

Innovation Systems Framework: Still Useful for New Challenges ?

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ABSTRACT

The innovation systems approach has proven useful in explaining the reasons behind varying economic performance in developing countries. The systemic understanding of the innovation process, which pays attention to the knowledge flow among interactive actors, serves as a useful 'focusing device' for elaborating effective policy to accelerate the innovation process and to contribute to economic development. The existing use of the innovation system may need some alterations to address present-day societal challenges. The emerging types of innovation—such as user innovation, public sector innovation, social innovation and innovation for inclusive development—have different features from firm level innovation. This paper examines the features of emerging types of innovation to assess whether and how the current innovation system can be adjusted to address emerging social agendas.

1. Introduction

Innovation is considered to hold the key to reaching developmental goals by promoting economic growth and improving welfare. Innovation policy should facilitate finding new ways of combining knowledge to solve problems or improve the way things are done. Innovation policy, hence, covers a much broader domain than just science, technology and industrial areas, and involves a wider set of issues such as provision of infrastructure, resources (human and financial) and institutions (legal frameworks, regulation and incentives) (Martin 2013 forthcoming). The innovation systems approach, which identifies

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the driving force of innovation—firms and surrounding actors that influence innovative behaviour—such as government organizations, research centres and universities—and its contextual background that shapes the innovative behaviour of actors—such as history, culture, socio-economic conditions—is considered a useful framework in this context for elaborating effective policy intervention. Using this framework is considered more practical than standard prescriptive policy guidelines because it captures knowledge flow in a holistic and dynamic manner. While the current innovation systems framework is useful in explaining ‘problem solving’—innovation—in the firm and business environment, this framework may need some alterations to be useful in promoting and understanding innovation that solves societal challenges. In fact, innovation in the non-business context—user innovation, public sector innovation, social innovation and innovation for inclusive development—is now being increasingly discussed.

This paper; therefore, explores whether and how the current innovation systems framework can be extended to meet new societal challenges. This involves various issues, including aims, actors, evaluation and expected outcome of innovation policy. The paper begins by discussing the key features of the innovation system in current use. Second, it reviews the emerging types of innovation. Third, the paper identifies the features of emerging innovations to be incorporated into the new innovation systems approach and, finally, concludes.

2. What is an innovation system ?

The origins of the systems concept, applied to innovation, lie in the concept of national systems of innovation (Freeman 1987; Nelson 1989; Lundvall 1992). The concept emerged as an alternative way to explain the innovation process, improving on an earlier view that considered this process as a simple linear progression of scientific research. The innovation system considers innovation as an outcome of interactions among firms, organizations and institutions, in the context of historical, cultural and socio-economic framework conditions. It was considered that a holistic approach to policy was needed to influence and change innovation behaviour in order to improve productive performance. The innovation system, in this context, was considered as a framework that facilitated monitoring and managing the elaboration of policy (Soete et al. 2009). The system of innovation provides key analytical insights to assist the policy-making process using a more holistic perspective.

The innovation systems approach has been implemented as a ‘focusing device’ to explain the productive problem of firms or to understand economic growth and the catching-up process of emerging countries. Due to the fact that, in the past, the dominant economic activities among OECD countries took place in high-tech manufacturing sectors, the prevailing understandings of innovation are concentrated in these areas (Martin 2013). Some advances in this regard have been made; for example the *Oslo Manual* (OECD and Eurostat 2005) has been expanded to the service sectors in response to recent studies (Miles 2005; NESTA 2007, among others), indicating the importance of other sectors for its contribution

to innovation. In addition, the *Oslo Manual* now pays more attention to ‘non-technological’ innovation such as organizational change and incremental improvements in the firm, owing to the diversity of the way innovation takes place in so-called ‘low-tech’ sectors (von Tunzelmann and Acha 2005), as well as the increasing role of emerging countries (Martin 2013), whose innovations rely less on technological change and more on organizational changes and incremental improvements compared to OECD countries (OECD and Eurostat 2005). While the above changes are taking place, the financial crisis in developed countries is also directing increased attention to innovations in the public and social sector as a possible alternative to reduce public spending. Both public and social innovations have different features from those in the business context. Despite the changing panorama of innovation policy, use of the innovation systems framework has not been discussed in the new context. Before going on to do this, I examine the features of the existing innovation systems framework (see also Hall 2005; Soete et al. 2009).

