companies and clustering of high technology enterprises together with telecommunication infrastructure in the form of Software Technology Parks in these cities has facilitated

Table 4: Illustrative S&T Infrastructure in Four IT Clusters in India

Type of NIS Infrastructure	Bombay	Bangalore	Delhi and around	Hyderabad
Institutions of Higher Technical Education and Excellence	IIT-B;Bombay University; SNDT Women's University; Bajaj Institute of Management and several other engineering and management institutes	IISc;Visvesraya University College of Engineering; SKSJ Technology Institute; and 28 private engineering colleges;Indian Institute of Management-B	IIT-D; Delhi College of Engineering; Delhi University Department of Computer Sciences, Roorkee University of Engineering (within 20 kms.); J.N. University;Jamia Milia Islamia Engineering College;FMS; IIFT; plus several private insttns.	J.N. Technological University; Hyderabad University; Osmania University; Kakatiya University;
Public Funded Research Laboratories and Institutions	TIFR; NCST; BARC; UDCT; SAMEER	ISRO; NAL, CMTI; Electronics and Radar Development Establishment Aeronautical Development Establishment; Gas Turbine Research Establishment; Centre for Aeronautical Systems Studies and Analysis;ER&DCI	NIC; NPL; Institute for Systems Studies and Analysis; SPL; C-DOT;	National Remote Sensing Agency; RRL; NGRI; IICT;Defence Electronic Research Laboratory;DRDL
Local Software Champions	TCS; PCS; Tata Infotech; Mastek; L&T ITL; APTECH; COSL; Datamatics; Silverline	Infosys Technologies Ltd.; WIPRO Information Technologies	HCL Technologies; NIIT Ltd.; CMC Ltd.;	Satyam Computer Services Ltd.

Table 4 continued

Table 4 continued

Type of NIS Infrastructure	Bombay	Bangalore	Delhi and around	Hyderabad
High Speed Data Communication Facilities	Earth Station of STPI	Earth Station of STPI	Earth Station of STPI	Earth Station of STPI
High Technology Enterprises, mostly public sector	L&T; Godrej; Tata group and a large number of engineering and electronics enterprises	ITI; BEL; HAL	Central Electronics Ltd.; NRDC; EIL; RITES; ETTDC; ET&T;RITES; TCIL	ECIL; BHEL

Source: Kumar (2001a).

agglomeration of software industry in these cities. It will become clear from a case study of Bangalore presented in Box 1.

To sum up the discussion it has been shown that India's success owes largely to the cumulative investments made by the government over the past five decades in building what is now termed as National Innovation Systems. These include resources in development of a system of higher education in engineering and technical disciplines, creation of an institutional infrastructure for S&T policy making and implementation, building centres of excellence and numerous other institutions for technology development, among other initiatives. The Indian government recognized the potential of the country in computer software way back in the early 1970s and started building necessary infrastructure for its fruition, in particular, for training of manpower. The government also facilitated technological capability building with investments in public funded R&D institutions and supporting their projects, by creating computing facilities, and developing infrastructure for data transfer and networking. The patterns of clustering of the software development activity and in particular the case study of Bangalore provides a further evidence to the contention that public funded technological infrastructure has crowded in the investments from private sector in skill intensive activities such as software development. It would appear from this that investments made by governments in national innovation systems have substantial positive externalities. On the whole, India's IT success is a typical case of proactive state intervention; Government laid the foundation and created the facilitating environment and the industry took off with greater participation by the private sector and high growth in world demand in the 1990s *inter alia* on account of the Y2K problem.

Are there any lessons for the new ASEAN aspiring to decelop an ICT base? Towards seeking an answer to this issue it is important to have a fair idea of the state of ICT sector in new ASEAN. The next section seeks to draw the broad contours of ICT sector in new ASEAN.

New Technology in the New ASEAN[15]

Information Technology Use

Let us begin with an examination of the present state of ICT infrastructure and ICT use in new ASEAN in comparison with the old ASEAN member countries and also with other low-income countries (see Table 5). With respect to IT infrastructure, it may be noted that the number of fixed telephone lines per 1000 people even in the largest city of the new ASEAN member countries is

