

Technological transfer of socially significant innovations as a condition for sustainable development of the region's economy

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Abstract. This paper reveals the essence and role of technological transfer of socially significant innovations to the economy of the region; regional priorities of scientific and technological development in the modern environment. Statements have been made important differences of process of transformations knowledge in product. Final part which is including satisfaction all stakeholders: society with performance effectiveness of problem solving and investors with economic efficiency.

1 Introduction

Technologies have different effects, for example, beneficial or destructive effects on individuals and the common good. The concept of sustainable development appeared in the process of combining three main points of view: economic, social and environmental. The initial ecological and environmental priorities, the tasks of responsible environmental management have been transformed today not just into the 17 Development Goals of developing countries, but into an integrated approach to the preservation of life and human potential. The term sustainable development began to enter scientific circulation in the 1980s, but became widespread after the report "Our Common Future", prepared in 1987 by the International Commission on Environment and Development, formed by the UN. Earlier, at the UN conferences in Stockholm (1972), conclusions were already made about the problems of the development of society and the anthropogenic impact on the natural environment. The first basic formulation of "sustainable development is development in which the needs of current generations are met without compromising the ability of future generations to meet their own needs" [1].

The role of information as a factor, its difference from knowledge, as a resource for the reproduction of new knowledge in the "informational" (M. Castels, 2000) was noted by many sociologists and economists. In the era of Accelerating technological cycles as a trend identified by international research organizations (Gartner), the Law of Accelerating Returns, also confirming at the human and robot level an increase in the speed of information transmission, the volume of information carriers, the power of information processors (Ray Kurzweil, 2004). Social changes are just as relevant and dramatic as the

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processes of technological, economic, and geopolitical transformation, and are just as interconnected. Predicting scientific and technological development, it is necessary to take into account not only the anthropogenic impact and reverse negative effects, but the impact of the processes of informatization, information saturation, digitalization on humans and the safety of future generations, which means a new aspect of sustainable development appears. The ecosystem approach already includes not only humans and the environment, but above all represents a new model of natural and artificial conditions of existence and development. At the same time, not only the processes of cybersecurity, the protection of intellectual and industrial property rights, the formation of competitive advantages due to the possession of unique knowledge and information come to the fore, but also the issues of information overload and information "toxicity", the development of artificial intelligence. The National Strategy for the Development of Artificial Intelligence for the period up to 2030 was approved by Decree of the President of the Russian Federation No. 490 dated 10.10.2019. In accordance with the strategy of Russia until 2030, the country should become one of the international leaders in the development of artificial intelligence, which will affect the growth of the welfare of the population and the economic development of the country, the safe operation of artificial intelligence at the level of human, humane and social institutions becomes a priority. Information overload is sensory overload in the information age as a cause of disorientation and lack of response (Toffler, 2004). The emergence of a "new class" of intellectuals — a kind of scientific and technical meritocracy, gaining class superiority, having the basic conditions for social advancement, possessing not property, but knowledge and technology (D. Bell, 1986) is associated with other processes that inevitably accompany technological progress. In modern conditions, artificial intelligence is actively learning, accumulating information potential and knowledge potential. The question of the possibility of forming "implicit" hard-to-copy knowledge in this case remains controversial (I. Nonaka, 2011). In the course of industrial development, new competitive conditions matured in the market environment, changing the general vector of competition from the preferential use of comparative national advantages to the use of dynamically changing competitive advantages based on scientific and technical achievements, innovations at all stages from the creation of goods to its promotion from the manufacturer to the consumer

Sustainable development of the region in the context of technological transformation in key sectors of the region's economy is gaining new opportunities, but the process of technological transfer and commercialization of technologies has social limitations, social goals and objectives. It requires innovative models that include social, environmental priorities of sustainable development, minimizing human impact on the environment. Technological transformation of economic sectors and the introduction of cross-cutting digital technologies, the list of which may change, are becoming fundamental stimulating innovation processes.

