Proceedings of Informing Science & IT Education Conference (InSITE) 2012

Open Innovation in Entrepreneurships: Agents of Transformation towards the Knowledge-Based Economy

Hakikur Rahman and Isabel Ramos
University of Minho, Guimaraes, Braga, Portugal

hakik@dsi.uminho.pt iramos@dsi.uminho.pt

Abstract

Innovation and globalization are the two essential components of economic achievement. The Internet is the catalyst and its emerging forms are assisting in this aspect. But, due to the global economic crisis, nations and enterprises are facing challenges. Those challenges include social, cultural, economical and political contexts. To overcome, all entities jointly and, or individually are trying through various policies, strategies and activities. Furthermore, the transformation of technologies has also transformed those strategies and approaches through the years. The main focus of this paper emphasizes on agents of transformation in OECD region to find open innovation in entrepreneurships leading to establishment of a knowledge based economy. This paper has found a few of the strategies that are acting as the agents of these transformations deducting from several exhaustive reports made by the OECD Secretariat. The paper has also reviewed extant literatures, including classical and relevant contributions supporting the hypothesis. The research observes that during this period (1999-2011) open innovation strategies have been transformed towards the knowledge based economy. In this aspect, the paper has synthesized a few key elements of the transformation ranging from human resources to venture capital to patenting. Before concluding on the research findings, the paper has tried to develop a research framework in relation to the agents of transformation.

Keywords: innovation, open innovation, globalization, knowledge economy, entrepreneurships, SMEs.

Introduction

Nowadays, innovation and globalization are the two major sources of economic accomplishment. They directly affect productivity, job creation and citizens' welfare, and help make it possible to address global challenges like education, health and the environment. As their role has taken on a greater extent, their characteristics are evolving and to overcome the situations, nations are taking adaptive policies and measures (OECD, 2007). In terms of sustained economic achievement of a country, successful entrepreneurship development is essential. And, therefore, countries are making efforts through various measures to challenge the effects of globalization through utilizing innovative strategies and policies.

Countries are building technological capabilities in new areas and expertise with the emergence of the Internet technologies. Revealed technology advantage indexes show that during the past decade China went from having no area of specialization to one of the top 3 countries specialized in innovation through information and communication technologies (ICTs). In Europe, Denmark, Belgium and Spain are among the top specialized countries in biotechnology; the Czech Republic, Ireland and the Netherlands are relatively specialized in nanotechnologies and Finland in ICT innovation. Furthermore, Europe is targeting and leading in clean energy technologies, Germany being the forerunner. The EU27 (The 27 member countries of the European Union) represented 37% of all patent cooperation treaty (PCT) filings in this field in the late 2000s, followed by the United States and Japan. China's share in such patents now ranks eighth worldwide. This has been observed that, the United States maintains the lead in health-related technologies, while Japan leads innovative efforts in environmental technologies including innovation for climate change mitigation (OECD, 2011:5).

In terms of entrepreneurship development, there have been several elements that may be referred as agents of transformation in this age of innovation. As observed by this study, a few of the transformation paths are listed below:

- transformation from the very basic research to bio-technology or nanotechnology R&D;
- transformation from the investment for human resources in science and technology to upholding value added occupations in science and technology;
- transformation of investing in venture capital to establishing university and innovation hotspots;
- transformation of enhancing cross-border ownership of inventions to technology-science linkages and collaborations in business value chains;
- transformation of promoting international cooperation in science and technology to international collaboration on innovation;
- transforming innovation in ICT to innovation in entrepreneurship; and
- leading patenting to trademarks, access to capital, public support to R&D, and tax incentives to R&D.

These elements of transformation could be treated as the rigorous processes of innovation forwarding from benchmarking the knowledge-based economy (initiated in 1999 by the OECD Secretariat with the theme, *Benchmarking Knowledge-based Economies*) to facing challenges of the innovation and growth in the knowledge economy (modified theme of 2011 OECD, *Innovation and Growth in Knowledge Economies*).

Argument of selecting OECD reports is that due to the prevailing economic crisis, especially in European region, reports dating back since 1999 are giving exact reflection of the initiation of the benchmarking for the establishment of knowledge based economy and furthermore, findings of this research have been supported by contemporary literatures. In this aspect, this paper has made a review of extant literatures (for clarification of this research method, see Hsu and Tsong-Ming, 2006; Weerakkody, Dwivedi and Irani, 2009) for entrepreneurship development in various business and industry sectors. However, in a few places certain emphasis has been given to the specialized business sector that are lagging the most in the innovation and collaboration competition, popularly known as small and medium enterprises (SMEs). The paper looks into the detail of OECD (Organisation for Economic Co-operation and Development) Science and Technology Scoreboards since 1999, incepted as the *Benchmarking Knowledge-based Economies*. Till date OECD has published 7 elaborated reports based on a large number of statistical databases and indicators, aiming to provide the most recent information on trends and competitive challenges in science, technology and industry in the OECD countries, namely *OECD Science, Technology and Industry Scoreboard* (OECD, 1999).

The paper has synthesized a few focus areas that are pertinent to act as agent of transformation towards knowledge-based economy, especially targeted to accelerate open innovation in entrepreneurships. The paper hereafter, has been segmented into three parts- after detailing concisely about various definitions in the background and keeping them as concise as possible, especially for the new readers; the second one put forwards the agents of transformation towards the knowledge-based economy, and the third one talks about possibility of applying these transformation agents for the innovation in SMEs. As extended methodology, this research has considered historical approach, which in turn tends towards developmental (Ellis and Levy, 2009). The paper has synthesized all the published reports of OECD S&T Scoreboard since 1999 and cross referenced through extant literatures, including a few classical researches to find out the most relevant focus areas pertaining to empowerment of entrepreneurships in the paradigm of open innovation that is gaining momentum in the knowledge-based economy.

Background

In recent years open innovation paradigms are becoming an integral part of the innovation strategies and business models of entrepreneurships. Innovation is increasingly based on knowledge assets beyond the boundaries of the company and cooperation is becoming an essential way of tapping into knowledge resources outside in order to generate new ideas and bringing them rapidly to the market (popularly known as, the “outside-in” approach). Simultaneously companies are spinning out technologies and intellectual property that they have developed internally but that are outside their core business and thus to be better developed and commercialized by others (popularly known as, the “inside-out” approach). Nowadays, open innovation is more about increasing research and development (R&D) options than about replacing existing ones. The external technological collaboration can be complementary to internal R&D investments. An OECD study of 59 companies in a dozen countries found that over 80% of them devoted the bulk of their R&D budget to in-house R&D activities. At the same time most companies are actively involved in open innovation practices, such as more than 50% of the companies allocate up to 5% of their R&D budgets to research in other companies. However, the term “open innovation” does not refer to free knowledge or technology. While “open source” refers to royalty free technologies, “open innovation” refers to the collaborative methods that are being applied in value addition (OECD, 2008:2).

This paper mainly selected all the reports of the OECD on science, technology and industry scoreboard with the observation on their benchmarking measures, methodical approaches, weightage, comparison with other economies, and most of all defined statistical procedures. However, where possible other research papers were being included as supporting ones to validate the hypotheses. A brief about the OECD is given next.

Pursuant to Article 1 of the Convention signed in Paris on 14th December 1960 that came into effect on 30th September 1961, the Organisation for Economic Co-operation and Development (OECD) is promoting policies to achieve the highest sustainable economic growth and employment by rising standard of living in Member countries, while maintaining financial stability, and contributing to the development of the world economy. The original Member countries of the OECD are Austria, Belgium, Canada, Denmark, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The following countries became Members subsequently through accession: Japan, Finland, Australia, New Zealand, Mexico, the Czech Republic, Hungary, Poland and Korea. The Commission of the European Communities takes part in the work of the OECD (Article 13 of the OECD Convention) (OECD, 1999:4). Hence, these reports provide a global view of science, technology and industry outlook covering Asia-Pacific, Europe and America. However, as mentioned earlier, due to the researchers´ research base and particularly due to the research theme, emphasize has been given predominantly to European (and OECD) region. Hence this study should not be taken as a generalized study of the world at large. With demand and scope, efforts will be given in near future to extend the research in other parts of the world.

