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The Missing Link of Human Capital Development in National System of Innovation Model

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ABSTRACT

The National System of Innovation (NSI) approach has become key concepts in the science and technology (S&T) literature. The NSI approach is important in most developed economies and it has been adopted by developing nations in order to enhance innovation through a systematic approach. In moving from a resource based to an innovation-led economy, human capital development is the critical factor since innovation is a function derived from human capital. However, there has been the only limited analysis of NSI approach that centered on human resource development, particularly in terms of individual learning and competence building, which is an important factor for spearheading innovation and knowledge-based activities. This paper highlights the gap in NSI approach with the hope that it will spearhead more research on this matter.

Key words: National System of Innovation, Human Resource Development, Innovation

Introduction

The root of this paper centres on the importance of human capital in relation to economic performance. Human capital theory, developed in the early 1960s by Becker (1964), Mincer (1962) and Schultz (1961), is still the most prominent thread linking education and training activities of individuals and firms to economic performance and outcomes. Nowadays, most countries increasingly emphasise on the development of human capital: the knowledge, skills and capabilities embodied in people needed for economic development. Growth in innovation and knowledge-based activities also depend on rich human capital. The obvious explanation, basic in all innovation analyses, is that innovation and development of new technologies occur through the activities of highly skilled personnel. Innovation is also a social process which involves not only generation of new techniques, such as new plant and equipment, but also new forms of knowledge, skills and competences. Competence is essentially embodied in the collective experience and activities of those who produce and implement a new technology. It relates not only to research results, but also to organisational concerns, problem solving and marketing (Smith 2001).

National System of Innovation (NSI) approach has become key concepts in the science and technology (S&T) literature. The NSI approach is important in most developed economies and it has been adopted by developing nations in order to enhance innovation through a systematic approach. The NSI approach is essentially supply orientated in its perspective. Most NSI research focuses on how the innovation system in any particular nation deals with production diffusion and use of knowledge in the innovation process (Freeman 1987; Porter 1990; Lundvall 1992; Nelson 1993; Edquist 1997). Less attention has been given to the demand side, such as response from consumers to products or services. In relation to individual learning and competence building, specifically in terms of skilled workers, supply and demand of skilled workers is considered a crucial factor to economic success. Several authors have highlighted that education and training, creation of human capital, competencies and individual learning as significant determinants of innovation, listed under functions and activities of NSI (e.g. Edquist 2005; Liu & White 2001; Johnson & Jacobsson 2000; and Rickne 2000). However, there has been only limited analysis of NSI approach that centered on individual learning and competence building, particularly in terms of skilled workers, which is an important factor for spearheading innovation and knowledge-based activities. This paper attempts to explore the gap or the missing link of human capital development in NSI approach and its significance to the Malaysian Innovation Model.
Discussion:

National Systems of Innovation (NSI) and Economic Performance:

The concept of NSI has become fundamental in most developed economies and has been adopted by developing nations with their own mould and approach (see Nelson 1993). The purpose of NSI is to enhance innovation through a systemic approach. Some of the basic ideas behind NSI approach go back to List (1841). His concept, known as national systems of production, took into account a wide set of national institutions including those engaged in education and training, as well as infrastructures such as transportation networks and commodities (Freeman 1995). In promoting the national production system, List stressed the need to build national infrastructure and institutions in order to fasten accumulation of mental capital and use it to spur economic development, rather than sitting back and trusting an invisible hand to solve all problems (Lundvall 2003).

Freeman (1987) was the first person who used the expression NSI. In early 1990s, two major books on NSI were published, edited by Lundvall (1992) and Nelson (1993). Meanwhile, Porter’s (1990) work on the competitive advantage of nations implicitly uses the concept of innovation system. He emphasizes feedback mechanisms between domestic suppliers and users as a factor that leads to competitive advantage of nations. Thereupon NSI spread rapidly and it is widely used in the academic circles as well as in policy context of national governments and international organisations, notably the OECD and European Union. This approach seems very attractive to policy makers who look to alternative frameworks for understanding the differences between economies, and various ways for supporting technological change and innovation (Edquist 2001).