Technological transfer affects society on several levels. At the economic level, this is the implementation of digital transformation processes, improving operational efficiency and productivity, provides a communication environment, promotes social integration, and influences individual behavior. Technological transfer for sustainable development, taking into account social effects, allows solving the problems of socio-economic development of the territories of the region, improves the quality and accessibility of social services provided, leads to the emergence of innovative products. For Russia, the model of innovative development and technological transfer, which includes free entrepreneurial choice as the basis for determining technological priorities for the development of the region, currently requires adaptation. In 2021, the number of applications filed worldwide for intellectual property (IP) registration in the form of patents, trademarks and designs reached a new record level, which indicates the resilience of the global innovation

ecosystem (Figure 1) to shocks such as a pandemic and other challenges. Also, it is precisely in crisis conditions that there is a need for new technological solutions (G. Mensch, 1979), social needs are increasing and lead to an increase in innovation activity.

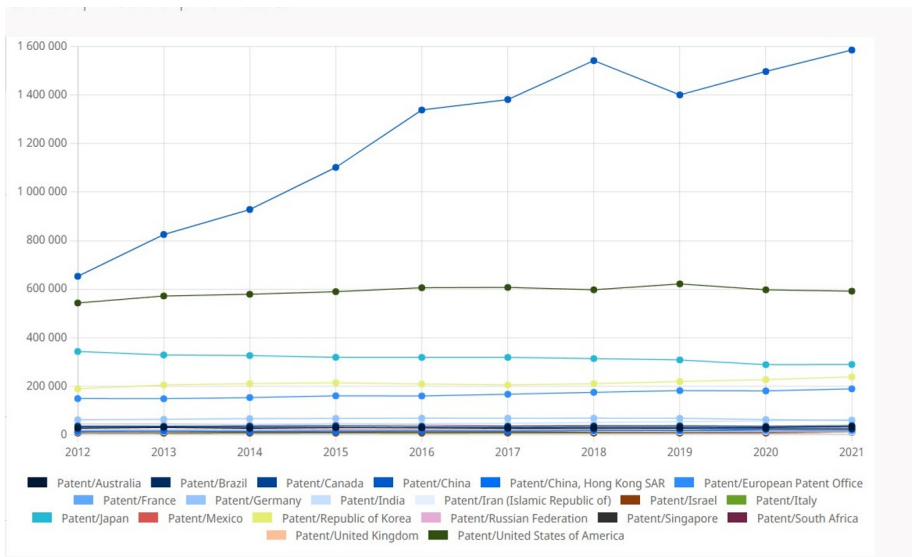


Fig. 1. Patent - Applications for the top 20 offices

The most significant growth in patent activity is observed in Asia. A noticeable increase in patent applications was observed in China (+5.5%), the Republic of Korea (+2.5%) and India (+5.5%) led to a global increase in the number of patent applications in 2021, as a result of which the share of applications filed in Asian countries exceeded two-thirds of the global number of applications. Patent activity in 2021 decreased in the USA (-1.2%), Japan (-1.7%) and Germany (-3.9%).

The works of M. Castels (2000), N. Nigroponte (1996), D. Bell (1986), Kling R., Lamb R. (2000), and I. Nonaka (2011), Raul Katz (2017), Toffler (2004) are devoted to the study of the process of technological development and the influence of new technologies on social formations, man and modern societies, and social efficiency. The current stage of developing the concept of sustainable development is characterized by an approach that takes into account the balance of social, environmental and economic goals and objectives of development. Technological transformation, putting forward new requirements for the level of innovation activity, leads to structural changes in industries and new technological priorities.

