Improving the State Policy in the Field of Intellectual Property Management in the Context of Sustainable Economic Development

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Abstract: The article considers the problem the state research institutes and universities intellectual property management effectiveness. The features of the structure and intellectual property protection dynamics in research institutes of the Russian Academy of Sciences and in Russia as a whole are determined. Intellectual property in Russia is characterized by an expanded list of indicators, in contrast to those available in the literature: the industrial property objects protection, the patent holders structure, technology areas, the protection areas, and other characteristics. The authors compare the indicators of the innovative level of science and industry development in Russia and the United States. A simple definition of calculating the patent maintenance index is proposed. The diagnostics of the quality of patent portfolios in the institutes of the Novosibirsk Scientific Center was performed. The diagnostics was made on the basis of the results of the natural science profile institutes survey. As a result of the study, a low degree of intellectual property protection was established, which is the reason for the decline in its demand in the market. The recommendations to modify the intellectual property management system in state research institutions were developed, i.e. to move from quantitative volume indicators (the number of applications, patents, license agreements) to indicators that reflect the patents quality (the maintenance and duration of patents protection, the protection areas, maintenance in priority areas of technology, etc.). The recommendations for the development of a State strategy for the intellectual property management in order to improve the intellectual activity effectiveness in the context of sustainable economic development are presented.

1 INTRODUCTION

In the last half century, the key factor in the development of economic systems is innovation, which has determined the qualitative changes in the interaction of science, business and State. The modern era of the knowledge economy development in Russia has its own characteristics, i.e. our country has a high scientific potential in the field of basic research and low efficiency of its implementation in the economy, which is confirmed, in particular, by its low ratings in the global innovation indices system.

The intellectual property management, its transfer and use accompanies all innovation commercialization processes, which should be an integral part of State and regional innovation development strategies. Meanwhile, governmental and regional documents lack a well-founded and mutually agreed system of targets in the field of intellectual property (IP). At the present stage, characterized by the structural slowdown of the economy and the deterioration of the macroeconomic situation, the IP management process improvement is a necessary condition for the economy sustainable development, an urgent and promising management task.

As one of the key determinants of sustainable development, economic indicators should be emphasised, the functional components of which are the reporting indicators of State research institutes and universities, which contain only quantitative data on intellectual property and its transfer to the industry

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(according to Rospatent, State research institutes and universities are increasing their patent portfolios). There is a question about the quality of patents, the solution of which will determine the origins of this problem and will help to form one of the indicators of the research institutes and universities intellectual property management effectiveness. In the intellectual activity management mechanism, public policy can be considered as a controlling influence that contributes to sustainable development, which ensures the achievement of strategic goals defined by State programs and national projects (Nekhoroshkov and Aroshidze, 2016).

2 RESEARCH RESULTS

According to the Higher School of Economics (HSE) "Science Indicators 2019" in 2017, 2.5 thousand organizations, out of 3.85 thousand organizations that performed R&D, belonged to the Federal State property, where 476 organizations are the research institutes that are subordinate to the Ministry of Education and Science (Website of the Ministry of Education and Science). The intellectual property of the Russian Academy of Sciences research institutions subordinated to the Ministry of Education and Science (Research Institute of the Russian Academy of Sciences), consists of inventions, utility models, computer programs, databases, know-how, and, to a lesser extent, industrial designs and trademarks. The share of inventions, computer programs and databases belonging to the Research Institute of the Russian Academy of Sciences, out of the total number of IP protected by Rospatent, is growing over time (Tables 1, 2).

Table 1: Intellectual property of the Research Institutes of the RASs. Inventions, pcs. (of them valid as at 01/04/2018) according to Rospatent.

	2000	2005	2010	2015	2019
Issued for a year of patents for inventions	534 (19)	558 (63)	1,084 (444)	1,070 (719)	1,056
Share of all Russian patents issued during the year, %	2.2	2.1	3.5	3.0	3.6
Total ammount of patents for inventions	4,461 (26)	7,243 (259)	11,352 (1,463)	16,314 (4,244)	20,752
The share among all Russian patents for inventions, %	1.83 (2.0)	2.04 (1.6)	2.3 (2.1)	2.5 (2.6)	2.5

Table 2: Intellectual property of the Research Institutes of the RAS. Computer programs and databases according to Rospatent data.