The first feature of an innovation system is its focus on firm activities. In innovation systems, the firm is placed at the centre and considered as the driving force. This is due to the fact that innovation is defined as “the implementation of a new or significantly improved product (good or service) or process, a new marketing method, or a new organization method in business practices, workplace organizations or external relations” (OECD and Eurostat 2005: para 146). The process of innovation involves implementation of new ideas to achieve desired social and economic outcomes (Hall 2005). The *Oslo Manual*, which refers to the innovation systems framework, clearly states that a new product or process is considered ‘implemented’ when it is introduced to the market (OECD and Eurostat 2005: para 146 and 150; Gault 2012). The emphasis on ‘introduced to the market’ also encourages placing the firm’s activities at the heart of the innovation process.

Understanding the innovation process requires knowing how ideas, skills and knowledge are transferred, diffused and acquired. The implementation of a new idea requires a prior learning process. This is stimulated by research Science Technology Innovation (STI) mode or by direct experience of actually putting knowledge into practice learning by Doing, by Using and by Interacting: DUI mode: Lundvall, 2007. The research (STI mode) can be observed by the R&D expenditure (input) and patenting activities (output), while the DUI mode requires another method of inquiry. Either way, the system of innovation can help identify a network knowledge flow by looking at the interactions among stakeholders. In this context, the innovation process is considered as a constellation of collective learning, with the firm playing the central role in introducing the new idea/product/service to the market.

Second, innovation requires supportive institutional settings for knowledge diffusion and creation among the stakeholders. The innovation system distinguishes organizations, such as firms or research centres, from institutions (habits, routines, practices and rule of law) that shape the interactions among the stakeholders following institutional economics (North 1990; Hodgson 1988, 2006; Aoki 2007; Grief 2006)¹⁾. The distinction between executive entity—organization—and factors that shape the behaviour—institution—is useful for policy

elaboration, particularly in dealing with agent failure, a situation where an economic agent fails to behave according to the rationale of maximizing his/her utility (Smith 1994).

Third, the innovation systems framework draws attention to the role of policy intervention in relation to the changes in innovation behaviour. The innovation systems framework is useful in capturing knowledge flow in order to elaborate policy. Knowledge demonstrates the features of public goods; the cost of efforts to develop or create a good is substantially higher than that of making it available to many users, and once it is available to the public, knowledge is essentially a non-rival and non-excludable good. These features of knowledge mean that market forces cannot work perfectly, making policy intervention necessary to stimulate investment towards its creation. However, neither market nor agent failure is enough to justify policy intervention and guarantee the successful policy outcome because the innovation process involves systemic coordination of actors (Cimoli et al. 2009). The justification for policy intervention involves system failure and coordination failure. This is because the effective interventions need to be placed in the 'right' institutional or systemic context in the 'right' sequence to create virtuous impacts.

Fourth, the system emphasizes the role of actors. The system recognizes that interaction between policy and the market alone does not determine the policy outcomes. The actors have a great deal to do with the policy outcomes. In fact, the innovation systems framework stresses the involvement of actors. The approach also considers that these differences have contributed to explaining different economic performance across countries. Comparative case studies (Nelson 1993, among many others; Lundvall et al. 2009) exist that illustrate how interactions among actors are useful in explaining differences in economic performance. For instance, the difference in evolving systemic linkages and correspondingly increasing interactions has illustrated why and how East Asian countries like Korea and China rapidly achieved competitiveness compared to Latin American countries (Cimoli et al. 2009; Cimoli and Katz 2003).

The four points mentioned above describe important features of the existing innovation system that is widely applied in observing the innovation process across countries (OECD and Eurostat 2005). Recent research has identified some challenges to understanding the innovation process that were not earlier recognized. The most obvious of these are found in the innovation process in the developing-country context. A number of studies have already indicated some of the features of innovation in developing countries: smaller firm size; informal setting; operating under a distinctive industrial and market structure with a different rationale in maximizing utility (OECD and Eurostat 2005; Prahalad and Mashelkar 2010; AU/ NEPAD 2010).

