MANAGEMENT OF NATIONAL ECONOMY DEVELOPMENT

DOI: https://doi.org/10.30525/978-9934-26-020-9-1

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DEVELOPMENT OF NATIONAL INNOVATION SYSTEMS OF COUNTRIES AS A FACTOR IN OVERCOMING DIFFICULTIES DURING THE PANDEMIC[1]

Summary

The development of their national innovation systems has an important impact on increasing the competitiveness of countries in the global economy. The study revealed the insignificant role of universities in the creation and implementation of national innovation systems of the BRICS countries. At the same time, the leading role of the state in this process was revealed. An analysis of the innovative development of the BRICS countries made it possible to determine the main elements of its potential: state, scientific, production and financial potential. The analysis made it possible to identify important problems of the innovative development of the BRICS countries, as well as to determine the main directions for solving the problems associated with the coronavirus pandemic.

Introduction

An important factor in stable economic development and increasing the competitiveness of countries in the global economy is the development of their national innovation systems (NISs). Danish scientist B.-A. Lundwall notes that the innovative development of countries contributes to their competitiveness and the growth of the general welfare of states in the world economy [1]. K. Freeman believes that the national innovation system is a network of public and private institutions whose activities are aimed at creating and implementing new technologies [2]. Both European and American scientists are engaged in research and development of the NIS idea. According to the definition of the American economist R. Nelson, the national innovation system includes institutions involved in the creation of innovations that contribute to improving the efficiency of innovation activities of national companies [3].

[1] This study was financed by a grant from the Plekhanov Russian University of Economics, Moscow, Russia # 969 05.08.2020, #1232 08.10.2020

We support the opinion of S. Gusarova, who noted that «the NIS concept presupposes the creation of a basis for a systematic, theoretical substantiation of the most advanced innovative initiatives of the governments of various countries» [4].

Modern national innovation systems are based on the development of relations of three leading actors of the innovation process: the state, private business and universities. Henry Etzkowitz's triple helix model assumes this relationship [5].

The role of universities in the creation, and implementation of innovative development in the BRICS countries is insignificant. The leading position in the development of innovation systems of the «five» countries belongs to the state. It is the state that directs the scientific and innovative activities of all structural divisions of NIS in these countries, «organizes work, carries out nationwide coordination and finances more than two thirds of all expenses both for pioneering developments and for bringing them to the level of implementation» [6].

Thus, the NIS of the BRICS countries can be attributed to the first type of «triple helix». This is due to the fact that the national innovation systems of these countries are in a state of formation and development.

The analysis of the development of national innovation systems of the BRICS countries made it possible to identify the main structural units involved in innovation and promoting the development and implementation of innovations in the economies of the BRICS countries, which can be divided into the following areas:

– state potential – government organizations responsible for the development of science and technology, research in the field of innovation (ministries, committees, councils, etc.);

– scientific potential presented by a) institutes of the Academy of Sciences engaged in fundamental research and development in various fields of knowledge; b) research institutes; c) universities developing research projects in key sectors of the economy;

– industrial potential, including research institutes and laboratories of private corporations, both local and foreign;

– financial potential a) government funds funding research in the field of innovation; b) banking structures, including development banks; c) venture companies.

The innovation systems of the BRICS countries are characterized by the following features.

Part 1. Development of national innovation systems of Russia, India, and China

The development of fundamental and applied science and modern technologies plays an important role in the development of the country's economy, increasing its innovative component.

In Russia, the Ministry of Education and Science of the Russian Federation is coordinated the work of the development of innovation. In 2018, 3950 organizations were engaged in scientific research and development, including 1574 research organizations, 254 design organizations, 20 design and survey organizations, 49 experimental plants, 917 institutions of higher education, 419 industrial organizations that had scientific research, design, and engineering departments. Among 3,950 organizations engaged in research and development, 38.3% are in the public sector, 33% are in the business sector, 25.3% are in higher education institutions, and 3.5% are non-profit organizations [7].

