Accelerator of innovations for pre-incubation stage of project lifecycle

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Abstract. The article is aimed at developing cogent proposals to shorten the implementation of pre-incubation stage of the innovation lifecycle. To achieve the goal, we proposed a framework to formalized description of innovative systems that allowed us to identify structure and set of elements of the system that are invariant with respect to its levels. The analysis of the most popular innovation process models allowed us to single out the feedback as a key structural element of the system, which to a large extent determines the dynamics of the innovation process. It is shown that the absence of specialized infrastructural elements of innovation systems that could provide cross-cutting feedback at the pre-incubation stage is a deterrent to accelerate innovation.

1 Introduction

To make the sustainable impact on development of the innovation system, the intermediaries shall be equipped with a set of new tools that make their support for innovation processes more effective. These newly created tools should also allow the intermediary organisations to meet the needs of SMEs and start-ups in the field addressed. Furthermore, relevant stakeholders shall start cooperating when supporting the commercialisation of products and testing innovative products and services. The long term challenge identified as necessity to accelerate the innovation process is to help innovation system to become a front-runner in sustainable innovation and entrepreneurship through improvement of the business landscape.

1.1 Generations of the innovation process model

Technological change is a complex process that has not been fully studied yet. This complexity is partly associated with a diverse set of phenomena, which are referred to as the term "innovations". Very different phenomena have made generalization of innovation process difficult. For a long time thinking about technological change and innovation has been guided by linear models. In the 1950s and 1960s the most widespread models were the technology-push models and then the need-pull models. It was assumed that in the first case, the development, production and marketing of new technologies would follow a clearly

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defined time sequence that began with fundamental and applied research, including the stage of product development, and then led to production and possibly commercialization. In the second model, the source of ideas and the initiator for the linear sequential R&D process was solvent demand and market requirements.

In the 1970s, the third generation of the innovation process model was represented by a combined model. This model showed that both technological and pulling models did not contain an adequate description of the innovation processes. At the same time, innovations appear on the market as a result of a special process, consisting of separate but interacting and interdependent stages, covered by feedback and with various links to research communities. Hence, the focus was on interactions between phases and actors that were combined [1,2].

The beginning of the 1980s was a period when companies were conscious of the strategic importance of developing and using new technologies and organizational innovations. The successes of Japanese firms that created a system of high-quality manufacturing with low production costs and short design cycle have become a kind of impetus for development of a new model of innovation process based on the integration of external and internal participants in product development processes.

In the late 1990s, the fifth generation of the innovation process model was disseminated. The information and communication technologies (ICT) play a key role in this model. Many researchers note that ICT have the ability to accelerate all the components of the innovation process [3-5].

The desire to increase the effectiveness of innovation process underlies the open innovation paradigm, which has become widespread at the same time [6]. Open innovations are designed to change the initial stages of innovation process, when the idea of an innovative project is formed and the necessary set of technological solutions is determined. The essence of the proposed changes consists in shifting the focus to external research and knowledge of outside experts in the organizing of R&D necessary for the innovation process. As a result, the number of successfully implemented innovation projects is significantly increased and the period of their implementation is shortened.

1.2 Feedback in the innovation lifecycle

The above models that have been used for formulation of national R&D policies in the past, have come criticized in recent years for several reasons, not the least of which is the lack of feedback at several stages of the project life-cycle. Intensifying competition and shorter product life cycles require a closer integration of R&D with the other phases of the innovation process. This criticism has led to a broader view of the process of innovation as an interactive process with a multilevel feedback (fig.1).

Currently, the evolving theory of innovation emphasizes the central role of the feedback effects between the phases of the innovation process in the downstream and upstream flows, and testing is a natural tool for obtaining this feedback [7]. As markets become customer-focused, customers focus on the scale of product success and technological innovation. This creates new challengers for innovators, as they need to adapt innovations to the dynamically changing needs of customers and to speed up commercialization process. The creation of innovation in this dynamic environment cannot rely anymore on standardized linear processes, but must be based on flexible processes that allow an acceleration of innovation as speed becomes crucial.

Fig. 1. Feedback in innovation process.