In real life, whether in developed or developing countries, knowledge flow is not limited to 'formal' production networks. Instead, a multitude of 'informal' social networks—such as professional associations, alumni associations or geographical locations of households; social networks such as parent-teacher associations—co-exist and influence knowledge flow. These 'informal' or 'non-market' networks can function as vital alternative sources of knowledge or influence the diffusion process, especially at the local level in clusters or communi-

ties (Putnam 1992).

The development of information and communication technology (ICT) allowed actors to create and participate in virtual ‘communities of practice’ where participants can freely exchange knowledge. Such communities can stimulate and extend the scope of a knowledge network beyond geographical distance. Moreover, it became clear that factors such as degree of ‘trust’ and ‘social capital’ nurtured through iterative interaction can influence the types of interaction, degree and speed of knowledge diffusion among the actors (Coleman 1988; Konte and Ndong 2012; Gebreyesus and Mohnen 2013). Such informal networks are more prevalent in developing countries because the majority of their productive activities take place unrecorded (OECD 2012; OECD and Eurostat 2005).

The innovation systems framework has been applied mainly to business practices where the firm is the driving force and the market is the main medium for knowledge flow. The recent finding on the role of informal networks in knowledge flow presents an interesting alternative perspective to extend understanding of the innovation process. In the next section, the changing context of innovation is illustrated in two ways: (1) by focusing on globalization of knowledge flow with regard to developing countries; and (2) by reviewing emerging types of innovation.

3. New challenges for the innovation systems approach

3.1 Globalization of knowledge flow and its impacts in developing countries

While the recent globalization of knowledge—accompanied by the global flow of commodities and services with increased provision of information and communication technology (ICT) and intellectual property regime (IPR) infrastructure—is thought to improve knowledge access, stimulate the innovation process and contribute to economic growth, there are mixed outcomes in developing countries. This is due to differences in absorptive capacity (Cohen and Levinthal 1990)—the capability to understand, adapt and internalize to utilize external knowledge (absorption process)—resulting in mixed outcomes for countries at different stages of development. In other words, improved access to knowledge does not immediately translate into its use.

Knowledge is often divided into two categories: codified and tacit (Nonaka and Takeuchi 1995; Polanyi 1966; Hayek 1945). The learning process usually requires interaction of two categories of knowledge in a spiral manner (Nonaka and Takeuchi 1995; Nonaka 2007). When the knowledge needs to be implemented in a local or specific context, the codified knowledge needs to be translated into tacit form according to the SECI (Socialization, Externalization, Combination, Internalization) process (Nonaka and Takeuchi 1995). This process is influenced greatly by the degree of absorptive capacity of previous knowledge (Cohen and Levinthal 1990). Therefore improved access to codified knowledge alone, without absorptive capacity, does not contribute equally to innovation and expected growth; nevertheless, due to differences in absorptive capacity, this may bring about the ‘knowledge di-

vide' (Chataway et al. 2003).

Moreover, some research findings indicate that establishment of a strict IPR system at an early stage of development restricts knowledge diffusion and deters the emergence of imitators, a crucial element for multiplying the knowledge-creating process and the basis for any economic and social activities to take shape. An institutional factor such as IPR interacts with local absorptive capacity and greatly influences knowledge flow, the innovation process and distribution of gains from knowledge flow. It is possible that highly embedded, local specific and relational knowledge—the tacit form of knowledge often found in the context of developing countries—is only with great difficulty the subject of appropriation under the current IPR system unless there is an institution or individual that acts as an intermediary to codify the tacit dimension of knowledge to be useable in different environments with a mechanism to distribute the benefit accrued from appropriation of knowledge (Gupta et al. 2003). This means that the 'knowledge divide' has potential to further develop into a 'benefit divide'.