Freeman (1987) defines NSI as the network of institutions in the public and private sectors whose activities and interactions imitate, import, modify and diffuse new technologies. Lundvall (1992) draws a distinction between a broad and a narrow definition of the system of innovation. The narrow definition is organizations and institutions involved in searching and exploring, such as R&D departments, technological institutes and universities. The broad definition is a system of elements and relationships which interact in the production, diffusion and use of new and economically useful knowledge. Nelson and Rosenberg (1993) term NSI as a set of institutions whose interactions determine innovative performance. Meanwhile, Edquist (1997) points out that the institutional setup related to innovation and the underlying production system are the basic characteristics of NSIs.

Based on the several definitions above, the NSI approach can be regarded as a set of distinct institutions which influence the development and diffusion of new technological knowledge (Freeman 1987, 1995; Lundvall 1992; Nelson 1993). Thus, NSIs are set of interrelated institutions whose core is made up of entities that produce, diffuse and adapt new technical knowledge, be they industrial firms, universities or government agencies. The links between these institutions consist of flows: knowledge, financial, human (people being the bearers of tacit knowledge and know-how), regulatory, and commercial (Niosi 2002). Generally, the broad aim of the NSI approach is to help understand and explain a process of innovation by taking into account all important factors that shape and influence innovations. Freeman (1995) suggests that there have been major differences between countries in the ways in which they have organized and sustained development and diffusion of technological innovation within their national economies. Nations differ not only in the quantity of innovations introduced, but also in the methods by which these innovations are adopted and in their sectoral composition (Archibugi & Michie 1995). When national systems are organized appropriately, they can be a powerful engine of progress in economic and scientific development (Nelson 1994). In general, the NSI approach has been widely discussed and is well established in most developed economies. It has become a leading paradigm for analyzing innovation processes (Freeman 1987, 1995; Lundvall 1992; Nelson 1993).

Innovations are often defined as the introduction of new or improved products, production techniques, organisational structures, the discovery of new markets and the use of new input factors (Schumpeter 1939). Each type of innovation has the capacity to increase productivity and improve competitiveness. There are various ways in which innovation can lead to economic growth. For example, firms that introduce new advanced products to the market have a good opportunity for expanding their share in domestic as well as in international markets, consequently increasing their revenues.

Many empirical studies on growth in terms of innovation support this argument, and it is indisputable that innovations are a major source of economic growth. Empirical evidence by Porter and Stern (2002) verifies a strong relationship at the country level between innovative performance and economic prosperity, measured in terms of gross domestic product (GDP) per capita. A considerable fraction of cross-country disparities in economic success (in terms of GDP growth, productivity growth, employment, etc.) can be explained by differences in innovative performance. Thus, the capability of one country to develop, absorb and diffuse new technologies needs to be examined critically. Detailed studies of innovative performance of countries can produce important insights into their competitiveness, thereby providing a better understanding of past and future economic success of nations.
Since there is a significant relationship between economic growth and innovative performance, the NSI approach can be considered as a relevant conceptual framework for an analysis of the main determinants of the innovative performance of countries (Edquist et al. 2001). Niosi (2002) agrees, claiming that the concept of national systems(s) of innovation is the key to explaining the behavior and performance of sets of institutions and organizations on which long-term economic growth and sustainable development are based.

Balzat (2002) provides an illustration (Figure 1.1) to show the role a nation’s innovation system in its overall economy. It identifies a strong link between innovative performance (generated by NSI) and competitiveness, affecting economic performance. However, innovations are not the only drivers of economic growth. NSI is not an isolated system and the processes within it are influenced by various subsystems in an economy, such as the legal, tax and financial systems, and the labor market. As stated by Nelson (1993), the innovation system can never be analyzed exclusively because there are many other subsystems in the economy that also shape innovation behavior. Even if any of these subsystems is not perceived as a building block of an innovation system, it should still be considered and included in the institutional framework of an NSI (Balzat 2002). It is thus feasible to focus on the main determinants of innovation and simultaneously to reveal differences between countries, or even to derive policy conclusions. It has been made clear by Edquist (2001) that it is the main purpose of the systemic approach to innovation to identify and explain the main determinants of innovative action. In summary, the way innovation is handled by institutions and organizations and the interaction between the main actors will have an impact on economic performance and competitiveness. This explains the widespread adoption of the NSI concept in both developed and developing countries.