The *OECD STI Scoreboard* reports are prepared under the guidance of the Industry Committee and the Committee for Scientific and Technological Policy, aiming to provide the most recent information on trends and competitive challenges in science, technology and industry in the OECD countries. It draws on a large number of statistical databases and indicators, most of which are developed in the OECD Directorate for Science, Technology and Industry (DSTI). These reports are alternating with the more policy-oriented *OECD Science, Technology and Industry Outlook.* As economies are becoming increasingly knowledge-based and globalized, scientific and technological efforts are becoming essential determinants of industrial performance and international competitiveness. Furthermore, for policy design and evaluation purposes, governments need to be able to monitor as accurately as possible the recent trends and structural transformations of innovation strategies pertaining to industry and technology, not only in their own countries, but also in comparison to others (OECD, 1999). In this aspect, this paper yields a comprehensive illustration on the utilization and transformation of open innovation strategies for the entrepreneurship development.

Contemporary studies provide clear indications that engaging in open innovation strategies has important advantages in terms of stimulating innovation performance (Poot, Faems and Vanhaverbeke, 2009). As mentioned above, open innovation strategies like outside-in open innovation processes (for example, acquiring knowledge from outside partners); inside-out open innovation processes (for example, selling knowledge to outside partners); or, reliance on external information sources (Laursen and Salter, 2006); collaboration with external partners like universities and/or research institutes (Belderbos, Carree and Lokshin, 2004; Faems, Van Looy and Debackere, 2005); sourcing external innovation, shared innovation, licensing internal innovation, hybrid of vertical innovation and licensing (West, 2006); and others are positively influencing radical innovation performance in companies. Furthermore, a crucial portion of the open innovation strategies of technology component suppliers is proactively developing ecosystems to attract systems integrators and complementors (West, 2006). But, in the context of critical economic crisis facing global competition, dynamically adjusted open innovation strategies should be linked with the knowledge content among them and turned towards developing ecosystems for attracting knowledge builders in a sustained way. In this aspect, the paper now is looking towards the transformation paths accepting a few agents of transformation and thereafter a framework of transformation is being deducted.

Transformation towards the Knowledge-Based Economy

As economies are becoming increasingly knowledge based and globalized, OECD (1999) reports that scientific and technological efforts are becoming essential determinants of industrial performance and international competitiveness. Supporting the argument, this paper has put forward the most relevant factors that are responsible for the transformation towards a knowledge based society (termed as Knowledge-Based Economy). Since 1999, OECD has published various reports under the OECD S&T Scoreboard. Despite being third in the series, the OECD (1999, with theme- *Benchmarking Knowledge-based Economies*) presented selected indicators for knowledge based economies and focused on the globalization challenges by examining selected indicators of economic performance.

In 2001, OECD adopted the theme, *Towards a Knowledge-based Economy* and did not change the theme for 2002, 2003 and 2005. However, these four reports have covered and focused on the growth in the knowledge base by creating and diffusing knowledge; the rising importance of information economy; the increasing international integration of economic activities; the economic growth and performance by observing economic structure and productivity; the R&D and innovation; the human resources in science and technology (S&T); enacting ICT as an enabler of the knowledge society; patents by protecting and commercializing knowledge; and observing the impact of knowledge on productive activities.

The 2007 issue has a theme, *Innovation and Performance in the Global Economy* that reflects the global trend of researches and activities in the area of innovation, which was being coined by Chesbrough (2003a; 2003b) and later supported by many researchers, academics and practitioners (Goldman and Gabriel, 2005; Surowiecki, 2005; Von Hippel, 2006; Chesbrough, Vanhaverbeke and West, 2006; Sawyer, 2007; Nambisan and Sawhney, 2007; Motzek, 2007). The 2009 issue does not have any changed theme, however, both these issues have emphasized on strategies of innovation, rather open innovation following the global trend of innovation and collaboration. These volumes include patenting by universities and governments, collaboration with public research organization by innovating firms, off-shoring of intermediaries, international cooperation in research, international collaboration on innovation, international research cooperation among regions and science linkages in technology as main focus areas. Furthermore, they include entrepreneurship as another area of research focusing knowledge-based economy. In addition to these, due to the prevailing economic crisis in the European region, both these volumes emphasizes on tackling this crisis by upholding issues like, R&D in the economic crisis and venture capital in the economic crisis.

Introducing a new theme, *Innovation and Growth in Knowledge Economies*, the 2011 edition of this series of reports has incorporated potentially new areas of research, such as industrial specialization, university and innovation hotspots, technology-science links and collaboration, and sectoral and technology specialization. Furthermore, focusing the knowledge-based economy, this volume emphasizes on e-commerce, collaboration in business value chain and scientific collaboration, while issues like, patenting, venture capital investment, and trademarks remain as transformation agents in the area of open innovation.

Table-1 illustrates the synthesized version of the main focus areas that this research likes to put forward as agents of transformation in the globalized knowledge economy. The focus areas also include the context of open innovation strategies pertaining to SMEs growth and development. A Among them the mostly emphasized and transformed areas are; Basic research, Human resources, Venture capital, Cross-border ownership of inventions, International cooperation in S&T, Innovation in ICT, and Patents. The table also shows the trend of transformation, which are being discussed next.

Table-1: Synthesized focus areas emphasizing strategies of open innovation towards the knowledge-based economy

Year	1999	2001	2003	2005	2007	2009	2011
Themes	Benchmarking KBE	Towards a KBE			Innovation & Performance in GE		Innovation & Growth in Knowledge Economies
Focus Areas	Basic research	Basic research	Basic research	R&D linkages	R&D in selected ICT industries	R&D in economic crisis	Biotechnology R&D
			Biotechnology R&D			Biosciences	
			Nanotechnology			Nanosciences	Environmental technologies
						Environmental sciences	Health innovation
	Human resources	Human resources in S&T	Human resources in S&T	Human resources in S&T	Human resources in S&T	Human resources in S&T	Human resources in S&T
			Researchers	Researchers	Researchers	Employment of tertiary-level graduates	New university graduates and doctorates
							Researchers
				International mobility of the highly skilled	International mobility of the highly skilled	Employment of doctoral holders	Employment of graduates and doctorate holders
					S&E doctorates and post doctorates	Earnings by educational attainment	Science and technology occupations
	Venture capital	Venture capital	Venture capital	Venture capital	Venture capital	Venture capital in economic crisis	Venture capital investment
				Innovation in SMEs	Innovation within companies	Innovation within companies	University and innovation hotspots
	Cross-border ownership of inventions	Cross-border mergers, acquisitions and alliances	Cross-border mergers, acquisitions and alliances	Foreign ownership of domestic inventions	Foreign ownership of domestic inventions	International research cooperation among regions	Technology-science linkages
		Cross-border ownership	Cross-border ownership	Domestic ownership of foreign inventions	Domestic ownership of foreign inventions	Cross-border inventions	Collaboration in business value chains
	International cooperation in S&T	International cooperation in S&T	International cooperation in S&T	International cooperation in patenting activity	International cooperation in research	International cooperation in science & research	Technology-science links and collaboration
							International collaboration on innovation
	Innovation in ICT	Investment in ICT	Investment in ICT	Investment in ICT	Investment in ICT	Entrepreneurship	Investment in ICT
							Entrepreneurship
			Internet and e-commerce	Internet and e-commerce	Internet and e-commerce	Internet and e-commerce	Internet and e-commerce
	Patents	Patenting	Patenting	Triadic patent	Triadic patent	Patents in environment related technologies	Patenting
				ICT related patent	ICT related patent		
					Regional patenting		Trademarks
				Biotechnology patent	Patenting by universities & governments		Access to capital
							Public support to R&D
					Biotechnology patents	Biotechnology patents	Tax incentives for R&D
					Nanotechnology patents	Nanotechnology patents	

Basic Research

According to OECD (1999:33), countries in this region devote between 12% and more than 30% of their R&D expenditure to basic researches, or between close to 0.1 and more than 0.7% of their gross domestic product (GDP). The major share of basic research is performed in the higher education sector and/or in government research laboratories. There is evidence that innovation efforts draw increasingly on basic research (Godin, 2005; Gulbrandsen, 2008), owing to greater possibilities of commercialization of its results. For example, basic researches in biotechnology and nanotechnology are leading to direct applications (OECD, 2001; 2009; 2011).

