Scientific Bases of Spatial Development of Innovative Activity in the Territory of Russia

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Abstract. The purpose of the study is to identify the Russian territories prepared to achieve a breakthrough in the field of innovation. The relevance is due to the declared leadership of the country in a number of documents and Federal programs aimed at accelerating the development of innovative economy. Usually, readiness for innovation is associated with the development of development institutions and service infrastructure of innovation. In this area, numerous borrowings were made and the real practice of large-scale Federal support for innovation centers in the way of expensive Greenfield ideology (Skolkovo, Innopolis) was implemented. However, to date, the domestic economy is not innovative. The problems of this lie in the fact that the most important questions have not been widely raised about how innovation differs from traditional scientific and technical activities, what is significant characteristic of the territory of the world-famous innovation centers in the economy of the West; in what urban conditions is the active development of innovation and whether it can provide, for example, science cities or innograd. These issues are relevant not only in the research area or for public education, but also fundamentally important for the development of regions seeking to actualize the innovative potential of specific territories. The study on the basis of extensive foreign experience (USA, Europe, Japan) examines the features of the territories characterized by the effective development of scientific and innovative activity. The hierarchy of the spatial organization of scientific and innovative activity is substantiated: Technopark-Technopolis - region of science. Given the typological characteristics of foreign science parks and regions of science. The list of Russian agglomerations that can be attributed to the regions of science is determined.

1. Introduction

Strategy of scientific and technological development of the Russian Federation for the period up to 2035, aimed at the development of scientific and innovative complex of the country in order to achieve competitive positioning of Russia in the international arena, considers, among others, the territorial aspects reflected in the section "Main directions and measures of implementation of the state policy in the field of scientific and technological development of the Russian Federation", p. 32ж), which States that

1 The author participated in the discussion of the territorial aspects of the "Strategy", presented his analytical developments in the CSR, which were used, has an act of implementation.
"the creation of conditions for research and development, corresponding to the modern principles of the organization of scientific, scientific-technical and innovation activities and the best Russian practices, is provided through the support of individual territories (regions) with a high concentration of research, development, innovation infrastructure, production and their relationship with other subjects of the Russian Federation". The definition of "individual" means the search for those that are characterized by a high potential of the scientific and technological complex with basic resources that ensure the achievement of an innovative breakthrough, and the purpose of the work is the evidence-based allocation of these territories.

The relevance of the study lies in the fundamental importance of this issue for regional policies seeking to actualize the innovative potential of specific territories, as the knowledge economy gives a visible multiplier effect in the development of territories. Thus, the efficiency of capital investment in the R&D industry for the overall growth of labor markets and employment: onemillion euros invested in science and development creates up to 90 jobs in various sectors of the economy²

The real practice of large-scale Federal support of innovation centers so far has followed the path of expensive Greenfield ideology, i.e. "projects in the open field" – SKOLKOVO, Innopolis. Meanwhile, to date, the expediency of the development of large innovation centers on the basis of already established research centers with a long history is increasingly evident. Moreover, the global trend of concentration of economic activity in the territories of existing and emerging agglomerations and mega-agglomerations is manifested, in particular, in the concentration of scientific and technical capital. So, at the Moscow Urban Forum-2017, the theme of which was "The era of agglomerations. New map of the world", present stage main building blocks providing economic success were specified: 1-Economy, 2-Research and development (R&D)³, 3 – Cultural resources, 4 – Quality of life, 5 – environment, 6 – Transport availability [1].

The second place of R&D factor implies a sharp increase in its role in the economy as that of determining the effective development of cities and agglomerations and bringing them closer to the position of world innovation centers. The main components of the R&D block, according to the rating Agency are as follows: the number of researchers; universities included in the TOP 200 of the world; success and recognition in mathematics and natural Sciences; institutional readiness to accept new researchers; the cost of R& D; the number of protected patents for industrial design; number of winners of high-authoritarian awards in the field of physical, mathematical, technical and natural Sciences.