Box 1:
Bangalore and the Software Industry: A Case Study

The city of Bangalore has emerged as a favoured location for the software companies from within the country and outside MNEs that have set up development centres in the country so much so that it is referred to as the Silicon Valley of India. Besides hosting headquarters of 122 companies, software centres of a number of other companies are located in Bangalore. Most of the foreign software majors that have set up development centres in India have also preferred Bangalore. These include Texas Instruments (TI) which entered the country in 1986 and followed by Hewlett-Packard, Novell, Oracle, among others. This pattern of clustering of software industry in Bangalore is to be explained in terms of a high concentration of the NIS infrastructure located in the city. Bangalore has been an important centre for engineering and technical education since the early twentieth century. The Indian Institute of Science (IISc) was set up with an endowment from Tata industrial family in 1909. IISc has emerged as a centre of excellence in different branches of engineering and technology. A polytechnic was founded in Bangalore in 1920s by M. Viswesvarayya, a prime minister of the princely state of Mysore. Since the Independence, many government research establishments and high-tech industries, besides educational centres have been set up in the city. That infrastructure provides a ready availability of a pool of trained manpower, high-end computer programming facilities and expertise, and other infrastructure for technological development besides agglomeration economies because of this concentration. Besides the mild climate has helped (see also Lateef, 1997).

Supply of Engineering and Managerial Skills

As observed earlier, Bangalore has a history of higher education in engineering and technology. Besides the IISc that offers integrated engineering degree programmes right from graduation to doctoral level, there are many engineering colleges in the city, providing degrees and diplomas in different streams of the subject. According to a city website, Bangalore has 30 engineering colleges out of 77 located in the Karnataka state, including private colleges. These colleges in Bangalore and at other places in the state ensure a steady supply of trained engineering manpower for the software houses. Besides the location of one of the premier management institute in the city Indian Institute of Management-Bangalore (IIM-B) ensures supply of trained management skills.

Technology Development Infrastructure

Bangalore has a high concentration of high technology institutions and research laboratories of different public funded scientific and technological establishments which have developed expertise in computer programming and software engineering. Hence, their presence provides benefits of agglomeration that can be substantial in the skill intensive activities such as software development. These institutions include:

Indian Institute of Science: A centre of excellence in various areas of engineering. In computer software, it has a Supercomputer Education and Research Centre (SERC) and a Department of Computer Science and Automation (CSA). SERC has been conducting industrial consultancy for a number of companies. Its clients include Digital

Box 1 continued

Box 1 continued

Equipment, Texas Instruments, HP, Tata Elxi, Wipro, BHEL, among others. CSA conducts Masters programmes in computer science, internet science, systems science and automation. IBM and Infosys have instituted fellowships at the CSA. Its faculty includes 21 PhDs in computer science.

Public Funded R&D Organizations Concerning IT Industry or using Computer Software: Bangalore hosts a number of CSIR national laboratories viz. National Aerospace Laboratory (NAL), Centre for Mathematical Modelling & Computer Simulation (C-MMACS), Central Machine Tools Institute (CMTI); Indian Space Research Organization (ISRO)'s Satellite Centre and Telemetry Tracking and Command Network (ISTRAC); Defence Research and Development Organization (DRDO) 's Centre for Artificial Intelligence & Robotics (CAIR), and Centre for Airborne Systems Studies and Analysis, and Electronics and Radar Development Establishment; Microwave Tube Research & Development Centre; Gas Turbine Research Establishment, and Central Power Research Institute. Some of these institutes, even though having a different focus than primarily on software development have built strong capabilities in computers, electronics and software engineering. NAL, for instance, has developed India's second parallel super-computer, Flosolver. NAL has attracted research contracts worth $25 million from global IT leaders such as IBM, Hitachi and Boeing among others. CMTI has spearheaded India's advance in CNC machine tools that require considerable software skills. Besides these specialized R&D institutions, Bangalore also hosts a number of other scientific and technology institutes such as Raman Research Institute and J.N. Nehru Centre for Advanced Scientific Research, both funded by the Ministry of S&T; Indian Institute of Astro-Physics, and National Institute of Advanced Studies. The presence of all these highly specialized high technology institutions in the city gives it a critical mass of expertise in nearly every domain of engineering that the software industry can tap.

High Technology Enterprises

A number of public sector electronics, communication and aerospace enterprises have been set up in Bangalore since the 1950s. These include Bharat Electronics Limited, and Indian Telephone Industries (ITI) Limited, and Hindustan Aeronautics Limited (HAL) started in 1950s and 1960s, Hindistan Machine Tools Ltd (HMT), and Bharat Heavy Electricals Limited in 1970s. Activities of these enterprises had numerous backward and forward linkages with the software development activity. HAL's capability in software engineering for aerospace industry has attracted British Aerospace (BA) to form a joint venture with it viz. BAeHAL Software Limited in 1993 headquartered in Bangalore. BAeHAL has developed an aircraft logistics package, CALSS, besides other products and services (Nasscom, 1999).