![Diagram of Institutional Framework](image)

**Fig. 1.1: The Significance of NSI for Economic Success**

**The Shortfall in Human Resource Development in Shaping the Innovation Process:**

Although the NSI approach focuses on the main components of NSI and the relationships between them, it is important to move beyond them. It is crucial to identify all the important factors that influence development, diffusion and use of innovations. An obvious way to do so is to critically deal with the activities or functions within the systems. Even though a system normally has functions, this aspect has not been systematically included in the early works on NSI (Edquist 2005, 189). Edquist (1997, 19) discusses the function of R&D in
NSI, and of activities within NSI itself, performed by different organizations and actors. Only recently have authors started systematically to address the gap in seeing systems as complex wholes with clearly defined overall functions.

The most important single function of NSI is to produce, diffuse and use innovations. The rallying point here is to identify and focus upon factors that influence development, diffusion and use of innovations. These factors are called the determinants of innovation. Examples may be the production of economically relevant knowledge through R&D, or the financing of development of innovations. Thus, the activities in, or the specific functions of, the systems are more or less the same thing as determinants of innovation processes (Edquist 2001).

The focus on the determinants of innovation is in line with the recent work by Liu and White (2001) which addresses what they call a fundamental weakness of national innovation system research, namely the lack of system-level explanatory factors (Liu & White 2001). In order to restore this, they focus upon the activities in the systems. These activities are related to the creation, diffusion and exploitation of technological innovation within a system (Liu & White 2001). They identify five fundamental activities:

1. Research (basic, developmental, engineering)
2. Implementation (manufacturing)
3. End use (customers of the product or process outputs)
4. Linkage (bringing together complementary knowledge
5. Education

Meanwhile Johnson and Jacobsson (2000) emphasize that for an innovation system to support the growth of an industry, a number of functions have to be served within it, e.g. the supply of resources. They suggest that the performance of an innovation system can be evaluated by assessing its functionality, i.e. how well these functions are served. They present a list of five functions, which are to:

1. create new knowledge
2. guide the direction of the search process
3. supply resources, i.e. capital, competence and other resources
4. facilitate the creation of positive external economies (in the form of an exchange of information, knowledge and vision)
5. facilitate the formation of markets.

Rickne (2000) discusses what functionality each type of actor can provide to new technology-based firms. The extent to which these functions are filled may be seen as an indicator of performance for how well any specific innovation system supports the establishment and growth of new technology-based firms. Rickne’s functions are to:

1. create human capital
2. create and diffuse technological opportunities
3. create and diffuse products
4. incubate in order to provide facilities, equipment and administrative support
5. facilitate regulation for technologies, materials and products that may enlarge the market and enhance market access
6. legitimize technology and firms
7. create markets and diffuse market knowledge
8. enhance networking
9. direct technology, market and partner research
10. facilitate financing
11. create a labor market that the new technology-based firms can utilize.

The work of these authors shows that there is still no agreement regarding which functions or activities should be included in a system of innovation. This focus of the research is at an early stage of development, and provides ample opportunities for exploration.

Meanwhile, Edquist (2004; 2005) stresses the importance of studying activities (factors, causes, determinants) in NSI in a systematic manner. He presents a hypothetical list of activities based upon the literature and his own knowledge regarding innovation processes and their determinants. The following activities can be expected to be important in most NSI:

1. Provision of R&D, creating new knowledge, primarily in engineering, medicine and the natural sciences.
2. Competence building (provision of education and training, creation of human capital, production and reproduction of skills, individual learning) in the labor force to be used in innovation and R&D activities.


