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Innovation infrastructure in the region: problems and directions of development

Svetlana Viktorovna
TEREBOVA
Ph.D. in Economics, Department Head. Federal State-Financed Scientific Institution the Institute of Socio-Economic Development of Territories of the Russian Academy of Sciences (56A, Gorky Street, Vologda, 160014, Russian Federation, svetlana-ter@mail.ru)

Abstract. Current models of innovation process prove that it is important to create a comprehensive infrastructure, since it is a necessary condition for promoting innovation development in the area. The article considers the concept of innovation infrastructure, defines its major subsystems and their constituent elements, and considers their functional purpose. The author argues that the effective functioning of innovation infrastructure requires the balanced formation and development of all its constituent subsystems: logistics, finance, personnel, information and marketing. The article shows that Russia is working actively in this direction. At the same time, the efficiency of using the infrastructure remains low. First of all, it is limited by the stagnation of demand for innovation on the part of Russian companies. It has been revealed that the infrastructure is developing primarily in those RF subjects and municipalities, which have the significant concentration of innovation potential and the high level of innovation activity (Moscow, Saint Petersburg, Tomsk Oblast, Republic of Tatarstan, etc.). At the same time, the transition to the innovation model of development requires the creation and effective use of innovation infrastructure in all the regions of the Russian Federation, and, first of all, in the regions where innovation, for whatever reasons, is not being developed properly. Such regions include the Vologda Oblast, which has been subject to the detailed analysis of the infrastructure subsystems; and its problems and development reserves have been identified. In general, the calculations indicate insufficient and unbalanced growth of the region's innovation infrastructure and the necessity to change its individual subsystems. The author justifies the growing need for the development of regional production and financial infrastructure and proposes activities to develop innovation infrastructure: 1) to create the missing infrastructure elements that enterprises need; 2) to increase the performance efficiency of existing organizations; 3) to solve the problems that impede their functioning.

Key words: innovation, innovation process, innovation infrastructure, region.

The restrictive political and economic measures against Russia, introduced at the initiative of the United States since March 2014 and supported by the Group of 7, concerned the sphere of high technologies and high technology industries. So, Rheinmetall AG, one of the largest manufacturers of military equipment and weapons in Germany and Europe, stopped supplying equipment to Russia [3]; Transnational Corporation Siemens announced that it would strictly adhere to all sanctions against Russia; American Applied Materials Corporation refused to supply equipment for the plant producing MRAM chips in Moscow, etc. According to the experts, it is the limited export of high technology to Russia and access of Russian banks to cheap credit resources that will have the most negative consequences [21] for Russian economy.

This encourages its transition to the innovative economy that can reduce the dependence on import of strategic goods and technologies. Thus, the most critical issue is to create the innovative system for the production of high-tech equipment and machines in the country. The current level of Russian enterprises' innovation activity is extremely low – about 10%, while in the late 1980s it amounted to 60–70%. In 1991 190 thousand applications for inventions was lodged [12], in 2013 this figure dropped to 44 thousand [17].

The innovative development concept and, in particular, the creation of the national innovation system [9] is a subject of a large number of discussions in the scientific literature. The following issues are disputable: who is the innovative development subject, what is the state role in the sphere of innovation, what mechanisms will allow to create an integrated innovation system, etc.

According to the Strategy for Innovative Development of the Russian Federation, the balanced development of the innovation system will be determined by the increased efficiency of current institutions (special economic zones, science cities, technology parks), as well as the wider support for innovation clusters.

The innovation cycle continuity is supposed to be achieved through innovation infrastructure (INI) [22], capable to rapidly and flexibly implement necessary innovation based on high production technologies. Its development is considered as a condition to introduce competitive products, the innovation process results, to the market.

This thesis is confirmed by the modern models of the innovation process (Japanese interactive, strategic networks). They prove that all the stages, from fundamental and applied research to production and marketing of the product, should be provided by the support structure and specialized financial resources.

The study of the theoretical and methodological foundations of innovative development allows us to conclude that the innovation sphere, which is an integral part of the economic sphere with its own internal specifics, should also have its own infrastructure that has both common and specific features.

