Current state of innovation infrastructure in the world

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Abstract. Innovation plays a key role in the formation and development of modern socio-economic systems. They support economic growth, increase labor productivity, contribute to the creation of new industries and markets, improve the quality of life of the population, and help solve global environmental problems. The implementation of innovative projects requires access to high-tech equipment, specialized laboratories, engineering and technical resources and financing, which necessitates the creation of infrastructure systems that help support innovation at the level of the industry, region and national economy as a whole. This article analyzes the essence and key elements of innovation infrastructure, their importance for ensuring sustainable economic growth, as well as current trends and challenges.

1 Introduction

Innovation infrastructure is a set of objects that ensure the implementation of innovation activities [1]. This infrastructure provides innovative enterprises and start-ups with access to technical, information, personnel and organizational support, and is also a necessary link between scientific developments and the real sector of the economy. The structural components of modern innovation infrastructure can be classified as follows (Fig. 1).

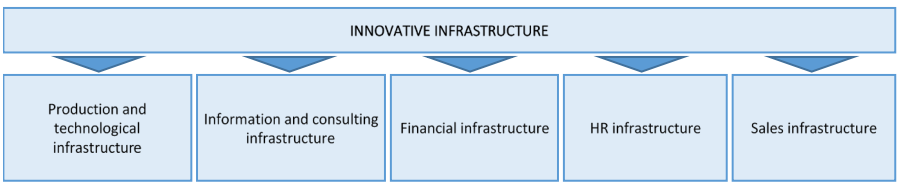

Fig. 1. Classification of innovation infrastructure

Let us consider each of the structural blocks of the innovation infrastructure in more detail.

Production and technological infrastructure includes separate facilities and scientific and industrial complexes, which contain modern equipment, analytical centers, laboratories,

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testing grounds, allowing for the development of innovative activities and the creation of prototypes and advanced technologies for use in industrial production. The category of production and technological infrastructure includes technology parks, innovation and production complexes, technology-innovation zones, technology clusters, centers for the collective use of high-tech equipment.

2 Materials and Methods

Innovation and technology centers (technoparks) are a special territorial entity or organization created to provide comprehensive support for innovative developments and their integration into mass production. Innovation and technology centers are aggregators of innovative business, uniting on their territory research institutes, educational institutions, scientific and technical laboratories, small innovative businesses, high-tech manufacturing companies, business and exhibition centers that ensure the popularization and promotion of innovative products.

The concept of technology parks is quite popular in many countries around the world. Thus, in Italy there are more than 40 such infrastructure facilities; an example of such an economic model is the Technopolo technology center in Rome. In the Russian Federation, an example of a technology park is the Skolkovo innovation center, created in 2010 in Moscow in the form of a self-developing ecosystem with a special economic status for companies working in the field of high-tech technologies. The Skolkovo Center was created as a science city with the presence of companies and organizations leading innovative developments in four areas: biomedicine, informatics and computer technology, energy efficiency, and innovation in industrial production.

Thanks to the high level of government investment, Skolkovo has become one of the main centers for the creation of startups that have access to shared use centers (CCCs). The CCU includes laboratories, workshops with modern equipment, and computer rooms. The center provides paid services, including computer engineering, sequencing, prototyping, mechanical processing of parts, and microelectronic soldering. In Skolkovo, the Skolkovo Institute of Science and Technology opened in 2011, modeled after the Massachusetts Institute of Technology and training specialists in demand in the field of high technology. Currently, about 2,500 companies are registered in Skolkovo, with total annual revenues in the region of 400 billion rubles.

The development of centers for the collective use of scientific equipment contributes to the intensification of scientific and innovative development. The first of these organizations was CERN, the world's largest high-energy physics laboratory, created in 1954 in Switzerland. In Russia, 645 centers for the collective use of scientific equipment have been created, which are divided into research, server and supercomputer centers and provide innovative organizations with services for conducting scientific research and experimental development. There are also 389 unique scientific installations (UNU) in the Russian Federation, which can be used for their intended purpose by any interested parties.

Innovative production complexes have their own production facilities or have access to modern production resources for scaling and introducing innovative solutions. They provide support for the commercialization of research and development results, transforming them into final products and services for the market.

Another option for organizing infrastructure support for innovative companies is special economic zones, which offer residents comprehensive administrative support and significant preferences in the field of taxation. An example of such a facility is the Shenzhen Special Economic Zone, which has largely contributed to China's unprecedented economic growth. In Russia, a model of special economic zones of technology-innovation type (SEZ TVT) has been developed, which are created for the development of information technologies, nuclear

physics and nanotechnologies, aerospace, energy and gas industries, the military-industrial complex and other strategic industries. Currently, there are 7 TVT SEZs in Russia (St. Petersburg, Dubna, Tomsk, Technopolis Moscow, Istok, Innopolis and Almaz),

Technological territorial clusters are a concentration in one region of research and technology companies, startups and incubators operating in a single technology industry. Within the cluster, accumulated knowledge and resources are exchanged, and the overall result is innovative technologies and products that can stimulate a specific sector of the economy.

