

India's Efforts to Promote Software Development – Lessons to be Learnt

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Abstract

India, a member nation of the economic forum consisting of Brazil, Russia, India, China and South Africa, enjoyed remarkable success as a software developing country. The question it raised was: what aspects played a role in India's achievements to establish its flourishing software industry which resulted in many economic benefits? A content analysis research approach was used to obtain more information on India's software development success. The research approach involved the examination of various text sources about the software industry in India. This research revealed that their approach included a number of specific key initiatives: enabling policies; economic incentives; educational and human resource initiatives; training; the existence of a Ministry of Information Technology; establishing computing infrastructure such as Software Technology Parks; the adoption of the Capability Maturity Model; and, attracting the outsourcing business of other countries. A number of policies were enacted which served to promote and encourage educational developments within the Information Technology sector. A combination of top-down initiatives and bottom-up factors collectively contributed to the development of the software industry in India which in turn promoted software development/engineering. These initiatives resulted in an environment that was conducive to the establishment of a vibrant software industry. The lessons learnt from India's success could be emulated by South Africa and other developing countries in order to cultivate a competitive software industry.

Keywords

software, software development, software engineering, computer science, information technology, policy, education, developing nation.

INTRODUCTION

India, as an emerging/developing member nation of the group of nations consisting of Brazil, Russia, India, China and South Africa (BRICS) (University of Toronto, 2012), has enjoyed remarkable success as a software developing country. This created many development opportunities for India such as: greater employment, development of businesses and economic benefits in terms of import/export transactions. The Indian Information Technology-Business Processing Outsourcing (IT-BPO) expects to exceed an income of \$100 billion by the end of 2012, which will represent 7.5% of India's Gross Domestic Product (GDP) (NASSCOM, Resource - Indian IT-BPO Industry, 2012). India has, over a period of many years, put in place the re-

quired policies, infrastructure and training of human resources to achieve this growth in software development (Heeks, 1998). **Figure 1** depicts the successes India achieved in the outsourcing of Information Technology (IT), before 2003, as compared to several other countries, some of which are well known for their software development successes (BBC News, 2007).

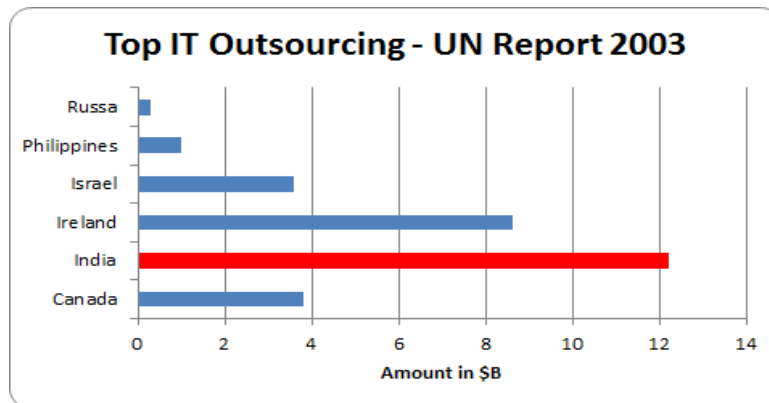


Figure 1: IT Outsourcing (BBC News, 2007)

It is worth considering what factors contributed to this success so that South Africa (and other developing countries) can emulate it by implementing similar initiatives to advance its software industries. India and South Africa share many commonalities which may be to South Africa's advantage: the two countries are linked via BRICS, are co-operating via the India, Brazil and South Africa (IBSA) Information Society Annual Programme (IBSA, 2012), use English in business and share a historical British influence. Business process outsourcing (BPO) in South Africa does not form as significant a part of South Africa's GDP when compared to India (ZDNet, 2012). The software industry initiatives in South Africa is compared to that of India in this article, but the lessons to be learnt from India's success, has implications for other developing countries as well.

This research is directed at answering the following questions: How should South African educational institutions and its Information Technology (IT) industry be transformed or assisted to achieve a similar success in terms of software development as India? What key initiatives did India undertake to transform its software industry into a world-class competitive industry?

Currently the Indian software industry is only 2nd to the United States of America (USA) (Rai, 2002) (Palmer, 2012), a major achievement for a developing country (within the BRICS family of nations). How India's initiatives achieved this success could provide information on how to develop South Africa's software industry, especially with regard to its human resources development.

A content analysis approach was used to gather data. General academic publications about India's software industry, historical documents (e.g. Indian government and embassy web sites), National Association of Software and Services Companies (NASSCOM) of India web site and newspaper reports were examined and themes were identified.