The term "infrastructure" was transferred to the economy in the late 1940s

Table 1. Innovation infrastructure notion

Author	Interpretation: "Innovation infrastructure is..."
D.I. Kokurin	Complex of organizational-economic institutions to ensure the conditions for the implementation of innovative processes by the economic entities (including specialized innovative organizations), according to the principles of economic efficiency of the national economy as a whole and its economic subjects under conditions of market fluctuations [8].
I.G. Dezhnina, B.G. Saltykov	Combination of all subsystems that provide access to various resources (assets) and / or render various services to the innovative activity participants [5].
V.A. Gnevko	Unified system of interrelated and complementary subsystems and consistent organizational elements that are necessary and sufficient for the effective implementation of the activity, which requires full support and maintenance of the innovation cycle [4].
K.I. Pletnev	Entire combination of the activity aimed at solving problems of socio-economic development and combining pilot studies, conducting applied research and practical application of the obtained results in the production and social sphere, including on the commercial basis [14].

from the military lexicon, where it defined a combination of permanent support facilities serving the armed forces. In the broad sense, infrastructure refers to the independent sphere of economy, which industries produce not material products but services. Its main function is creation of the favorable business environment for economic subjects and national economy as a whole.

Innovation infrastructure in the works of most domestic economists (A.A. Rumyantsev, V.A. Gnevko, A.B. Serebryakov, D.I. Kokurin, K.I. Pletnev, I.G. Dezhnina, B.G. Saltykov) is defined as a complex, a set of organizations providing the innovation process subjects with the economic conditions *(tab. 1)*. Similar semantic content of this notion interpretation is given in the legislative documents of the Russian Federation, regulating the sphere of innovative development[1].

[1] Federal Law "On innovation activity and state innovation policy" as of December 1, 1999. Main directions of the RF policy in the development of innovative systems for the period up to 2010

Innovation infrastructure should facilitate the free exchange of resources between innovation process participants and the implementation of the national economy functions of self-regulation and self-adjustment due to the fluctuations on the market.

The researchers [1, 4, 5, 14, 20, 23] argue that innovation infrastructure is a system consisting of separate subsystems with functional specificity and different constituent elements – innovation infrastructure organizations. In turn, INI organizations are technologically and economically tied and united at all stages of innovating activity, but they differ by activity sectors, types, presence or absence of foreign branches and enterprises [7]. There are the following main subsystems of innovation infrastructure *(tab. 2)*.

Thus, on the basis of various authors' opinions and the study of domestic and foreign experience we can identify material and technical, financial, personnel, information and marketing subsystem of innovation infrastructure, as well as their functions and elements *(tab. 3)*.

Table 2. Innovation infrastructure subsystem

Author	Innovation infrastructure subsystem
I.G. Dezhnina, B.G. Saltykov	Financial, industrial and technological (or material), information, personnel, expert consulting [5]
G.V. Shepelev	Industrial and technology, consulting, financial, information, personnel, marketing [23]
V. A. Gnevko	Industrial, financial, personnel training, information, coordination, promotion [4]
D.I. Kokurin, I.P. Nikolaeva, V.M. Shepelev, G.D. Kovalev	Transport and communication, information technology and telecommunications, financial sector, stock market, institute of intermediaries, companies and firms that provide services of special character [20]
V.A. Balukova, I.A. Sadchikov, V.E. Somov	Financial, informational, organizational [1]
K.I. Pletnev	Dataware, expertise of the scientific-technological and innovative programs, projects, proposals, financial support, production and technology support, certification of high-tech products, promotion, training and retraining of personnel, coordination and regulation of development [14]

Table 3. Main subsystems of innovation infrastructure: functions and elements

Subsystem	Functions	Elements
Material and technical	Production and technological assistance to the creation of new competitive science-intensive products and high technologies, their practical application	Technology parks, innovation and technology centers, business parks, innovation and industrial complexes, technological clusters, industrial parks, common use centers
Personnel	Training innovation managers to manage the implementation of innovative projects, promotion of researchers and developers' fulfilment, enhancement of the innovation culture of the population	Coaching centers, higher educational establishments, institutes, academies, etc.
Financial	Provision of the economic and financial support for innovative activity, accumulation of investment resources for the implementation of innovative projects and programs, organization of scientific-technological activities in terms of the program-target priority approach	Different types of funds (budget, venture capital, insurance, investment) and other financial institutions
Information and marketing	Creation of the opportunities for the transfer and dissemination of data on the trends in the innovative sphere development , the state of market environment, the presence of new objects of intellectual property; organization of marketing, advertising and exhibition activities, patent and licensing work and protection of intellectual property rights; certification of high-tech products	Libraries, information centers, technology transfer centers, cluster development centers, chambers of commerce, exchange of knowledge-intensive and information technologies, various telecommunication systems, mobile digital voice communications, etc.
Management	Provision of the opportunities to coordinate and regulate the development of scientific-technological and innovative activities by means of economic methods. Elaboration of the strategy for innovative development, support and monitoring of its implementation.	Departments of government and management, responsible for the development of innovative activities