However, in difficult economic periods spending on "long-term" research may seem a luxury, not only because the effort will not pay off for a long time, but also due to the fact that the results are usually disseminated widely and it is usually difficult to establish a direct link between the resources invested and the result obtained. Nevertheless, most countries spent a higher share of their GDP on basic research in 1996-99 than in the early 1980s. Since 1995, the ratio of expenditure on basic research to GDP has been flat in the United States, but it has grown in Japan, France and Italy. Relative to GDP, Switzerland allocates close to 0.8% of GDP to basic research, almost twice as much as the United States or Japan. In Korea, Japan and Ireland over 30% of basic research is performed by the business sector (OECD, 2001:10).

In this aspect, public and business researches act as complementary inputs for innovation. Public researches mainly comprised of funding from public sector and conducted in public research institutions and universities, while business researches may be funded by above entities and conducted in specialized entities or public research institutions. However, research in the business sector is closely linked to the creation of new products and production techniques, and public research is important for funding and performing basic research though it does not lead immediately to commercial returns. Yet, often public research supports business sector research via knowledge spillovers (Irish Council, 1999; OECD, 2009).

The trend in basic research expenditure during the 1990s has been somewhat more favorable in other countries, but has been leveling off or diminishing slightly when compared with GDP in several countries since 1994 or 1995, such as Australia, France, Hungary, Italy, Japan, Norway, Poland, Portugal, Spain (OECD, 1999). In countries with high R&D intensity (except Switzerland), basic research usually accounts for one-fifth or less of total R&D. Although the proportion of GDP allocated to basic research in Hungary, Mexico, Poland and Portugal is low compared with other OECD countries, their basic research expenditure relative to total R&D expenditure is among the highest of all OECD countries. This is due to the relatively low share of the business sector and the high share of the government and higher education sectors, where the bulk of basic research is performed. In Hungary, Italy, Mexico, and Poland more than 90% of basic research is conducted in the higher education or government sectors. In Austria, Norway and Portugal the higher education sector has taken the largest shares of basic research (more than 70%), while it is the smallest in the Czech Republic and the Slovak Republic (less than 30%). Relative to other OECD countries, basic research is carried out more frequently in the business sector in Korea, the Czech Republic, Japan and the United States, where this sector performs more than one-third of basic research (OECD, 2001:40; 2003:37).

However, to cope up with the economic crisis, countries have adopted *R&D linkages*, where an increasing share of government-financed R&D is performed in the business enterprise sector. Lately in many countries, an increasing share of government-financed R&D is performed in the business enterprise sector. Likewise, business funds a growing share of the R&D performed in the higher education and government sectors, averaging 4.9% in 2002 in the OECD area (and 6.3% in the EU25). In spite of increases in many countries, these flows still represent less than 7% in most large OECD economies (OECD, 2005). Furthermore, the highly innovative ICT sector invests heavily in R&D. In 2004, ICT manufacturing industries accounted for more than 25% of total manufacturing business R&D expenditure in most OECD countries (OECD, 2007). *This indicates the transformation of basic research into R&D linkages towards the direct value addition processes using the ICTs.*

Human Resources

As the knowledge-based economy requires new skills and competencies, the quality of human resources is the major factor behind the invention and dissemination of technologies. Despite their imperfections, measures of educational attainment are the most commonly used proxies for human capital, though they may not cover quality of schooling and formal or on-the-job training (OECD, 1999).

Human resources in science and technology (HRST) are covered by a new set of indicators that build on methodological work by the OECD and Eurostat (the "Canberra Manual", 1995). HRST are major actors in innovation (Holbrook, Hughes and Finch, 1999; Collins and Smith, 2006). They seek to address important policy issues, such as the mobility of science and technology resources across industries and borders (OECD, 2001). Workers in professional and technical occupations are actively involved in the creation and diffusion of knowledge and technological innovation (OECD, 2005).

A look at the industry structure of employment shows that HRST employees are more concentrated in services than in manufacturing. In 2007, the share of professionals and technicians in services varied between 19.6% (in Japan) and 44.1% (in Luxembourg), whereas in manufacturing they were about 18% on average in OECD countries for which data were available (OECD, 2009:137). In 2008, the share of professionals and technicians in services varied between 19.3% (in Japan) and 46.9% (in Luxembourg) and it is mostly concentrated in community, social and personal services, as well as business services; in manufacturing it was around 20% on average in OECD countries. Over 1998-2008, HRST occupations increased more rapidly than total employment in most OECD countries. In services, their average annual growth rate has always been positive, ranging from 1.2% (in Japan) to 6.3% (in Iceland). However, in manufacturing, the share of professionals and technicians decreased by an average annual rate of more than 1% in Luxembourg (-2.3%) and Japan (-1.3%) (OECD, 2011). *This shows the trend of transformation of HRST from manufacturing sector to service sector.*

International Cooperation in S&T

Cross-border co-authorship of scientific articles and co-invention of patents provide an indication of the level of internationalization of scientific and technological activities (OECD, 1999). The production of scientific research and technological know-how increasingly depends on research conducted in other countries. Indicators of cross-border co-authorship of scientific articles and co-invention of patents are intended to shed light on this trend (OECD, 2001; 2003). International collaboration by researchers can take place either within a multinational corporation (research facilities in several countries) or through a research joint venture among several entities (from several countries). In 1999-2001, 6.7% of all patents filed at the European Patent Office (EPO) were the result of international collaborative research (OECD, 2005:84).

In the mid-1990s, 27% of scientific publications in the OECD area were the work of multinational teams and 7% of patents were the result of international co-operative research. However, there are significant differences exist across the OECD countries. Several factors may affect the degree of a country’s internationalization in science and technology, such as size, technological endowment, geographical proximity to regions with high research activity, language, culture, industrial specialization, existence of foreign affiliates, etc. Internationalization tends to be higher in smaller European countries, where the domestic pool of researchers is limited. Among the leaders, over 40% of scientific publications are published with a foreign co-author in Belgium, Denmark and Austria. Likewise, 35% of patents have foreign co-inventors in Luxembourg and 15% in Iceland and Belgium. International co-operation in science and technology is also relatively high in Hungary, Poland and the Czech Republic (OECD, 2005:114).

International cooperation in research allows firms to stay abreast of developments and tap into a large pool of ideas and technologies. The innovation capability of a country depends to a significant extent on the degree of cooperation between its firms and their foreign partners. International cooperation has increased in recent times. The average share of patent applications filed under the Patent Cooperation Treaty (PCT) that involved international co-invention increased from 6.6% in 1996-98 to 7.3% in 2004-06. However, the degree of international cooperation differs significantly between small and large countries. On average, small and less developed economies engage more actively in international collaboration. This reflects their need to go beyond their small internal markets and/or have access to better research infrastructure (OECD, 2009:25).

Furthermore, collaboration with foreign partners can play an important role in the innovation process by allowing firms to gain access to a broader pool of resources and knowledge at lower cost and to share or minimize the risks. It can take a variety of forms and levels of interaction ranging from simple one-way information flows to highly interactive and formal arrangements. Collaboration rates vary widely across countries. In some countries, collaboration mainly involves national partners (for example Korea, China, Australia, Chile), but in most countries there is a greater balance between national and foreign partners. In some countries firms are strongly oriented towards international collaboration (like, Luxembourg, the Slovak Republic, Finland and Switzerland) (OECD, 2011).