2 Materials and Methods

The purpose of the article is to reveal the essence and differences of technological transfer of socially significant innovations as the basis of sustainable development of the region. The article presents an analysis of the key mechanisms of technological transfer in different countries, the evolution of these systems at the legislative level. Conclusions are drawn regarding various approaches to the definition of technological transfer in modern conditions. Transfer is defined not just as the movement of technology using any information channels, the practical implementation of innovation, but a new context of sustainable development is highlighted, changing the target priorities of the innovation project and technological transfer. The definition of sustainable development is presented

taking into account the digital overload of a person in modern society. Sustainable development is revealed only in the context of environmental, sociotechnical priorities. It is necessary to fundamentally change the organizational conditions and motivational mechanisms in order to involve all participants in innovative projects and programs, the introduction of technological solutions, infrastructure, technological audit and determination of the innovative potential of the territory, calculation of indicators of innovative performance for this territory. The methodological basis of this work includes fundamental research by Russian and foreign scientists in the field of scientific and technological development, formation of technological transfers, strategic management, innovation management, regional economy. In the process of preparing the article, the following methods of scientific research were used: methods of systematic and formal-logical, scientific analysis and synthesis, comparative analysis, economic and statistical methods.

3 Equations and mathematics

The decline in productivity growth in traditional industries was intensified by the crisis of transition from the fifth to the sixth technological order. The effectiveness of scientific research and technical developments aimed at solving the most important social problems should become the main focus of the socio-economic development of the country. The transition to a new model of the Russian economy and the achievement of the level of technological sovereignty determines the search for effective factors of innovative development of the country, provided that social tension and differentiation are reduced. The innovative efficiency and effectiveness of the region's economy for residents of any country includes the goals of sustainable development: the growth of well-being and employment, the fight against poverty, improving the educational level, improving health, improving the institutional conditions for economic development. Socially significant innovations are aimed at solving urgent social problems and achieving the goals of breakthrough scientific, technological and socio-economic development of the country, meeting the key needs of society using new technologies. Widespread digitalization, affecting all spheres complicated by external problems caused by geopolitical events, sanctions against Russia, is becoming not only a matter of innovative development, but a matter of national security †Every year more and more large and medium-sized organizations use digital technologies in their activities. Institute of Statistic Studies and Economics of Knowledge (ISSEK) of HSE has identified the main trends in the field of digital business transformation based on the results of the federal statistical observation for 2022. Among digital technologies, big data collection, processing and analysis technologies and cloud services are most in demand: about 30% of organizations use each. Noticeably more organizations began to use artificial intelligence technologies (6.6%), which is associated with the emergence of new solutions (including standard ones), the implementation of training programs to work with them and active state support. Digital platforms (14.9%) and geoinformation systems (13%) showed a decrease in dynamics. The use of such complex niche solutions as additive technologies and digital twins remained at almost the same level (1.3%). It is possible to note the technological cyclicity and continuity.

Socially significant innovations can relate to various areas of life, including ecology, healthcare, education, and social security. For example, for the Krasnoyarsk Territory, the development of social sectors is the leading mechanism for increasing human capital and

†From cloud services to additive technologies: Differentiation of Business Demand Retrieved from: <https://issek.hse.ru/news/867015357.html>

improving the quality of life of the population. Innovations aimed at the technological and logistical development of industries, the expansion of the use of non-stationary and intensive technologies for providing social services to the population are needed. Continuous technological development of healthcare in the coming years should include improving the system of medical care through the introduction of mobile scanning systems (gadgets) for diagnosing the state of the main parameters of the human body, the development of remote and mobile forms of counseling and medical examination; replenishment of specialized medical care with modern high-tech methods; development of informatization in healthcare in order to improve the quality of medical care, efficiency and the effectiveness of health system management processes through the introduction of a medical electronic information system, an integrated electronic medical record, electronic digital signature technology for a doctor, minimizing the volume of medical documents in paper form, modern means of communication between doctors, doctors and patients, a patient's personal account, a doctor's workplace and a nurse, electronic decision-making assistance systems, access to electronic information and training resources, introduction of telemedicine technologies, application of navigation technologies, modern information technologies for emergency medical care, integration of the regional segment of the information system with unified federal resources in the field of healthcare [1].