In economically developed countries, the creation of technological clusters is stimulated at the state level; leading international organizations take part in the development of innovative territorial clusters: the World Bank, the European Commission, the Organization for Economic Cooperation and Development. In a number of countries, direct government funding is provided for projects for the creation and development of territorial clusters, expert, analytical and information support is provided, and stimulation of cluster development is provided through the creation of coordination and advisory bodies.

The most recognizable technology cluster in the world is Silicon Valley, a region in California where the largest high-tech corporations are concentrated, including Apple, Nvidia, Google, Cisco, Seagate, Western Digital, AMD. The emergence of the cluster was made possible due to the location in this region of the Stanford Industrial Park, leading American universities, laboratories and technology companies of the National Aeronautics Advisory Council and the first companies producing silicon semiconductors. Silicon Valley now accounts for a third of all venture capital investment in the United States, allowing the cluster to remain a leading hub for high-tech innovation startups.

3 Results and Discussion

One of the most successful Russian cluster projects was the creation of the Altai Biopharmaceutical Cluster (AltaiBio), which was created on the basis of the science city of Biysk and united the capacities of 38 scientific and manufacturing companies specializing in the development of pharmaceuticals and dietary supplements. Thus, within the framework of this cluster there are such organizations as Evalar JSC and Altaivitamins JSC, which have a high reputation both in Russia and abroad. In St. Petersburg, on the basis of JSC Technopark of St. Petersburg, a Cluster Development Center was created to support SMEs and implement large-scale innovative projects. The cluster approach corresponds to the most advanced foreign traditions of state support for the innovation sector.

Information and consulting infrastructure –this is a set of organizations, resources and services designed to support and stimulate innovative activity, provide access to information, expert support and advice in the field of innovation and technological development [2]. A key element of such infrastructure are business incubators - facilities or programs designed to support small innovative businesses in the initial stages of their development. A typical set of services for participants in business incubators includes the provision of office equipment and premises, business consulting and mentoring, assistance in filling out applications for competitions and grants, legal advice, outsourcing of accounting services, etc.

Thus, Y Combinator (YC) is one of the most famous business incubators specializing in supporting telecommunications startups in the United States. The international network of business incubators Techstars London provides assistance to young innovative companies in Europe. The Brazilian business incubator and innovation center Cubo Itaú provides modern workspace, offices and laboratories, as well as access to mentors, experts and investors for startups. One of the most effective Russian infrastructure projects of this type is the Business Incubator of the Academy of National Economy, which implements not only standard forms

of support for startups, but also arranges meetings with leaders of the innovation industry, organizes sessions to attract potential investors, pays for patents for inventions,

A virtual business incubator is an incubator that provides support and resources for startups and entrepreneurs, but operates in an online environment, without a physical space. Virtual business incubators are designed to provide services and resources to startups that may operate remotely or do not have access to traditional physical incubators. Online incubators are available to startups from different countries and regions, which promotes international cooperation and the development of global startup communities. An example of such an infrastructure facility is the 500 Startups incubator in San Francisco.

Technology transfer centers are infrastructure facilities specializing in the commercialization and transfer of technologies and innovations from research or academic centers to the business sector. CTTs are united in technology transfer networks. For example, the European Entrepreneurship Support Network includes more than 500 TTCs from around the world. In Russia, one of the technology transfer centers was formed in 2018 on the basis of the National Research University Higher School of Economics in order to support the competitiveness of the country's agrotechnological sector in the context of international sanctions. In many countries, special consulting centers are being created to provide information support to small innovation-oriented businesses in the field of technology, finance, marketing and foreign economic activity.

An integral structural element of the innovation infrastructure are information resources that provide access to scientific publications, patents, statistical data and other information necessary for research and innovation. This category includes government scientific and technical information systems (NTIS in the USA, CORDIS in the EU), digital databases of full-text scientific journals (for example, JSTOR, eLibrary.Ru) and other online sources.

To ensure sustainable growth and development of the national economy, an effective financial infrastructure must be created. One of the areas of support for innovative projects is direct government funding, which may vary in different countries in scale, priorities and mechanisms. Thus, the American National Institutes of Health (NIH) provides significant funding for scientific research and innovation in the field of medicine and biology, as well as funding biomedical start-ups and research projects. The Federal Ministry of Economic Affairs and Energy (BMWi) supports innovation and development in the fields of industry and alternative energy. China is actively investing in innovation through various programs such as "Made in China 2025", which is aimed at supporting high technology and modern industry. In Russia, financial support for innovation is provided within the framework of the state program "Economic Development and Innovative Economy" and the national projects "Science", "Digital Economy", "Labor Productivity" and "Small and Medium Enterprises and Support for Individual Entrepreneurial Initiatives".