Finally, some of India's more successful national software enterprises such as WIPRO and Infosys Technologies have also originated in Bangalore, while others like Tata Consultancy Services (TCS) have established their development centres there. The presence of national champions in Bangalore has also crowded in other software enterprises from within and outside the country.

Source: Kumar (2001a).

Table 5: Indicators of ICT Infrastructure and use in ASEAN countries (2001)

ASEAN Member Countries	Telephone Mainline				Mobile Phone Per 1000 People	Personal Computer Per 1000 people	Internet Users (000)	Information and Communication Expenditure	
	Per 1000 People	In Largest city per 1000 people	Waiting time year (2000)	Cost of local call per 3 minute ($)				% of GDP	per capita $
Old ASEAN									
Brunei									
Indonesia	35	261		0.02	31	11	4000	2.2	17
Malaysia	196		0.7	0.02	314	126.1	6500	6.6	262
Philippines	42	265		0	150	21.7	2000	4.2	41
Singapore	471	471	0	0.02	724	508.3	1500	9.9	2110
Thailand	99	452	1.6	0.07	123	27.8	3536	3.7	76
New ASEAN									
Cambodia	2	19		0.03	17	1.5	10	-	-
Lao PDR	10	65	1.1	0.02	5	3	10		
Myanmar	6	32	5.3	0.01	0	1.1	10	-	-
Vietnam	38	-	-	0.02	15	11.7	1010	6.7	26
Low Income	30	130	1.4	0.05	10	6.1	15932	-	-
Low Middle Income	93	270	2	0.04	72	21.6	112591	-	
High Income	593	-	0	0.08	609	416.3	388888	-	-

Source: Adapted from Joseph and Parayil (2004) based on The World Bank, World Development Indicators, 2003.

lower than the national average for the old ASEAN countries. When it comes to mobile telephones, computers and Internet, the divide between the old and new ASEAN countries is much wider. In general, in terms of ICT infrastructure and use, while the old ASEAN member countries are found to be either on par with or at a higher level than the middle-income countries, the new ASEAN member countries lag not only behind their counterparts but also behind the low-income countries in general. Here, Vietnam appears to be an exception. More importantly, It has been found that IT use in these countries (with the possible exception of Vietnam), in terms of telecommunication network (fixed or mobile) and internet use, is confined to the urban areas leading to what is called the "intra-national digital divide".

To address these issues there have been initiatives at the individual country level and at the regional level. At the country level, all the new ASEAN (CLMV) countries have made a series of institutional arrangements and policy measures, which in general aims at building up ICT infrastructure, ICT production base, human resource development and promoting the use of ICT in different sectors of economy and society.

Policy Initiatives

While the economies in the New ASEAN in general were faced with making the difficult choice of "investing in Pentium or in Penicillin" they have undertaken a series of bold initiatives towards in terms policy reforms and institutional interventions towards developing an ICT base and using new technology for addressing their development needs. Nonetheless, given the gigantic task at hand and the rocky road through which they have to traverse, the destination still remains far away.

In case of Cambodia, the present policy towards IT lays emphasis on promoting IT use in different sectors of the economy and also for promoting e-governance. To achieve this, policy calls for among others, the development of infrastructure, promoting computer literacy, standardization of Khmer language in computers and greater role for the private sector. However, a comprehensive IT policy is yet to be framed and NiDA is responsible for undertaking initiatives to promote information Technology in the country.

In Lao PDR, as early as in 1996, the Science Technology and Environment Agency (STEA) was given the approval by the Prime Minister's Office to implement the overall policy for monitoring and controlling Information Technology. Given this mandate, STEA proposed a four year plan (1996-2000)

which dealt with, among other things, developing IT infrastructure (including human capital, IT industry base, communication network), promoting IT application (in Government, business and industries as well as economy at large) and devising policies for promoting ICT development which also included policies relating to promotion of FDI in IT. Achievements by the year 2000 appears to have fallen short of the targets on account of various reasons which *inter alia* included lack of resources and lack of coordination among different agencies involved. Today the government is in the process of making an integrated IT policy for the country and five working groups have been appointed for this purpose.

In case of Myanmar, an examination of the computer science law which governs the use of computers and internet in the country and IT production to a great extent revealed that, though the objectives were highly laudable, the series of restrictions have had the effect of mitigating the positive effect of various initiatives that the government has undertaken to promote the use of IT for development. Hence the study highlighted positive outcomes of phasing out various restrictions on the use of information technology in general and Internet in particular. In case of Vietnam, IT production and use is governed mainly by an eminent Vision Document concerning new technology prepared by the Party and subsequently developed Action Plan by the government. Both these documents are unambiguous in their approach, exhaustive in their coverage and ambitious but realistic in their targets (Government of Vietnam, 2001, 2002.