The formation of the technology transfer system of socially significant innovations is determined by the role of social goals and modern challenges affecting innovation processes. The lifetime of technologies is shortened and becomes too short, less than the time it takes to obtain legal protection, conduct patent examination. Another reason is the level and quality of patent examination. In the most modern areas related to nanotechnology, quantum technologies, genomic research, it is difficult to ensure the quality of work of experts corresponding to the pace of development of science and the speed of knowledge exchange. The introduction of technologies does not occur separately and independently of each other – on the contrary, sets of complementary technologies (and related institutions) form an integral, closed and stable complex called the technological order [2]. According to representatives of the Department of Science and Technology of the Ministry of Education and Science of the Russian Federation, the compression of the cycle starting from research, development, to the market implementation of an innovative product.

D.V. Gibson defines transfer as the movement of technology using any information channels from one of its individual or collective carriers to another (Gibson, 1991). Taking into account modern conditions and revealing the essence of the process of technological transfer for socially significant innovations, it is possible to define this process as a study at the first stage of the region's problems, accelerated introduction of new technologies, implementation of mechanisms of commercial and non-commercial scientific and technological exchange aimed at innovative development of socially significant sectors of the region's economy. Technological transfer of socially significant innovations involves the dissemination and practical use of technologies, scientific achievements for the purposes of social policy. The purpose of technology transfer is to create economic and social added value. Although economic value creation is widely studied and can be relatively well measured, this does not apply to social value creation. However, social benefits do not arise automatically as a result of ongoing technological transformation. The social orientation of technologies should be the goal, evaluated in accordance with specific criteria, since technologies can have negative and positive effects. Examples of creating conditions for technological transfer in many countries have their advantages and differences. In 1980, the U.S. Congress passed the Bayh-Dole Act, allowing universities, educational departments at medical institutions, research institutes to have an automatic right to acquire ownership rights to inventions made with federal funding. In response,

these institutions opened offices to obtain patent protection for these inventions and were given the opportunity to license and commercialize new knowledge. It's not about financing and commercial benefits, which is certainly the goal to satisfy investors in innovative knowledge-intensive fields of activity. Technology transfer should serve as our main mission of the innovation project, the exchange of ideas and innovative reproduction serves the well-being of the preservation of society.

The growing importance of knowledge production and innovation for economic life created new potential roles for universities at the end of the last century. Research and education have been the main tasks of universities since their foundation; however, a third task has been added. The so-called "third mission" has emerged, which is to transform the value of academic institutions for the benefit of society (Zomer, 2011).

The "third mission" refers to the social, entrepreneurial and innovative activities that universities, as educational organizations, carry out in addition to their main activities, research activities. The essence of this mission is to transfer knowledge and technology from academic institutions to society to solve real problems. In practice, this concept usually means the transfer of licenses for research results to industrial partners or the creation of subsidiaries. Although such a commercialization process may generate revenue for the participating university, it is not aimed at technology transfer. Instead, the goal of the "third mission" is to make a valuable contribution to society. It should be noted that the transfer of knowledge from universities and state scientific organizations has always been carried out. It is bi-directional and, through the exchange of research results and business information, ensures mutually beneficial cooperation and satisfaction of all interested parties. Socio-ethical concepts in management emerged in the second half of the 20th century in response to many social upheavals, environmental challenges and disasters, but also in response to the formation of the information society by a new reality and communication channels. Traditional methods of knowledge transfer are still relevant and will remain so, but managerial tasks of coordination and control, motivation and organization are being implemented in new technological conditions.