Various budgetary and extra-budgetary funds for technological development are also of great importance. Thus, in Russia there is an Industrial Development Fund that provides preferential terms for financing projects aimed at the development of new high-tech products, import substitution, leasing of production equipment, machine tool construction, and digitalization of existing production facilities. Grant support for small innovative projects is provided through the Innovation Promotion Fund within the framework of the "Student Startup", "Start", "Development", "Commercialization", "Internationalization" programs.

Credit institutions in different countries also have preferential support systems for companies producing high-tech and innovative products. Many states have also created a system of guarantee support for innovative companies, which simplifies their access to financial resources and reduces risks for investors and creditors. Thus, in the USA, the Small Business Investment Company (SBIC) Program provides financial guarantees to private investors and venture funds investing in small and medium-sized enterprises, including innovative companies. Spring Singapore provides various guarantees and subsidies to

Singapore companies, including innovative start-ups. In Russia, such organizations are created at the regional level:

The key investors in the innovation ecosystem are venture funds - financial institutions that invest in startups and young companies with high growth potential with the aim of generating profit in the long term. Venture investments are associated with high risks, since many startups do not reach profitability or do not achieve the expected success, but these losses are compensated by excess profits from successful innovative projects. Thus, the American venture fund Sequoia Capital has financed such successful companies as Apple, Google, Airbnb and others. Venture capital fund Balderton Capital has invested in European startups such as Revolut and Citymapper. The most well-known venture funds in Russia are ru-Net Ventures (financed by Yandex and Ozon) and Runa Capital (contributed to the development of the online language project LinguaLeo).

Along with venture funds, the subjects of the financial innovation infrastructure are business angels - private investors who provide financial support to start-ups and young companies in the early stages of their development. Thus, Ron Conway is one of the most active business angels in Silicon Valley, having invested in many startups, including Google, Facebook and Twitter. Mark Cuban is the owner of the NBA team Dallas Mavericks and one of the “super angels” in the startup world. He has invested in more than 100 startups, including Unicorn companies such as Uber and Airbnb. Russian entrepreneur and business angel Dmitry Chekhunov has provided funding for such significant technology startups as Scentbird and Wakie.

The objects of the personnel infrastructure for supporting innovation are universities and advanced training courses specializing in training specialists in the field of high technology and innovative development. In Russia, higher educational institutions that implement training programs for innovation-oriented employees are given the status of research universities. Examples of such institutions are the National Research Technological University "MISiS", the National Research Nuclear University "MEPhI" and others. Specialized online resources and platforms bring together specialists and provide access to training and knowledge exchange in the field of innovation.

Sales infrastructure is of particular importance when promoting products developed using innovative technologies. This category includes foreign trade associations, intermediary companies and exhibition organizations.

4 Conclusion

The participation of foreign trade associations consists in the development of business activities, concluding agreements with foreign partners, and assisting domestic manufacturers in the international promotion of innovative products. Thus, in Russia, an important object of marketing innovation infrastructure is the Chamber of Commerce and Industry of the Russian Federation (CCI RF), which unites hundreds of regional business associations, commercial and non-profit organizations. Within the structure of the RF CCI there is a committee on scientific and technical innovations and high technologies, designed to create conditions for the successful promotion of innovative products and technologies. The committee advises companies in the high-tech sector on the advisability of participating in exhibitions and fairs, organizes business missions, forums and conferences,

Intermediary companies are included in the marketing innovation infrastructure when it comes to mass production of an innovative product. In this case, the necessary conditions for promotion are factors such as advertising of goods, a wide distribution network, the availability of warehouse facilities and developed logistics. An innovative enterprise delegates the solution of these issues to intermediary companies that have an established scheme for selling goods on the world market.

Exhibition activities are an important tool for promoting innovative products and technologies. By demonstrating their products, high-tech companies inform a wide range of specialists and consumers about technological innovations and introduce fundamentally new products to the market. In this way, the commercial prospects of specific types of products are clarified and ways to improve them are outlined. Innovative exhibitions make it possible to determine the state of affairs in the industry, predict trends in the development of the innovation sphere, and determine directions for further development. Currently, the main arena for demonstrating innovative technologies is the World EXPO, which takes place every five years and exhibits the most current technical and technological achievements.

The key challenges for the innovation infrastructure system are:

- lack of funding for projects that do not have sufficient potential for commercialization;
- the need for rapid training of qualified specialists in the field of science, technology, engineering and mathematics in the context of continuous digital transformation;
- the global nature of modern innovations, requiring the development of international cooperation.

Current trends in the development of innovative infrastructure are active digitalization, increased investment in artificial intelligence, biotechnology and space research, as well as increased attention to projects that are focused on solving global problems and comply with the principles of sustainable development of civilization.

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