The key elements (themes), which emerged from this analysis, are that India undertook a number of specific initiatives w.r.t software development/engineering which resulted in a maturing software industry. These key elements are policies and economic incentives, educational and human resource initiatives, a Ministry of Information Technology, establishment of Software Technology Parks, adoption of the Capability Maturity Model and attracting outsourcing business.

METHODOLOGY

The approach involved the examination of various text sources about the software industry in India. Text sources included journal articles, as well as web sites

containing information on India's software industry. Amongst the trusted web sites are those hosted by NASSCOM (NASSCOM, 2012) and the official site of the Indian government (Government of India, Communication and IT, 2012). Concept analysis (Colorado State University, 1993) was implemented by initially searching for the existence of phrases such as the software industry in India and software development or engineering mentioned within the context of the Indian software industry. Writings containing these phrases were considered in the light of the research question to determine what measures or initiatives were promoted to establish a strong software development/engineering culture, which in turn enhanced the software industry in India.

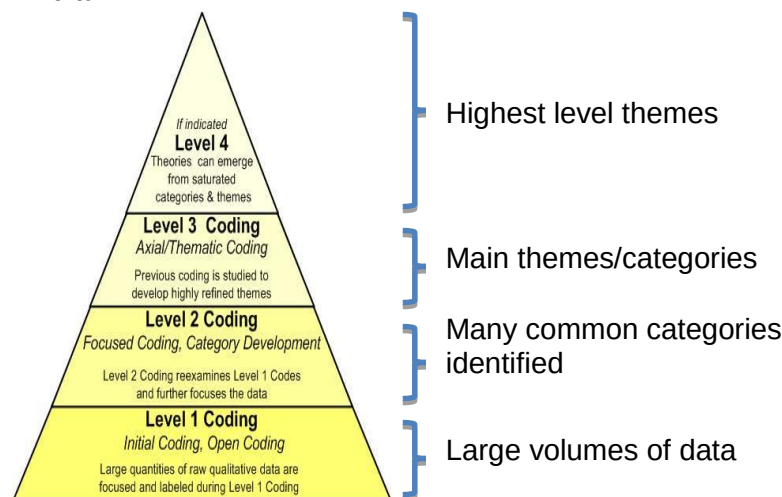


Figure 2: Grounded Theory Model by Hahn (Hahn, 2012)

The Grounded Theory Process model proposed by Hahn (Hahn, 2012) (see Figure 2) guided this pilot study and a diverse set of writings about the software industry in India was considered. A number of themes emerged from this process which, when analyzed, could identify and define the initiatives India took to establish its software industry and what steps in particular it encouraged to develop software development/engineering education and skills. These themes and categories are discussed in the section below.

RESULTS

The main themes that emanated from the Grounded Theory process and the many sources consulted using the level 1 initial coding (see Figure 2) were: implementation policies to encourage software development, educational and government initiatives, human resources development, the development of software technology parks, the adoption of the capability maturity model and the acceptance of the outsourced software development of other countries.

Policies

The Indian government implemented a number of policies which resulted in the promotion of the IT industry and in particular the software industry. One such major step taken in 1998 was the establishment of the National Task Force on Information Technology and Software Development (Chakraborty & Dutta, 2002). It's significant to note that the term Software Development appears in the name of the task team, which signalled the importance of software development together with the IT industry. Three reports emerged during 1998/9 from this task team with a number of recommendations to boost the IT industry, e.g. no customs and excise duty on software, all universities and research institutions to be networked, no license fees for first five years for Internet Service Providers (ISPs), and monopolies on international gateways removed (India News, 1998).

Specific policies were implemented to encourage software development, these included (IT Task Force, 2000): delivery of educational content through various computer mandated networks; special financial help to assist training and education; special venture capital provided for IT education facilities; universities and colleges allowed to establish IT education and training companies with the private sector; companies encouraged to set aside 6% of revenue to support the Human Resource Development (HRD) sector with IT education and training. Thus a multi-pronged intervention, affecting nearly all economic activity, was approved in order to propel IT education and training and the software industry in general.