On the whole, the policy initiatives and institutional interventions tend to suggest that there is high degree of awareness among the policy makers of new ASEAN countries regarding the need for harnessing new technology for development. While comprehensive ICT policies have already been formulated in Vietnam, others like Cambodia, Lao PDR and Myanmar are yet to come up with a comprehensive ICT policy. The institutional arrangements were also found to be varying from country to country. While there is a ministry exclusively for ICT in Vietnam, in other countries, ICT issues are handled either by the Ministry of Science, Technology and environment or an Independent Agency like NiDA in Cambodia. There are also instances of more than one agency dealing with ICT related issues leaving room for co-ordination failures. Given the pre-eminent role that the new technology plays today, cutting across different ministries and administrative departments, it may be worthwhile to have an exclusive Ministry for Information Technology in those countries, which are yet to set up a separate ministry.

These policy initiatives notwithstanding present state of IT production is in its infancy, in the new ASEAN as is evident from the forthcoming discussion.

IT Production

Conceptually, IT production could be divided broadly into ICT goods and IT services. Each of these broad product groups comprises of wide range of goods and services with varying levels of entry barriers and incorporates varying level of technology. Hence, the central issue is to find ways and means of evolving a national system of innovation that enable the new ASEAN countries to enter into IT production.

In Cambodia as of now there is only one firm engaged in the production of IT goods in the country. The company began its operations in 1992 as a joint venture and became 100 per cent foreign owned by 2000. In addition to producing television sets and VCRs, it also had the dealership for leading computer companies. In the initial years the company used to employ more than 70 people. Over the years, various reasons, like high import duty and VAT (import duty plus VAT put together about 26.5 per cent) leading to large scale smuggling and poor infrastructure, have led to a situation wherein the firm was forced to scale down its operations in the country. Today the company employs only about 20 people in its IT factory and focus more on Computer and software service related activities. Given the fact that the present level of IT production in the country is negligible, the entire domestic demand is being met entirely through imports. This has had the effect of adversely affecting the overall trade balance of the country on the one hand and forgoing the potential opportunities for employment and income generation in the country through ICT production on the other. The situation is not much different in Lao as well.

In Mynamar, too the IT goods production in the country is at a low level. While there are two local producers of computers, almost 70-80 per cent is accounted by the so called “Grey market”. While looking at the major areas of operations of the members of Myanmar Computer Industry Association, it was discerned that hardly any one is engaged in computer production. Most of them are engaged in hardware/software supply and service, and software production. In consumer electronics, MNCs like Toshiba and Daewoo are have operations in the country. In the public sector, Myanma Machine Tool and Electrical Industries (MTEI) has one electrical and electronics factory located

at South Dagon, with following product lines - Fluorescent Lamps & incandescent bulbs, electric rice cookers, electric irons, electric hot plates and dry cells.

While the production base in the IT goods appears to be limited, Myanmar has already initiated some bold steps towards creating software/ service production in the country. This is manifested in the setting up of Software Technology Parks at the instance of Myanmar ICT Development Corporation (a consortium of 50 private companies) with the active support and cooperation from the Government of Myanmar wherein the needed communication infrastructure is being provided by the publicly owned Bagan Cybertech. The project, set up in the Hline University Campus with a total investment of about Ks 2.5 billion, was initiated in March 2001 and the first phase was completed with in a very short span of about 10 months and the park was inaugurated in January 2002. The first phase of the project, covering a developed area of about 11 acres has 32 rooms (100ft*50ft). As of June 2003, the occupancy rate is 100%. The park has been able to attract two foreign companies; it is also the home for an incubation center for promising local software programmers and the Japan-Myanmar e-learning Centre. The activities in the Park include; software development, human resource development, national level projects, data processing services, consultancy services and provides employment to about 700 people. On the whole, the technology park experiment is a testimony to the positive outcome of public private participation. The government is in an effort to replicate this success by setting up another park at Mandalay.[16]

Vietnam is perhaps the only country in the region having various explicit policy resolutions for promoting IT production. Also Software technology parks have been set up in HCMC, Da Nanag and Hanoi to attract investment into the software development and export sector and to achieve the target of US $ 500 million worth software production including an export of US $ 200 million by 2005. It is understood that there Vietnam's ICT industry (covering software, hardware, network services and systems integration) was about $ 337 million in 2000. It has been estimated to reach US $ 417 in 2002 and $ 690 by 2003. Surveys conducted by the International Data Group indicate that the IT market in Vietnam has been recording an annual growth rate of 25per cent and this rate of growth is expected to continue through 2010[17]. Another survey by the PC World has shown that by the end of 2002 there were about 260 software companies, employing about 5000 specialists and the recorded growth rates in

sales was of the order of 23 per cent. On an average, these firms employ 20 persons and the turnover per person for the year 2000-01 was $ 6400 and $11,000 for software companies and software outsourcing companies respectively.