The commercialization of knowledge in the process of technological transfer requires the participation of four parties: the developer and initiator of scientific research or the search for solutions to public problems, the investor, the technology transfer center (TTC), which helps the developer of the idea (in the Russian model), but also a society with social needs and limitations (in new models of technological transfer). The successful activity of technology transfer centers as a tool to ensure the stable technological sovereignty of the country was noted by the Commission of the State Council of the Russian Federation. It is important to take into account technological priorities and sustainable development goals, the role of man and the impact of modern technologies. Technologies have various effects, for example, beneficial or destructive effects on individuals, the environment and society. The concept of sustainable development sets the framework. Thus, the task is to develop technologies (and related business models) that will have social efficiency and are aimed at achieving sustainable development goals. As noted above, sustainable development includes not only the preservation of the natural environment, but also human information security, its preservation in the technology transfer system as a carrier of implicit knowledge. A huge array of information and data can upset the balance and lead to both misinformation and disorientation in the process of making managerial decisions. Traditional key indicators of technology transfer efficiency (number of patents, license revenues, by-products) are insufficient tools for the development of the innovation process. Society needs methodological and organizational support in order to expand the traditional dimensions of technology transfer efficiency, namely: technological advancement and market attraction – demand for innovative products, including the main condition – the social significance and role of these technological solutions. The latter component should

be taken into account when allocating investments. According to expert estimates, in Russia, only 8 to 10 percent of innovative ideas and projects are currently used in the production sector. 95 percent of innovations are implemented in Japan, 62 percent in the USA. It is time to reverse the situation and ensure technological and social security. The Ministry of Industry and Trade periodically opens a season of free privatization of state innovations, provided with a regulatory framework. Technological transfer is the most important condition for increasing the innovative potential of domestic industry.

To regain the leading positions in the global scientific and technological progress, we must form an effective innovation system: a well-coordinated interaction of science, government and business. There is a colossal problem: all participants in the innovation process are distanced from each other or exist separately: there is no business interest in research and development, production in science. And in a crisis, business does not risk investing in innovations at all. That is why the state is ready to open its intellectual bins, for the formation of which billions of rubles are allocated annually.

The new approach consisted in the fact that, having renounced intellectual property rights, the state brought the rights to scientific and technical results to the market. The American authorities have clearly defined the goals of state financing of R&D. Russia also has experience in creating conditions for technological transfer. The Government decree adopted in 2012, which regulated the transfer of rights to inventions and other results of intellectual activity to the executors of state contracts. Enterprises have been given the opportunity to involve the rights to scientific inventions in economic turnover, and thereby use them in the country's economy. Nevertheless, the mass privatization of inventions has not begun. First of all, due to the fact that organizations ready to use the results of intellectual activity had an additional tax burden, because intellectual property transferred free of charge is profit. But the problem was solved by tax amendments to the Tax Code, which exempt organizations from additional tax burden.

By giving up its intellectual property rights, the state intends to allow inventors themselves or private companies to commercialize it. According to expert estimates, in Russia, only 8 to 10 percent of innovative ideas and projects are currently used in the production sector. Using 10 principles, we have illustrated that technologies have different effects, for example, beneficial or destructive effects on individuals and the common good. Thus, the task is to develop technologies (and related business models) that will have a more positive and less negative social effect, to create business models with socially significant innovative solutions, the ability to solve or create solutions for social problems previously solved inadequately, new ideas, strategies, technologies that contribute to solving socially significant tasks that cause social changes in society.

An important role in the economic recovery of Japan was played by the countries of the USA, France, Germany, this was manifested in the borrowing of scientific and technical developments and the accumulation of knowledge. After the tragedy of Hiroshima and Nagasaki, Japan actively acquired technologies, licenses, patents, the best samples of products that were subjected to qualitative changes, eventually receiving a new innovative product and reproducing new technologies. Even the famous lean manufacturing management technology developed in Japan as an industrial company's experience has American roots. Artificial intelligence technology, experiencing a phase of active growth today. Artificial intelligence learns and absorbs a huge amount of information, while the human mind experiences several other processes. New competencies are also being formed, but there is another effect of the loss of the implicit most valuable components of knowledge due to the development of the technological solutions of remote work themselves, as well as information overload, simplification, substitution. The model of copying knowledge in the historical context contributed to the achievement of positive results, thus, the country turned from an importer into a net exporter of the latest

competitive products. Later, China, South Korea and a number of other countries successfully borrowed this experience.