For instance, increased access to global knowledge can put some developing countries in a more vulnerable position instead of strengthening their knowledge base. The 'knowledge divide' between those who have the capacity to codify locally integrated tacit knowledge (such as traditional medicine, agricultural practice, traditional forestry/fishery management methods) from those who cannot often has the unfortunate consequence that local traditional knowledge is stolen from its rightful owner (for example, bioprospecting or biopiracy) if proper institutions to support and protect commonly shared knowledge are not in place. At the same time, with intermediary institutions for intellectual property rights, a win-win scenario can be envisaged, as in the case of a traditional remedy used by Africa's San people obtaining royalties from the UK-based pharmaceutical company Phytopharm due to the presence of South Africa's Council for Scientific and Industrial Research (CSIR), which had acted as knowledge intermediary and installed a system of wealth distribution (Makoni 2010). The deal between the San people, CSIR and Phytopharm did not go through in the end, but gives an insight into how this could be done, given the opportunity and sufficient local capability. A similar example can also be observed with Australia's aboriginal traditional medicine (IP Australia 2011). In this case, the indigenous knowledge needs to be reviewed both scientifically and legally to be appropriated. Moreover, to distribute the benefit of appropriation among the community requires a new institution. As can be seen, increased global access to knowledge under the condition of a knowledge divide can be converted into increasing disparity without sufficient local provision of knowledge and countervailing power (Myint 1951).

For developing countries to take advantage of increasing global knowledge flow requires strengthening local capacity. While local innovation strategy and capacity become essential to surviving in the global economy, the impact of policy at national level has diminished significantly. In other words, the system of innovation framework, in such a context, must take into account the global flow of knowledge and actors beyond national borders, making the system of innovation a framework to link multiple levels—national, regional and global

—of activity. Furthermore, the examples made it explicit that effective knowledge flow involves various actors and institutions, and their evolutionary interaction in a systemic and dynamic manner, which also indicates the appropriateness of using the innovation systems framework.

3.2 Emerging types of innovation in a changing world

Several emerging forms of innovation are observed, reflecting the changing panorama of innovation in the present-day context. The following explains these in detail.

a. User innovation

Contrary to the existing thinking of innovation studies, where producers are the driving force of innovation, users—the consumers or firms who benefit from the use of products or services (von Hippel 2005)—are increasingly considered as important sources of innovation (von Hippel 1988). User innovation is the creation or alteration of goods or services by a user with the aim of increasing the benefit of the user. Some existing studies (Flowers et al. 2010; Gault and von Hippel 2009) indicate that there is a significant presence of this user innovation among consumers and in firms. The knowledge generated by users is diffused in various ways: through users transferring it to producers; by users themselves starting a business; or by users sharing it with a community of practice (Gault 2012).

Despite the fact that users play an important role in the innovation process, as there are no independent criteria for user innovation in the official definition of innovation (OECD and Eurostat 2005), much of user innovation is not recorded separately from other types of innovation. Hence this area requires further research, particularly regarding the extensive nature of this activity and its implications for innovation policy (Gault 2010).

b. Social innovation

Social innovation is both good for society and has the potential to enhance the social capacity to act (Murray et al. 2010) or to exert a significant impact on social performance (Pol and Ville 2009) in meeting social goals (Young Foundation 2007: 8). Similarly, the OECD LEED Forum on Social Innovation (OECD 2008) defines social innovation, indicating that it will “deal with improving the welfare of individuals and community through employment, consumption or participation, its expressed purpose being to provide solutions for individual and community problems”. Existing business innovation also aims to improve social welfare or human well-being; however, social innovation is believed to be separate from the pecuniary interest of making a profit but focused more on creating or offering better solutions for people (Pol and Ville 2009; Kuznets 1974; OECD 2008).

Attention to social innovation has recently increased because of a recognition that the existing structure of policies is limited in solving some pressing issues (such as climate change, finding the cure for chronic disease and widening inequalities), as well as the current financial crisis in developed countries and chronic shortages of welfare funding in developing countries, forcing new actors to search for alternative solutions, different from those offered by the public and the private sector.

Social innovation, in its implementation, suffers from a number of conceptual overlaps.

For instance, although it is ‘social’ and non-pecuniary, financial viability is crucial for sustaining social innovation, demonstrating the blurred boundary with business innovation. In addition, various concepts used to describe social innovation, such as improving ‘quality of life’ and ‘desirable innovation for whom at which moment’, still need to be defined clearly to allow comparative measurement of success across cases.

c. Public sector innovation

Public sector innovation aims to improve the efficiency and productivity of the public sector in its delivery of services to citizens, such as policy making and implementation, or providing social services such as education, health care and various other support services for civic needs (Gault 2012).