	2,013	2015	2017
Registered for the year by the Research Institute of the RASs, computer programs	337	487	668
Total registered computer programs for the year in Rospatent	9,757	13,410	15,021
Share of Research Institutes of the RASs, %	3.45	3.63	4.45
Registered for the year by the Research Institute of the RASs, DB	86	88	139
Total DB ammount registered for the year in Rospatent	1,394	1,829	1,531
Share of Research Institutes of the RASs, %	6.2	4.8	9.1

Table 3: Number of employees (thousand people) according to Rosstat.

Year	2000	2010	2015	2017
Number of research staff, total over country	426	369	379	360
Of them in the institutions of the RASs	62	55.2	52.9 (2012)	45

Despite the reduction in the number of personnel from 2000 to 2017 by one and a half times (Table 3), changes in funding, legal status, the scientific institutions of the RASs show a slight increase in the number of applications submitted for inventions and utility models, databases and computer programs. Meanwhile, the growth of intellectual property objects transmitted to industrial production is not observed.

Despite the large share of universities and research institutes among patent holders, their participation as sellers or buyers in the IP market is more modest than the share of industrial enterprises. Table 4 shows the dynamics of changes in the activity of participants in registered contracts, depending on the category of economic entities.

Table 4: Activity of participants in registered contracts for the transmission of exclusive rights to inventions, utility models, and industrial designs. The share of economic entities categories from the total number of agreements, in percentage (Site of Rospatent).

Category	2010	2012	2014	2016	2010	2012	2014	2016
	Transmitting party				Receiving party			
Physical entities	34.5	31.6	25.46	26.1	9.7	9.09	8.28	7.5
State-owned Enterprises, Research Institutes, Design Bureaus, Universities	13.8	19.93	10.67	13.2	7	6.39	3.12	5.9
Non-governmental Organizations, including:	51.7	48.47	63.87	60.7	83.3	84.52	88.60	86.6
Foreign companies	7.6	6.59	11.95	15.4	7.1	5.3	10.9	13.9

License agreements are made at the stage of inventions readiness for industrial production, between the R&D final stage performers and industrial enterprises, which is confirmed by the structure of the participants in the license agreements. Industrial enterprises filed 23% of applications for patents for inventions in 2016, made 61% of license agreements, and universities and research institutes, respectively, 32.8 and 13.2%.

Table 5: Patent activity of Russian applicants for 9 months in 2017-2018 by categories of economic entities (units) (Effective use of intellectual property. Report. Moscow, 2017).

Managing subjects		9 months. 2017	In % of the total number	9 months. 2018	In % of the total number	Increase, 9 months 2018 to 9 months 2017
1	Universities	3,613	22.83	3,695	21.14	+2.3 %
2	Research institutes/scientific institutions	1,339	8.46	1,618	9.26	+20,8 %
3	Legal Entities	4,253	26.87	3,694	21.14	-13,1%
4	Physical entities	6,509	41.13	8,142	46.59	+25.1 %

Table 4 shows that the receiving country is dominated by commercial (non-state) enterprises. Their share in 2016 was 86.6%. The activity of state-owned enterprises, research institutes, design bureaus, and universities is low both as a transmitting and receiving party (Table 5).

The structure of patent holders. A feature of the Russian residents patent holders structure is, first of all, a high proportion of research institutes and universities, and, secondly, a high proportion of physical entities (Table 5).

Protection areas and protection coefficients. In 2019, Russian Federation was among the top 10 States in terms of resident applications submitted to the National Patent Office (NPO), it was on the 21st place in terms of applications for inventions submitted abroad, on trademark applications, i.e. on the 13th place to Rospatent and on the 27th place abroad, and on applications for industrial designs – on the 14th place to Rospatent and on the 32nd place abroad (according to WIPO). Moreover, on applications for inventions abroad, the lag behind the leader was 40 times (6 thousand in Russia and 236 thousand in the United States). On applications for trademarks abroad there was a lag by 20 times (30 thousand in Russia and 718 thousand in the United States), on applications for industrial designs abroad by almost 100 times (2.6 thousand in Russia and the 209 thousand applications has filed the leader – China). If we consider the changes in the Russian situation since 2000, Table 6, then a positive trend can be noted only for abroad applications for trademarks.

Table 6: Russia place in the world ranking for patents for inventions and applications for trademarks and industrial designs to Rospatent and abroad from 2000 to 2017. Calculated by the author according to WIPO data (WIPO website, statistics).