4. Articulation of quality requirements emanating from the demand side with regard to new products.

5. Creating and changing organizations needed for the development of new fields of innovation, e.g. enhancing entrepreneurship to create new firms and intrapreneurship to diversify existing firms, creating new research organizations, policy agencies, etc.

6. Networking through markets and other mechanisms, including interactive learning between different organizations (potentially) involved in the innovation processes. This implies integrating new knowledge elements developed in different spheres of the SI and coming from outside with elements already available in the innovating firms.

7. Creating and changing institutions, e.g. IPR laws, tax laws, environment and safety regulations, R&D investment routines, etc., that influence innovating organizations by providing incentives or obstacles to innovation.

8. Incubating activities, e.g. providing access to facilities, administrative support, etc. for new innovative efforts.

9. Financing innovations processes and other activities that can facilitate commercialization of knowledge and its adoption.

10. Provision of consultancy services of relevance to innovation processes, e.g. technology transfer, commercial information and legal advice.

Edquist (2005) stresses that this list is provisional, and subject to revision and further research as knowledge regarding determinants of innovation processes increase. Eventually, a clear set of determinants of innovation will be identified. In order to develop within a more theoretical and conceptual framework, it is vital to integrate with empirical studies in an effort to identify the determinants of the development and diffusion of innovations. As suggested by Edquist (2004) theoretically based empirical work is the best means by which to straighten out the NSI approach conceptually and theoretically; the empirical work will serve as a disciplining device.

Conclusion:

In summary, the NSI approach focuses on macro- and meso-levels of the learning process in terms of product and process innovation, as well as on research activities in terms of the development and advancement of new knowledge. However, there have been no serious studies in NSI on individual learning, especially in terms of skilled personnel, and even this is an important factor for innovation and knowledge-based activities. As discussed above, Liu and White (2001), Johnson and Jacobsson (2000), Rickne (2000) and Edquist (2004, 2005) agree that competence-building aspects such as education and training, creation of human capital, competencies and individual learning are determinants of innovation processes. Activities and functions related to the education, training and skills as well as individual learning have therefore been regarded as one of the significant determinants of innovation systems, particularly in terms of producing skilled personnel.

However, to date, the NSI approach has to a large extent neglected this aspect. Looking at some of the major contributions on innovation systems (Freeman 1987; Porter 1990; Lundvall 1992; Nelson 1993; Edquist 1997), the focus remains on production and innovation systems while much less attention is given to the part of the economy engaged in the development of human resources through education, training and skills. Nonetheless, there has been initiative in engaging the development of human resources in innovation studies. For example, in designing the edited book by Lundvall (1992) entitled ‘National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning’, the Aalborg group planned to have a chapter on the education system, however at the end they did not succeed (Lundvall & Christensen 1999). The failure was due to the conflict interest between innovation scholars, on one hand, and education and labour market scholars, on the other. This highlights the fact that innovation scholars are not seen as experts on labour market and education, whilst education and labour market scholars are often not interested in introducing the innovation perspective into their fields of research.

This initiative of Lundvall’s is also reflected in other work, including a major OECD study on knowledge management in the learning society by the Centre for Educational Research and Innovation (CERI) (OECD 2000a). Another study by CERI included a conceptual framework which tried to integrate innovation and education in the same generic learning framework, as well as empirical studies of the role of education and innovation for economic growth at a regional level (OECD 2001b). Hence, it can be said that the crucial importance of education, training and skills for innovation is found in some writing on systems of innovation. Nevertheless, there is no deep, detailed analysis of education and training specifically on individual learning in the context of innovation systems. Though, it is essential to integrate the development of human resource
through learning and competence building in innovation system as NSI is not segregated from other subsystem in an economy such as the labour market. This paper hopes to open up more research possibilities on the importance of human capabilities in National System of Innovation particularly in developing economies.

References