Public sector innovation has been an important area in innovation research (for example in Mulgan 2007; Mulgan and Albury 2003; Kelly et al. 2002), but interest in this area increased recently due to the financial crisis in developed countries that requires reduced public spending but at the same time maintenance or increase in public services (Bloch 2010; Bugge et al. 2011; Bloch 2013). A number of recent studies on public sector innovation suggest the following difficulties in applying the existing framework: (1) definition; (2) measurement of innovation expenditures; and (3) survey methodology, such as target population, statistical units and classifications (Bloch 2013). This calls for some changes. For instance, Gault (2012) proposes a change in the existing definition of innovation. He suggests that the definition in paragraph 150 of the *Oslo Manual*, which defines innovation as implemented when it is ‘introduced to the market’ to be extended to ‘made available to the potential user’ (Gault 2012). This change would solve the first difficulty mentioned by Bloch (2013) and may give clues to solving the second and third difficulties mentioned above.

d. Innovation for inclusive development

Innovation for inclusive development is yet another emerging concept. There are several concepts of innovation addressing developing countries or poor and marginalized segments of population: ‘grassroots innovation’ (Gupta et al. 2003), ‘innovation for bottom (base) of pyramid’ (Prahalad 2005; Prahalad and Hart 2002), ‘below the radar innovation’ (Kaplinsky 2011), ‘frugal innovation’ (Tiwari and Herstatt 2012; Zeschky et al. 2011). All seem to address slightly different target groups, types of innovation and objectives of innovation in developing countries. Despite these differences, all seem to agree that applying the innovation concept in developing countries requires local knowledge and capability. The concept of innovation for inclusive development attempts to address the poor more directly by focusing on innovation in informal settings targeted at marginalized populations (Cozzens and Sutz 2012). For example, some of the examples of innovations—mobile phone banking and microfinance—enable marginalized populations to be included in formal economies by providing vital services, which were being provided by neither the private nor the public sector. UNDP defines inclusive development as “development that marginalized groups take part in and benefit from, regardless of their gender, ethnicity, age, sexual orientation, disability or poverty. It seeks to address the deepening inequality across the world that has

arisen despite unprecedented economic growth” (UNDP website 2012). Some of the features of inclusive development are: multi-stakeholder (Berdegue 2005), ‘actor’ and ‘social value’ centred (Sen 1999) and collaborative learning (Lundvall 2010). Some of these features share the similarities mentioned in other emerging types of innovation.

Much of the innovation in developing countries takes place in an informal setting, but this has been understudied due to lack of information, data and access to such communities; this is ‘dark innovation’²⁾ (Martin 2013). Limited research on innovation in informal settings has indicated that several fundamentally different features of the innovation process have been observed in informal settings, as follows.

First, innovation in an informal setting is often initiated by strong demand from users to acquire improved welfare or quality of life. This is due to the absence of conventional actors (public and private) that supply such goods or services, making this particular set of population invisible or marginalized. *Second*, many of the skills in an informal setting are learned outside the formal education/training system. This means that institutional set-ups that stimulate and prepare knowledge flow—such as existing local knowledge (traditional knowledge, culture, routine), institution of rules of law (tradition, custom, routine), networks of learning, communities of practice—are very different from the conventional form and remain largely understudied. *Third*, interactions beyond local networks, such as national, regional or global—all formal—networks benefit greatly from scaling up and improving knowledge diffusion and creation in an informal setting, while currently the interaction of actors in informal settings and in formal setting is still limited (Cozzens and Sutz 2012). *Fourth*, it became evident that the role of intermediary (Howells 2006) organizations or actors that facilitates knowledge diffusion in formal settings is important; however, very limited knowledge is available on how intermediaries are established and behave in informal settings (such as agricultural extension officers, NGOs, informal media, local corner shops) in order to diffuse the knowledge and scale up the innovation activities. *Fifth*, the dominant types of innovation in developing countries are non-technological and much more reliant on incremental and organizational innovation (OECD and Eurostat 2005; Cozzens and Sutz 2012). *Finally*, the policy of enhancing the welfare of marginalized populations in informal settings is new and requires further research to understand the effective design and implementation with regard to the local and specific context of knowledge flow (Kraemer-Mbula and Wamae 2010; Cozzens and Sutz 2012).