The main center of fundamental research in the natural and social sciences is the Russian Academy of Sciences (RAS) [8]. As of 01.01.2020, 707 employees worked in 484 RAS organizations [9]. RAS is a member of more than 120 international organizations, it interacts in various areas with 600 international organizations, has 70 cooperation agreements with 48 countries and 400 protocols of intent to cooperate with foreign organizations, and takes part in the implementation of 9 intergovernmental agreements. In Russia, fundamental and applied research is also carried out by the Russian Academy of Medical Sciences, the Russian Academy of Agricultural Sciences, the Russian Academy of Architecture and Construction Sciences, the Russian Academy of Education, and the Russian Academy of Arts. A great achievement of modern medicine was the creation of cellular engineering products, namely, bioartificial liver based on cellular technologies, by Russian scientists of the Federal Scientific Center named after Academician V.I. Shumakov.

Foreign partners are interested in cooperation with Russia, since the country possesses a significant number of qualified scientific and technical workers who receive relatively low wages. In training centers created by foreign TNCs, Russian specialists acquire the necessary skills to carry out effective activities in these companies, study corporate standards for making business decisions. At the same time, the analysis made it possible to draw a conclusion about the weak implementation of innovative technologies by branches of foreign TNCs. A relatively high level of innovative activity was noted in some joint ventures.

The system of scientific institutions indicators, developed by the Ministry of Education and Science of the Russian Federation, is based on the following four groups of indicators. The first group assesses the quantity and quality of works indexed in international scientometric databases, as well as the level of inventiveness. The second group includes the number of defended dissertations, internships in leading Russian and international research centers, the number of graduate students, masters and bachelors engaged in scientific research. The third group of indicators is based on assessing the contribution of organizations to the dissemination of scientific knowledge. The fourth group includes the number of employees, the main areas of

research of scientific organizations, and financial indicators. An important role in the training of highly qualified specialists is assigned to the higher education system. In the rating of the 600 Top universities in the world in 2020, the best among Russian universities was Lomonosov Moscow State University, which took 84th place in the world (up 34 positions against 2012). In addition, nine more Russian universities were included in the list of 600 best universities. For the development of research activities, an important place is given to the training of postgraduates and doctoral students, whose number in 2010–2018 decreased by 5.6% (to 25288 people) and 4.2% (to 75042 people), respectively. In 2018, more than half of all doctors of sciences (61.5%) conducted scientific research in the field of natural and technical sciences, 13.3% in the field of medical sciences, 11.3% in social sciences, 8.9% in the humanities, 4.9% agricultural sciences. The publication of scientific research results both in Russian journals and abroad is of great importance for the development of the country's national innovation system. In 2019, 1202.5 thousand scientific papers were published in Russia (27.4 times more than in 2013), 97.6% of them were cited.

In the global database of scientific publications «Science Citation Index», the share of publications by Russian scientists was 1.71%. And the share of publications by Russian researchers in the total number of publications in world scientific journals indexed in the WEB of Science database was 2.3%; by 2020 it was planned to increase it to 3% [10].

Russia is in 11th place in the world in terms of intellectual property. For 94.2% of the submitted applications, 35.8 thousand patents for inventions were received, of which about a third – 34.5% – was by foreign inventors. More applications were filed for simpler inventive activities. Thus, 263.6 thousand applications were received for trademarks and industrial design, while local specialists submitted 77.4% of applications, and foreigners – and 22.6%. The index of inventive activity in Russia was 2.5, and by 2020 it was planned to increase to 2.8 [10]. According to this indicator, the task is set for Russia to become one of the world leaders.

A high index of relative specialization of issued patents in Russia is noted in the field of inorganic chemistry (0.032), metallurgy (0.516), «green» energy (0.365), medical technologies (0.155) [11]. A negative indicator was obtained in the field of semiconductor development (-0.831), which indicates Russia's interest in foreign innovative technologies necessary for the development of this area.