The model of technological transfer of socially significant innovations, including the following components, is revealed only through the principles of knowledge exchange, knowledge building, effective knowledge management (Figure 2):

- stimulating the growth of knowledge, creating infrastructure and conditions for activation, motivational mechanisms at the level of the organization, organizational conditions and support infrastructure in the territories of the region for initiating scientific research to solve socially significant problems, the formation of internal motivational mechanisms for building up implicit knowledge;

- selection and accumulation of significant information from sources external to this organization about technological capabilities and directions of development of scientific research, applied research in order to identify and rank, differentiate according to the degree of importance and specifics of issues and social tasks;

- preservation, classification, transformation, ensuring the availability of knowledge, creation of a database of innovative projects and programs for the implementation of socially significant innovations, expert communities, formation of a digital control loop, improving the efficiency and security of communication channels used in the implementation of an innovative project;

- dissemination and exchange of knowledge and the creation of a collaborative environment, communication relationships for targeted systematic work in order to implement socially significant innovative projects and programs, including within the organization; the use of knowledge to create effective business models that include the state and society, including in the process of making strategic innovative decisions;

- implementation of knowledge in products, services, documents, databases and software, creation of a regional market for innovative products, creation of a competition standard for innovative organizations;

- assessment of knowledge, measurement and use of intangible assets of an organization, use of intellectual property rights, assessment of relevance and novelty, determination of the stage of the technology life cycle and its synchronization with the stages of implementation of an innovative project and business model, assessment of satisfaction of all stakeholders, including society, assessment of the degree of achievement of socially significant benchmarks and solving social problems;

- protection of knowledge, intellectual property rights, development of motivational mechanisms and personnel policy in relation to carriers of implicit knowledge in order to form sustainable competitive advantages of the project, preserve social priorities and opportunities for innovative solutions to social problems, ensuring digital security and efficiency.

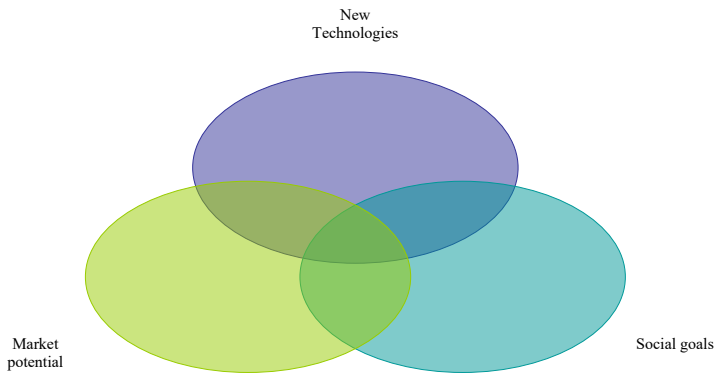


Fig. 2. The model of technological transfer of socially significant innovations

Social innovation refers to the development and implementation of new solutions that imply conceptual, process, product or organizational changes, ultimately aimed at improving the well-being and well-being of individuals and communities [4]. The most up-to-date knowledge has the highest value and provides the marketing potential of an innovative project. Social and marketing effectiveness determine the result of technological transfer of socially significant innovations. The effectiveness of scientific research and technical developments, the high rate of mastering new knowledge and creating innovative products are certainly the key factors determining the competitiveness of the country's economy and the effectiveness of national security strategies. In Russia, the dynamics of the number of patent applications for inventions depends on the overall level of patent activity due to a reduction in the number of technical solutions registered by domestic developers within the country.

Social innovations are new ideas, strategies, technologies that contribute to solving socially significant tasks that cause social changes in society. Social innovations include new social systems, educational technologies, innovations for healthcare, but also for production in order to ensure its environmental friendliness. The division of innovation processes into managerial, organizational, and production processes is not typical for the technological transfer of socially significant innovations, since the effectiveness is determined complementarily. Today, more than ever, it is important to expand the range of tools to support not just social entrepreneurship, but to build a system for identifying the needs for technological innovations to meet the social needs of society, to assist in the development of social initiatives and the adoption of high-tech solutions. One of the ways of effective support can be educational programs and the transformation of the support system, the identification of the necessary preferential instruments.