Coordination and regulation of the innovation infrastructure subsystems are carried out by the state bodies, responsible for the development of innovative activities in the region. Their key task is to elaborate an innovation development strategy (it should include a section on the innovation infrastructure development), support and monitor its implementation [2].

The research in the theoretical and methodological bases of innovative infrastructure formation leads to the conclusion that the effective functioning of infrastructure requires balanced formation and development of all constituent subsystems. Russia is actively working in this direction. Thus, according to the Unified information and analytical portal of state support for business innovative development [6], there are more than 3.4 thousand innovation infrastructure organizations.

Only for 2005–2010 over 100 technology transfer centers have been created. In the framework of the program to support small and medium enterprises 34 innovative business incubator have been established, with the federal budget expenditures totaling 863 million rubles. At the end of 2010 there were 63 federal centers for collective usage of scientific equipment; they concentrated about 2100 pieces of equipment that cost 15 billion rubles. In addition, there are more than 140 technology and innovation centers and technology parks. The government backs the development of the Russian territories with high scientific and technological potential, including science cities [18].

Infrastructure development is envisaged in the Strategy for Innovative Development of the Russian Federation. The second phase of its implementation (2014–2020) includes the increase in the share of expenditure on innovation in the budget and the share of private funding in the total domestic costs on research. The special emphasis is laid on investment in the modernization of necessary elements of innovation infrastructure.

At the same time, the infrastructure performance remains low. First of all, it is limited by stagnated demand for innovation on the part of Russian companies due to insufficient support for cost recovery. As a result, infrastructure either ceases to function or is used for other activities [18].

Infrastructure is developing in the RF subjects and municipalities with the high concentration of innovative potential and the high level of innovation activity (there are 730 infrastructure organizations in Moscow, 197 – Saint Petersburg, 152 – in the Tomsk Oblast, 139 – in the Republic of Tatarstan). However, the transition to innovative model of development requires the creation and effective use of innovative infrastructure in all regions and, primarily, in those where innovation activity, for whatever reasons, does not develop [19]. According to the ISEDT RAS research, 61 of 80 analyzed regions had a low level of innovation development in 2012, with one of them being the Vologda Oblast, located in the Northwestern Federal district (NWFD).

In 2012 the Northwestern Federal district ranged the 3d by the rate of innovation activity lagging behind the Volga and Ural Federal districts where innovation infrastructure is better developed by its functional structure [15] *(tab. 4)*.

Table 4. Innovation activity of enterprises in the RF districts, %

Federal district	Year								Deviation 2013 to 2000, %
	2000	2005	2008	2009	2010	2011	2012	2013	
RF	**8.8**	**9.7**	**9.4**	**9.3**	**9.5**	**10.4**	**10.3**	**10.1**	**1.3**
Volga	10.1	10.8	12.5	12.8	12.3	12.7	11.9	11.7	1.6
Northwestern	**7.7**	**9.4**	**8.9**	**9.5**	**9.4**	**11.2**	**11.0**	**10.7**	**3**
Central	10.0	10.3	9.4	8.8	8.6	10.2	10.9	10.7	0.7
Ural	10.6	12.4	10.1	10.2	11.5	11.5	10.6	9.6	-1
Far Eastern	6.3	6.2	7.2	8.3	8.6	11.2	10.8	9.5	3.2
Siberian	6.1	7.7	7.7	7.3	8.2	8.8	8.5	9.1	3
Southern	8.1	8.6	8.0	7.2	7.5	6.5	7.4	7.2	-0.9
North Caucasian	6.2	8.2	5.2	5.8	6.2	5.2	6.4	5.9	-0.3
Source: www.gks.ru.									

