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ON DEVELOPING TERRITORIAL CLUSTERS WITHIN INNOVATION SYSTEMS

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К ВОПРОСАМ РАЗВИТИЯ ТЕРРИТОРИАЛЬНЫХ КЛАСТЕРОВ В РАМКАХ ИННОВАЦИОННЫХ СИСТЕМ

The article presents a combined analysis of national, regional and corporate innovation systems and innovation clusters. The evolution of these concepts and the main characteristics of modern national innovation systems have been analyzed. An innovation cluster is considered as an element of the regional innovation system which provides scientific, technical, organizational, financial, and personnel support for all stages of the innovation cycle. The experience of the St. Petersburg Cluster of Clean Technologies for the Urban Environment, which is a part of the regional innovation system of St. Petersburg, has been analyzed. The requirements for the properties of a corporate innovation system of organization that acts as an initiator of cluster creation have been formulated. The conclusion that the innovation cluster is a special element of the regional innovation system with clearly defined properties is substantiated. These properties include: functional completeness in relation to all stages of the life cycle of complex high technology projects; the proximity of geographical location of the main participants in the cluster, combined with close informal relations of persons which make decisions of various levels during implementation of cluster projects; intrinsic motivation (readiness) of cluster members to use non-economic principles of business development in the implementation of cluster projects; intrinsic motivation (readiness) cluster members to modernize their own CIS meet the requirements of cluster projects.

INNOVATION CLUSTER; INNOVATION SYSTEM; CLEAN TECHNOLOGIES; CLUSTER'S PROJECT; INNOVATION PROJECT' LIFE CYCLE.

В статье анализируются инновационные кластеры и национальные, системы различных уровней. Рассмотрена эволюция данных понятий и проанализированы основные черты современных национальных систем. Доказано, что эффективная инновационная система должна обеспечивать как виртуальное (информационное), так и физическое взаимодействие субъектов инновационной деятельности. При анализе инновационной деятельности были выделены следующие типы инновационных систем: национальные инновационные системы (НИС); региональная инновационная система (РИС); корпоративная инновационная система (КИС). Доказано, что инновационная деятельность реализуется уже не только внутри отдельной организации, а все шире опирается на широкое межкорпоративное взаимодействие и как следствие, запускается процесс конвергенции технологий. Инновационный кластер рассматривается как элемент региональной инновационной системы, обеспечивающий научно-техническое, организационно-финансовое и кадровое сопровождение всех этапов инновационного цикла. Проанализирован опыт развития Санкт-Петербургского кластера чистых технологий для городской среды, как элемента региональной инновационной системы Санкт-Петербурга. Сформулированы требования к свойствам корпоративной инновационной системы организации, которая выступает инициатором создания кластера. Обоснован вывод о том, что инновационный кластер можно рассматривать как особый элемент региональной инновационной системы, который обладает следующими ярко выраженными свойствами: функциональная полнота по отношению ко всем этапам жизненного цикла комплексного наукоемкого проекта; близость географического расположения основных участников кластера в сочетании с тесными неформальными связями лиц, принимающих решения различного уровня при реализации кластерных проектов; внутренняя мотивация (готовность) участников кластера к использованию неэкономических принципов развития бизнеса в ходе реализации кластерных проектов; внутренняя мотивация (готовность) участников кластера к модернизации собственной КИС с учетом требований кластерных проектов.

ИННОВАЦИОННЫЙ КЛАСТЕР; ИННОВАЦИОННАЯ СИСТЕМА; ЧИСТЫЕ ТЕХНОЛОГИИ; КЛАСТЕРНЫЙ ПРОЕКТ; ЖИЗНЕННЫЙ ЦИКЛ ИННОВАЦИОННОГО ПРОЕКТА.

