INNOVATIONS IN AN EMERGING SOFTWARE CLUSTER

Arun M
Society for Promotion of Alternative Computing and Employment,
C11, Elenkom Gardens, Vellayambalam, Trivandrum,
Kerala, INDIA 695010
Email: arun@space-kerala.org

ABSTRACT

Low wage rate in India, rather than technological innovation, is widely believed to have caused the phenonmenal growth of the Indian software industry. Low total software exports from India is taken as an indication of lack of innovation in the industry. This paper argues, based on the case study of the software firms in Trivandrum, that the software industry in India is innovative and that the nature of innovation depends on the characteristics of its knowledge base.

INTRODUCTION

India is home to a thriving software industry with an estimated total production of Rs 3012 billion (2009-10). The industry, with its strong export orientation, has done wonders for India's foreign exchange, earning a gross export revenue of 50.1 billion USD. It has put India in the fifth place among countries that export Information and Communication Technology(ICT) services and in the first place among non-OCED countries(UNCTAD, 2009). India is also the most dynamic country in terms of software services export, going by the data on export growth between 2000 and 2007 (UNCTAD, 2009).

These impressive figures notwithstanding, the Indian software industry has also come in for some criticism for not being innovative and offering only low value services (D'Costa, 2002; Joseph and Harilal, 2001; Heeks, 1996). Researchers attribute the industry's growth to India's low wage rates, an advantage which India could soon lose in the face of stiff competition from other Asian and East European countries. Most authors, therefore, believe that for the industry to sustain its growth, it should move up the value chain with an increase in wage rate or grow quantitatively with increased labour supply which could, on the other hand, lower wages. Anything short of these strategies is expected to stunt the growth of the Indian software industry.

India's low share of software products[1] in total software and related services exports(Heeks, 1996; Joseph and Harilal, 2001) has been oft-cited as a sign of lack of innovation in the industry. The export orientation of the industry and the lack of a domestic market for software are held responsible for this turnaround(D'Costa, 2002; Heeks, 1996). However, there are others who argue that the Indian software industry is moving up the value chain(Arora *et al.*, 2001; Balakrishnan, 2006). Their argument is based on anecdotal evidence

1Software products are those piece of software which provide generic functionality so that it can be useful to more than one user. Software products are made once and sold many times.

of software products coming up in India and the enhanced capability of Indian software industry in the form of adoption of new technology and upgradation of software development processes. The emergence of embedded software development is also considered as an indication of Indian firms delivering higher value services.

Innovation in software sector need not be only in the form of new technology or products. Recently new business models have become an important source of innovation. From software as a value add to hardware, software production has evolved into an independent specialised activity. With the evolution of technology, the business model has continued to change. This interaction between business model and technology has been a continuous source of innovation in software sector. Recently, with the emergence of free and open source software(FOSS), a range of new business strategies and licensing software has come up(Lippoldt and Stryszowski, 2009), fueling more innovation in the sector.

This paper is structured into five sections. Section 2 summarises the research question and methodology. In Section 3, I briefly discuss the analytical framework used for this study and clarify some of the concepts used. Section 4 provides a background picture of the software industry in Trivandrum and an analysis of the case studies. In the concluding section, I reflect on the findings of case study and their implication for the Indian software industry.

RESEARCH QUESTION AND METHODOLOGY

Existing literature throws little light on innovation in the Indian software industry. Developing a micro level picture can help comprehend innovation as it manifests itself in whole of Indian software industry. Hence I raise the following questions in the context of the emerging software cluster in Trivandrum:

- Are the software firms in the cluster innovative ?
- If yes, how do they innovate ?

To answer the research questions, I adopted multiple case study method(Yin, 2009) covering six firms from Trivandrum cluster. While Trivandrum has only a small share in India's over all software production, it is one of the oldest and fast growing clusters. It is a microcosm of the Indian software industry in that both are dominated by software service firms with a few large firms and several small firms. But there is a limit to this comparability. This study does not capture innovation in large firms which contribute to a bulk of India's software production. The study also leaves out multinational firms in India.

The most important challenge was in accessing information. Firms, in general, are not open about their internal operations. This study required someone at the senior management level to provide necessary information.