According to the analysis of innovation infrastructure development in terms of the Northwestern Federal district subjects [13], business incubators dominate in its structure. Saint Petersburg takes the lead in the number of infrastructure institutions in the Northwestern Federal district; it is followed by the Murmansk Oblast and the Leningrad Oblast.

The identification of the most effective tools and mechanisms to form innovation infrastructure in the region requires distinguishing the regions where it is developed to further transfer the experience to those subjects where it is underdeveloped [24]. The results of the INI quantitative analysis performed by the ISEDT RAS Department for Innovation Economics helped group together the NWFD regions by the INI functional structure. There are four groups of regions: I – "regions with the full functional structure of innovation infrastructure"; II – "regions with the insufficient functional structure of innovation infrastructure"; III – "regions with the narrow functional structure of innovation infrastructure"; IV – "regions with the limited functional structure of innovation infrastructure".

The analysis of the presence and structure of innovation infrastructure reveals that the first group includes Saint Petersburg, the Murmansk Oblast and the Leningrad Oblast, which are also leaders in the total number of INI organizations. Business incubators and innovation-technological centers of innovation infrastructure predominate in the structure. The second group includes the Arkhangelsk Oblast, the Kaliningrad Oblast and the Novgorod Oblast (with the predominance of business incubators and technology transfer centers), the third group – the Republic of Karelia and the Vologda Oblast, the fourth – the Komi Republic, the Pskov Oblast.

The active regional policy on the creation and functioning of INI activities is carried out in the subjects with the full functional part of innovation infrastructure.

Nowadays Saint Petersburg, the Murmansk Oblast and the Leningrad Oblast are elaborating or already have special programs to support innovation infrastructure, working on creation of new innovation and technology centers, technology transfer centers and technology parks.

Financial funds are being created there on the basis of public-private partnership. These regions experience is advisable to use in the areas with the narrow, limited functional structures of innovation infrastructure, and in the Vologda Oblast, in particular. Let us consider the problems of infrastructure development on its example.

In the Vologda Oblast there is a number of the INI organizations to help regional enterprises create and develop innovative products by rendering them a wide range of services, such as marketing, legal services, registration of intellectual property rights, search and attraction of investments for a specific project.

However, the infrastructure organizations do not provide small business with high demand services, such as lending production facilities and laboratory equipment on concessionary terms.

In general, the ISEDT RAS calculations disclose the insufficient and unbalanced development of innovation infrastructure in the Vologda Oblast, the need to change some subsystems *(tab. 5)*.

This situation is caused by the low development level of material and technical (the subsystem development index is equal to 0.47), financial (0.68) and personnel (0.69) subsystems. The information and marketing subsystem has the highest development index (1.18), which indicates a high level of its development.

The problems that hinder the effective functioning of innovation infrastructure in the Vologda Oblast are the following:

a) a lack of INI organizations funding to provide financial support to small innovative enterprises (SIE);

b) a lack of qualified specialists in the field of innovative projects implementation and management;

c) a limited list of sources to provide small innovative enterprises with information;

g) low material and technical equipment of innovation infrastructure organizations, as well as unattractive for small innovative enterprises lease terms[2]...

What is more, according to the ISEDT RAS surveys of business leaders, the level of their interaction with the objects of innovation infrastructure is assessed as low *(tab. 6)*.

Thus, the insufficient development of private innovation infrastructure organizations is caused by low demand for their services due to the low level of enterprises' innovation activity in the region. As for public infrastructure, we can note stippling measures for its creation and a lack of the systematic approach.

The reason for it is fragmentation of the regional innovation policy, the absence of the policies and programs for innovative development in the region. The strategy should include formation and development

[2] According to the survey of heads of innovation infrastructure organizations, conducted by ISEDT RAS.