	2000	2005	2010	2017	2019
Patent grants for inventions to the NPO	5	6	6	6	7
On the received patents for inventions abroad	22	19	21	21	22
Patents in force	Regulatory documentation	4	5	6	7
For operative patents for inventions in a given year, abroad	Regulatory documentation	23	23	25	27

Table 6: Russia place in the world ranking for patents for inventions and applications for trademarks and industrial designs to Rospatent and abroad from 2000 to 2017. Calculated by the author according to WIPO data (WIPO website, statistics).

	2000	2005	2010	2017	2019
On trademark applications to the NPO (by residents)	13	16	17	17	13
On Trademark applications abroad	32	38	49	47	27
On applications for industrial designs to the NPO	16	15	18	13	14
On applications for industrial designs abroad	33	42	40	41	32

By the number of patents for inventions, Russia constantly holds 5-7 places, by the number of patents abroad Russia is usually in the thirties. By the number of applications for trademarks and industrial designs to Rospatent, Russia is in the middle of the twenties places, by the number ofapplications for trademarks and industrial designs abroad Russia is in the thirties or fourties.

Figure 1 shows the applications distribution dynamics for inventions by copyright holders categories (Effective use of intellectual property. Report. Moscow, 2017). This graph shows that research institutes/institutions and universities consistently have a large share among applicants, which is also confirmed by the results of 2018. The share of research institutes and universities as patent holders in Russia exceeds the global average.

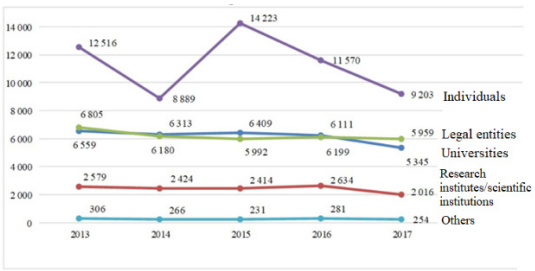

Figure 1: Graph of Russian applicants patent activity in 2013-2017 by category of economic entities (units) (Effective use of intellectual property. Report. Moscow, 2017).

As shown, for example, in the WIPO reports, universities in the world, together with research organizations, are increasing their presence in the intellectual property market. In Russia, in 2016, the share of researchers in higher education institutions, according to the draft Strategy for scientific and technological development, reached 9% (62 thousand people) and became equivalent to the number of researchers in the academic sector of science (67 thousand people), at the same time, the amount of research and development costs reached 10% (83 billion rubles), while in the academic sector costs reached 6% (50.1 billion rubles).

The university science priority funding in Russia and the introduction of the number of patents in the reporting indicators in the tenth years led to an explosive increase in patents owned by Russian universities. In Russia, the number of patents granted to universities from 2000 to 2015 increased by 3 times, from 1,823 to 5,726! In total universities in Russia have received 57.2 thousand patents for inventions from January 1, 2000 to August 3, 2018, but only 9 thousand of them are valid as at 03/08/2017. Universities in the United States and Russia covered almost the same number of inventions per year by patents. At the same time, Russian universities have fewer active patents, which are no longer supported in the absence of prospects for their use. For example, Russian universities do not have any US patent, and the possession of IP in the United States is one of the signs of the developed technologies high competitiveness (Website of the US National Patent Office).

Currently, in 2019-2020, universities in Russia, in contrast to state research institutions, show a decrease in the number of patents for inventions: if in 2014 Rospatent issued 4,987 patents, in 2017 issued 5,564 patents, then in 2020 issued 4,469 patents. In 2014, Russian universities received the same number of patents for inventions in Rospatent as American universities received in the USPTO. In the same year, there were 2,700 small enterprises established under Federal Law 217 at Russian universities, and 4,700 small enterprises operated at American universities (according to Rospatent, USPTO, WIPO, OECD, and Rosstat). Despite the significant number of patents and small innovative enterprises in Russian universities, the contribution of Russian university science to the economy innovative development indicators was modest in the same year. Table 7 shows a comparison between the Russian and American indicators.

On the other hand, analysts note the increased demand for Russian university inventions. In 2012 — 2016, the share of intellectual property transferred under license agreements in universities reached only 1.7%, and in 2020 the indicator was almost 5%. At

the same time, the number of foreign university patents has increased almost two and a half times, although their total number still remains insignificant and in 2020 did not exceed 400. This trend (a decrease in the number of patents and an increase in the commercialization degree) is associated with a change in the policy on intellectual property management in Russian universities.