The state development corporation VEB (Vnesheconombank – Bank for the Development of Foreign Economic Activity) is engaged in financing the innovative development of Russia in partnership with other commercial banks. The implementation of the bank's main projects – the development of infrastructure, industry, social sphere – is aimed at strengthening the technological base of the country's economy, at improving the living standards of the people. The main share of projects is concentrated in

infrastructure development (54.5%), natural resource efficiency (21.8%), national projects (9.8%), export support (4.9%), innovation development (1.7%), and energy efficiency (0.5%) [12]. VEB assists in the development of small and medium-sized businesses, public-private partnerships.

Among the main innovative projects of VEB are the following: a) development of innovative drugs (VEB's share amounted to 9.4 billion rubles); b) production of synthetic sapphire for optoelectronics (3 billion rubles); c) development and organization of production of MS-21 aircraft (7.1 billion rubles); d) production of aircraft units by NPO Nauka (1 billion rubles); e) biotechnological complex «Fort» (4.8 billion rubles); f) Avtovaz development program (60 billion rubles); g) creation of the Sukhoi Superjet-100 aircraft family (73 billion rubles); h) data center in St. Petersburg (2.2 billion rubles); i) Express-AM7 spacecraft (7.7 billion rubles).

In terms of innovative potential, Russia is in the 32nd place in the world. The analysis made it possible to identify the main problems of the development of the innovative economy of Russia, the solution of which will allow the country to cope with the difficult situation due to the coronavirus pandemic: a) weak funding for research and development; b) a very low level of cluster development; c) weak commercialization of innovative products, developments and new technologies; d) low volume of government orders for the creation of innovative technologies; e) insufficient number of applications for patents for inventions and trademarks; f) the insignificant level of cooperation between universities and industrial companies in the field of R&D; g) weak joint work with foreign specialists and scientists to create inventions; d) insufficient quality of activities of research institutes; e) reduction in the number of Russian researchers engaged in scientific research.

India in 2010–2020, set a benchmark for a «decade of innovation». The Indian model of innovative development was aimed at providing services to low-income people, the development of small and medium-sized businesses not only in the developed regions of the country, but also in depressed areas. The main task assigned to scientists was the task of generating ideas.

The National Innovation Council of India is responsible for coordinating the innovation strategy and creating scientific and technical developments in the country. The main goal of the council is to support the creation of massive technological innovations in various fields, the creation of a knowledge-based economy, and assistance in the commercialization of innovative technologies. The Council has created a database containing 322 thousand technological ideas and innovations from 608 regions of the country. The innovative ideas of 1,093 innovators have been implemented. The Council promoted the development of cooperation between various research institutes, academic institutions, agricultural organizations and universities to introduce innovative technologies into production. The council established a production laboratory

for the development and creation of new innovative products. Participants of innovative developments have received 1200 patents for inventions. Applications were submitted for registration of 24 design projects and 10 trademarks. Out of 74 applications for registration of a new plant variety developed by farmers and aimed at plant protection, 13 applications were successfully registered [13]. The Council facilitated the supply and commercialization of the created innovative products to 110 countries of the world, satisfying 1,500 requests.

The Microenterprise Innovation Fund has been established under the National Innovation Council of India, which is also supported by the Small Business Development Bank of India. The bank has provided venture capital for 230 innovative corporate projects that are not only at a late but also at an early stage of incubation. The Council facilitated the licensing of 109 innovative technologies created by poor people, proving that Indian innovators are creative people with knowledge and their potential as providers of innovative ideas is great. The Council concluded that it was necessary to collect innovative ideas across the country to strengthen and expand the research and development base.

The development of the innovation sphere in India is facilitated by the creation of an innovation infrastructure – incubators, technology parks, clusters, etc. The Council awarded grants to 15 seed-stage incubators that are dedicated to implementing technological innovations.

The Government of India is interested in developing innovation infrastructure and ensuring cooperation between business incubators and technology parks with research institutes and universities, which will contribute to the development of the country's national innovation system.

The Agency for the Creation of Science and Technology Parks and the Support of Science and Technology has created more than 30 technology parks, including the Kerala technology park, which employs 15,000 software development specialists in 110 companies. This technology park also has two universities specializing in programming and management.