Table 5. Subsystems of innovative infrastructure in the Vologda Oblast

Subsystem development index*	Subsystem elements	Subsystem description
Material and technical subsystem		
0.47 (very low)	SI VO "Business Incubator", Innovation and Technology Center at the premises of LLL "Start-Park", etc.	The reasons for the low value of the subsystem development index are the following. First, the subsystem functional structure is incomplete. There are not important elements of industrial infrastructure, such as common use centers, which provide access to high-tech equipment, engineering centers, etc. Second, as the study shows [13], the area of INI organizations designed to accommodate small innovative enterprises has not been used in full – 25% on average. It is caused by insufficient attractiveness of the lease terms of these areas and low innovative activity of the regional enterprises
Financial subsystem		
0.68 (low)	Northwestern Venture Investment Center (Cherepovets Branch), NGO VO "SME Assistance Fund", etc.	Financial assistance to regional small and medium enterprises on the part of INI organizations is mainly provided by means of grants, support to find investors. The low value of the development subsystem index is caused by the limited share of investment for small innovative enterprises financing and the number of projects funded through the regional system of grant support. The reason for it is a lack of investors' interest to allocate funds for the enterprises' innovative development, as this activity is associated with high risks. At the same time, the budget financing of innovative projects in the form of grants does not cover the needs of small innovative enterprises in investment.
Personnel subsystem		
0.69 (low)	Universities in the region (the innovative managers training to get a degree in "Innovation" has been at the premises of only on the basis of HVE VGU since 2009).	The important indicator of INI development is university training of specialists for their further work at innovative enterprises and INI organizations. In general, innovation infrastructure of the region is characterized by a small share of employees who have special education for the implementation of innovative projects, low qualification of INI personnel and growing need for practical experience in the innovative projects implementation and management. The reasons for this situation are the following: violation of the reproduction process of scientific personnel; slow transfer and dissemination of management knowledge, lack of the institute to train innovation managers in the region.
Information and marketing subsystem		
1.18 (high)	TTC at the premises of ISERT RAS, SI VO "Business Incubator", Urban Development Agency in Cherepovets, VTP, Vologda Bureau of Intellectual Property, etc.	The high level is caused by the increased activity of the INI organizations to promote innovative enterprises development (increase in the share of enterprises that participate in regional and national seminars, contests and programs aimed at stimulating innovation activity, activation of publishing activities aimed at PR and advertising of small innovative companies and INI organizations services), the provision of services to register intellectual property rights. However, the INI organizations do not use all advertising and PR tools to encourage innovative projects in the region; do not actively stimulate inventive and rationalizing processes and cooperation with science and education. At the same time, it is necessary to strengthen and expand the work of INI organizations in order to transfer and commercialize the R&D results of the enterprises.
Index of regional innovation infrastructure development		**3.02 (insufficient)**

* The method, developed by ISEDT RAS in 2012, was used to calculate the innovation infrastructure development indices [13]. The integral index rating scale is the following: 1 – infrastructure is not fully developed; 1 – 1.99 – very low development; 2 – 2.99 – low development, infrastructure requires changes; 3 – 3.99 – underdeveloped, separate infrastructure subsystems require modifications; 4 – 4.99 – developed infrastructure, there are resources for further development; 5 – absolutely developed. The rating scale for subsystems is the following: less than 0.25 – the subsystem is not fully developed; 0.26 – 0.50 - very low development; 0.6 – 0.75 – low development; 0.76 to 1.00 the subsystem is underdeveloped; 1.01 – 1.24 – high development; 1.25 – the subsystem is fully developed.

Table 6. Assessment of communication relations in the science and innovation sphere of the region, %

Answer	Survey year					2013 to 2009, p.p.
	2009	2010	2011	2012	**2013**	
The Vologda Chamber of Commerce and Industry	44.3	42.9	40.5	30.8	**35.7**	-8.6
Technology Transfer Center at the premises of ISEDT RAS	23.9	24.7	23.8	13.8	**23.2**	-0.7
SI VO "Business Incubator"	9.1	14.3	9.5	13.8	**16.1**	7.0
Vologda Scientific-Technological Information Center	12.5	11.7	11.9	12.3	**12.5**	0.0
RTTN (Russian Technology Transfer Network)	6.8	8.9	2.4	1.5	**10.7**	3.9
NPO "Urban Development Agency"	6.8	6.5	7.1	3.1	**5.4**	-1.4

of innovation infrastructure as one of the priority directions. In our opinion, the activities to promote innovation infrastructure should be the following:

1) creating the lacking and essential elements of innovation infrastructure;

2) increasing the efficiency of existing organizations; solving the problems that hinder their functioning.