Introduction. Since the 1990s, we can observe in the scientific literature a lively discussion about the importance of innovation for enterprises, regions, countries and societies in general. It is intuitively obvious that innovation is a complex concept which takes into account a

variety of aspects of the process of obtaining new products and services on the basis of scientific achievements. It concerns the matters of using scientific and technological equipment, special principles of financing, special organizational forms of work of participants of the process, etc. The term «innovation system», which is used in the literature, reflects this complexity and comprehensiveness. The term was proposed by Freeman for comparing the levels of technological development of different countries [1]. Currently, this term is widely used in the scientific literature in the analysis of patterns of occurrence and distribution of innovations [2-6]. Recognizing the complex and multifactorial nature of innovation, researchers are exploring innovative systems, identifying them as complex of agents who share common policies and institutions that ensure the implementation of new technologies, products and services.

Following Freeman, the researchers of the innovation process pay significant attention to its regional aspects, considering geographic clustering as one of the most important qualities of innovation systems. The idea of geographic clustering was proposed by Alfred Marshall in 1921, but it has gained particular importance in recent years. The reason for this is as follows.

The implicit (hidden) knowledge, which is based on individual or corporate experience, plays an important role in the innovation process. At present, this knowledge cannot be distributed by means of ICT, since there are no methods and technologies of its formal representation (coding). Implicit knowledge requires for its transmission spatial proximity of the carriers of knowledge and innovation agents and organizing their direct interaction.

Both the innovative high-tech industry and the traditional industry, which strive for innovation, often lack a clear understanding of the market needs due to the high dynamics of changes in the knowledge-based economy. Due to the lack of specific knowledge of the future needs, the strategy (and often tactics) of behavior in the market is based on the general idea on the trends of technologies development and future demand for their applications. This common vision must be formed only on the basis of regular, frequent informal contacts between the participants of the innovation process.

The maximal effect can be achieved in the case when the innovation activities subjects which have similar mentality are interacting within the innovation system. This helps develop a common culture of innovation and enhance mutual trust.

Thus, one of the important features of the innovation system is its ability of using implicit knowledge, informal connections, and interacting subjects' common system of values. A necessary condition for the development of this feature is the geographical proximity of innovation activities subjects. As a result, territorial innovation clusters are forming, i. e., groups of organizations concentrated in a limited area, which are complementing each other within creating value chains in developing innovative products and services.

Rather a lot of attention is paid to the matter of researching innovation clusters in contemporary scientific literature. Traditionally, the following features of clusters are distinguished [7]:
− the geographical proximity of the cluster's participants;
− the affinity of technologies used in creating value chains;
− the commonness of subjects which are about to change in the process of creating the value chains;
− the presence of an innovative component;
− the presence of a mechanism for cooperation of cluster participants and coordination of their activities;
− the presence of a synergistic effect from the interaction between participants of the cluster.

There is also a unity of two opposite features of the cluster: mutual competition of its members, and their close cooperation in the formation of the unique competences of the cluster. [8].

Innovation clusters are an effective tool for the development of regions of Russia [9]. For their support, organizational and financial instruments are used, which including:
− providing grants for the implementation of development programs for regional innovative clusters in the regions of the Russian Federation;
− implementation of measures for the development of regional innovative clusters within the federal target programs of the Russian Federation;
− involving development institutions to implement programs of territorial innovative cluster development;

− encouraging the participation of big companies in the activities of regional innovative clusters;

− dissemination of experience in the use of tax allowances to stimulate innovative activities of the participants of innovative territorial clusters.

Problem definition. A number of works note a close relationship between regional innovative clusters and regional innovation systems and the elements of the innovation infrastructure [10−12]. Even though the terms «innovation system» and «innovation cluster» are widespread, it should be noted that there is a problem of identifying the scope of application for these terms. The urgency of this problem stems from the fact that a number of researchers are using these terms without a clear explanation of what exactly is meant by innovation system or cluster, what are their functions, composition and structure and how these concepts are related. By analogy with the term «innovation» [13, 14] there is a broader interpretation of the terms «innovation system» and «innovation cluster», when these words mean everything that is directly or indirectly related to the development of production.

An analysis of the typology of innovation systems is required, comparing them with the basic functions of regional innovative clusters and allowing to substantiate the relationship of these concepts and understand the perspectives of their development.