Educational Initiatives

A number of policies were enacted which served to promote and encourage educational developments within the IT sector. In the Long Term National IT Policy of India, the following initiatives were mentioned which specifically impacted positively on IT and Computer Science education (IT Task Force, 2000):

- All training and education related to IT at all levels will be treated as a Service Industry.
- Special financial instruments will be established to provide capital for investment in IT education. Special lower interest rates were applicable to IT HRD companies and institutions for these special financial arrangements.
- Special financial packages were made available to start IT HRD educational facilities. These were also applicable for non-resident Indians (NRI's).
- Research was encouraged to ensure the IT goals were achieved.
- Promoting IT training and education collaboration between public funded institutions (e.g. universities) and industry and allowing the establishment of education and training companies in this context.
- Public funded IT institutions were allowed to attract community funding to assist in upgrading these institutions.
- All companies were encouraged to set aside 6% of revenue for investment in IT training and education and could allocate such funds to an institution of their choosing.
- Government and IT HRD companies would strive for 100% IT literacy within 5 years at senior secondary schools and within 10 years at secondary schools.
- All engineering institutes were mandated to ensure that graduates were able to not only work in the IT sector, but also in the IT enabled services sector.
- Specific academic policies to advance IT training and education were implemented (see **Table 1**).
- National infrastructures in support of IT HRD were developed, e.g. government and industry would build a high speed national network backbone.
- Various financial schemes were developed to allow more money be made available for IT training, education and research, e.g. IT investments by IT HRD companies would be deductible.

Table 1: Academic policies to advance IT training

Special encouragement for emphasis on the advanced IT education and specialized areas.
IT HRD companies were allowed to be linked to universities (local and abroad) giving them the ability to award degrees.
Indian Institutes of Technology (IIT's) and Indian Institutes of Information Technology (IIIT's) were allowed to establish Virtual Institutes to promote advanced post graduate studies and continuing education in IT.

Education in Computer Science was encouraged alongside the basic IT skills and education.
Upgrading the remuneration of IT teachers/lecturers and IT professionals (in general) to retain these people within India.
Student performance and their placement in industry to be publicized by institutions. A credit rating system for IT HRD institutes was envisaged.
The uses of IT within education delivery from all levels were encouraged.
Aptitude tests were developed to determine which students (e.g. using a ranking system) will be well suited for studies in IT.
A system of continuous assessments (rather than terminal examinations) were used to assess the various knowledge levels needed by IT professionals.
National IT competency examinations were undertaken.
Institutions allowed (via autonomy) to design own IT courses and modify these as often as needed.
Students can complete IT courses at different institutions and then sit for completing IT examinations.
Respected international Computing organizations such as the Association for Computing Machinery (ACM) (ACM, 2012) and the Institute of Electronic and Electrical Engineers (IEEE) (IEEE, 2012) were invited to participate in development of ethics and standards in IT courses. Employer organizations (e.g. NASSCOM) would similarly be involved.

MINISTRY OF INFORMATION TECHNOLOGY (MIT) – A GOVERNMENT INITIATIVE

The Ministry of Information Technology (MIT) (Government of India, Department of Electronics and Information Technology, 2012) was established in 2000 to create a co-ordinated department within government for national IT policy development and implementation (Drozdowski, Huynh, Lininger, Peng, & Sakulyong, 2007). Prior to this formation, a number of different bodies within the government were promoting IT, but this new ministry would serve to integrate and co-ordinate these initiatives to be more effective. The establishment of this ministry shows the commitment and seriousness with which the Indian government viewed the development of the IT industry as part of developing its economy.

Three areas in particular were identified as the core initiatives undertaken by MIT to promote the IT industry (Nagala, 2005): co-ordination of government's initiatives (e.g. policy) within IT advancement; the establishments of Software Technology Parks (STP's); and the harnessing of the skills and influence of Indians who had left India to pursue jobs and businesses in other countries such as the USA.

Human Resource Development

The establishment of various Institutes of Information Technology at the higher education (i.e. university) level by the Ministry of Human Resource Development sought to increase the human resource development in IT. An example of such an institute is the International Institute of Information Technology (IIIT) at Hyderabad (IIIT-H) which was established in 1998 (International Institute of Information Technology, 2012) with a focus on Computer Science, Electronics and Communications. It is an autonomous university built on a public private partnership and was the first one using this model. There are a number of similar International Institutes (Wikipedia, 2012).

The Indian Institute of Information Technology, Allahabad (IIIT-A) was established in 1999 by the Indian Government to further advance education and training in IT and related areas (Indian Institute of Information Technology, 2012). The IIIT-A obtained university status in 2000. There are also a number of Indian Institutes of Technology (Indian Institute of Information Technology, 2012) such as the Indian Institute of Technology, Mandi (IIT Mandi) (Indian Institute of Technology Mandi, 2012) which offers courses in Computer Science via its School of Computing and Electrical Engineering. IIT Mandi is one of sixteen similar Institutes established by the Institutes of Technology Act of 1961 and the Institutes of Technology (Amendment) Act of 2012 (The Gazette of India, 2012).