The Council for Scientific and Industrial Research is a modern, cutting-edge Indian research organization in various fields of science and technology. The Council has a dynamic network of organizations, which includes 38 national laboratories, 39 information centers, 3 innovation complexes and 5 branches [14]. The main directions of the council's research work are research in the field of space, the oceans, metallurgy, chemistry, mining, oil and gas industry, food industry, environmental protection. The Council coordinates the work of scientific clusters in the fields of biology, chemistry, engineering, physics, etc.

Indian companies, developing innovative technologies, have made great strides in the innovative development of the pharmaceutical and automotive industries. The Indian government has introduced investment protection measures in these industries.

In India, an important place in the formation of the country's national innovation system is given to higher education. In the ranking of the 600 Top universities in the world in 2020, the best among Indian universities was the Indian Institute of Technology Bombay, which took 152nd place in the world (up 27 positions compared to 2018). In addition, six more Indian universities are included in the list of top 600 universities [15].

The level of innovative development of a country can be characterized by the effectiveness of research and development. In 2019, Indian scientists published 1,873.3 thousand scientific papers (17.7 times more than in 2013), 93% of them were quoted in other scientific papers.

India is ranked 12th in the world in terms of intellectual property. In 2018, Indian inventors filed 50.1 thousand applications for patents for inventions, of which foreign inventors accounted for 67.5%. For 27.7% of the submitted applications, 13.9 thousand patents for inventions were received, of which 83.5% of the patents were foreign inventors.

India's resourcefulness ratio was the smallest among the BRICS countries (0.4). India has a high efficiency in the development of innovative technologies in the field of computer technology (the index of relative specialization of issued patents for inventions was 0.103) and organic chemistry (0.787) [11].

In terms of innovation potential, India is ranked 35th in the world. The main problems that need to be addressed in the formation of the national innovation sphere in India in the difficult situation in the country in connection with the coronavirus pandemic are: a) a weak diversity of the workforce; b) low commercialization of innovative products and technologies; c) a small number of applications for patents for inventions and trademarks; d) insufficient amount of R&D expenditures; e) insignificant cooperation with other foreign inventors in the creation of innovative technologies.

For the development of the national innovation system in India and the solution of economic problems during a pandemic, it is necessary:

a) to implement a strategic government initiative aimed at encouraging innovation;

b) to improve incentive measures for the development of innovations in universities and research institutes;

c) to organize favorable conditions for the introduction of innovations by small and medium-sized enterprises;

d) to create global competitive approaches to the introduction of innovations by companies in strategic sectors of the economy;

e) to develop innovations in the service sector;

f) to create an ecosystem focused on environmental protection, conducive to inclusive innovative development;

g) to introduce innovative technologies in the healthcare system;

h) to reduce the difference in living standards between people with high and low incomes (by increasing the living standards of the poor);

i) to introduce responsible financing aimed at obtaining economic, social and environmental benefits.

The Chinese government decided to reorient the development of the country's economy from an export-oriented model to the growth of domestic consumption, building an innovative economy by 2020. Only the development of innovations on their own can contribute to the growth of the competitiveness of high-tech Chinese products on the world stage.

A socialist system with Chinese characteristics has been established in China. The development of the main directions of China's innovation policy until 2020 was carried out in accordance with the objectives of the state strategic plan for the medium and long-term development of science and technology until 2020 (Innovation 2020).

The Ministry of Science and Technology of China coordinates and finances the work of national high-tech programs aimed at the innovative development of the country's economy. Most of the universities, institutes, academies of sciences and research institutes in China are state owned, they carry out the bulk of fundamental and applied research and development in accordance with government programs.

A special place in the formation of China's national innovation system is given to raising the level of education. In the ranking of the 600 Top universities in the world in 2020, the best among Chinese universities was Tsinghua University, which was ranked 16th in the world (up 9 positions against 2018). In addition, another twenty Chinese universities were included in the list of top 600 universities.