However, size has been found as a strong determinant of foreign collaboration. Large firms have a much higher propensity to collaborate internationally than SMEs (usually twice to three times as much), though in Australia, the United Kingdom and Israel the gap is narrower. In Korea, Brazil, China and Spain, which have relatively low international collaboration rates, there is almost no participation by the SMEs. Among European firms, intra-European collaboration remains the predominant form of cross-country cooperation on innovation. In terms of collaboration outside Europe, European firms tend to partner mainly with US firms, although collaboration with firms in China and India is significant in Sweden, Finland and Belgium (OECD, 2011). In addition to firm size, patterns of collaboration differ in terms of types of partners. Among large firms, suppliers usually play a main role, but in the United Kingdom, Korea, Luxembourg, Australia and Germany, collaboration with clients is equally or even more important. This may reflect increasing integration along value chains as well as the growing importance of user-driven innovation. *Hence, international cooperation in S&T is dominated by integrated-valued-added collaborative research, despite size, nature or geographical diversities.*

Cross-border Ownership of Inventions

R&D activities have become more international in recent years. Transformations in the global value chain, in the cost of R&D, in flexibility in handling cross-border R&D projects (especially, ICT technologies), and major policy changes (for example, strengthening of intellectual property rights) have all favored this trend (OECD, 2007). Cross-border ownership of patents reflects the inventive activity of foreign affiliates of multinational firms (OECD, 1999). Cross-border ownership is mainly the result of activities of multinationals; the applicant is a multinational company and the inventors are employees of a foreign subsidiary. Patent data thus make it possible to trace the international circulation of knowledge from “inventor” countries to “applicant” countries (OECD, 2005). As firms progressively relocate their production and research facilities abroad as part of their internationalization strategies, an increasing share of technology is owned by firms of a country that is not the inventor’s country of residence (OECD, 2003).

Furthermore, in the search for new technological competences, better adaptation to local markets, and lower research and development costs, companies are moving research activities abroad. This internationalization of research activities is an important driver of innovative firms and country competitiveness (OECD, 2003). Although R&D activities are less internationalized than trade and production, they have become increasingly so over the past decade. Firms are progressively relocating production and research facilities abroad as part of their business strategy, and an increasing share of technology is owned by firms of a country that is not the inventor’s country of residence. In 1999-2001, on average 15.4% of all inventions filed at the European Patent Office (EPO) were owned or co-owned by a foreign resident (OECD, 2005:80).

Since the early 1990s cross-border ownership of inventions among total patented inventions has expanded from 11 to 16%. Similarly, world-wide cross-border cooperation on inventions (share of patents with co-inventors located in two or more countries) nearly doubled as a share of total inventions (from less than 4% to more than 7% between 1991-93 and 2001-03). Foreign ownership of domestic inventions (patents) has increased by 50% between the early 1990s and the early 2000s. *It reflects the importance of multinationals' R&D labs located in a country different from that of their headquarters.* It has been observed that the EU countries interact most often with each other and are less globalized than the United States, while Japan and Korea are less internationalized (OECD, 2007:168).

Furthermore, the breakdown of collaboration by main partner country reveals patterns similar to those reported for cross-border ownership. It has been found that the EU countries mainly collaborate with other EU countries, whereas Canada, Mexico, India, China, Israel, Korea and Japan collaborate most frequently with the United States. For instance, more than 20% of inventions made in India, Canada and Mexico are collaborations with a US inventor. On the other hand, Brazil and South Africa collaborate more with EU inventors (OECD, 2007:168) *showing varied degree and direction of collaborations among innovative entities*.

During 2006-08, in the great majority of countries, large firms were significantly more likely to collaborate on innovation than SMEs. Among SMEs, the rate of collaboration is between 25% and 40% of innovative firms in half of the countries surveyed by the OECD, but it varies widely for large firms. More than 70% of large innovative firms collaborated on innovation in Denmark, Slovenia, Finland, Belgium, the United Kingdom and Austria, while less than one-third did so in Brazil, China and Mexico (OECD, 2009). *This shows that SMEs are lagging in adopting collaboration as an innovative approach.*

Innovation in ICT

Innovation is particularly important for ICT (OECD, 1999). Investment in physical capital is a way to expand and renew the capital stock and enable new technologies to enter into the production process and is therefore, important for growth. Furthermore, with the rise of the Internet, ICT has been the most dynamic component of investment in recent years (OECD, 2005) and ICT investment accounts for a considerable share of total fixed non-residential investment. In 2007-09, it represented over 30% in the United States, about 25% in Sweden and Denmark, and over 20% in the United Kingdom and New Zealand (OECD, 2011).

Over 2000-09, ICT investments provided a significant contribution to labor productivity growth in a number of OECD countries. They accounted for 66% of labor productivity growth in Denmark, over 50% in Switzerland, Belgium and Canada, and no less than 40% in the Australia, Netherlands and New Zealand. However, the higher growth rates in labor productivity in Korea, Ireland, the United Kingdom, the United States and Japan are mainly due to the rise in multifactor productivity (OECD, 2011).

Moreover, with the prevailing growth of the Internet, a number of countries have started to measure the value of the Internet and electronic sales. Electronic sales that are sales over any kind of computer-mediated network, reach 10% or more of sales in Austria, Finland, Ireland and Sweden. In the US retail sector alone, the share of electronic sales in terms of total sales grew by 70% between the fourth quarter of 2000 and the fourth quarter of 2002 (OECD, 2003:13). In OECD countries, in 2004, on an average, about 25% of all businesses (with 10 or more employees) used the Internet for purchasing, and about 12% for selling goods or services (OECD, 2005).

The Internet is a tool that enables businesses to reach large numbers of new customers every day. SMEs can now advertise and reach customers on a scale that just a few years ago was possible for only a handful of companies. Business use of the Internet has become fairly standard practice in most of the OECD countries. Increasingly, businesses use broadband platforms to connect to the Internet. The share of businesses that use broadband in all businesses with ten or more employees ranges from 46% in Mexico to 99% in Iceland. In Iceland, Korea, Canada, France, Spain, Finland, Belgium and New Zealand, over 90% of businesses have a broadband connection, whereas the OECD average is 83% (OECD, 2009:105).

Another component of business innovation is the use of the website. In most of the OECD countries, over half of businesses have their own website. The share of businesses with their own website in all businesses with ten or more employees ranges from 46% in Portugal to 89% in Japan (OECD average is 69%). Denmark, Japan, Sweden and the Netherlands have the highest proportion of businesses with their own website (over 85%). However, official data on access to and use of ICTs by businesses are relatively scarce outside the OECD area, as the surveys to collect these data are expensive to undertake and this is not being treated as a priority in most of the developing countries (OECD, 2009:105).

Observing this thread of discussion, it has been found that, to cope up with the knowledge dynamics focusing innovation, countries have transformed their strategies of innovation in ICT towards development of entrepreneurship. Entrepreneurship is increasingly recognized as an important driver of economic growth, productivity, innovation and employment. As firms enter and exit the market, theory suggests that the new arrivals will be more efficient than those they displace. In this context, existing firms that are not driven out are forced to innovate and become more productive in order to compete and survive. This is the reason why policy makers give importance to the number of high-growth firms and the number of young, high growth firms (popularly known as, gazelles) (OECD, 2009). Furthermore, entrepreneurship empowers people to take their future into their own hands, whether through self-employment or by creating a firm that employs other individuals. Following this emerging trend, a country's entrepreneurial activity may range from self-employment to the creation of high-growth firms (OECD, 2011). *Thus innovation in ICTs has been transformed into innovation in entrepreneurship using ICTs.*

Venture Capital

Venture capital refers to equity investment in new firms. It is expanding rapidly in most countries, mainly due to the creation of new financial markets that facilitate the floatation of new companies. It has been found that the United States' venture capital market is by far the largest, followed by the United Kingdom and Canada. Even expressed in terms of percentage of GDP, investment in venture capital in these three countries is at the highest among all OECD countries. It is also high in the Netherlands, Finland and Belgium, but still rare in Japan (Baygan and Freudenberg, 2000; OECD, 1999:55; 2009).

Although contemporary venture capital investment is quite small relative to GDP, but it is a major source of funding for new technology-based entrepreneurships and plays a crucial role in promoting the radical innovations (OECD, 2001). Almost half of venture capital in North America finances firms in their early stages, whereas in Europe it mostly finances the expansion of firms that are already present in the market. To be specific, in 1997, ICT and health/biotechnology account for more than 75% of venture capital in the United States. The corresponding figures are only about 20% for Europe, and 10% for Japan (OECD, 1999:55).