Software Technology Parks

The establishment of Software Technology Parks (STPs) was a key vehicle in promoting the interaction or collaboration between government, private business, academia and foreign organizations in order to further advance the software/IT industry in India and in particular the export capabilities (Nagala, 2005) (Vaidyanathan, 2008). These STPs were an initiative of the Ministry of Information Technology and allowed various economic incentives to attract investment (e.g. 100% tax rebate for export profits) (Vaidyanathan, 2008). The interaction of the various role players at the STPs allowed research, development and innovation to take place and offered an environment where incubation was encouraged. The first STPs were established in 1991 at Bangalore, Pune and Bhunaneswar (Drozdowski, Huynh, Lininger, Peng, & Sakulyong, 2007) with high speed Internet connectivity plus the necessary IT infrastructure and other facilities (e.g. telephone, back-up, etc.) needed (Vaidyanathan, 2008).

Amongst the key objectives of the STPs was training and human capital development (Drozdowski, Huynh, Lininger, Peng, & Sakulyong, 2007). Thus STPs were places where software development and software engineering was strengthened within India.

Adoption of the Capability Maturity Model

The Software Engineering Institute (SEI) established at the Carnegie Mellon University in 1984 (Software Engineering Institute, 2012) has developed the Capability Maturity Model (CMM) and CMMI (CMM Integration) to measure the maturity of software engineering processes and to improve processes to ensure quality software production (i.e. software which is reliable, efficient, on time, within budget). There are a number of maturity levels starting at 1 (Initial), 2 (Repeatable), 3 (Defined), 4 (Managed) and 5 (Optimizing) (Herbsleb, Zubrow, Goldenson, Hayes, & Paulk, 1997) with level 5 being the most respected. India encouraged the adoption of the CMM to attract foreign companies to outsource programming and software engineering to Indian based companies (Drozdowski, Huynh, Lininger, Peng, & Sakulyong, 2007). In fact in 1999, the Indian company Wipro was the first level 5 company in the world (Lahagu, Capps, Lingareddy, Mundanda, & Sumitsawan, 2001) and this was evidence of India's seriousness in improving its software production processes in support of its software industry. This attracted outsourcing to Wipro and subsequently many more India software companies achieved various levels on the CMM rating scale (Drozdowski, Huynh, Lininger, Peng, & Sakulyong, 2007) attracting even more outsourcing.

Outsourcing software Engineering to India

Outsourcing or Business Process Outsourcing (BPO) is a business model or strategy whereby a company in one country (e.g. USA) outsources some business process or activity (e.g. software engineering) to another country (e.g. India) (Mehta, Armenakis, Mehta, & Irani, 2006). This model was preferred by many USA based software companies because of the cost reduction (e.g. lower labour costs) in India

together with a well-educated English speaking engineering graduates who had been trained in Computer Science and Software Engineering (Lahagu, Capps, Lingareddy, Mundanda, & Sumitsawan, 2001). These factors, as well as the initiatives outlined in the earlier sections (e.g. legislation which opened the economy to attract foreign investment), all played a role in attracting software development projects to India.

DISCUSSION

A combination of top-down initiatives and bottom-up factors collectively contributed to the development of the software industry in India which in turn promoted software development/engineering.

The top-down initiatives are those policies, which were devised and implemented by the Indian government, which resulted in a friendly environment that was conducive to the establishment of the Software Industry. Amongst the key strategies were the founding of the Ministry of IT, the opening up of the economy to attract foreign investment, the provision of Internet access, the development of software parks, promoting Computer Science and IT education, training through various vehicles and the acceptance of the CMM as a way to instil confidence in the software development/engineering process through improved quality.

The bottom-up factors are those factors which supported the top-down initiatives due to earlier efforts to improve education. One key factor was a large English speaking work force educated in Engineering via the IIT's and later the IIIT's that were available for incorporation within the software industry. The cost of this software engineering labour was relatively inexpensive compared to employing an American software engineer. It was furthermore important that the software work products produced by these engineers were of the highest quality. This required a quality framework such as the CMM or some other form of certification which ensured a process which leads to quality software.

The general lesson for developing countries is that, in the first instance, the overall economic policies and the resulting investment environment, in its broadest scope, must be such that companies from other developed countries would want to outsource software development/engineering to the developing country. Along with these economic incentives, sufficiently educated people in Software Engineering, IT and Engineering, with English fluency needs to be in place as well adequate provisioning of high speed connectivity and Internet facilities.