According to the selected criteria, the state of affairs in Russian science and economics in comparison with the United States was considered (Table 7) in 2016. The table shows that science in Russia slightly lags from the science in the United States in terms by the number of researchers. As for the State science and the innovative development of industry financing, there is a striking difference. The indicators differ by tens of times, and the number of foreign patents differs by more than 100 times.

Table 7: Indicators of the science and industry innovative level in Russia and the United States in 2016. According to (Site of Rospatent, Rosstat, WIPO, US National Patent Office, Science and Engineering Indicators 2018; Perepechko, Yagolnitser and Rakhmanova, 2017; Voronov, 2012; World Bank Database)

Indicator	Russia	USA
Number of researchers, million people.	0.43	1.4
Science funding in billion US dollars	14.1	510
Export of high-tech products, billion US dollars	9.8	155.6
Applications for inventions to the NPO, thousand units.	27	295
Filed applications for inventions abroad, thousand units.	4.7	227
Applications for trademarks (TM) submitted by residents to the NPO, thousand units.	41.5	300.5
Applications for technical design submitted abroad by residents, thousand units.	21	619
Applications for Industrial Design (ID) submitted by residents to the NPO, thousand units.	2.4	21
Applications for Industrial Design (ID) submitted abroad by residents, thousand units.	1.5	97
The metalworking equipment production, in 2015, billion US dollars	0.49	4.6
IP revenue, billion US dollars	0.55	124.5
GDP, trillion US dollars	1.28	18.7

Technology areas. The structure of protected industrial property objects according to the technology area varies in different countries. But around the world, the information and communication technologies (ICTs) are a priority. IP protection in the field of information technology in Russia requires separate consideration. In our country, inventions in the field of ICT are not numerous and until 2014, according to WIPO, were not included in the top 10 industries in terms of the number of patents. In Russia, software and methods of processing and storing information are protected mainly as computer programs and databases, i.e. their text appearance is protected, but algorithms are not protected (Perepechko and Zuckerblat, 2020).

In 2017, this situation did not change qualitatively (Perepechko and Zuckerblat, 2020). If we consider the patent dynamics, it is more optimistic. The inventions in the ICT show better dynamics than the average for all areas compared to 2000 and 2010.

For example, from 2010 to 2018, the largest increase in the number of patents issued per year was shown by the following areas of technology: "digital communications" by 2.2 times, "computer technologies" by 2.5 times and "measurement methods" by 5.1 times. But even such performance is not enough to catch up with the leading countries in the field of ICT patents in the upcoming years (USA, China, Japan, South Korea), Figure 2. While maintaining this performance, ICT inventions will soon take the first place by the number of issued patents in Russia, but their number itself will remain small compared to the world leaders (Perepechko and Zuckerblat, 2020).

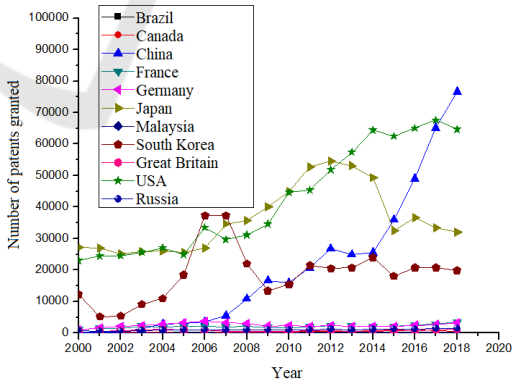

Figure 2: Number of patents for ICT inventions issued to the country residents by the National Patent Office (NPO). According to the WIPO (WIPO website).

As for patenting abroad, patents in one of the technology areas in ICT, "computer technologies", according to WIPO, occupy the 3rd place in the number of patents issued to Russian residents in 2017,

their share is almost 6%. But the number of patents granted abroad in 2017 is small (3,149 pcs). Getting patents to computer technologies inventions abroad is associated with the growing export of Russian software (Munshi Naser Ibne Afzal, 2014). According to the non-profit partnership Russoft, its volumes have doubled in seven years from US $ 4 billion in 2011 to US $ 9.7 billion in 2018, increasing annually by more than 10% since 2003 (Russian software industry, 2019).