In 2019, Chinese scientists published 6,589.7 thousand scientific papers (15.5 times more than in 2013), 98.2% of them were quoted in other scientific papers. The share of publications by Chinese scientists and researchers in the global scientific publications database «Science Citation Index» is 16.58%. The bulk of research in China was conducted in the field of experimental development (81.7%), while basic research accounted for the smallest share (6.5%).

Technology parks and business incubators play an important role in the commercialization of scientific achievements, innovative technologies in the formation of the national innovation system of China (1.4 million specialists work in 1,239 technological business incubators). Many high-tech Chinese startups have developed in business incubators. More than 180 companies that left the incubators went public and were listed on stock exchanges. Leading innovative projects of technology parks and business incubators are carried out in the field of green energy, environmental protection, agriculture, infrastructure, information and communication services, mineral resources, health care, etc.

China’s resourcefulness indicator was the highest among the BRICS countries (4.8). The most effective implementation of innovations in China is in the field of inorganic chemistry (0.085), digital communications (0.466), metallurgy (0.319), and wind energy (0.067).

China should pay more attention to the development of computer technology, organic chemistry, semiconductors, transportation, medical technology, fuel cell technology and geothermal energy, where inventive activity rates were negative.

Despite the fact that many foreign companies are gradually withdrawing their assets from China, the country remains an important research base for branches of foreign TNCs. Over the years, the quality of China’s labor resources has improved significantly, and the number of highly qualified engineering and technical personnel has increased. That is why many foreign TNCs are locating their innovative research centers in Beijing, Shanghai, but more recently in Guangdong, Jiangsu and Tianjin.

In these scientific and technical research centers, work is being carried out to create new highly efficient information and telecommunication technologies, to develop and introduce modern high-tech equipment, and to carry out scientific research in the field of biotechnology, medicine, automotive industry, etc.

However, branches of foreign TNCs located in China are in no hurry to increase investment costs in creating high innovative technologies in China. They only conduct research and development in sectors of the economy where they have to compete with Chinese companies by adapting their technologies to local conditions. Investments of foreign branches of TNCs in the Chinese economy do not have an effective impact on improving the innovative development of local companies, on the inflow of innovative technologies and the development of the country’s national innovation system.

In terms of innovative potential, China is in the 24th place in the world (the best position among the BRICS countries). The study made it possible to conclude that, despite the fact that the national innovation system of China is at a higher level of development than the NIS of the rest of the BRICS countries, it has a number of unresolved problems, the implementation of which will improve the economic condition of the country in connection with the coronavirus pandemic:

a) poor diversity of the workforce;

b) insignificant participation in international cooperation in the field of joint research and innovative development;

c) insufficient investment in R&D, including foreign ones.

Part 2. Formation of national innovation systems in Brazil and South Africa

In Brazil, the Ministry of Science and Technology is responsible for the creation of innovations, the development of nanotechnology and the development of nanoscience [16], which subordinates the National Council for Scientific and Technological Progress (responsible for the allocation of state GRANTS for research and development in leading sectors of the economy) and the National Agency for Research Financing and projects. The ministry also oversees and coordinates the activities of the Center for Governance and Strategic Studies, the National Nuclear Energy Committee, and the Brazilian Space Agency. In addition, it has 19 research units dedicated to innovation and four government-owned enterprises operating in the nuclear, heavy industry, space and advanced electronics industries.

An important area of activity of government organizations in Brazil to support and stimulate the creation and implementation of innovations is the development of close cooperation between universities, research institutes and industrial companies. The main research and development in Brazil is focused on the introduction of innovative technologies and products in strategic sectors of the country's economy and in the field of social development. To address these challenges, the country adopted programs such as the Productive Development Strategy [17] and the Brazilian Master Plan [18].

The main task of creating the Productive Development Strategy program was to increase funding for research and development in the field of innovations in strategic sectors of the country's economy, to create tax incentives and customs preferences for the development of this sector of the economy. Such strategic areas of the economy as, for example, the medical industrial complex, the information and telecommunications complex, nuclear energy, bio- and nanotechnology were identified. The government has set the goal of increasing the international competitiveness of such industries as the automotive industry, capital goods, textiles and clothing, forestry and woodworking, cosmetics, perfumery, hygiene products, civil engineering, service complex, naval and coastal industries, and footwear.