ANALYTICAL FRAMEWORK

The word innovation comes from the Latin word, 'innovatus', which means 'to renew or change'. According to Joseph Schumpeter, innovation is what drives economy through a qualitative change at a historical time(Fagerberg, 2005). Change brings the newness that is often associated with innovation. Schumpeter identifies five different types of innovation — (1) introduction of new products (2) new methods of production (3) identification of new sources of supply (4) exploitation of new market (5) new ways to organize business. Despite the recognition of five types of innovation, in economics literature there is an overemphasis on the first two. For example, in OECD's Oslo Manual(OECD, 2005), innovation refers to "implemented technologically-new products and processes and significant technological improvements in products and processes". A broad perspective of innovation as outlined by Schumpeter has been adopted for this study. The study looks at whether firms are able to bring in change within themselves and in the world around.

Innovation is nowadays considered a complex interactive process involving several actors. These actors include firms like suppliers and organisations like governments, academic institutions, users, etc. They influence and are influenced by each other. The system of innovation approach helps to understand innovation in its complexity. It is considered as a holistic and multidisciplinary approach to innovation(Edquist, 2005). Lundvall who made pioneering contributions to the development of the system of innovation approach argues that, even if the approach is not sufficiently 'theoretical', it does offer itself as an analytical tool to build general and valid knowledge of causality relating to innovation(Lundvall, 2010). He refers to the system of innovation as an analytical framework (See Lundvall (2007) for general process inovlved using this analytical framework). Along with this broad framework, I also use ideas developed in the sectoral system of innovation.

The idea of sectoral system of innovation comes out of the question, why different sectors of industry like chemical, software, machine tools, etc., differ in terms of innovation. Apart from the difference in terms of actors, institutions and interconnections, Malerba, the pioneer of this approach, brings in characteristics of knowledge and technological domain as the key differentiator for innovation in different industrial sectors(Malerba, 2002). The boundary of sectoral system is determined by knowledge and technological domain, which can have national, regional and global dimensions.

Learning

Learning is the most important process in innovation. Two different modes of learning are discussed in the context of innovation – STI and DUI mode of learning(Lundvall, 2010). STI learning is the learning associated with scientific and technological knowledge creation. R&D and other activities that relate to utilisation and access to knowledge are emphasised here. It is associated with exchange of explicit codified knowledge. DUI learning on the other hand, is about learning by doing, using and interacting. It involves organisational learning, employee participation and competency building, participation in industrial networks, etc(Jensen *et al.*, 2007). I try to look at the role of these different learning modes in software firms in Trivandrum.

SOFTWARE CLUSTER IN TRIVANDRUM

The growth of software industry was closely tied up with the growth of electronics industry in Kerala in the 1970s. Trivandrum, the capital city of Kerala, was one of the nine locations selected by the Government of India to setup software technology parks. Until 2004-05, the software industry of Kerala was almost exclusively based in Trivandrum. Although new locations like Kochi have emerged, Trivandrum continues to be the most important hub for software industry in Kerala.

Most software firms in Trivandrum are situated in Technopark, a technology park under the government, As of November 2010, it is host to 164 fully operational firms, which account for nearly 30,000 employees. Out of these firms, 110 are software firms and 52 are ITeS firms (2 are unknown). Two software firms, UST Global and IBS Software Services, together account for nearly 40 percent of the total employment (6000 numbers each). Both firms were started by entrepreneurs from Kerala who were working abroad.

In terms of size, the industry is positively skewed. 26 percent of software firms and 31 percent of ITeS firms are in the incubation stage with 10 or less number of employees. Four firms in software sector and two firms in ITeS sector have more than 500 employees .

More than 60 per cent of firms were started and are owned by Indian entrepreneurs. Except for the two Indian IT majors, Infosys and Tata Elexi, all other firms were started in Technopark by entrepreneurs from Kerala. 31 percent of the firms have foreign equity. There are no important multinational firms in Kerala. `

CASE STUDY ANALYSIS

Table 1: Summary of firms selected for case study

Firm	No of Employees	Year of Establishment	Type of firm
NeST	1000	1991	Embedded Systems
SunTec	400	1990	Software Product
QBurst	300	2004	Software Service
PIT Solutions	128	2000	Software Service
InApp	100	1996	Software Service
Ospyn	25	2008	Software Service

Source: Technopark

Nature of Innovation

Table 2 summerises the case studies. Adoption of new processes and aquiring new technological capabilities are two important forms of innovation in the cluster. Nature of innovation is also found to be linked with the challenges the firms face. Lack of skilled human resouce and need for addressing attrition have forced firms to come up with innovative organisational strategies.

Economic recession has been another challege, which forced firms to look at new

markets like Japan and India itself. Some firms try to turn recession into an opportunity for itself. They recognise that by providing FOSS based solutions over proprietary solutions, they can create new business opportunities during recession.