When it comes to IT goods production in Vietnam it is understood that the about 0.4 million computers have been produced in the year 2002 and the industry has been recording a growth rate of 30-40 per cent in the recent years. About 60 per cent of this has been accounted for by the non-branded sector. With a view to gain a better understanding of the growth of IT goods sectors we have analyzed the data on the production of IT goods (TV, radio communication equipment-ISIC 32; Computing machines – ISIC 30) and compared its share as well as growth of the industrial sector as a whole and other industries (2 digit level) and reached following conclusions.

The industry segment office accounting and computing machinery recorded a very high growth rate of over 72 percent, albeit from a very low base, which is in tune with the observations made by the industry associations. When it comes to the industry segment Radio, TV and communications equipment, the recorded growth rate has been only a little over 15 per cent only marginally higher than the growth rate recorded by the manufacturing sector as a whole (14.13). More importantly, there have been a number of industries, which recorded higher growth rate than this industry. It we look at the IT sector as a whole, notwithstanding the importance attached to the IT sector, its share in the manufacturing output increased only by about 0.5 per cent (from 2.5 per cent in 1995 to 3.0 per cent in 2002) and the recorded growth rate has been only of the order of 17.6 per cent. Thus, it appears that there is the need for greater focus on developing the IT goods sector, which could not only be a source income and employment in the domestic economy but also a source of foreign exchange.

Human Capital Constraint for IT Use and Production

If the experience of India is any indication the availability human capital, which plays a dual role as both producer and user, is a necessary condition for developing an ICT production and use base. Against this background what follows is a brief discussion of the institutional arrangement for creating IT human capital in the new ASEAN.

The higher education system in Cambodia comprises of five public universities, three semi-independent specialized institutes of faculties and

six recognized private higher education institutes. It is estimated that all these institutes together turn out a total of 25,000 students. Of these only two, Royal University of Phnom Penh and Norton University, offer degree programs in Information Technology related fields. The total number of IT graduates from these institutes is estimated at about 200 to 300 per year. Recently CISCO, at the instance of NiDA, also started imparting IT training. Also a number of NGOs are found to be involved in capacity building and IT training along with large number of private training centers offering short-term courses in IT. Thus there are multiple actors involved in the generation of human capital for IT.

In Laos, Computer and IT related education[18] is provided not only by the National University of Lao PDR but also by the private sector. The computer science program in the NUL began in the year 1998 under the faculty of Science, Department of Mathematics[19]. The number of out turn of graduates is only 29 (UNDP 2002). The faculty of Engineering and Architecture (FEA) is considered as best equipped with IT facilities in the NUOL system[20]. The main component of these facilities is the Lao-Japan Technical Training Center (LJTTC). The courses offered at the LJTTC are a combination of general application courses; computer aided engineering courses and a course on network software. LJTTC even offers a course on Internet café set up and maintenance.

Given the limited IT education facility in the public sector the vacuum is filled up, at least partly, by the private sector. The following private colleges are currently providing IT education, albeit at a very preliminary level. The Vientiane College, a private Institution with the academic and financial support of the Monash University in Australia, was established in 1992. Other institutions involving foreign investment are the Micro Info Centre (Joint Venture) and Lao American College, another joint Venture. The Lao American College has established working relations with the National University of Lao PDR, City University of Washington State, USA, the Ohio University, USA, and the Bangkok University, Thailand. In addition to these educational institutions with foreign investment there are three local initiatives like Rattana Business Administration College, Com Centre and PVK Computer Center. Parallel to these educational institutions, there are a number of computer dealers who provide short-term training in computer operations.

In Myanmar, the Government has taken pro active steps in promoting education is Science and technology in general and IT in particular. Major

institutions of higher learning have been kept under the administrative control of the S&T Ministry to enable better focus and attention. These are;

a) Yangon University of Technology
b) Mandalay University of Technology
c) Pyay Technology University
d) Yangon University of computer studies and technology
e) Mandalay University of computer studies and technology

It could be observed that out of the five institutions two of them are specialized universities focusing exclusively on IT (d & e above). The Yangon University of Computer Science and Technology, the leading university in IT education, provides 12 courses in IT education (Kyaw A. 2002).