Innovation systems typology
− The key components of the innovation systems are the following [5]:

− innovation-active firms, investing in research and implementation of new technologies to increase profits and meet consumer demand;

− specialized public institutions which support or conduct research and promote the dissemination of new technologies;

− institutions of higher education (universities) that combine research activities and personnel training;

− specialized state programs (sets of measures) aimed at the development of science and the spread of new technologies;

− industry legislation that regulates intellectual property rights, features of the interaction of various institutions, etc.

In general, the following resources are required for developing an innovation system [15]:

− Financial Capital (available «seeding» venture and investment capital).

− Physical infrastructure (transport, communications, water and electricity, etc.).

− Business infrastructure (institutions such as industry associations, chambers of commerce, development agencies).

− High-quality living conditions and anticipated benefits from the placement of businesses in this location.

− Administrative regulation of low cost of infrastructure and / or loans for business start-ups.

− A diversified economic base consisting of product suppliers and distribution networks, as well as suppliers of specialized services.

− Proximity to markets.

− Proximity to sources of knowledge, such as universities or research centers which perform fundamental and applied research.

The last point is particularly important for contributing to the continuous updating of the knowledge base within the innovation system. This applies in particular to the science-intensive and high-tech industries. Universities and research institutes promote the development of innovation clusters and provide a steady stream of creation and transfer of new knowledge as a source of innovation. This transfer includes not only the processes of explicit and implicit knowledge transfer in the process of cooperation, but also the physical movement and communication between people.

Thus, an effective innovation system should provide both virtual (informational) and physical interaction of the subjects of innovation activity.

The following types of innovation systems are traditionally selected in analysis of innovation activity:

− National Innovation System (NIS);
− Regional Innovation System (RIS);
− Corporate Innovation System (CIS).

Many authors emphasize the inextricable link between NIS, RIS and CIS, carrying out a comparative analysis [16,17]. Summarizing the results of studies of Russian and foreign scientists dedicated to the problems of the development of innovative systems, we distinguish the following elements of the innovation system.

$\{C_i\}$ − a set of subjects of innovative activity (research organizations that are engaged in the implementation of its research results into production, or solve the problem formulated by production; small innovation companies created by the authors of scientific achievements for their commercialization; innovators which are at

the pre-incubation stage of the development of innovative ideas; specialized divisions of large industrial corporations and universities).

{Ei} − a set of objects of the innovation infrastructure (business incubators, innovation and technology centers and other organizations that provide specialized services to subjects of innovation activity).

{Ni} − a set of normative legal documents regulating various aspects of innovation (laws, regulations and directives of government authorities, forming a favorable innovation climate).

{Ui} − a set of financial and other support mechanisms available to subjects of innovation activity. The mechanism in this case means a set of rules and procedures aimed at a certain limited number of participants and at achieving some kind of goal. Support mechanisms within innovative systems include:

− measures to promote the demand of government authorities of various levels for innovative products;

− procedures providing tax concession and loans for the subjects of innovation activity

− procedures providing direct subsidies for the subjects of innovative activities to compensate for the costs of certain types of activities;

− procedures providing indirect subsidies and guarantees to subjects of innovation activity;

− procedures for organizing special congresses, exhibitions and other informational and marketing activities with the use of administrative resources of public authorities to promote innovative products both in the Russian and foreign markets;

− procedures providing a system of consulting and outsourcing services to the subjects of innovation activity on a preferential basis;

− procedures of targeted training and retraining of personnel for subjects of innovation activity.

{Pi} − a set of priorities of innovation activity (international and national priorities of development of science and technology and critical technologies; regional priorities of innovative development; the priority areas of innovation activity of certain corporations and enterprises; the area of highest-level competences of certain innovators).

By the innovative system we mean a coherent set of its elements, corresponding to the known attributes of systematicity.

$$Si = < Pi\ Ci\ Ei\ Ni\ Ui >$$

The innovative system has a hierarchical nested structure: an innovative system of the lower level is an element of an innovation system of a higher level $S_{cor} \subset S_{reg} \subset S_{nat} \subset S_{int}$

Each of the levels of the innovation system hierarchy possesses its own set of elements [18].