Table 2: Innovation in firms under study

Firm	Firm Type	Type of Innovation	Source of Innovation opportunity	Knowledge Source	Significance of NDA	Learning Mode	Presence of formal R&D
NeST	Embedded	New technology development; HR process	Development in hardware technology	Hardware manufacturers (client), FOSS community, Research organisations	Strong	STI Mode	Yes
SunTec	Software Product	New features in product, HR process	New Platform Software technology; New business requirement	Suppliers of Platform Software; User community	Nil	Combination of STI and DUI	Yes
InApp	Software Services	New market, New technological capabilities, New quality practices	Learning new software technology	Suppliers of Platform Software, FOSS Community	Moderate	DUI Mode	No
PIT Solutions	Software Services	New technological capabilities, New quality practices;	Learning new software technology	Suppliers of Platform Software, FOSS Community	NA	DUI Mode	No
QBurst	Software Services	New technological capabilities, New organisational practice	Learning new software technology	Suppliers of Platform Software, FOSS Community	Nil	DUI Mode	No
Ospyn	Software Services	New technological capabilities	Learning new software technology	FOSS Community	Nil	DUI Mode	No

Source: Own compilation

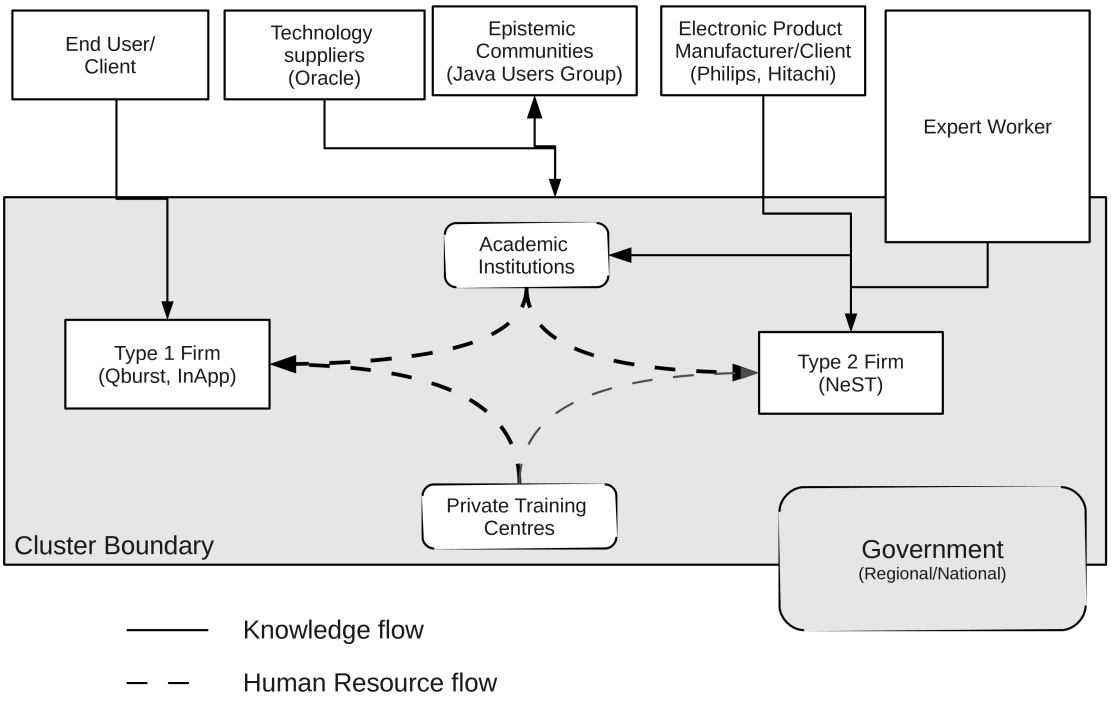
Systemic View of Innovation

Firms are at the core of any innovation. Figure 2 illustrates how firms linkup with other actors to create system of innovation. Based on the linkages, firms can be classified into two types. This classification interstingly correlates with the nature of work done and learning mode.

General software service companies, which represent a majority of firms, come under the first group (Type 1 firm). They concentrate on DUI mode of learning and innovation. Firms like NeST, on the other hand, focus on development of new technologies either based on client needs or based on anticipated user needs (Type 2 firm).