The first direction, according to the results of the study (see tab. 5) and the survey of enterprises' heads, requires the development of industrial infrastructure: industrial parks, centers for collective usage of high-tech equipment by the priority activity directions in the region, engineering centers and the development of infrastructure, ensuring the formation of enterprises with high concentration of scientific and technological potential – clusters – cluster development centers [10, 11].

First of all, the potential of young people should be used, that is why it is necessary to form infrastructure developing creative potential of the youth.

The Youth Innovation Creativity Centre[3] can be such a tool. The practice to establish such centers has been successfully tested in Moscow, Saint Petersburg, the Tomsk Oblast, the Kaluga Oblast, the Penza Oblast and other areas.

The construction of these infrastructure facilities can be funded by the RF subjects by means of federal budget subsidies on the state support of small and medium enterprises [16].

Second, it requires the development of the financial subsystem of innovation infrastructure. Today there are quite a lot of financial tools.

[3] The Youth Innovation Creativity Centre is a property complex, established for the implementation of activities in the sphere of high technologies that includes technologies of direct digital manufacturing; on the basis of modern technologies it ensures rapid prototyping, manufacture of individual and small-scale products, as well as necessary facilities and infrastructure (Resolution of the Cabinet of Ministers of the Chuvash Republic "On approval of the Procedure for granting subsidies to small and medium businesses to create and / or maintain the activities of the youth innovation creativity centers" as of September 26, 2013, no. 394. Available at: http://base.consultant.ru/regbase/cgi/online.cgi?req=doc;base=RLAW09;n=65482.).

However, the surveys of business leaders indicate that the main source of funding for the development of innovative industrial enterprises is their own funds. Bank loan remains too expensive for development of innovative activity.

The state budget resources are available primarily for large enterprises. But even for them, the scale of provision of budget funds is not more than 5–10% of the required amount [23].

For small innovative enterprises the financing problem is more acute. The initial funding program, implemented by the Fund for assistance to small enterprises in the scientific and technological sphere and the local programs to support small business, apply mainly to innovative enterprises in the capitals and major cities. In the Vologda Oblast, the Fund annually supports only 2–3 projects, which is clearly insufficient. The transition to innovative economy requires not less than 20–25 such projects annually.

In general, the financing of innovation in the region is the same as in the country as a whole.

In our opinion, to develop the financial subsystem of innovation infrastructure in the region is impossible without solving this problem at the federal level. We believe this goal requires:

- development of the venture financing system on the basis of public-private partnership;
- intensification of the banking sector by preferential taxation of commercial banks that provide loans for the innovative projects implementation, ensuring state guarantees of loans repayment, provision of commercial banks with loans on preferential terms to finance innovative enterprises.

At the regional level to address the problem of insufficient financial support for innovation infrastructure organizations it is reasonable to give grants, subsidies for infrastructure development of the region on a competitive basis.

Attracting investment in innovation infrastructure and its maintenance is possible through programs of the RF Ministry of Economic Development, contests of the Fund for assistance to small enterprises in the scientific and technological sphere, international competitions, grants, programs, etc.

The development of personnel resources of innovation infrastructure organizations should begin with monitoring of the requirements in the professional workforce. The staff assistance system should be based on training, retraining and advanced training of the specialists who have innovative thinking and can carry out the transfer and commercialization of technologies. It is necessary to raise the prestige of " an innovation manager".

The implementation of organizational and marketing mechanisms to support innovation infrastructure includes:

- raising the enterprises' awareness about the services, provided to the infrastructure organizations;
- information and news letters on the INI organizations' activities in the region;
- promotion of innovation activity;

- organization of the system that monitor the state of science, technology and innovation spheres (based on the data provided by scientific and educational organizations, the Territorial Body of Federal State Statistics Service in the Vologda Oblast and various departments in the course of their current activities);
- organization and maintenance of the database of inventions, technologies, innovative projects, developers and experts;
- carrying out of measures for the establishment and development of interregional and international technological and scientific cooperation (participation in the international competitions, grants, programs, etc.).

In our opinion, the implementation of the main directions of innovative infrastructure in the framework of the Strategy for Innovative Development of the Region will ensure balanced formation and functioning of its constituent subsystems. This will contribute to the formation of necessary infrastructure for introducing innovative products of the region on the market and, consequently, will accelerate its transition to the innovative model of development.

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