The determining positions of the R&D factor are currently associated with the accumulation of its potential in highly urbanized areas, in particular under the influence that the ideas of M. Porter [2] and his school in the 1980-1990 had on the economic development. In one of his works, which reveals the strategic conditions for achieving economic success, he was frank: "the creation of national innovation potential is a fundamental problem of development of many countries for many years to come"[3]. The most important role in this process M. porter assigned to the quality of human potential, especially that in technical strata, developed research infrastructure of universities, communication and information networks. The successful development of these categories should be provided by the related institutions [4], without which it would be impossible to form and develop innovative economy: the creation of infrastructure for innovation and technological development, the system of next generation research networks, the achievement of a qualitative leap in improvement of the competence of the business community. This process is possible only under the presence of large-scale diversity of activities, under

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² Data on this were obtained on the basis of the study of the development of the region of Brainport Eindhoven (Netherlands) (http://www.brainport.nl) and IdeonTechnopark in Lund (Sweden) (http://ideon.se)
³ R & D – literally "Research and Development", does not directly correspond to our concept of the industry "science, research and development"; S & E – science and engineering
the environment of generation and exchange of knowledge, experience and information, since in the new economy, allocation of high-tech activities is done not according to the past specialization of cities and regions, but according to presence of necessary conditions for these activities on those territories.

2. The phenomenon of innovation and its relationship with urban development
The author of the term "innovation" (1928) and one of the first researchers of the phenomenon of innovation as a driver of economic development was Joseph Schumpeter [5], who pointed to the fundamental difference between invention and innovation: while invention (or discovery) is a pure idea, innovation, on the other hand, is a scientific idea, demanded by the market and adapted to it, i.e. the result of innovation are new or additional goods/services or goods/services with new qualities. Schumpeter's theory has come a certain way, changing and developing both in his own scientific works and in the works of his followers, and is now embodied in the so-called model of "open innovation" [6], according to which knowledge is so pervasive, accessible and spreads quickly that no one can have a monopoly on knowledge as it was in the past. This involves constant collaboration and exchange of ideas among researchers, that includes universities, large and small firms, partner companies, and even consumers themselves. Thus, the model of "open innovation" is directly related to the territorial problems and the quality of human potential.

Since the last quarter of the twentieth century, experts began to note the importance of the environmental factor for the development of innovation, which is known as the Jacobs factor [7] in the formation of a successful innovation economy. Its essence is this: "innovation increasingly occur where there are many people with backgrounds in diverse fields: engineers, humanists, scientists, who share different ideas" [8, p. 157]. In other words, innovation is not only developed by different and many industries concurrently, but is also supported by the totality of all knowledge, both in the natural Sciences and in the Humanities. The best conditions for increasing the mass of participants and the intensity of the process of such exchanges is a high social quorum of the urban environment and urban areas of agglomerations. In the process of creating innovations, economic and social aspects, including aspects of human potential, become more important than scientific and technological results.

3. World experience in spatial organization of innovative activity
Awareness of the complexity of the innovation process has caused in the West the concept of innovation as a special type of scientific and technical activity of a complex nature, which leads to the formation of territorial and urban formations, the economic specialization of which is the design and production of various types of modern science-intensive goods. At the same time, the innovation sphere itself constantly receives a reverse impulse to increase efficiency from the concentration of the main actors of the innovation process in these territories – universities, higher engineering schools, technoparks, and high-tech business.

To date, in the world practice, as shown in a number of works [9,10,11,12] a system hierarchy of material and spatial organization of scientific and innovative activity has formed:
1-technoparks (space-planning level);
2-technopolises (town-planning level);
3-regions of science (territorial level).
The territorial problems of innovative activity are connected with the objects of the second and third levels – technopolises and regions of science.

To determine the typological characteristics of the territories of successful innovation activity, the cities proposed in the expert studies [13] as the most well-known scientific centers on a global scale were considered. Data on the population and the number of employees in the scientific and innovative complex of these cities are shown in the diagram (Fig.2.), where it is clearly possible to identify three groups of cities:

- The first group includes cities with populations in the range of 100-300 thousand, and employment in the research and innovation complex of those cities reaches 25%;
- The second group includes cities with the population ranging from 500 thousand to 5 million. Number of employees in scientific-innovative complex is substantially lower than in the first group – up to 10%;
- The third group includes cities with a population of 500 thousand people to 10 million people. Number of employed in the scientific and innovation complex is negligible in relation to the population, so these cities can’t be positioned as innovation centers as a whole, although located on their territories technoparks and innovation complexes as single independent objects can be successful and known globally.

**Figure 1.** A model of functional relationships of entities in the system of territorial-urban development organization of research and innovation activities.
Figure 2. The relationship between the population size and number of employed in the scientific and innovation complex of cities, positioned as global innovation centers.