In addition to these universities, there are 24 government colleges and 80 university colleges and all of them have IT departments and offer diplomas or degrees in IT education. All these universities have access to computers with LAN. Today, it was understood that the outturn of students with IT qualification is as high as 3000 per annum and the government has the target of reaching 25,000 by 2010.

Vietnam, has a target of training over 50,000 IT specialists at different levels of whom 25,000 are high level programmers fluent in English. For IT training there are 20 IT faculties in Vietnam's various universities and colleges, 45 technical colleges with IT programs, and about 67 vocational schools with IT subjects. It is estimated that at present there are approximately 20,000 IT professionals (with bachelors' degrees) in Vietnam, with 10,000 working directly in the IT industry on research and development or in education services (USAID 2001).

There are number of bilateral agreements to promote the IT training In Vietnam. A joint working Group on IT and electronics between India and Vietnam has been in existence since 1999. The Prime Minister of India during his visit to Vietnam in January 2001, announced a grant of Rs 100 million for a software and IT training Centre in Vietnam. In November 2001, the Government of Vietnam allocated this grant to Hanoi People's Committee for utilization in a US$ 4.4 million Hanoi IT Transaction Centre project[21]. In November 2001, a Vietnam- Japan e-learning Center was opened in HCMC as part of cooperation between the two countries in IT. Under a MoU signed between the two countries in August 2001, Japan's Ministry of Economy, Trade

and Industry had agreed to provide US $ 150,000 a nonrefundable aid to Vietnam for IT courses. The Republic of Korea plans to send about 50 government officials to Vietnam to provide training in the latest IT techniques.

Government also has been successful in attracting investment in the field of IT training. A number of private schools are entering the local Vietnamese market with a specific aim of developing IT professionals. The Royal Melbourne Institute of Technology (RMIT) has opened a school in HCM City, with plans to build a large campus near HCM City[22]. APTech , Tata Infotech and NIIT, the three leading private training institutes from India with operations in many countries, are also providing IT-related programs in Vietnam. In addition to these formal educational institutions, there is considerable IT-related training provided by IT-related business associations. The Vietnam Association of Information Processing (VAIP) has been instrumental since the early 1990s in providing IT-related awareness over public TV and in setting up 90 IT training centers throughout Vietnam. These centers issue approximately 1,000 certificates a month. In addition, the VAIP sponsors an annual IT Olympiad with participation from each university in an effort to promote student IT learning.

While all go well with quantity, what matters in a highly skill intensive and competitive field like IT and software development is quality. A study by USAID (2001) quoted the results of another study conducted by the Political and Economic Risk Consultancy Ltd., in which a Human Resource Index for Asian countries was developed. Vietnam ranked low in virtually all categories (e.g., none were above 3.50 on a scale of 0-10), with the high-tech proficiency ranked 2.50 — the lowest of all countries included in the survey! English proficiency was also ranked the lowest of any country (including China) with a ranking of 2.62 out of 10.

Concluding Observations and Lessons for New ASEAN

Our analysis of the contributory factors towards the development of ICT sector in India has shown that the National System of Innovation, which evolved overtime as an outcome of the policies initiated by the government. These included development of a system of higher education in engineering and technical disciplines, creation of an institutional infrastructure for S&T policy making and implementation, building centres of excellence and numerous other institutions for technology development, among other initiatives. The Indian government recognized the potential of the country in computer software

way back in the early 1970s and started building necessary infrastructure for its fruition, in particular, for training of manpower. The government also facilitated technological capability building with investments in public funded R&D institutions and supporting their projects, by creating computing facilities, and developing infrastructure for data transfer and networking. We have seen that the new ASEAN economies are also in the process of making various initiatives towards building up the three pillars of ICT – IT infrastructure, human capital and an IT production base. Against the backdrop of this discussion we shall now reflect on the plausible lessons for the new ASEAN from the Indian experience. Here we must hasten to add that India's National Innovation System has been built up over nearly five decades and the road ahead the new ASEAN is long as well as rocky. Nonetheless, much could be learned from India, which in turn could facilitate their leapfrogging.

Discussion of the policy initiatives and institutional interventions by the new ASEAN tend to suggest that there is high degree of awareness among the policy makers on the need for harnessing new technology for development. While comprehensive ICT policies have already been formulated in Vietnam, other countries like Cambodia, Laos and Myanmar are yet to come up with a comprehensive ICT policy. The institutional arrangements also found to be varying from country to country. While there is a Ministry exclusively for ICT in Vietnam, in other countries, ICT issues are handled either by the Ministry of Science, Technology and Environment or an Independent Agency like NiDA in Cambodia. There are also instances of more than one agency dealing with ICT related issues leaving room for co-ordination failures. Given the pre-eminent role that the new technology plays today, cutting across different ministries and administrative departments, and the imperative need for evolving a National System of Innovation, it may be worthwhile to have an exclusive Ministry for Information Technology in those countries, which are yet to set up a separate ministry.