National innovation system and its effectiveness evaluation. The NIS concept was proposed by Freeman (1987), and later it was developed by Porter (1990), Lundvall (1992), Nelson et al. (1993) and by other researchers. The main idea of the NIS concept is that the innovation process in the country should be coordinated and supported by both private and public institutions.

Lundvall defines NIS as a set of elements and their relationships, which are used for production, dissemination and use of new and economically useful knowledge and interact within national boundaries [19].

OECD defines NIS as a set of technologies and information belonging to people, companies or organizations that play a key role in development of innovation, competitiveness and economic efficiency at the national level [6]. In fact, this concept confirms the statement that effectiveness and competitiveness of the economy depends not only on individual innovation subjects (innovators, innovative companies, science and technology organizations, universities, etc.), but also on the degree of development of their interaction as elements of a unified system using knowledge in the real sector of the economy, taking into account categories such as the priorities and values, norms and law.

Currently the NIS conception is widely used in the scientific literature worldwide, forming the basis for estimating the global competitiveness of countries [20-22].

A typical feature of the present stage of development of NIS is that innovation activity happens not only within particular organization, but increasingly relies on a wider inter-company collaboration. Large corporations are acting as initiators of creating knowledge networks, involving in these networks other institutions, such as universities, independent laboratories, government research institutions, etc. There are forming ecosystems of open innovation aimed at creating new business opportunities by sharing complementary knowledge and skills of different partners, including not only suppliers, customers, research organizations, but sometimes even competitors.

Another typical characteristic of the current stage of NIS development is the convergence of technologies. The most perspective areas of technological convergence are computer, nano- and biotechnologies, as is reflected in the approved list of crucial technologies of the Russian Federation [23].

Much of today's research on NIS is devoted to the models and methods of evaluating of NIS effectiveness and efficiency [24-26]. At the core of these studies is the idea of allocating a set of indicators that characterize the degree of development of one or another component of the NIS. Each of these indicators is assessed on the basis of statistical data and expert estimates. In the future, the obtained values can be used in making management decisions for the development of NIS, or its particular elements using a multi-criteria optimization methods.

The idea of transition to one-criterion evaluation of the effectiveness of NIS is realized in the formation of the Global Innovation Index (Global Innovation Index – GII) [27]. The final GII index forms as the arithmetic average of two indicators: the input intermediate Innovation Index (Innovation Input Sub-Index) and the output intermediate Innovation Index (Innovation Output Sub-Index). Each of these indicators reflects the key attributes of NIS. The input intermediate index reflects the properties of NIS elements: the quality of the institutional component, human capital and research, infrastructure development, market development level and the level of business development. The output intermediate index reflects the effectiveness of NIS: the level of knowledge and technological results and the level of creativity results. Depending on the research objectives, the GII is used to analyze the influence of the human factor on the national level of innovation, the local dynamics of innovation or the impact of innovation on the global economic growth.

Regional innovation systems and clusters. For the first time the RIS concept was formulated by Braczyk, Cooke and Heidenreich in 1996 [20]. Later it was developed in the works of a number of Russian and foreign scientists [21–24]. The key elements of RIS are the innovative companies, which are the subjects of innovation interacting with the external environment that is formed by competitors, suppliers, customers, governments and other external organizations on the basis of regional policy, territorial, social and cultural and other features of the business environment in the region.

Important role in the RIS belongs to universities and other scientific organizations, which form the knowledge that is the basis for the innovation process, as well as for a network of structures ensuring the spread of innovation. The traditional focus of research is the issue of benchmarking and performance measurement RIS [25–29].

Among the above-mentioned properties of innovation systems, the geographical location of its main elements is essential. This thesis is confirmed by the increasing frequency of the use of the term «innovation cluster» in the analysis of innovation systems.

According to the definition proposed by Porter (Porter 1998), clusters are defined as «a geographically connected group of interacting organizations: specialized manufacturers, service providers, industry and related organizations (e. g., universities, agencies, standardization and trade associations), who specialize in a certain subject area, being both competitors and partners» [30]. Recognizing the importance of regional innovation clusters and the benefits of synergies from the agglomeration of innovative agents, many regional governments in Russia and abroad have been implementing programs for development of regional innovation systems with certain different clusters as their elements. The following strategy for the development of these systems could be selected depending on degree of the authorities participation [31].