Over 1998-2001, the United States and Iceland had the largest venture capital investment as a share of GDP. Other OECD countries had substantially less. It is a usual trend is that, about 33% of venture capital goes to firms in their early stages and 75% in their expansion stage. In Finland, Ireland and Switzerland, almost 50% is attributed to firms in early stages (OECD, 2003:47).

Over 2000-03, venture capital investment was highest in Iceland followed by the United States, Canada and Korea (OECD, 2005:44).

> Interestingly, over 2003-05, venture capital investment rose significantly in the three countries with the highest level of venture capital investment as a percentage of GDP. Those countries are, Denmark, with an annual growth rate of 95%, Sweden (45%) and United Kingdom (35%). However, during this period it declined in Finland, Spain and Italy (OECD, 2007:40).
>
> In 2008, the United States alone accounted for 49% of total venture capital investments in OECD countries. The United Kingdom was the only other country where this share was greater than 10% of the OECD total. Denmark and Luxembourg have the highest intensity of venture capital investment, while the intensity is also high in Finland and the United Kingdom (OECD, 2009:23). *This shows the incremental trend of venture capital investment in various countries.*

However, venture capital differs significantly among countries and observed as very sensitive to market cycles in terms both of amounts invested and stages of investment (OECD, 2011). Furthermore, in recent years *venture capital investment has transformed into more focused outcome* due to the prevailing economic crisis.

Patents

Patent-based statistics are being treated as the most widely used indicators of the output of inventive activity and offer a uniquely detailed source of information on the inventive activity of countries (OECD, 1999; 2001; 2004; 2009; Khan and Dernis, 2005). Patents provide two complementary indicators of the internationalization of research. Firstly, it is the share of patents filed by one country for an invention made in another country (ownership of inventions made abroad, i.e., domestic ownership of foreign inventions), and secondly, it is the share of inventions made in one country and patented by a foreign country (foreign ownership of domestic inventions) (OECD, 2003).

Historically, R&D expenditures and patent filings have moved in parallel with GDP in a country and slowed drastically during the economic downturns. Furthermore, patenting is more rapidly affected by the economic situation than R&D expenditures funded by the business sector. Provisional data for 2008 show a considerable slowdown of patenting activity in most countries. The United States, Japan and Germany are the three most inventive countries, followed by Korea and France. From 2000, a significant upsurge occurred in Asia, with average growth of 33% in China and 20% in India and Korea. It has observed that the more a country spends on R&D, the higher the propensity to patenting goes. The Netherlands has the strongest patent intensity of all OECD countries, followed by Switzerland, Japan and Germany. Emerging economies such as Brazil and China have a small number of patents relative to R&D (OECD, 2009:37) and patenting has been transformed into much more focused based. This emerging trend has been discussed next. As one of the most important and delicate element of open innovation strategy, exhaustive discussion is given about the transformation trend.

- *ICT-related patents* have risen much more rapidly than overall patent applications at the European Patent Office (EPO). Between 1991 and 2001, they augmented by 8.3% a year, while total EPO patent applications grew by 6.0%. To measure a country's level of specialization in ICT-related patents, country shares can be expressed in terms of a specialization index, like the state of telecommunication, e-commerce, computer hardware and software, etc. By this measure, Japan and the United States have been found to be specialized, while the European Union has been found to be lagging. However, among OECD countries, Finland, Korea and the Netherlands are the most specialized in ICT-related patents (these countries also show high ICT-related R&D expenditures) (OECD, 2005:76).

- As value added outcomes *biotechnology patents* have grown faster than overall EPO patent applications. During the 1990s, their growth rate was 3.1 percentage points above that of total EPO patents. The latest available data show that in 2001 around 5.4% of all EPO patent applications are in biotechnology. Furthermore, since 1997, the European Union's and Japan's shares of biotechnology patents have increased, while that of the United States has decreased. However, Germany, the United Kingdom and France have a high share of biotechnology patents (OECD, 2005).

- *Regional patenting* is another way of assessing the concentration of innovative activities within countries. Particularly, the number of Patent Co-operation Treaty (PCT) applications by region indicates innovative regions that act as important sources of world knowledge. Inventive activities are likely to be intense in a small number of regions, but need to be explored (OECD, 2005).

- The *share of public institutions* (government laboratories and universities) in the ownership of patents shows both the strength of their technological research and the legal framework. In Sweden, Germany and Japan, university professors have been entitled to own patents resulting from their research. The patents are thus registered as belonging to individuals or businesses rather than to public institutions (OECD, 2005). This may encourage individual researchers to intensify their researches under these forms of institutions. It has been observed that high-income countries are responsible for most of the university and PRO filings under the PCT. However, such filings have also increased rapidly in certain middle-income countries. In terms of university applications, China is taking the lead, followed by Brazil, India and South Africa (WIPO, 2011).

- As another element of patenting, since the end of the 1990s, inventive activities in nanotechnology have been gathering momentum. International applications for *nanotechnology patents*, filed under the PCT, increased steadily from the mid-1980s to the mid-1990s and have risen strongly over the past decade. In 2004, the United States had the highest share of nanotechnology patents filed under the PCT, followed by the EU25, Japan and Germany (OECD, 2005). Most countries report a significant increase in their shares of nanotechnology in total national patenting, although activity remains relatively limited. With respect to relative patenting activity, Singapore has been found to be most specialized in nanotechnology. Singapore´s proportion of nanotechnology patents is nearly three times than the average share of nanotechnology patents in all patents over the period of 2004-06 (OECD, 2009).

- Due to the climate change around the world, investment in *"clean" technologies* is assisting countries achieve a wide range of environmental objectives, from mitigating climate change in controlling air and water pollution and enhancing resource efficiency. In this aspect, patents in renewable energy technologies or in techniques for controlling pollution and waste, especially contribute to the development of clean technologies. It has been observed that the renewable energy and air pollution control are the most dynamic groups of environmental technologies among patent applications filed under the PCT. Also, it has been observed that in between 1996 and 2006, the number of patented inventions in renewable energy and air pollution control have increased more rapidly than total patents. Furthermore, in the mid-2000s, for all environment-related technologies, the largest number of patents resulted from European research and among European countries, Denmark has been found to be highly specialized in the development of wind energy technologies. Among others, the BRIICS (Brazil, Russian Federation, India, Indonesia, China, South Africa) countries also substantially involved in waste management, water pollution control and renewable energy (OECD, 2009).

- *Matching patent* as another emerging patenting shows that firms in high- and medium-high-technology manufacturing sectors are adopting this form of patenting on average 56% of all patenting. However, in Ireland, Poland and the United Kingdom more than 50% of patents come from firms in the business services sector. It has also been observed that the medium-low-technology manufacturing firms rarely contribute more than 10% of patent filings. Similarly, matched enterprise and patent data also reveal the broad industrial basis of these enabling technologies. In this aspect, chemical firms contribute to the advancement of pharmaceuticals and biotechnologies, and to a minor extent to nanotechnologies. Not surprisingly, research and development service providers are essential to these fields, as are institutions such as universities or research houses. Furthermore, new ICT-related technologies are more or less focused to a set or sub-set of computer and communications industries, but environmental technologies are increasingly shaped by the patenting activity of specialized machinery manufacturers and certain technical and engineering service activities (OECD, 2011).

- Moreover, the presence of *young patenting firms* (popularly, known as start-ups) among patent applicants underlines the inventive dynamics of firms early in their development and their desire to develop new activities and products, which ultimately affect their survival and growth. In OECD region, during 2007-09 firms less than five years old filing at least one patent application represented on average 25% of all patenting firms, and generated 10% of patent applications. However, the share of young patenting firms varies considerably across countries, led by Ireland and followed by the Nordic countries (OECD, 2011).