The first group was identified as technopolises, that covers historic University cities, such as Cambridge, Oxford (England), Lund (Sweden), Louvain (Belgium), Leiden, Delft (Netherlands), the former industrial cities of Oulu, Turku, Espoo (Finland), the new city of Tsukuba (Japan), cite Descartes, Sofia-Antipolis, the plateau of sakle (France) [10]. Following a sequence of analytical procedures intended to identify characteristics of science parks, the number of researchers was identified as the primary typological characteristic of science parks, the lower limit of which is called the critical mass [14, p. 10] and corresponds to 5,000 people. The critical mass of researchers is the basic typological characteristic of innovation territories, it defines the boundary of favorable conditions for the breakthrough to mass production of innovations.

The criteria laid down in the basis for the allocation of regions of science in the United States is data on the number of S&E employees, publication and patent activity, data on the economic role of R&D in the formation of GRP, business participation in the financing of research and others. The territories of the regions of science were studied on the basis of American resource data [15] with the involvement of a number of expert developments [16,17,18], which allowed to determine at least 12 regions of science in the United States [12] (Fig.3). Regions of science in the United States are prosperous territories with high ratings of quality of life, are in the top positions of the world rankings on this indicator [18].
Figure 3. Territorial allocation map of regions of science, technopolises and research centers in USA.

The region of science should be characterized as a large urban area, the footprint of which may not coincide with administrative boundaries of the base city and its agglomeration, or with that of several towns, but one that fits within the limits of comfortable transport accessibility. City-forming enterprises of the region of science-educational and research centers, technology parks (R & d of small and medium-sized businesses) and high-tech production of large business, implementing the results of research, which creates the most opportunities for the formation and successful implementation of the cluster, as in the field of territorial and economic influence of the region of science is a developed infrastructure for innovation. The region of science is characterized by high quality of the urban environment and of social infrastructure, the service industry, leisure and entertainment, networks of all types of communications, outbound transport, the presence of airports, including for international lines, the proximity of transcontinental high-speed roads.

In the sense of spatial relations, American regions of science are compound territorial formations of at least three forms.

The first form of the region of science includes agglomerative polycentric areas on the basis of one or more comparable cities, integrated on the basis of educational, scientific, and innovative functions (agglomeration of the Role-Durham, North Carolina).
The second form of the region of science is the agglomerative monocentric on the basis of a large city form, which is a major educational, and research and innovation center, and small cities-technopolises or research and production centers, in its agglomeration (agglomeration Greater Boston, Massachusetts).

The third form of the science region is the urban within a single major city form, which is a world-class educational, research and innovation center (Austin, Houston, Texas, Seattle). In the latter case, it is necessary to clarify that the city, which is the base of the urban form of the region of science, in turn, may be the center of the agglomeration in its conventional sense, but included in this agglomeration other urban entities do not have educational or research functionality. And in this case, the region of science is only the Central city of such an agglomeration.

The factor of educational, scientific and technical potential is a typological characteristic of the region of science, as well as for Technopolis. As a rule, in the region of science there are several universities, often with a significant history, with a classical or research type of education. In some cases, it is the whole educational system, such as Houston-77,0 thousand students (4 universities) or California – 190,0 thousand. students (12 universities) in the conurbation of three agglomerations: the Metropolitan area of San Francisco and Redwood, Metropolitan area of Richmond, Oakland, and Hayward, and the Metropolitan area San Jose and Santa Clara. In Greater Boston, almost 250,0 thousand students study at all universities and colleges, in education 5% of the number of employed, it is a world educational center with top universities in all rankings – Harvard, MIT, Boston University. The Metropolitan area of Chicago has 18 universities with a total number of students more than 176,0 thousand the Smallest number of students in the Seattle – Everett – Tacoma science region-46,0 thousand. students, the average number of students in the identified regions of science - 100 thousand.

The average number of people employed in S&E in the regions of science is 91 thousand people. Another Important indicator is the total number of scientific and technical personnel with bachelor's degree or higher, which relates to the quality of human capital on those territories. All regions of science are characterized by a high percentage of residents with collage degree, exceeding the national average. Thus, in Minneapolis-46.3% have collage diplomas, which is the second highest in the United States, while the highest percentage is in Seattle with 59.8%. Those people represent the so-called creative class, in whose interests and to attract which the administration is modernizing the urban environment.