– Negligible involvement of public authorities in the formation of innovation clusters.

– Indirect involvement of public authorities in the RIS formation is limited to the role of a catalyst of the process.

– Direct involvement of the authorities in the RIS creation by investing in infrastructure and education, including programs of additional vocational training.

– Direct support of the authorities of changing the economic structure of the region through the implementation of the cluster's programs.

– The strategy of direct intervention, coupled with the practice of making major management decisions based on more political than purely economic goals. Typical tools of this strategy are the subsidies and other targeted tax preferences, regulatory and legal framework of protection and control, as well as government ownership and control.

Corporate innovation systems and their role in clusters formation. Recognizing the leading role of innovative companies in ensuring the RIS effectiveness, a number of authors consider the company as a special enterprise-level innovation system (CIS) [32, 33].

Many authors emphasize the inextricable link between NIS, RIS and CIS and conduct their comparative analysis [26, 33]. However, the main focus of research traditionally done on analysis of the processes of creation and dissemination of knowledge within the NIS, RIS or KIS while the structure and functions of NIS, RIS and CIS, as well as their interactions studied enough. There are also no studies that reflect the relationship of the CIS parameters and innovation clusters. In this regard, it is important to analyze the stages of development of existing clusters and their relationship with innovation systems at various levels. For this analysis, we consider the stages of development of St. Petersburg Cluster of Clean Technologies for the Urban Environment [34]. This cluster was created in 2014 under the management of the Center for Cluster Development of St. Petersburg as part of the St. Petersburg RIS [35].

At the time of the survey (January 2016), 26 companies were members of the cluster. These companies are designed to support all stages of the innovation cycle of introduction of resource-saving technologies in housing in St. Petersburg.

One of the special features of this cluster is the dynamics of development of its geographical constituents.

The cluster founders were organizations, compactly located within the restricted area (St. Petersburg). The systems approach to solving complex problems of resource conservation in housing showed the need for innovative organizational and technological solutions that have already been tried and worked outside the geographical scope of the cluster (in Norway and Finland). In addition, the problems for which the cluster is created, are relevant not only for St. Petersburg, but are typical for the regions of Russia. In this regard, the cluster included representatives of the Kurgan Region and the Republic of Tatarstan. As a result, the geographic scope of the cluster have been extended beyond one region and reached the national and international levels. The dynamics of the St. Petersburg Cluster of Clean Technologies for the Urban Environment

reflects the general principle of development of the complex innovative project life cycle:

1. *Identification and systematic analysis of the problem at the site of its occurrence.* A necessary condition for effective implementation of this step is to have an organization that is involved in the problem-solving process, and knows its nature, characteristics and solutions. For St. Petersburg Cluster of Clean Technologies for the Urban Environment such organization was the Non-Profit Partnership «The urban homeowners association» [36] which has initiated a project to improve the energy efficiency of typical apartment buildings in St. Petersburg.

2. *Search for the best organizational and technical solutions to the identified problems.* The advanced Russian and foreign technical solutions and organizational and financial arrangements were used in this project. These include an effective model for attracting investment, the introduction of technology and innovation in housing, which is based on experience in public and private companies in Norway, as well as organizational and technical solutions of Finnish companies that have been studied during the project «Efficient Energy Management» EFEM Neighbourhood Programme and Cooperation Southeast Finland and Russia ENI [37]. Referred organizational and financial mechanisms are part of the RIS of St. Petersburg, which confirms the thesis of the structural and functional relationships of the cluster and RIS.

3. *Formation of the development team providing solutions for scientific, technical, organizational, personnel and other tasks in frame of the solving problems.* The objectives of this phase are completely adequate for the formation of an innovation system. A necessary additional condition for formation of a cluster is the typical character of the problem being addressed. For the problem under consideration this condition is satisfied, as efficiency improvement in housing in relation to the old buildings is typical for St. Petersburg and other regions of Russia.