This classification also matches with the nature of knowledge these firms use. The first group deals with knowledge of business. It combines business knowledge with software technology to create software that addresses some business needs. The other group deals with scientific and technological knowledge, where it produces new scientific and technological knowledge in the form of software .

Figure 2: Innovation system in Trivandrum Software cluster



Important Actors

For all the firms, the user or the client is the most important source of innovation. Linkage with the lead user is identified to be particularly useful (Hippel, 1986). Product firms like SunTec have created user communities on the Internet which help them identify new requirements and faults in existing software. The client has been the source of technological and process related knowledge, particularly when the client is an intermediate user with technological capabilities of its own.

Academic institutions enter innovation process in two ways. They build human resource through educational activities and develop knowledge through research activities. For all the firms in the cluster, academic institutions like universities are a source of skilled human resource. This has been identified as the most important role of academic institutions in the innovation system.

Type 2 firms use academic institutions as sources of knowledge. Firms specialising in Embedded Systems like NeST have linkages with institutions like Sree Chitra Thirunal Institute for Medical Sciences & Technology (SCTIMST), College of Engineering, Trivandrum and Centre for Development in Advanced Computing for research. They build technological and scientific knowledge collaboratively (STI learning).

Demand for human resource has spawned a large number of private training institutions. They focus on training people in specific technological skills that firms need. They fill the gap between a university level education and the industry's needs.

Expert professionals are the next set of actors who contribute independently to the innovation process of a firm. While there is a lot of discussion around reverse migration and knowledge coming back, none of the firms studied here were able to give an example of an expert coming back to the cluster with new knowledge and enhancing the innovation potential of the firm. However, many of the entrepreneurs are expert professionals who have worked outside the cluster. Interpersonal relation is another channel through which an expert professional contributes to innovation process. This has been exploited in the case of Type 2 firms, where knowledge access is restricted.

Epistemic communities form a very important source of knowledge for firms in a cluster. Virtual communities in the form of mailing lists act as an important knowledge base for firms. There are communities centred around various technologies and products. Some of them are supported by supplier firms like a community of developers using a microprocessor or they are independent like free software users group. Unlike codified and explicated knowledge that is available through knowledge bases like scientific articles, books or patents, these communities are source of what is usually considered as tacit, contextual knowledge. The firms find it easier and efficient to use these community forums to raise questions about technical challenges they face. According to a manager of a research division, these community forums are a more efficient source of knowledge than even a known peer in the cluster, as chances of getting contextually relevant knowledge is higher in forums in which professionals from different parts of the world participate. Often, they receive a response from someone who has experienced a similar challenge. In the process, a lot of contextual knowledge which is tacit, gets explicated.

Open Technology and Innovation

Open Technologies like web related technologies, and free and open source software have contributed significantly to innovations by firms. Open nature of knowledge and fewer cost barriers such as licensing, give firms easier access to knowledge. All the firms reported to be heavy users of free software. More than 50 percent of NeST's projects now depend on GNU/Linux Operating System, the most popular free software operating system. Firms

become part of an epistemic community built around these technologies and access knowledge from it.

There is a significant concentration of firms working on web technologies in the cluster. All the generic software solution providers in the cluster work with web technologies. Most of them claim expertise in free software tools for web development. These tools vary from a simple tool to publish content on the web to software development framework to develop complex software for business needs. Availability of free software for all these needs helps firms to provide various solutions, from websites to high-value e-commerce and social networking solutions, easily and quickly. Free availability of tools helps firms to move up the value ladder. It is observed that firms start off as a simple website design company. Then they make use of tools like Content Management System to provide more complex websites and slowly move to higher value solutions such as cloud based software. From supply side, heavy concentration of firms in web technologies has to be understood from the point of view of low entry barrier with very low skill requirement, low cost of access to knowledge (open, non proprietary knowledge base) and advanced development tools (free software) and high level of scalability from simple website to complex software (innovation potential). On the demand side, the industry has been moving more towards web based solutions for custom software needs. Demand for services also vary considerably in its quality, from a simple web site to complex software. Web has turned out to be the most important platform for software innovation in the last several years.

Learning and Related Institutions

Accessing and accumulating knowledge is one of the most important processes that go on in firms. Two important institutions that have come up in this context are Non Disclosure Agreements (NDAs) and FOSS license. NDAs play a significant role in knowledge access for all firms. While the objective of NDA is to limit a firm's ability to exploit knowledge transferred to it, the case studies show that it does not achieve its objective.