In South Africa, the government IT initiatives (at national level) are spearheaded under the more broader Information and Communications Technology (ICT) plan of the Department of Communications (DoC) (Department of Communications, 2012). The DoC also oversees a number of portfolio organizations such as the South African Broadcasting Corporation (SABC), the South African Post Office (SAPO) and the Independent Communications Authority of South Africa (ICASA) amongst others. The DoC has set itself the goal of using ICT's to improve the quality of people's lives through socio-economic development. In the DoC's Strategic Plan 2011-2014 (South African Government Information, 2011) mention is made of the following initiatives and plans within ICT relevant to this discussion: ICT policy and legislation; incentives to develop ICT's and attracting BPO; an Integrated National Broadband Plan and ICT infrastructure; e-skills Institute and increased ICT skills; and establishing an International Advisory Panel consisting of specialists to advise on ICT matters.

South Africa's National Research and Development Strategy (SA Government, 2002) also recognizes the important role of ICT and sets itself the goals of building strong research and development in ICT. A number of matters related to ICT development will be given attention to promote ICT, e.g. equipment, skills, and innovation.

South Africa supports a National System of Innovation (NSI) which was recently reviewed (Department of Science and Technology, 2012). This report contains many

references to ICTs and the importance of the knowledge based economy. The report acknowledges that past efforts within the NSI has not achieved the desired affect and makes a number of recommendations to improve the NSI which no doubt will result in an improved ICT infrastructure and human resources which will advance innovation within the ICT sector. Specific mention is made of adequate broadband provision for participators in the innovation system as well as the importance of software development. The importance of SANReN (South African National Research Network) within the innovation system for a knowledge based economy is emphasized.

South Africa's (SA) Department of Trade and Industry (DTI) has recently announced improved incentives to attract BPO. The new scheme makes it 20% cheaper to establish BPO operations in SA (IT News Africa, 2011).

At the provincial government (regional) level, the Gauteng Provincial Government (GPG) has presented an ICT development strategy which, amongst its objectives, lists the following: public-private collaboration; innovations; broadband and network infrastructure; ICT skills and building a software industry (Gauteng Provincial Government, 2012). This strategy mentions that all the basic building blocks (e.g. largest concentration of ICT companies, economic capital, universities, etc) already exist but needs co-ordination to establish an ICT innovation hub. The CPG has also recently launched the Gauteng Growth and Development Agency (Gauteng Growth and Development Agency, 2012) which incorporated the earlier Blue IQ initiative with one of the objectives being the promotion of The Innovation Hub (a Science Park). This hub has a focus in IT/ICT research and innovation in particular.

South Africa has five Science/Technology Parks listed by the United Nations Educational, Scientific and Cultural Organization (UNESCO) (UNESCO, 2012). These parks are not specific to any particular type of industry or business but are of a general nature accommodating different types of enterprises. The technology park close to the town of Stellenbosch (near Cape Town) called Technopark (Technopark, 2012) has a concentration of 23 companies listed under its software category and is in close proximity with four universities for collaborative ventures.

Another local-based initiative to promote ICT is the Cape Information Technology Initiative (CITI) (Cape Information Technology Initiative, 2012) which is a collaborative effort by the city, provincial authorities, universities and business to promote the technology sector which includes IT and software development.

The Joburg Centre for Software Engineering (JCSE, 2012) is a collaborative effort between industry, government and academia with the aim of promoting software development, software engineering and the ICT industry in SA. This centre is also encouraging the use of the CMM to strengthen software processes.

CONCLUSION

A multi-pronged strategy or approach could lead to the successful establishment of a competitive and viable software industry. To achieve this, a number of basic building blocks need to be in place IT friendly economic policies; Internet and IT infrastructure; innovation and collaboration between universities/research bodies and industry; process management; and Computer Science and Engineering education.

This study of the software industry in India shows that it is possible for a developing country to establish a competitive software industry, which can attract foreign investment, create jobs and contribute to the overall economic improvement. Lessons learnt on how India made this possible would be worth noting for South Africa if it wishes to establish a competitive software industry. South Africa's Research and Development Strategy and its innovation efforts does create a broad environment in which ICT in general is recognized as important and in need of promotion for the knowledge economy. South Africa's current framework for the promotion of its software industry would need to be more focused (e.g. the establishment of an IT minis-

try) with emphasis on IT and software promotion, if it were to emulate the software successes of India. Furthermore, South Africa would need to strengthen its Computer Science education (for example through higher funding levels) and encourage more software institutes modelled in a similar way as the Joburg Centre for Software Engineering.

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