- In the arena of intellectual properties, *Trademarks* (TM) may serve as indicators of innovative and marketing activity, and may proxy non-technological innovations and innovation in service industries. Primarily, firms tend to register trademarks in their home country. However, trademarks registered by non domestic firms can be used as a measure of market penetration and may assist understand the kind of products, whether goods or services, exported. Japan, Luxembourg and the United States show the highest ratio of trademark activity to GDP at the Japanese Patent Office (JPO), the European Office for Harmonization in the Internal Market (OHIM) and the United States Patent and Trademark Office (USPTO) combined (OECD, 2011).

- *Bank loans* are being treated as an important source of financing for starting a new business or expanding an existing one. The World Economic Forum's Global Competitiveness Report (Schwab, 2010), which collects data through executive opinion surveys, provides insight on individuals' views on access to bank loans in different countries. However, the data shows that due to the financial crisis, bank financing has become more difficult to obtain between 2007 and 2010 in all countries. Hence, debt financing is becoming one of the most common sources of financing for small, young firms, while innovative and high-growth firms seek equity financing (OECD, 2010). Often entrepreneurs seeking equity investment start with their own funds and those of friends and family. Furthermore, depending on the size and scope of the venture, entrepreneurs may need other external sources of equity seed capital, such as angel investment or venture capital (OECD, 2011).

- Finally, governments can encourage the business R&D with direct support via grants or procurement and fiscal incentives, such as *R&D tax incentives*. In recent years, OECD governments are using fiscal incentives to promote business expenditure on R&D. In this aspect it has been found that, the United States and Spain rely more on direct support, while Canada, the Netherlands, Portugal and Japan mostly use indirect tax support to foster industrial R&D. It has also been observed that the United States, France, Canada, Japan and Korea provide the largest volumes of tax incentives for R&D volumes. Moreover, countries that spend relatively more in funding business R&D appear to have higher business R&D intensities (OECD, 2011).

A Framework

Based on the study, mainly referring to the published OECD reports and the literatures review, this research suggests that the following elements are keys to sustained innovation and economic development aiming to knowledge economy:

- Expenditure on research and development;
- Investment in knowledge;
- Integration of human resources in science and technology; and
- Collaboration among foreign partners.

In this context, the study likes to establish a framework of the agents of transformation that may assist future researchers, academics and policy makers in finding a short route to face the emerging challenges in the economic crisis, thus making the move towards establishing a knowledge based economy (see Table-2).

Table-2: Framework of the agents of transformation

Initial strategies	Transformed strategies
Invest in basic research	Invest in value added R&D (biotechnologies, nanotechnologies, clean energies)
Invest in human resources in S&T	Target value added occupations
Venture capital investment	University and innovation hotspots
Cross-border ownership of inventions	Collaborations in business value chains
International cooperation in S&T	International collaboration on innovation
Innovation in ICT	Innovation in entrepreneurship development; e-commerce
Patenting	Trademarks; enabling environment (increased access to capital, public support to R&D, tax incentives to R&D)

Investigating into the changes of agents on entrepreneurship development utilizing open innovation strategies, the framework as shown in Table-2 deducts that;

- Investment in basic researches should be directed more towards values added research and development activities, such as advanced researches on biotechnologies, nanotechnologies, clean energies and researches of concurrent demand of the communities;
- Investment in human resource development should be targeted to provide value added occupations rather than producing mere tertiary educated skill builders, such as emphasis should be given towards post doctoral researches producing value added innovative ap-

proaches, or pre-post graduates should be engaged in promoting researches towards direct or indirect value addition from their research outcomes;
- Cross-border ownership of investments should not only be limited to the boundaries of the inventors or promoters, but should overflow among collaborative networks of entrepreneurs, researchers, academics and practitioners;
- International cooperation in science and technologies be targeted towards promoting innovative products, services or processes thus directly or indirectly effecting the value addition of the innovation;
- Innovation in information and communication technologies need to be carried out for building and promoting entrepreneurship through the appropriate utilization of the Internet technologies, such as e-commerce or e-business or e-entrepreneurship; and
- Extended researches need to be carried out for promoting effective utilization of intellectual properties, such as patenting and its various emerging forms or natures providing direct or indirect outcome of value addition.

Before the conclusion, the next section likes to make an overview on adoption of open innovation strategies those have been discussed so far on the promotion and development of entrepreneurships belonging to the small and medium enterprises. It is yet a field that has not been matured and nourished, although journey has started long ago and many researchers are working towards this end.

Innovation in SMEs

Innovation is a major source of economic performance and social welfare of a country (OECD, 1999; Conceição, Heitor and Veloso, 2003a: 2003b; Hamalainen and Heiskala, 2007; Ghili and Tavana, 2011; Abreu, Grinevich, Kitson and Savon, 2011; Rahman and Ramos, 2011a; 2011b). It directly affects productivity, job creation and citizens' welfare and assists to address global challenges such as the economic crisis, health, education and environment (OECD, 2009). Innovation no longer depends solely on how firms, universities, and research institutes perform independently, but, progressively more and more, on how they collaborate. Furthermore, firms' recognition of the usefulness of academic research for their innovative activity directly translates into business's incremental share in the funding of university research. OECD-wide, business provides funding for about 6% of university research and about 3% are of government research. However, countries differ significantly because of differences in national innovation systems. Data from innovation surveys suggest that firms with collaboration arrangements are near to 10% of the labor force, except in Nordic countries where the share is much higher, though such agreements are more common for larger firms than for smaller ones (OECD, 1999).

In terms of innovation development, small firms play key role. They are a constant source of renewal of technology, technological breakthroughs and competitive pressures for large firms, which compelled them to innovate for maintaining their technological periphery and even their survival. Among the so-called "new technology-based firms", most of which are small, play a crucial role in radical innovation and the establishment of new markets. However, SMEs face specific challenges (such as access to funds, markets and skilled manpower) for innovating and for adopting new technologies. Moreover, it is frequently argued that public policies are more or less biased against SMEs and that this might justify corrective action in their favor (OECD, 2003). Fortunately, many countries and their policy initiators have taken it seriously and engaged in making policy or action plans for the innovation research in SMEs.

Additionally, there are concerns that the recent economic crisis may have affected SMEs disproportionally in terms of securing funding for R&D and other innovation-related activities. In some countries governments play a key role in funding R&D activities of SMEs and at most, between

40% and 80% of government financed business expenditures in research and development (BERD) go to SMEs. This figure reaches over 90% in Estonia and Hungary. However, it has been observed that in larger countries, such as the United Kingdom, France and the United States, the bulk of public support goes to large firms (OECD, 2011).

Furthermore, the behaviors of small firms vary substantially due to various reasons that include resource constraints, global competencies and innovation acquisitions. Among them tendency to engage in broader horizons of entrepreneurship is significant and participation in innovation opportunities is pertinent. Current economic crisis around the world has also leads this sector of business to navigate around diversified channels of organizational sustenance and occupational challenges. Additionally, for many reasons seen or unseen, SMEs take different paths to be innovative in their strategies.

To learn about their behaviors and measure pertinent indicators, innovation surveys are being carried out in a growing number of OECD and developing countries. These surveys attempt to capture aspects of the innovation process that fall outside the scope of other science and technology surveys such as those focusing on R&D or ICT. The third round of the Community Innovation Survey (CIS3) examined innovation in firms during the period 1998-2000. The survey focused not only on product and process innovations, but also examined non-technological changes that are of relevance to innovation (OECD, 2005).

However, innovations have different degrees of uniqueness. A firm's introduction of an innovation developed elsewhere may have a significant impact on its performance, but being an adopter is different from developing an innovation in house, especially if it is new and unfamiliar to the market. The OECD (2009) finds that for product innovation, more than 50% of all large firms introduced a new-to-market innovation in Austria, Belgium, France, Greece and Luxembourg, while less than 25% did so in Hungary, Norway, Poland, the Slovak Republic, Turkey and the United Kingdom. Furthermore, on an average, SMEs are less likely to introduce novel innovations. Also in terms of introduction of innovation processes, there are differences across countries. Within Europe, SMEs in France, Luxembourg and Sweden had a significantly higher propensity to introduce new-to-market product innovations than those in Hungary and Poland (OECD, 2009).