Also the policies in almost all the countries seem to be not assigning an appropriate role for the provincial governments in developing and harnessing ICT for development. We have seen that as of now most of the provincial governments in India have their own IT policies to promote the production and use of IT in the respective states. While the role of private and public sectors and the coordinated effort has been underlined in the policies of all the countries, there are other stakeholders, like Civil Society Organisations who

could play a very constructive role especially in addressing the issue of "intra-national digital divide" and harnessing ICT for the rural sector in general and agricultural sector in particular- the mainstay of all the new ASEAN economies.

Given the fact that affordability is a major issue in promoting the use of IT in the new ASEAN, which in turn arise on account of the high price of hardware and software in relation to their income levels, there appears to be the need for greater focus on promoting the use of open source software. In this regard, there is great potential in cooperating with each other as well as with other developing countries like India, known for her IT capabilities.

A major issue being confronted by the new ASEAN relates to the human capital constraint. It may be argued that the present approach of "training the trainers" adopted by most of the countries has its obvious limits and underscores the need for targeted measures to attract more investment into the field of IT education and Training. While ambitious targets coupled with concerted actions have been made towards developing IT manpower by most of the countries, the focus so far appears to have been on "quantity" leading to mushrooming of private training institutions. This has the potential danger of creating a pool of "un employable" human power. Hence, drawing from the Indian experience, there appears to be the need for an accreditation system on the one hand and evolving deliberate policies on the other to nurture strong linkages between the academia and the industry wherein the teachers are exposed to the real world environment through consultancy and other means, students take up internship with the private sector and the private sector participates in the teaching and development of the curriculum in the academic institutions and ultimately resulting in an overall improvement in the quality of manpower. Here again much could be gained by joining hands with countries like India known for the institutional arrangements for bringing out high quality IT manpower.

Since the present IT production base in the new ASEAN is limited, there is an urgent need to devise appropriate policies that in turn will facilitate the establishment of IT production base in the near future. If India could develop a broad based electronics industry as early as in 1970s, development of IT production base today is well within the limits of new ASEAN. While the IT policy in Vietnam and Myanmar lays emphasis on IT production and could claim some success, there is an urgent need for other countries in the region to build an ICT production base which needs to be incorporated as an integral

part of the IT policy. Here, there is the need for appropriate trade and investment policies and creating a facilitating environment such that the new ASEAN countries appear in the radar screen of "flying gees" and those firms operating in high cost countries planning relocation. Here it may be noted that India, as early as in the 1970s had a much liberal trade and investment policy for the IT sector.

Hence, high entry barriers notwithstanding, there might be real opportunities for the new ASEAN to enter into those areas of ICT goods characterized relatively stable technology and low skill requirements like passive components and the assembly of equipment like radio and TVs, computers etc. In the sphere of ICT services, again there appears to be real opportunities to enter into some of the relatively less skill intensive ICT services like data entry and IT enabled services like, medical transcription, call centers etc wherein the required skilled labor could be developed in the short run and they are ideal for generating large scale employment. But such IT enabled services also call for better communication infrastructure at affordable prices. Hence the present study underscores the need for initiating steps such that the new ASEAN countries find a place in the international production networks of IT in the near future.

In making efforts towards developing an IT production base, it is important to keep in mind the lessons offered by the experience of India. To begin with, the strategy might be to make available a large pool of IT manpower at different levels such that the primary condition for the establishment of IT goods/service production base is satisfied. Here the strategy needs to be one of pooling together the resources of different actors like civil society organizations, private sector etc. Also the strategy should be not one of spreading thinly the resources across the country, instead the investment needs to be undertaken in such a way as to take advantage of the agglomeration economies. This might be possible through the setting up of Technology Parks wherein, built up space, communication infrastructure and others, which are beyond the reach of an individual entrepreneur is provided along with a "single window clearance" system so that the prospective investors need to have only limited interaction with the bureaucracy. Secondly, such technology parks needs to be close to and have constant interaction with the centers of learning such that mutual learning and domestic technological capability is built up in the long run. Thirdly, there is also the need for conscious efforts towards skill empowerment such that the economy does not get locked up in low technology activity and

an upward movement along the skill spectrum is ensured. It needs to be noted that in the investment policy of new ASEAN, given their commitment towards developing an ICT base needs to focus on developing a National System of Innovation, which in turn facilitates the creation and strengthening of the basic pillars of ICT like IT infrastructure, Human capital and IT production base. In this process much could be learned from India.