The above discussion of emerging new variants of innovation—user innovation, social innovation and public sector innovation, innovation for inclusive development—reveals various common features. These emerging variants of innovation pay attention to knowledge flow, as does business innovation, but with a slightly different twist: aiming at improving ‘non-economic’ aspects, initiated by users or communities of users and not directly linked (if linked at all) to the market. Furthermore, the dominant form of innovation is non-technological but relies more on incremental and organizational innovation.

4. Can the system of innovation framework meet the new challenges?

The system of innovation framework has proven to be useful in explaining the innovation process in a formal context where firms are considered as the driving force for the innovation process. The innovation system was useful in explaining how and why some firms/countries/regions are successful in economic growth compared to others by identifying existing actors in connection to the market, observing types of interactions and understanding the process of knowledge flow among the actors. The system is able to identify the bottleneck of knowledge flow holistically, making it a useful ‘focusing device’ for elaborating effective policy for economic development within national boundaries. Can the system of innovation framework meet the new challenges?

As examined in an earlier section, emerging types of innovation in a global context search for alternative solutions to new societal challenges. The emerging types of innovation differ from the existing business innovation in the following ways: (1)aim of innovation; (2)driving force of innovation; (3)actors in innovation; (4)contextual conditions and institutional setting of innovation; (5)understanding of knowledge flow; and (6)the policy needs for effective design and implementation. These points are explained in detail below.

4.1 *The shifting aim of innovation from ‘improving the productivity of the firm’ to ‘solving a problem for better quality of life for the community’*

The major goals of innovation studies and the innovation system have been to understand the process of putting a new idea/good/service on the market. The current *Oslo Manual* (OECD and Eurostat 2005: para 146, 150) clearly states the direct link to the market as one of the preconditions for newly implemented ideas to be considered as innovations. Nevertheless, in emerging variants of innovation—social innovation, user innovation, public sector innovation and innovation for inclusive development—most of the new ideas/goods/services directly serve the users or community of users and are not always introduced to the market. For example, the Linux operating system was created by the user and shared and improved among the self-organizing community of users in an open form. In this case, the driving force of innovation was a group of individuals existing in global networks. The aim of the innovation was to create a better operating system and the knowledge was shared among the community without market intermediation. As in this example, the emerging innovations try to satisfy social needs—better operation systems—with less focus on pecuniary gains in return, as in existing business innovation.

4.2 *Self-organizing users or community as new driving force for innovation*

As can be seen from the example of the Linux operating system, the user or group of users is the driving force or initiator of innovation in the emerging types of innovation, contrary to business innovation where the producers or firms have always been considered

as the driving force. Several studies have already demonstrated the significant contributions of user innovation (Flowers et al. 2010; Gault and von Hippel 2009).

Businesses as user innovators can be accommodated in the *Oslo Manual* definition, but this role is not made explicit in implementations of the *Manual*, such as the EU Community Innovation Survey (CIS). Consumers as user innovators do not appear in official statistics unless they start a firm, becoming a business, or transfer their knowledge to a producer. The act of sharing the knowledge gained from an innovation activity within a community of practice or a peer group is not recorded, although suggestions are being made to do that (Gault 2012). Measuring user innovation will require a good understanding of non-market linkages and introducing different types of actors as the driving force in the existing system of innovation framework.

4.3 *Include non-conventional actors in knowledge networks*

To understand knowledge flow within emerging types of innovation, innovation systems may need to include a wide range of non-conventional actors (such as local corner-shop owners, neighbourhood associations, NGOs, local communities, communities of practice) who are often not directly associated with productive networks. The concept of non-conventional actors requires further research.

4.4 *Different contextual conditions for interactions: blurred boundaries*

The new variant of innovation involves multiple interactions between polarized conceptual domains with blurred boundaries. These conceptual domains are: global-local, user-producer, economic-social and informal-formal. The boundary of each domain is blurred because actors interact between the two worlds in each domain to diffuse and create knowledge with the purpose of 'problem solving'. The interaction within a domain can be facilitated by intermediaries. This process is similar to the knowledge diffusion and creation that took place via spiral transformation from codified and tacit knowledge and vice versa (Nonaka and Takeuchi 1995).