Data on innovations mainly developed within a firm, known as in-house innovation, confirm that SMEs tend to be "adopters" more easily than large firms. In more than half of the countries surveyed under OECD (reported in 2009), 40% or more of all large firms developed an in-house product innovation during 2004-2006, while around 20% of all SMEs has *in-house product innovation*. The pattern is similar for *in-house process innovations*. The highest rates (more than 40%) are for large firms in Australia, Belgium, Estonia, France, Germany, Ireland and Luxembourg, while for SMEs these rates are around 20% to 25% in those countries. It has also found that, manufacturing firms tend to undertake more in-house innovation than services firms, for both products and processes. However, in most countries, there is less sectoral difference in terms of firms' propensity to innovate in house for processes than for products. This confirms that in most countries, product innovation is still more prevalent among manufacturing firms than process innovation (OECD, 2009).

But, in terms of promoting advanced researches and practices along the agents of transformation, SMEs are much more relying on universities, research houses or their parent companies or associations they belong. Similar situation prevails for venture capital investment or patenting, as majority of SMEs are yet to be aware of the real benefits of these approaches and be confident to utilize them appropriately. These researchers are carrying out a survey to measure the pattern of innovation among a few selected SMEs in Portugal (and a few Asian and European countries) and it is expected that this learning curve will assist in formulating an improved innovation framework.

The share of turnover from *new-to-market product innovations* can be used as another indicator to measure the impact of innovation at the firm level. However, the data need to be interpreted with caution as some firms may find this as complicated to estimate. Moreover, in this respect, in most countries differences between SMEs and large firms are not that significant. OECD (2009) report shows that in Germany the share of turnover from such innovations is more than four times higher for large firms than for SMEs. But, in Norway and Portugal, the relative share of turnover from new-to-market product innovations is considerably higher for SMEs than for large firms.

To understand how dissemination of new technologies takes place, and to generate a more complete picture of how innovative a firm is, innovation surveys usually collect data on whether the innovation was developed within or outside the firm, to what extent the firms are using them and to what extent the firm interacted with other parties during the process. OECD is consecutively publishing bi-annual reports since 1999 (though 1999 one is the third publication in the series, as an alternate to OECD Outlook that has started in 1995), which this study has taken as setting the benchmarking of various investments for enhancing knowledge-based economy. This paper thus further has tried to find out patterns of transformation through various agents or processes that effects innovation in SMEs growth towards the knowledge-based economy, particularly in European (including OECD) region. Due to limitation of this research similar serial reports, though scant, are not included in the review. However, efforts will be given in future to include some other series of reports and research papers focusing global view on open innovation strategies to justify extended hypotheses on these transformations and reasoning towards the emergence of the knowledge economy.

Conclusion

Assessing the accurate scale and importance of open innovation is challenging. It is not easy to draw a clear distinction between open innovation strategies and longstanding collaborative practices, such as joint R&D, joint marketing or strategic partnerships. On one side, certain element of open innovation strategies, such as new policies internal to firms or informal knowledge exchanges that cannot easily be traced. On the other side, examples of truly new approaches abound, namely, crowdsourcing initiatives, prizes and competitions, and Internet platforms on which firms can post challenges. Modern ICTs have facilitated many of these approaches (WIPO, 2011) and many universities including intermediaries are acting successfully in these endeavors.

This study has synthesized the related empirical studies from the OECD reports from 1999 to 2011, including extant research publications and other relevant literatures. The study had acquired some conclusions: the current trend of transformation towards knowledge based economy incorporating innovative measures and strategies are dynamic in nature and deserves further empirical studies in terms of their value added outcomes. Furthermore, the study finds that these agents of transformation are more end users driven and targeted to make value addition rather than promoting basic researches.

First, the study observes that in OECD countries, basic researches have a propensity towards possibilities of commercialization of their results, such as biotechnology or nanotechnology related research applications. However, it has also been observed that a major share of basic research in many countries goes to the higher education sector and government research laboratories. Furthermore, it has been observed that as complimentary inputs to innovation, public and business researches are prominent.

Second, it follows the effect of human resources on innovation. As the knowledge-based economy requires new skills and competencies, measures have been taken to increase the quality of human resources through incorporation of science and technology, known as human resources in science and technology (HRST). Workers in professional and technical occupations need to be involved in the creation and diffusion of knowledge and technical innovation.

Third element is the international cooperation and it is a particular aspect of globalization of research activities (OECD, 2007). At the same time it has been observed that collaboration among foreign partners play important role in the innovation process.

Fourthly, cross-border co-authorship of scientific articles, co-invention of patents, and co-creation of innovative services provide an indication of the level of internationalization of scientific and technological activities. However, despite the size (mainly large corporate houses are in advantageous position on foreign collaboration) as a strong determinant of foreign collaboration, this study finds that large firms have higher tendency to collaborate internationally than SMEs and this research concludes that further actions need to be taken to incorporate SMEs in the innovation processes at the local and regional levels. Resulting from co-authorship, co-invention and co-creation, the cross-border ownership has come to the lime light in recent years. Despite R&D activities being less internationalized than trade and production in the earlier period, cross-border ownerships are becoming more international. This has lead to new technological competences through better adaptation to local market and lowering R&D costs. Furthermore, collaboration in business value chains has become prominent in recent years among SMEs.

As the fifth agents of transformation, investment in ICT provides significant contribution to labor productivity growth in many countries. This is applicable to OECD countries, too. Furthermore, with the global rise of the Internet, electronic sales have been taken leading role to reach large numbers of new customers through computer-mediated networks. However, the ICT investments have been transformed to entrepreneurship building as an essential driver of economic growth, productivity, employment and innovation.

Venture capital is a new term that has been adopted in the innovation sequences and it has been taken as the sixth element of transformation agent. Venture capital refers to equity investment in start-ups and it is a major source of funding for new technology-based firms. It has been observed that as an important element of open innovation strategies, venture capital investment is becoming popular among nations flourishing towards knowledge economy. However, the dynamic business sector has adopted not only venture capital investments, but also business angel networks (better known as knowledge houses or, intermediaries), regulatory indicators and taxation indicators to make smooth transition into entrepreneurship building.

Commercialization of invention as reflected in patenting (final and the seventh agent of transformation) is another way to measure technological innovation. While countries are becoming specialized in certain economic activities, OECD (2011) reports that this new indicator, based on linking patents with companies´ information reveal the benefits of a broad industrial base and a strong university based research sector for the development of key enabling technologies. Furthermore, newly evolved ICTs are intense in computer and communication industries, while environmental technologies are shaped by the patenting activity of specialized machinery manufacturer and certain technical and engineering service activities. Along this transformation processes, regional patenting, biotechnology patent and nanotechnology patent have advanced in recent years. Additionally, supporting processes like, trademarks, soft bank loans, government support in business R&D, and tax incentives have profound impact on technological innovation.

Finally, it must be noted that broader innovation is essential for economic growth and social advancement. Innovation entails investment in a range of complementary assets beyond R&D such as software, human capital and new organizational structures. The good thing is that investment in these intangible assets is growing and even exceeds investment in physical capital (machinery and transport equipment) in countries, such as Finland, the Netherlands, Sweden, the United

Kingdom and the United States. Encouragingly, in some other countries, recent estimates of intangible assets explain a significant portion of multi-factor productivity growth (OECD, 2011). However, the impact of these measures require further investigation and data on policy inputs, including any economic output and value gain. Furthermore, all these study deserve careful research design to identify the challenges inherited within these knowledge intensive transformatory processes.

References

Abreu, M., Grinevich, V., Kitson, M., & Savon, M. (2011). *The changing face of innovation policy: Implications for the Northern Ireland economy*. Programme on Regional Innovation, University of Cambridge, UK.

Baygan, G., & Freudenberg, M. (2000). *The internationalisation of venture capital activity in OECD countries: Implications for measurement and policy. STI Working Paper 2000/07.* Available at: www.oecd.org/sti/working-papers

Belderbos, R., Carree, M., & Lokshin, B. (2004). Cooperative R&D and firm performance. *Research Policy*, *33*, 1477–1492.

Canberra Manual. (1995). *The measurement of scientific and technological activities*. Manual of the Measurement of Human Resources Devoted to S&T "Canberra Manual", OECD, Paris.