Endnotes

1 See in this context, the three-part article on Indian IT industry by India's IT Minister Arun Shourie (2004a, 2004b, 2004c).

2 Freeman defines NSI as the network of institutions in the public and private sectors whose interactions initiate, import, modify and diffuse new technologies. Lundvall defines NSI as elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge . . . a national system encompasses elements and relationships located within or rooted inside the borders of the nation state

3 For a more detailed discussion see Kumar (2001a).

4 Mention need to be made of the substantial reduction in the duties and tariffs across the board for components and sub assemblies, zero duty of software import and zero income tax on profits from software exports.

5 A detailed comparative analysis of the policies initiated by different state governments against the backdrop of the national policies would be highly rewarding, but it falls beyond the scope of the present paper and reserved for future work. For the details of policies enacted by different state governments the interested reader may visit the home page www.nasscom. org

6 See India, MIT (2000) and http://www.mit.gov.in for programmes of the Ministry

7 Dataquest, 31 May 2000, 15 June 2000

8 Kumar, 2000, for details.

9 A Software Technology Park (STP) in all respects is similar to a free trade zone exclusively for the software. The specific objectives of the STPs are :

- To establish and manage the infrastructural resources such as data communication facilities, core computer facilities, built up space, common amenities, etc.
- To provide services (import certification, software valuation, project approvals, etc.) to the users who undertake software development for export purposes.
- To promote development and export of software and software services through technology assessments, market analysis, marketing support, etc.
- To train professionals and to encourage design and development in the field of software technology and software engineering (Government of India 1995)

10 In 1991 there was also a policy change as regards the management of the STPs. The earlier autonomous societies for managing each park were dissolved and a new society, called the Software Technology Park of India registered in June 1991, was given the charge of managing all the STPs in the country through individual executive in each of the parks. Under the new scheme the participating companies have the advantage of being fully involved in all decision-making, including fixing of rent, selection of hardware etc. The companies are represented in the executive board which manages the park under the overall supervision of the governing council.

11 "STPI now opens office at Silicon Valley, USA", The Economic Times, New Delhi, Special Supplement on Software Technology Parks of India, June, 11 2000. Also see, Software Exports and Role of Exim Bank, (Mimeo), Exim Bank, Mumbai (undated).

12 Based on discussion with Mr. T.C. Venkat Subramanian, Chairman and Managing Director, Export-Import Bank of India

13 To begin with, there was the Computer Society of India, which is essentially an association of academics and professionals and did not address many of the issues faced by the industry. Hence a new association called Manufacturers Association of Information Technology (MAIT) was formed in 1982. This consisted both the hardware and software firms. Later an association, currently known as Nasscom, was formed to address specific issues being faced by the software and service companies. The Electronics and Software Export Promotion Council, an autonomous body under the MIT, though its various, initiatives also made significant contribution towards India's IT export growth.

14 For a detailed account of the Nasscom activities in promoting IT and role played by late Mr Dewang Metha, see " Power Lobbying", Business India, February 19 to March 4, 2001.

15 This section draws heavily from Joseph (2004).

16 See for details, "Billions of Kyats, millions of Dollars spent in developing ICT infrastructure and facilities" Opening address given by Secretary- I at the Second Annual Myanmar ICT week.

17 Quoted from www.emich.edu/ict_usa/Vietnam.htm

18 For a detailed account of higher education in Lao PDR, see John C Weidman (undated) Reform of Higher education in the Lao People's Democratic Republic, Paper presented at the 1995 Annual Meeting of the Association for the Study of Higher Education, Orlando, Florida, 1 November. Revised version published under the title, "Lao PDR" (Chapter 9), in Gerard A. Postiglione and Grace C.L. Mak (Eds.), Asian Higher Education: An International Handbook and Reference Guide. Westport, CT, USA: Greenwood Press, 1997.

19 For a detailed account of the IT education in Laos, see UNDP (2002).

20 The UNDP study reported that the FEA intends to offer a course on Computer Engineering Program in the near future.

21 Sudhir Kumar, Foreign Presence in the field of IT in Vietnam, Indian Embassy in Vietnam (mimeo), undated.

22 The Melbourne based Royal Melbourne Institute of Technology (RMIT) has announced a US $ 30 million expansion plan. RMIT, which currently has about 700 students at both graduate and post graduate level (in IT and other fields) in its facilities in HCMC and other places has a target to reach 10,000 students at its new educational centre in HCMC.

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