4. *Treatment received organizational and technical decisions as part of a pilot project.* With regard to the analyzed problem, this stage was implemented in the course of the project «Increasing Energy Efficiency of Apartment Houses of Mass 137 Series», which won the regional stage of the Second All-Russian competition of completed projects in the field of energy conservation, energy efficiency

and energy ENES-2015 in the nomination «Best energy-efficient apartment building».

5. *Replication of the pilot project results.* For implementation of this phase, the Kurgan State University and the Agropolis «ALKIAGROBIOPROM» (Republic of Tatarstan) joined to the cluster. Thus, access at NIS level for the cluster was provided.

This example of cluster development shows the extremely important role of the company which is the cluster initiator. It can be regarded as the center of crystallization, without which the crystallization process does not start. In this connection, it is necessary to formulate requirements for initiators of cluster creation. First of all, these requirements relate to the mission and strategy of the company, which in general terms can be summarized as follows:

− The priority of social orientation of the company's focus on business results;

− The priority of the strategy of developing cooperation above the strategy of combatting competition;

− The priority of the open innovation principles above the principles of the intellectual property protection;

− The use of the social networks formation principles for the interaction of participants of the implemented cluster projects.

All of these principles should be implemented in the CIS of the initiator of a cluster creation.

Results. The above-described observations suggest that the innovation cluster can be regarded as a special element of the regional innovative system which has the following pronounced properties:

− Functional completeness in relation to all stages of the life cycle of complex high technology projects;

− The proximity of the geographical location of the main participants in the cluster, combined with close informal relations of decision makers at various levels within the framework of implementing cluster projects;

− Intrinsic motivation (readiness) of cluster members to use non-economic principles of business development in implementing cluster projects;

− Intrinsic motivation (readiness) of cluster members to modernize their own CIS to meet the requirements of cluster projects.

REFERENCES

1. **Freeman C.** The 'National System of Innovation' in historic perspective. *Cambridge Journal of Economics*, 1995, no. 19, pp. 5−24.

2. **Lundvall B.A.** National innovation systems − analytical concept and development tool. *Industry and Innovation*, 2007, no. 14, pp. 95−119.

3. **Nelson R.R.** (ed.). National innovation systems. A comparative analysis. New York, Oxford University Press, 1993.

4. **Edquist C., Johnson B.** Institutions and organizations in systems of innovation. In: Edquist C (ed.) Systems of innovation. Technologies, institutions and organizations. London, Pinter, 1997, pp. 41−63.

5. OECD. National systems of innovation: General conceptual framework. DSTI/STP/TIP 94(4). Organisation for Economic Co-operation and Development, Paris, 1994.

6. OECD. Proposed Guidelines for Collecting and Interpreting Technological Innovation Data. OSLO, Paris, 1997.

7. **Bullinger H.-J., Auernhammer K., Gomeringer A.** Fostering the flow of innovation in the knowledge driven economy — challenges and success factors in innovation networks. Proceedings of the XX IASP World Conference on Science and Technology Parks, Lisbon, Portugal, 2003.

8. **Lundvall B.-A.** (ed.). National systems of innovation: Towards a theory of innovation and interactive learning. Pinter, London, 1992.

9. **Liu J.S., Luand W.-M., Ho H.-C.** National characteristics: innovation systems from the process efficiency perspective, R&D Management, 2014, pp. 1−22.

10. **Fagerberg J., Sapprasert K.** National innovation systems: the emergence of a new approach. *Sci. Public Policy*, 2011, no. 38(9), pp. 669−679.

11. **Fagerberg J., Mowery D.C., Verspagen B.** The evolution of Norway's national innovation system. *Sci. Public Policy*, 2009, no. 36(6), pp. 431−444.

12. **Naser M., Afzal I.** An empirical investigation of the National Innovation System (NIS) using Data Envelopment Analysis (DEA) and the TOBIT model. *International Review of Applied Economics*, 2014, vol. 28, no. 4, pp. 507−523.