Chesbrough, H. W. (2003a). *Open innovation: The new imperative for creating and profiting from technology*. Boston: Harvard Business School Press.

Chesbrough, H. W. (2003b). The era of open innovation. *MIT Sloan Management Review, 44*(3), 35–41.

Chesbrough, H., Vanhaverbeke, W., & West, J. (2006). *Open innovation: Researching a new paradigm*, Oxford University Press.

Conceição, P., Heitor, M. V., & Veloso, F. (2003a). *Innovative shocks and productivity*. Paper presented at the conference 'What do We Know About Innovation? A Conference in Honour of Keith Pavitt' University of Sussex, Brighton, UK, 13th-15th November 2003.

Conceição, P., Heitor, M. and Veloso, F. (2003b). *Innovative shocks and productivity,* Paper presented at the Conference in Honour of Keith Pavitt "What do we Know about Innovation", Brighton, UK, Mimeo.

Collins, C. J., & Smith, K. G. (2006). Knowledge exchange and combination: The role of human resource practices in the performance of high technology firms. *Academy of Management Journal*, *49*, 544-560.

Ellis, T. J., & Levy, Y. (2009). Towards a guide for novice researchers on research methodology: Review and proposed methods. *Issues in Informing Science and Information technology, 6*, 323-337.

Faems, D., Van Looy, B., & Debackere, B. (2005). Interorganizational collaboration and innovation: Toward a portfolio approach. *Journal of Product Innovation Management*, *22*, 238–250.

Ghili, S., & Tavana, M. (2011). Innovation or imitation: Some economic performance and social welfare policy perspectives. *International Journal of Information System and Social Change, 2*(3), 48-66.

Godin, B. (2005). *The linear model of innovation: The historical construction of an analytical framework*. Working Paper No. 30, Project on the History and Sociology of S&T Statistics, Montreal, Canada.

Goldman, R., & Gabriel, R. P. (2005). *Innovation happens elsewhere: Open source as business strategy.* Morgan Kaufmann.

Gulbrandsen, M. (2008). The role of basic research in innovation. In W. Østreng (Ed), *Confluence*: *Interdisciplinary communications 2007/2008*. Oslo, Norway: Norwegian Academy of Science and Letters, Center for Advanced Studies, pp. 55-58.

Hamalainen, T. J., & Heiskala, R. (Eds.) (2007). *Social innovations, institutional change and economic performance: Making sense of structural adjustment processes in industrial sectors, regions and societies*. Edward Elgar Pub.

Holbrook, J. A. D., Hughes, L. P., & Finch, J. A. (1999). Characteristics of innovation in a non-metropolitan area: The Okanagan Valley of British Columbia. *Third International Conference on Innovation*, Austin, Texas.

Hsu, Li-Ling, & Tsong-Ming, L. (2006).The longitudinal literature review on the interaction between manufacturing and marketing: a multidimensional content analysis. *International Journal of Management and Enterprise Development, 3*(1/2), 114 - 146.

Irish Council. (1999). *Statement on public research and technology services for innovation in enterprises*. Irish Council for Science, Technology and Innovation, September 1999.

Khan, M., & Dernis, H. (2005). *Impact of patent cooperation treaty data on EPO patent statistics and improving the timeliness of EPO indicators*. STI Working Paper 2005/2, OECD, Paris. Available at: www.oecd.org/sti/ipr-statistics

Laursen, K., & Salter, A. J. (2006). Open for innovation: The role of openness in explaining innovation performance among UK manufacturing firms. *Strategic Management Journal*, *27*, 131–150.

Motzek, R. (2007). *Motivation in open innovation*, VDM Verlag (March 22, 2007)

Nambisan, S., & Sawhney, M. (2007). *The global brain: Your roadmap for innovating faster and smarter in a networked world.* Wharton School Publishing.

OECD (1999). *Benchmarking knowledge-based economies,* OECD Science, Technology and Industry Scoreboard, OECD, Paris

OECD (2001). *Towards a knowledge based economy*, OECD Science, Technology and Industry Scoreboard- 2001 Edition, OECD, Paris

OECD (2003). *OECD science, technology and industry scoreboard- 2003 Edition.* OECD, Paris

OECD (2004). *Compendium of patent statistics 2004.* OECD, Paris, available at: *www.oecd.org/sti/ipr-statistics*.

OECD (2005). *OECD science, technology and industry scoreboard- 2005 Edition.* OECD, Paris

OECD (2007). *Innovation and Performance in the Global Economy, OECD Science, Technology and Industry Scoreboard- 2007 Edition.* OECD, Paris

OECD (2008). *Open innovation in global networks.* OECD Policy Brief, Paris

OECD (2009). *OECD science, technology and industry scoreboard- 2009 Edition.* OECD, Paris

OECD (2011). *Innovation and growth in knowledge economies, OECD Science, Technology and Industry Scoreboard- 2011 Edition*. OECD, Paris

Poot, T., Faems, D., & Vanhaverbeke, W. (2009). Toward a dynamic perspective on open innovation: A longitudinal assessment of the adoption of internal and external innovation strategies in the Netherlands. *International Journal of Innovation Management, 13*(2), 1–24.

Rahman, H., & Ramos, I. (2011a). Open innovation strategies in SMEs: Development of a business model. In: *SMEs and open innovation: Global cases and initiatives*, pp. 224-237. IGI Global.

Rahman, H., & Ramos, I. (2011b). Empowerment of SMEs through open innovation strategies: Life cycle of technology management. *International Journal of Information Communication Technologies and Human Development (IJICTHD)*, *3*(3), 42-57.

Sawyer, K. (2007). *Group genius: The creative power of collaboration.* Basic Books.

Schwab, K. (Ed.). (2010). *The global competitiveness report 2010-2011. 2010* World Economic Forum.

Surowiecki, J. (2005). *The wisdom of crowds.* Anchor.

Weerakkody, V., Dwivedi, Y. K., & Irani, Z. (2009). The diffusion and use of institutional theory: A cross-disciplinary longitudinal literature survey. *Journal of Information Technology*, *24*, 354–368.

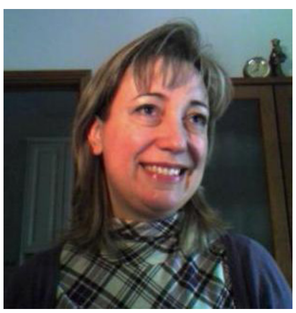
West, J. (2006). Does appropriability enable or retard open innovation? In H. Chesbrough, W. Vanhaverbeke, & J. West (Eds.), *Open Innovation: Researching a New Paradigm,* pp. 109-133. Oxford University Press.

WIPO (2011). *World intellectual property report: The changing face of innovation.* WIPO Economics and Statistics Series, World Intellectual Property Organization.

Von Hippel, E. (2006). *Democratizing innovation*, The MIT Press.

Biographies

Hakikur Rahman is an academic who, over 25 years, has served leading education institutes and established various ICT4D projects funded by ADB, UNDP and World Bank in Bangladesh. He is currently serving as a Post Doctoral Researcher at the University of Minho, Portugal. He has written and edited over 20 books, more than 40 book chapters and contributed over 100 articles on computer education, ICTs, knowledge management and research in newspapers, journals and conference proceedings. Graduating from the Bangladesh University of Engineering and Technology in 1981, he has done his Master's of Engineering from the American University of Beirut in 1986 and completed his PhD in Computer Engineering from the Ansted University, BVI, UK in 2001.



Isabel Ramos is an Assistant Professor at Information Systems Department of University of Minho, Portugal. She coordinates a research group in Knowledge Management. She also has research work in the field of Requirements Engineering. Isabel Ramos is associate editor of the International Journal of Technology and Human Interaction and Secretary of the IFIP TC8 (Information Systems). Her research and teaching interests include: requirements engineering, knowledge management, organizational theory, sociology of knowledge, history of science, research methodology. She is responsible for the user studies in two funded R&D projects. Isabel Ramos is author of more than three dozen scientific papers presented at international conferences and published in scientific and technical journals. She advises the work of several PhD and Master students.