Similarly, the FOSS model of open and collaborative development provides access to a wealth of knowledge which firms leverage on. Stock of knowledge openly available for appropriation enables new firms to leapfrog older firms which have accumulated knowledge.

As a source of knowledge, virtual epistemic communities have a prominent role. A lot of contextual and tacit knowledge flows through these communities. Considering the importance of tacit knowledge in production, it is important that the working of these communities is investigated more. SunTec has been able to create a community around its software, which provides inputs for innovation. It is an innovative approach to ensure continued flow of knowledge relevant for innovation from users to firms.

Global Linkages over Local

One interesting aspect that comes out in the case study is that important knowledge related linkages of innovation are global. These include the linkage between firms and the user/market, between firms and suppliers of technology. Only a few firms have connections with other agents regionally or nationally. Hence, clusters like Technopark appear as nodes in

a global system of innovation. Their linkage with national or regional actors is primarily for skilled human resource.

CONCLUSION

Innovation

The growth record of Indian software industry has proved all pessimistic observers wrong. The study of software firms in Trivandrum suggest that the industry is indeed innovative. The industry has been improving its capabilities through improvement in process, absorption of new technological capabilities and entry into new markets.

Discussions on the innovativeness of Indian software industry are often based on the assumption that creation of software products and new technological knowledge signal superior innovation. Such an assumption comes out of a narrow perspective of innovation which emphasises on technological knowledge and STI mode of learning. The micro level investigation shows that software service firms are also quite innovative and dynamic.

Literature on the Indian software industry so far has not looked into the characteristics of the knowledge base that the firms in the industry deal with. This paper argues that there are atleast two sub sectoral systems of innovation that depend on two different knowledge base-business knowledge and technological knowledge. These sub sectoral systems emphasise on different modes of learning and adopt different models. Further research in this direction will help to better explain the service orientation of the Indian software industry and its evolution.

Changing Pattern of Innovation

The innovation strategy of software firms has been predominantly based on learning the latest technologies, combining them with business knowledge and building solutions for specific needs of customers. It follows Schumpeter Mark II model characterized by 'creative accumulation'. The industry is dominated by a stable core of large firms which present a significant barrier for new firms from entering. This configuration is changing with the availability of technological knowledge through FOSS and spillovers. The industry may move to Schumpeter Mark I model characterized by 'creative destruction'(See Malerba, 2002 for discussion on this). Rather than follow technologies developed outside, the industry may build new technologies at home. The industry may come up with new products and services that address as well as create new demand. The current stable organisation of industry could be replaced by a more turbulent one, with new firms emerging with new technologies or addressing new demands.

Bibliography

Arora, A., Arunachalam, V. S., Asundi, J. and Fernandes, R. (2001) The indian software services industry, *Research Policy*, **30**, 1267–1287.

Balakrishnan, P. (2006) Benign neglect or strategic intent? : Contested lineage of indian

software industry, *Economic and Political Weekly*.

D'Costa, A. P. (2002) Export growth and path dependence: The locking-in of innovations in the software industry, *Science Technology & Society*, **7**, 51.

Edquist, C. (2005) *Systems of innovation–Perspectives and challenges' in Fagerberg J, Mowery DC and Nelson RR*, The Oxford Handbook of Innovation. Oxford: Oxford University Press.

Fagerberg, J. (2005) Innovation: a guide to the literature, *The Oxford Handbook of Innovation. Oxford University Press, New York, S*, p. 1–26.

Hippel, E. V. (1986) Lead users: a source of novel product concepts, *Management science*, **32**, 791–805.

Joseph, K. J. and Harilal, K. N. (2001) Structure and growth of india's IT exports: Implications of an Export-Oriented growth strategy, *Economic and Political Weekly*, p. 3263–3270.

Lippoldt, D. and Stryszowski, P. (2009) *Innovation in the Software Sector*, OECD Publishing.

Lundvall, B. (2007) National innovation systems-analytical concept and development tool, *Industry and innovation*, **14**, 95.

Lundvall, B. (2010) *National Systems of Innovation: Toward a Theory of Innovation and Interactive Learning*, Anthem Press.

Malerba, F. (2002) Sectoral systems of innovation and production* 1, *Research policy*, **31**, 247–264.

OECD (2005) *Oslo Manual: Proposed Guidelines for Collecting and Interpreting Technological Innovation Data*, OECD.

UNCTAD (2009) Information economy report 2009: Trends and outlook in turbulent times, Tech. rep., United Nations.

Yin, R. K. (2009) *Case study research: Design and methods*, Sage Publications, Inc.