2 The problem definition

The above last generations of the innovation processes models consider the acceleration and reduction of the terms of innovation cycle as one of the key tasks. At the same time these models describe the static of innovation processes while a process is dynamic system. Implicitly the process dynamics in these models is reflected in the form of logical interaction chains of model elements, including feedback. There are no selected elements which provide feedback for acceleration of separate stages of innovation lifecycle at these models. The need for such elements is determined by the fact that the structure and content of tasks that are being addressed at different stages of the life cycle are significantly different. Hence, the

methods and means of acceleration must be different. In other words, in addition to common acceleration tools, such as ICT, for each stage of the life cycle of innovation, their own tools must be used. The subject of this study is the accelerator for the initial stages of the innovation life cycle (Fig. 2).

Fig. 2. Innovation lifecycle and its stages.

3 The acceleration in the context of innovation systems

Both the high-tech innovation industries and the traditional industry striving for innovation often lack a clear understanding of existing market needs due to the high dynamics of changes in the knowledge-based economy. Lack of knowledge about specific demand is replaced by a general idea of the development directions of future technologies and the demand for their applications. This is reflected in directions of development of innovation systems in general, and its elements and the tools used for development of innovations in particular.

The innovation system is an interconnected set of elements, corresponding to the known characteristics of the system:

$$Si = < Ai Ei Ni Pi Ui > \tag{1}$$

where $\{A_i\}$ is the set of innovation actors; $\{E_i\}$ is the set of elements of innovation infrastructure elements; $\{N_i\}$ is the set of normative and legal documents which create a legal framework for innovation activity; $\{P_i\}$ is the set of innovation priorities, $\{U_i\}$ is the set of financial and other sources for support of innovation.

Traditionally, researchers identify the national, regional and corporate levels of

innovation systems. The concept of national innovation systems (NIS) was proposed by Freeman in 1987, and was further developed by Porter in 1990, Lundwal in 1992, Nelson et al. in 1993, and by other studies [8-10]. The main idea of the NIS concept is that the innovation process in the state should be coordinated and rely on both private and public institutions. The concept of regional innovation system (RIS) was formulated by Braczyk et al in 1996 [11]. Later it was developed in a number of works [12-14]. The key elements of RIS are innovative actors - innovative companies interacting with the external environment, which is formed by competitors, suppliers, customers, authorities and other external organizations on the basis of regional policy, territorial, social and cultural and other features of the business environment of the region. An important role in RIS is assigned to universities and other scientific organizations that form knowledge, which are the basis for the innovation process, as well as to the network structures that ensure the dissemination of innovations. Since the early 2000s, there has been a growing interest in the subregional dimensions of innovation systems, partly because of a growing dissatisfaction with their relevance at the national and regional levels [15]. In recent years there has been a growing interest in the study of corporate innovation systems (CIS) [16-18]. Being active actors of NIS and RIS, large corporations, universities and other participants themselves represent a rather complex system, which draws all elements according to (1). Summarizing the above studies, and also using the results of monitoring of innovation systems in Russia and abroad, we came to conclusion that description of the innovation system in the form of (1) allows us to distinguish a supranational level - international innovation systems (Table 1).

Table 1. Types and composition of innovation systems.

	International Innovation Systems IIS	National Innovation Systems NIS	Regional Innovation Systems RIS	Corporate Innovation Systems CIS
Elements of the set $\{A_{ij}\}$	Transnational corporations realizing innovative projects. National companies working with external markets for innovation. International innovative networks. Innovative communities	National institutes of innovative development. National companies supplying innovative products and services to domestic market. National innovation networks	Stakeholders which determine the strategy and tactics of innovative development of the region. Companies of the region using its key resources for innovation. Regional clusters	Specialized innovative divisions of the company. Management bodies that determine the innovative strategy and tactics of the company. Innovators
Elements of the set $\{E_{ij}\}$	International organizations that provide financial support to legal entities and innovators. Specialized information systems focused on innovation.	Specialized national organizations providing financial, consulting, technical and information support to legal entities and individuals	Innovation intermediaries and support organizations in the region (business incubators, technoparks, innovation centers, technology transfer centers etc.	Specialized divisions of the company, whose business models are focused on services to innovative divisions of the company