Possessing significant natural resources and a certain scientific potential, the Brazilian government put forward the idea of expanding leadership in the air navigation complex, in the production of oil, petroleum products, bioethanol, natural gas, in steel production, in the production of cellulose, in the production of beef.

In accordance with the second part of the country's development program, the Brazilian Master Plan was adopted. The strategic direction for the implementation of this plan was to expand investment (including FDI) in innovation to improve the competitiveness of the Brazilian economy and improve the quality of life of the country's population. It was decided to stimulate the implementation of investments in innovative development by

exempting companies engaged in innovative development from paying income tax and providing customs preferences.

The task was to move from creating an economy of competitiveness to developing an economy of competence. Particular attention was paid to the further development of the internationalization of Brazilian companies, the expansion of the domestic and foreign markets, an increase in the share of high-tech goods in the structure of the country's GDP, export diversification, the development of innovative infrastructure, the introduction of innovative technologies in the energy sector, the creation of clean innovative technologies that contribute to environmental protection.

A special role in the formation of the country's innovative potential was assigned to raising the level of education. In the ranking of the 600 best universities in the world in 2020, there were 49 universities from the BRICS countries. When compiling the rating, such indicators as the volume and directions of scientific research, the organization of the student learning process, assistance in the employment of students after graduation from the university, and the organization of the internationalization process are taken into account. In 2020, the University of São Paulo (Universidade de Sao Paulo) was the best among Brazilian universities, and was ranked 116 (up 11 positions against 2013). In addition, six other Brazilian universities are included in the list of top 600 universities [15].

Diversifying the economy, expanding the production of high-tech products, introducing innovative developments into production requires improving the quality of education, increasing the volume and expanding the areas of applied and fundamental scientific research in various fields of knowledge.

The state pays great attention to increasing the amount of funding for fundamental and applied scientific research, which is carried out at the institutes of the Brazilian Academy of Sciences, in research institutes and universities.

Funding for research and development by private corporations is negligible. The main research and developments of branches of foreign TNCs are concentrated mainly in the automotive industry and occupy an insignificant place in the total volume of scientific research of the country.

The number of scientific publications and their citation is one of the most important indicators of the effectiveness of scientific research. According to this indicator, China ranked second in the world in 2019 (after the United States), India – ninth place, Russia – twelfth place, Brazil – fifteenth place, South Africa – thirty-fifth place in the world.

In 2019, 1,027,700 scientific papers were published in Brazil (17.4 times more than in 2013), 94.7% of them were cited [19]. In the global database of scientific publications «Science Citation Index», the share of publications by Brazilian scientists was 2.3%.

Brazil was 26th in the world in terms of intellectual property. In 2018, Brazilian inventors filed 24.9 thousand applications for patents for inventions,

of which 79.9% were foreign inventors. For 40.2% of the submitted applications, 10 thousand patents for inventions were received, of which 89% of patents fell to the share of foreign inventors.

The number of patent applications per 10,000 people allows for an ingenuity ratio of 1.5 in Brazil. To determine the innovative potential for the development of modern technologies in the country, an analysis of the index of relative specialization of issued patents is carried out, which made it possible to conclude that the introduction of innovations in the field of inorganic chemistry is promising in Brazil (the index of relative specialization was positive and amounted to 0.195).

In terms of innovative potential, Brazil in 2019 ranked 40th in the world and fourth among the BRICS countries. The main problematic issues in the development of the innovative potential of the Brazilian economy are: a) poor labor force diversity; b) insufficient implementation of joint inventions with specialists from other countries of the world; c) weak multilateral economic cooperation; d) insufficient number of patent applications for inventions and trademarks; e) low commercialization of inventions.