Social goals and technologies require modern digital technologies to solve the most pressing social and environmental problems in the world. Technologies for the benefit of society play a crucial role in achieving the Sustainable Development Goals. The following strategic priorities have been identified for Russia in the field of digital transformation of the ecology and nature management industry: artificial intelligence technology, which will be used as part of the development of the ecology and nature management industry to analyze monitoring information, automate decision-making in real time; Internet of Things technology will be used as part of the development of the state observation network of the Federal Service for Hydrometeorology and Monitoring to improve the efficiency of data

collection and transmission from stationary and mobile observation points; Earth remote sensing and unmanned aerial vehicle technologies will be used as part of the development of the ecology and nature management industry for survey, planning of effective use and reproduction, protection of natural resources, environmental protection and control over climate change; Big Data technologies and analytical data processing will be used as part of the development of the ecology and nature management industry for the accumulation, storage, analysis and processing of data in the federal state information systems and digital platforms being created; digital twin technology will be used as part of the development of the ecology and nature management industry to update and create a database of a new generation of natural objects (ecosystems), including subsurface, water objects, forests, habitat of objects of the animal world. The European Green Deal Strategy also includes a package of measures designed to make the economy environmentally sustainable, including the transfer of new technologies, investments in environmentally friendly technologies. It should be borne in mind that a number of technological breakthroughs are expected at the turn of 2025-2035, reflecting profound technological changes that will lead to the transformation of traditional industrial production. According to the Intergovernmental Panel on Climate Change, global warming has been observed since the 1970s, which manifests itself in an almost linear increase in temperature and is associated with an increase in the concentration of greenhouse gases in the atmosphere due to an increase in their anthropogenic emissions. Many innovations are systemic in nature, which means that their commercialization involves change, adaptation and joint specialization. Social effects are inevitable in the implementation of any innovative project. Systematic innovation is increasingly stimulating the processes of commercialization and implementation of socially significant projects through ecosystems. Technological transfer and solutions to these problems, the introduction of technologies is carried out both through natural market mechanisms. Technology transfer centers are being created in Russia as a tool to ensure the country's stable technological sovereignty. Technology transfer centers identify developments ready for implementation into the economy and form an order for research from the business side. There will be 20 new technology transfer centers in 10 regions. At higher educational institutions, these structures are aimed at the registration of security documents for the results of intellectual activity, i.e. the transformation of the results of intellectual activity into intellectual property, which in rare cases becomes a commodity. The Technology Transfer Center commercializes the results of intellectual activity of scientific organizations and educational organizations of higher education, including participates in planning the implementation of research, development and technological works by these organizations, the result of which may be the results of intellectual activity subject to legal protection, performs other functions. In 2023, more than 235 million rubles will be allocated for the development of such centers, in 2024 — 400 million rubles.

At the international level, technology transfer is implemented using the methods and tools of traditional business, adjusted for the specifics of the innovation component, which is characterized by high risk, uncertainty, capital intensity, and intellectual labor resources. In Russia, a standard has been adopted that allows for the unification of approaches to assessing the maturity of technologies and making decisions on the application and development of certain critical technologies and components when creating target and support systems.

The possibilities of scientific and technological development of the Russian Federation, taking into account new challenges, include the implementation of an alternative scenario for the formation of technological sovereignty, overcoming the prevailing negative trends, restructuring the management system of scientific research, innovation, increasing investment in research and development work. The transition to a new model of technological transfer with the priority of social goals as the basis for sustainable

development of the region using motivational mechanisms of business involvement, collaboration of business and government as participants in innovative projects and programs, which becomes a prerequisite for their implementation.

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