Elements of the set $\{N_{ij}\}$	International agreements for joint development tools or for restrictions for certain activities or products.	National laws and other legal acts regulating taxation, measures of restrictions and stimulating of innovation	Regional laws and other normative acts on regulation of innovation activities, including the regional budget	The company's strategy, expressed in the documents approved by the management
Elements of the set $\{U_{ij}\}$	International innovative programs. Educational programs to support mobility for the development of innovation. International Innovation Forums and Exhibitions	National innovative programs that provide subsidies and grants, as well as ordering innovative products. Educational programs for innovation management	Regional programs to support innovative development, grants to legal entities and individuals of the region. Innovation awards	Internal regulations of the company, which stimulate staff and provide financial resources and support for innovators
Elements of the set $\{P_i\}$	Formed and accepted by the international community directions of scientific and technical development of society, science and technology	National priority areas for the development of science and technology, critical technologies that determine the country's global competitiveness	Regional priorities of innovative development, taking into account the geographically determined role of the region in the division of labor and the world economic system	Programs of innovative development, areas of the greatest competencies of the enterprise employees

4 Logic of study

The proposed framework for the innovative systems definition makes it possible to identify those elements of the system that have the greatest effect on the quality of feedback in the system. These elements belong to sets $\{E_{ij}\}$ and $\{U_{ij}\}$. Elements of the infrastructure provide an internal (physical) opportunity for feedback, and support mechanisms provide external conditions for effective work (financing, consulting support, social incentives).

Within the framework of the task the next level of the monitoring of innovation systems was concentrated at selected sets. During the monitoring, elements were identified, the main function of which is formation of the necessary feedback in different stages of innovation lifecycle. In total, more than 60 elements of innovation infrastructure and more than 20 events and instruments for supports of innovators were studied. In the course of monitoring it was found that quite often the innovation infrastructure elements, as well as innovation support activities, have names that reflect their marketing potential, rather than functional characteristics, making it difficult to analyze their effectiveness. To avoid this difficulty, the innovation process was presented as a set of stages of innovation lifecycle (SIL) reflected technology development and level of testing (Table 2).

Table 2. Testing in the innovation process.

	Content of the innovation activity	Level of testing	Elements of innovation infrastructure

SIL 0	Unproven concept	No testing have been performed	Innovation co-workings
SIL 1	Basic research	Principles postulated and observed but no experimental proof available	Research laboratories at universities and research institutes
SIL 2	Technology frameworks formulation	Concept and application have been formulated	Centers of technology transfer
SIL 3	Applied research	First laboratory tests of technological parameters completed.	Innovation-technology centers, Centers for collective use of high-tech equipment
SIL 4	Prototyping	Small scale prototype to test technical parameters	FabLab, Centers of fast prototyping
SIL 5	Consumer properties demonstration	Large scale prototype to test the system in intended environment	
SIL 6	First of a kind commercial system	Manufacturing issues solved	Technoparks
SIL 7	Full commercial application	Technology available for consumers	Technopolices and Special economic zones with privileges for innovative companies

Two different levels of testing were identified: testing in a single stage (business plan evaluation, experiment etc.) and cross-cutting testing. The last one is more important since it's absence could create more essential delays for innovation development. The study shows that there is no specialized elements of innovation infrastructure oriented to large scale prototyping to test the system in intended environment. The main task of this SIL is finalization of technical specifications to ensure the necessary consumer properties (see Fig. 1). The similar result was obtained from analysis of supporting mechanisms for this type of the feedback.

5 Conclusion

The lack of infrastructure elements of innovation systems which are focused on testing of developed innovation products and services could become a challenge for acceleration of innovations at pre-incubation stage. Some examples of attempts to solve this problem (Living Labs in Europe, Innovation Sandboxes in Russia) show that innovation stakeholders become aware of the importance of this problem. The system approach to solving this problem requires coordinated changes in all selected elements of innovation system including behavior of innovation actors. Thus a road map for acceleration of innovation should contain coordinated measures on creation of specialized infrastructure elements for testing innovative products and services and on corresponding training and coaching of innovators at pre-incubation stages to prove importance and significance of these elements for accelerating the innovations.

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