4. Russian territories that have the resources to achieve a breakthrough in innovation
Despite the creation in the previous period of a number of institutions of innovation infrastructure, experts state that the domestic economy is non-innovative [20]

In Russia, technopolises are practically non-existent in their Western sense, since science cities and research centers, entirely subsidized establishments, can’t be equated with technopolises due to the very small number of researchers, far from reaching the lower limit of the critical mass. Moreover, the vast majority of them don’t have developed educational structures. Only three renowned research centers have the prerequisites for transformation into Technopolis: city of Obninsk, Dubna and Novosibirsk Academic city. The latter is a district of Novosibirsk, but given proper development can acquire a certain independent status of economic and territorial entity, like The TechnoparkAdlershof in Berlin, one of the largest research and innovation centers in Europe.

With regards to the regions of science in Russia, the sad fact has to be state that the number of researchers, as well as scientific and technical workers (hereinafter NTR) in the industry, having fallen sharply during the well known period, was steadily decreasing. Cities that were initially classified in Russia as regions of science, based on the number of STD and researchers can’t compete with regions of science in the United States or Europe, with the exception of Moscow, St. Petersburg, Nizhny Novgorod and Novosibirsk. Therefore, in order to identify the Russian regions of science by the factor of the number of STD and the critical mass of researchers, they had to be compared with technopolises, despite the
multiple predominance of the population in Russian cities. In Russia, in only ten regions besides Moscow, we observe an insignificant excess, in comparison with foreign analogues, over the lower limit of the critical mass of researchers: the Moscow region, St.-Petersburg and Leningrad region, subjects of the Russian Federation: Nizhny Novgorod (18,1 thousand), Sverdlovsk (10,16 thousand people), Novosibirsk (9,0 thousand people), Chelyabinsk (7.2 thousand people), Rostov region (6,5 thousand people), the Republic of Tatarstan (6.8 thousand persons), Samara (5.8 thousand people), Voronezh (6.6 thousand.) Tomsk regions (5.26 thousand people), Perm region (6.65 thousand.)

The study was based on the indicators used in the work on the American regions of science: the number of researchers, the number of students, patent activity in comparison with financing, the number of publications, the quality of human capital (the percentage of employees with higher education), the participation of regional business in the financing of research and development. In addition to the direct indicators mentioned above related to research and innovation, the study included expert and rating assessments [21], additional data, such as the presence of RAS organizations, corporate and departmental science, ratings of regional universities, compliance of their programs with the criteria adopted in the world practice [22,23]. The production profile of the city was also considered for the presence of enterprises with products of a pronounced innovative orientation [24], including basic ones for the defense industry [25].

The regions of science in Russia, according to the results of the study included 17 capital cities of the Federation, with the exception of Moscow and St. Petersburg: Nizhny Novgorod, Yekaterinburg, Novosibirsk, Rostov, Kazan, Perm, Chelyabinsk, Voronezh, Tomsk, Samara, Ufa, Krasnoyarsk, Omsk, Ulanovsk, Irkutsk, Saratov, Vladivostok, Fig.4. The reliability of the data obtained is confirmed by the fact that the number of Russian regions of science satisfies the principle of paretto-distribution.

It is necessary to explain how the study is carried out the transition from the number of studied parameters on the scale of the subject of the Federation to the scale of the region of science", i.e. a large city or agglomeration. For this purpose, the profile of the subjects of the Federation in terms of data on the placement of scientific and technical potential, as well as the number of students in cities and towns of the regions and regions was considered. This allowed us to assert that, as a rule, both scientific and technical, and educational potential is located in the capital of the subject of the Federation. This, in a significant number of cases, allows the data on the subject of the Federation as a whole to be interpreted as data on the capital city and its agglomeration, or only on the city.

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*Rosstat data, 2016.
As it turned out, this fully applies to such regional centers as Yekaterinburg, Chelyabinsk, Voronezh, Perm, Tyumen, Yaroslavl, Ulyanovsk, Omsk, Ufa, Kazan. These regions of science were assigned to the urban form.

Regions of science, in which the scientific and technical potential, in addition to the capital city, is located in the satellite city, were assigned to the agglomerative form in two versions: a compact version and a remote version.