Promising directions for the development of Brazil NIS, contributing to the country's exit from the difficult conditions associated with the coronavirus pandemic, are:

a) industrial modernization;

b) further development of production and increase in the export of high-tech goods and services;

c) expanding the use of «green» energy;

d) further implementation of innovation infrastructure (innovation clusters, technology incubators, technology parks, innovation centers, etc.);

e) development of the higher education system (creation of new directions that meet the present requirements).

The main directions of the formation of the national innovation system of South Africa, its leading elements are reflected in the «White Paper for Science and Technology» [20] approved by the Department of Science and Technology. The paper notes that fostering a national innovation system will be central to empowering all South Africans in their pursuit of social, political, economic and environmental goals. The main task of the development of the South African Department of Science and Technology is to support the improvement of the well being of the people, building a strong and productive knowledge economy, and the growth of socio-economic development of South Africa by ensuring the efficiency and effectiveness of the development of science, technology and innovation.

Technological innovations are being carried out in such new areas as space science, energy, biotechnology, nanotechnology, and robotics. Great importance is attached to the introduction and commercialization of innovative technologies. The development of space science and technology is aimed at establishing the implementation of the national space strategy.

Bioinnovation activities are aimed at supporting and expanding research, development and creation of technological innovations in the country related to the bioeconomy. Particular attention is paid to the development of nanotechnology, synthetic biology and robotics. The creation of technological innovations in the country is funded mainly by state financial agencies.

Joint research and development in the field of health development and space research carried out by local companies and foreign TNCs. However, as in many countries, foreign TNCs are not interested in the development and implementation of innovative technologies in South Africa. They improve the productivity and efficiency of local companies, but only by introducing technologies that are not innovative for these countries, but may be new to the South African market.

In the ranking of the 600 best universities in the world in 2020, the best among South African universities was the University of Cape Town, which was ranked 198th in the world (down 7 positions from 2018). Also in the list Top 600 universities included three more South African universities.

South Africa took the 37th place in the world in terms of intellectual property, which was the worst position among the BRICS countries. Researchers in South Africa filed 6.9 thousand applications for patents for inventions in 2018, the share of foreign researchers accounted for 89.8%. For 68.1% of the submitted applications, 4.7 thousand patents were issued. More applications were filed for simpler objects of intellectual property (trademarks) than for obtaining patents – 22.5 thousand.

Conclusions

The analysis made it possible to identify the main problems of the innovative development of South Africa, the solution of which is necessary to overcome the consequences of the coronavirus pandemic:

a) small volume of applications for patents for inventions and trademarks;

b) low level of joint international inventions;

c) insufficient commercialization of scientific and technical developments, innovative technologies and products;

d) insignificant amount of research and development;

e) insufficient volume of scientific publications.

The formation and development of national innovation systems of the BRICS countries plays an important role in increasing the potential of their economic development, increasing the efficiency of industrial production, increasing the competitiveness of their goods and services in the world arena, and in improving the living standards of the population of their countries. Comparative analysis of the formation of national innovation systems of the five states, identification of their bottlenecks and unresolved problems, made it possible to determine the main directions of their development to solve the problems associated with the coronavirus pandemic:

a) widespread use of public-private partnerships in the field of research and development in strategic sectors of the economy;

b) conducting joint international research by experts from the BRICS countries in the field of creating innovative products and technologies;

c) development of multilateral intra-group trade and investment cooperation of the «five» countries in the creation and implementation of high-tech goods;

d) strengthening cooperation between government organizations, private companies and universities in the field of R&D;

e) creation of a modern innovation infrastructure in the BRICS countries (research clusters, business incubators, etc.);

e) increasing the volume of government orders for the development of innovative technologies in strategically important sectors of the economy;

f) improving the structure of research funding and the implementation of innovative projects by stimulating the attraction of funds from banking structures, venture companies, foreign investors (by providing tax incentives, customs preferences, etc.);

g) support for innovation activities of small and medium-sized enterprises;

h) improving the quality of training of highly qualified specialists and scientific workers;

i) improving legislation, protecting the rights of investors financing innovative projects, developments and research.

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