4.5 *Incorporate multiple dimensions of the knowledge network and its diffusion process*

Understanding knowledge flow is crucial to understanding the innovation system. A number of studies have demonstrated that knowledge flow is multidimensional and goes beyond national boundaries as the individual belongs to various networks of interactions. The quality and type of network, such as degree of trust and social capital, can influence the speed and trajectory of knowledge flow and determine the overall innovation process. Hence, extending to the non-market network and informal context can contribute in revealing the dynamics of the innovation process.

4.6 *Search for alternative solutions: 'technology fix' to 'holistic solution'*

The existing analysis of the innovation system gave more attention to R & D and tech-

nological innovation of the firm, while the new variants of innovation assign technology a more supportive role in solving problems. For example, some policy solutions for maintaining citizens' health may not encourage technological innovation in medicine to achieve a scientific fix but can offer an alternative innovative policy to prevent disease through subsidies to sports facilities, medical check-ups and dietary advice. Another example is reducing waste. Instead of trying to create biodegradable fibre for carpets to reduce waste after use (technological fix), changing the business model from selling carpets to selling an integrated service of 'covering the floor' (for instance to include carpet rental, maintenance and recycling after use) can encourage more efficient use of resources and generate better services, and ultimately achieve waste reduction through holistically solving the problem at the systemic level (Hawken et al. 2000). Similarly, in developing countries, using mobile phones for transferring money can be considered an incremental and organizational innovation, with technology playing the supporting role.

Can the innovation systems framework still be a useful tool for innovation to confront the emerging challenges? Because of the increased importance of understanding systemic solutions (point 4.6) and interaction within polarized domains (point 4.4), systemic understanding can become increasingly useful for effective policy making. Nevertheless, as discussed above, slight adjustments need to be made to the framework, such as the choice of driving force—firms to non-firms (such as community of practice, user, public sector, an individual) (point 4.2)—incorporating a wider set of actors in the networks beyond national borders (such as global, informal, user and social) (point 4.3), from multiple networks in different contexts (such as informal, public sector) (point 4.5) with a different aim of the innovation (such as non-pecuniary, social, welfare), problem-solving process (point 4.1).

Although the existing innovation systems framework is greatly influenced by the studies that in the high-tech manufacturing sector were strongly connected to the market, the original definition of innovation given by Schumpeter (1934) was much broader. He grouped innovation in the following five groups: (1) a new or improved product (not necessarily new to the world); (2) a new or improved process (not necessarily new to the world); (3) the opening of a new market (new to the sector or country); (4) the acquisition of a new source of raw materials or semi-manufactured goods; and (5) an organizational change (Schumpeter 1934: 65). This means that the emerging innovation panorama is not so different from the view of Schumpeter, and well within the original definition of innovation.

5. Conclusion

Innovation has offered various solutions to productive challenges in the business context. The innovation systems framework was useful in this context because it essentially identified the key actors and knowledge flows within the system dynamics, allowing policy mak-

ers to elaborate policy to better target and steer the knowledge creation and diffusion process.

Currently, the innovation systems approach is presented with challenges whose aim is to 'solve non-market problems' in less-understood and underresearched settings (informal, global, traditional, community of practice). Under these conditions, the system needs to incorporate and extend its scope to include unconventional actors and take account of different contexts and conditions and interactions. Not much is known about innovation in the non-business context, and further research would allow us to identify the local specificities and common features in order to achieve a new understanding of policy elaboration and frameworks.

The innovation systems approach still has value in confronting existing as well as emerging societal challenges. Many of the key features of the existing innovation system—attention to institutional setting, policy and actors—are considered important points in the emerging types of innovation (see sections 3 and 4). This indicates that 'problem solving' is still within the domain of innovation defined by Schumpeter (1934). The innovation systems framework that originated from Schumpeter's definition will continue to be a useful 'focusing device' for the 'problem-solving' process with careful understanding of the new context based on further research into adjusting the framework.

Notes

- 1) There are slight differences among these authors in the way institution is defined. Here the focus is on the distinction between organization and institution.
- 2) Martin (2013) argues that innovation studies have been overrepresented in the sectors that are technology based, such as the large manufacturing sector, with available R & D and patenting data—the visible innovation—as against dark innovation.

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