13. **Carrincazeaux S., Gaschet F.** Regional Innovation Systems and Economic Performance: Between Regions and Nations. *European Planning Studies*, 2015, vol. 23, no. 2, pp. 262−291.

14. **Braczyk H.J., Cooke P., Heidenreich M.** Regional Innovation Systems. UCL Press, London, 1996.

15. **Alkemade F., Kleinschmidt C., Hekkert M.** Analysing emerging innovation systems: a functions approach to foresight. *Int. J. Foresight Innov. Policy*, 2007, no. 3(2), pp. 139−168.

16. **Asheim B.T., Gertler M.** The geography of innovation: regional innovation systems. *Fagerberg J., Mowery D., Nelson R. at al. The Oxford Handbook of Innovation*. Oxford University Press, USA, 2005.

17. **Cooke P., Uranga M.G., Etxebarria G.** Regional innovation systems: institutional and organisational dimensions. *Res. Policy*, 1997, no. 26(4−5), pp. 475−491.

18. **Akinfeeva E.V., Abramov V.I.** The Role of Science Cities in the Development of the National Innovation System in Russia. *Studies on Russian Economic Development*, 2015, vol. 26, no. 1, pp. 91−99.

19. O merakh po privlecheniiu vedushchikh uchenykh v rossiiskie obrazovatel'nye organizatsii vysshego obrazovaniia, nauchnye uchrezhdeniia, podvedomstvennye Federal'nomu agentstvu nauchnykh organizatsii, i gosudarstvennye nauchnye tsentry Rossiiskoi Federatsii v ramkakh podprogrammy «Institutsional'noe razvitie nauchno-issledovatel'skogo sektora» gosudarstvennoi programmy Rossiiskoi Federatsii «Razvitie nauki i tekhnologii» na 2013−2020 gody: Postan. Pravitel'stva RF № 220 ot 09.04.2010 g. (rus)

20. **Ivanova N.I.** National Innovation Systems. *Voprosy ekonomiki*. 2001. № 7. S. 61. (rus)

21. O gosudarstvennoi podderzhke razvitiia innovatsionnoi infrastruktury v federal'nykh obrazovatel'nykh uchrezhdeniiakh vysshego professional'nogo obrazovaniia : Postan. Pravitel'stva RF № 219 ot 09.04.2010 g. URL: http://ivo.garant.ru/#/document/12174942/paragraph/196:1 (rus)

22. Kontseptsiia gosudarstvennoi innovatsionnoi politiki Rossiiskoi Federatsii na 2002−2004 gody. *Innovatsii*. 2002. № 2-3(49-50). S. 11−14. (rus)

23. Global Innovation Index Reports. URL: http://www.globalinnovationindex.org/content.aspx?page=past-reports (rus)

24. Perechen' kriticheskikh tekhnologii Rossiiskoi Federatsii. URL: http://kremlin.ru/supplement/988 (rus)

25. Indikatory innovatsionnoi deiatel'nosti: 2008: stat. sbornik. M.: GU-VShE, 2008. 423 s. (rus)

26. Natsional'nye innovatsionnye sistemy v Rossii i ES, Pod red. V.V. Ivanova, N.I. Ivanovoi, I. Rozenbuma, Kh. Khaisbersa. M.: TsIPRAN RAN, 2006. 280 s. (rus)

СПИСОК ЛИТЕРАТУРЫ

1. **Freeman C.** The 'National System of Innovation' in historic perspective // *Cambridge Journal of Economics*, 1995, no. 19, pp. 5−24.

2. **Lundvall B.A.** National innovation systems − analytical concept and development tool // Industry and Innovation, 2007, no. 14, pp. 95−119.

3. **Nelson R.R.** (ed.). National innovation systems. A comparative analysis. New York, Oxford University Press, 1993.

4. **Edquist C., Johnson B.** Institutions and organizations in systems of innovation. In: Edquist C (ed.) Systems of innovation. Technologies, institutions and organizations. London, Pinter, 1997, pp. 41−63.

5. OECD. National systems of innovation: General conceptual framework. DSTI/STP/TIP 94(4). Organisation for Economic Co-operation and Development, Paris, 1994.