The compact version of the agglomerative form includes such regions of science as Tomsk, Nizhny Novgorod, Vladivostok, Irkutsk, Novosibirsk. Satellite cities: in the Tomsk region of science – Seversk, in Nizhny Novgorod – Dzerzhinsk, in Vladivostok – about-Russian with the FEFU campus, in Irkutsk – Angarsk, in Novosibirsk – Koltsovo, Krasnoobsk, and Akademgorodok is part of urban areas.

The second variant of the agglomerative form of the science region, remote, is presented by Krasnoyarsk, Rostov and Samara regions of science. In Krasnoyarsk region of science the second city – Zheleznogorsk, in Rostov-Novocherkassk, in Samara-Togliatti.

It is the regions of science that can be primarily considered as the reference areas for the implementation of cluster policy [26] in the Russian Federation. According to the volume and scale of the cluster potential functional regions of science was defined as versatile (N. Novgorod, Voronezh, Rostov-on-don), complex (Novosibirsk, Yekaterinburg, Samara, Kazan, Krasnoyarsk, Omsk), specialized (Ulyanovsk, Tomsk, Chelyabinsk, Irkutsk, Vladivostok, Perm, Ufa, Saratov). Universal region of science forms at least 6-8 clusters, complex – at least 4-6 clusters, specialized – 3-4 clusters.

5. Conclusion
1. The main trend in the formation of the reference areas of the innovation economy is the concentration and consolidation of resources that implement the entire innovation chain from basic science and applied
research to prototypes. The global trend of concentration of economic activity in the territories of existing agglomerations and mega-agglomerations, characterized by a high concentration of scientific and technical capital. The realization of this circumstance will allow to return the attention of decision-making bodies to the expediency of the development of large innovation centers of Russia on the basis of already held research centers with a long history.

2. Typological characteristics of the territories of innovation, technopolises and regions of science are: 1) the number of researchers is not lower than the critical mass; 2) a significant educational complex; 3) scientific and innovative profile of specialization of the economy. The economic essence of the territories at the level of "Technopolis" and "regions of science" is a significant and significant contribution of the main actors of the innovation economy to the budget, not only urban, but also regional or national.

3. Technopolis and the region of science characterize the significance of the connection of innovative economy with the territory. Industrial processes were aimed at simple forms of activity, in the innovative economy the subject of the work is intellectual work, i.e. thinking: "Innovative economy is a kind of process of "industrialization of thinking, for the effective implementation of which it is necessary that a compact area maintained a high density of thinking and a variety of activities" [19].

4. The foreign region of science differs from Technopolis by its territorial-town-planning scale and economic power, Fig.5. The value of the critical mass of researchers in the region of science exceeds that in Technopolis by an order of magnitude, and the average – almost ten times and is 91.0 thousand researchers. The average number of students in the region of science is also significantly higher than in Technopolis – almost five times. Universities in the region of science can be 3-5, and in Boston, for example, seven only world-famous.

Figure 5. The comparative value of the General typological characteristics of the world areas of innovation, Technopolis and regions of science.

5. The presence of Russian regions of science indicates a consistent process of localization of the sphere of knowledge, research and innovation development in the Russian Federation as a whole.
Cities-regions of science in Russia have the prerequisites and grounds for the emergence of innovations with the potential of global competition, which is currently crucial for success. This breakthrough can be achieved by: existing high-tech industries with R & d, including the defense industry, corporate and fundamental science with established scientific schools, universities with a significant number of students. Cities-regions of science-are, first, already leaders of technological development in Russia, and secondly, basic scientific and educational centers of formation of the future intellectual capital of the country as a whole and potential employees capable of scientific and innovative activity in particular. It is necessary to increase the quantitative indicators of these resources to bring them closer to those in the regions of science in the US and Europe.

6. As our research has shown, in countries with actively developing innovative economies the processes of concentration and consolidation of scientific and technical potential in the territories are deepening, in response to which there is a transformation, modernization of infrastructure and improvement of the quality of urban environment in order to provide comfortable living conditions for the main actors of the innovation process-scientists, researchers, engineers, students.

It seems obvious that such principles can and should be applicable to domestic conditions, especially since the allegations of a significant backlog of the country in the field of science and innovation sound at the government level. The study substantiates the feasibility of introducing the concept of" region of science " to ensure increased attention of Federal and regional authorities to the areas of concentration of the Russian scientific and technical potential. Moreover, as the author's project practice has shown, in the largest capitals of the subjects of the Federation the term "region of science" was well received, referring it to a kind of brand characteristics of the city and agglomeration.

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