6. OECD. Proposed Guidelines for Collecting and Interpreting Technological Innovation Data. OSLO, Paris, 1997.

7. **Bullinger H.-J., Auernhammer K., Gomeringer A.** Fostering the flow of innovation in the knowledge driven economy — challenges and success factors in innovation networks. Proceedings of the XX IASP World Conference on Science and Technology Parks, Lisbon, Portugal, 2003.

8. **Lundvall B.-A**. (ed.). National systems of innovation: Towards a theory of innovation and interactive learning. Pinter, London, 1992.

9. **Liu J.S., Luand W.-M., Ho H.-C.** National characteristics: innovation systems from the process efficiency perspective, R&D Management, 2014, pp. 1−22.

10. **Fagerberg J., Sapprasert K.** National innovation systems: the emergence of a new approach // Sci. Public Policy, 2011, no. 38(9), pp. 669−679.

11. **Fagerberg J., Mowery D.C., Verspagen B.** The evolution of Norway's national innovation system // Sci. Public Policy, 2009, no. 36(6), pp. 431−444.

12. **Naser M., Afzal I.** An empirical investigation of the National Innovation System (NIS) using Data Envelopment Analysis (DEA) and the TOBIT model // International Review of Applied Economics, 2014, vol. 28, no. 4, pp. 507−523.

13. **Carrincazeaux C., Gaschet F.** Regional Innovation Systems and Economic Performance: Between Regions and Nations // European Planning Studies, 2015, vol. 23, no. 2, pp. 262−291.

14. **Braczyk H.J., Cooke P., Heidenreich M.** Regional Innovation Systems. UCL Press, London, 1996.

15. **Alkemade F., Kleinschmidt C., Hekkert M.** Analysing emerging innovation systems: a functions approach to foresight // Int. J. Foresight Innov. Policy, 2007, no. 3(2), pp. 139−168.

16. **Asheim B.T., Gertler M.** The geography of innovation: regional innovation systems // Fagerberg J., Mowery D., Nelson R. at al. The Oxford

Handbook of Innovation. Oxford University Press, USA, 2005.

17. **Cooke P., Uranga M.G., Etxebarria G.** Regional innovation systems: institutional and organisational dimensions // Res. Policy, 1997, no. 26(4−5), pp. 475−491.

18. **Akinfeeva E.V., Abramov V.I.** The Role of Science Cities in the Development of the National Innovation System in Russia // Studies on Russian Economic Development, 2015, vol. 26, no. 1, pp. 91−99.

19. О мерах по привлечению ведущих ученых в российские образовательные организации высшего образования, научные учреждения, подведомственные Федеральному агентству научных организаций, и государственные научные центры Российской Федерации в рамках подпрограммы «Институциональное развитие научно-исследовательского сектора» государственной программы Российской Федерации «Развитие науки и технологий» на 2013−2020 годы: Постан. Правительства РФ № 220 от 09.04.2010 г.

20. **Иванова Н.И.** Национальные инновационные системы // Вопросы экономики. 2001. № 7. С. 61.

21. О государственной поддержке развития инновационной инфраструктуры в федеральных образовательных учреждениях высшего профессионального образования : Постан. Правительства РФ № 219 от 09.04.2010 г. URL: http://ivo.garant.ru/#/document/12174942/paragraph/196:1

22. Концепция государственной инновационной политики Российской Федерации на 2002−2004 годы // Инновации. 2002. № 2-3(49-50). С. 11−14.

23. Global Innovation Index Reports. URL: http://www.globalinnovationindex.org/content.aspx?page=past-reports

24. Перечень критических технологий Российской Федерации. URL: http://kremlin.ru/supplement/988

25. Индикаторы инновационной деятельности: 2008: стат. сборник. М.: ГУ-ВШЭ, 2008. 423 с.

26. Национальные инновационные системы в России и ЕС / под ред. В.В. Иванова, Н.И. Ивановой, Й. Розенбума, Х. Хайсберса. М.: ЦИПРАН РАН, 2006. 280 с.

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