It should also be noted that the number of registered computer programs and databases has increased over the past decade from 10.6 thousand in 2013 to 17.9 thousand in 2020. An increase is almost by 1.7 times, it confirms that RIA in the field of ICT in Russia are protected mainly not as inventions, but as computer programs. While being protected in the form of inventions, Russian and foreign patents, information and communication technologies can become one of the most profitable items of Russian exports, which is determined primarily by the high qualification of specialists, the level of Russian developments and the low ruble exchange rate. On the other hand, the NP Russoft annual report does not mention the importance of intellectual property protection in the field of ICT (Russian software industry, 2019).

Patent maintenance index. The term "patent maintenance" refers to both a single patent and a company patent portfolio. For example, in relation to a single patent, the research conducted at Cass Business School (Munshi Naser Ibne Afzal, 2014) showed that the number of references, claims, and classes in a patent can be informative about the degree of protection that a patent provides. Novelli suggests using the number of invention claims and the number of technological classes in which patent examiners classify these claims to measure the amount of rights covered by a patent (Novelli, 2015).

Methods for determining the patent and patent portfolio maintenance indices are also modified and patented (Russian software industry, 2019; US application for invention US20080154767A1). In the United States, successful industrial systems have been created on the basis of such studies. For example, The Patent Board (The Patent Board website) conducts independent research on the characteristics of companies patents and intellectual property investments, as well as develops tools and metrics for evaluating them. And the private company Pantros IP, Inc. offers clients a tool for patents individual in-depth analysis. This tool includes an assessment of about 30 patent factor indices that characterize and consider the relationship between the commercial value, technological level and legal force of the patent. There is direct links contribution, back links contribution, licensing potential, market activity, the total number of different classes, etc. among these indeces than can be taken into account.

A fundamentally different high-performance patent analysis algorithm was created with the support of the financial company ICAP Ocean Tomo (USA). This algorithm is based on the statistical relationship of a large ammount of information indicators and accurate data on the patents maintenance (Barney, 2002). We shall emphasise that this technique is difficult to use to determine the research institute or university patents and the patent portfolio maintenance index.

Patent statistics are also used to calculate a new group of financial coefficients that reflect the company innovation activity, help analyze the financial indicators dynamics and see trends in the company financial and economic state, make the necessary management decisions, using the huge opportunities of the company patent portfolio (Russian software industry, 2019; Barney, 2002; European Commission, 2005). In particular, such coefficients are the value of intangible assets to the company book value ratio or the intangible assets book value to the total costs ratio that the company has generated to conduct R&D and obtain these patents.

Intellectual property management systems presented in the Russian literature (Rosstat: Federal State Statistics Service, Website of the US National Patent Office; Science and Engineering Indicators, 2018; Perepechko, Yagolnitser and Rakhmanova, 2017) do not contain recommendations on achieving targets or monitoring the intellectual property management effectiveness. Meanwhile, the patent protection can be one of the important indicators of the research institutes and universities intellectual property protection quality. In essence, the patent maintenance index is a complex indicator formed on the basis of a number of indicators, such as the patent duration, the family geographical coverage, the patent quotation, the availability of licenses or disputes on the family documents, the amount of rights in the patent claim, etc. Thus, the patent maintenance index is one of the indicators of "the operative patent protection" general concept. This paper selects easily measurable numerical indicators to assess the patent maintenance index (Table 8).

Table 8: Indicators for calculating the patent maintenance index, F_P.

	Indicator	pc.
1	number of backlinks	K_1
2	number of independent formula items	K_2
3	number of dependent formula items	K_3
4	number of classes in the patent	K_4
5	number of graphic images	K_5
6	patent age	K_6

The patent maintenance index is calculated by the formula (1).

$$F_p=\sum_{i=1}^{5}\frac{K_i}{10}+(20-K_6)/20 \quad (1)$$

Using formula (1) we shall introduce the following indicators: the main patent index (the sum of the patents maintenance for all objects), formula (2); the average patents maintenance index, formula (3). These indicators are calculated for eleven natural science institutes of the SB RAS (SB RAS) and Novosibirsk State University (NSU).

$$I_p = \sum_{i=1}^{N} F_i \quad (2)$$

$$P = I_p/N \quad (3)$$

When calculating the patents maintenance index, it turned out that the data on back links are not clearly defined, i.e. there are links in patent search reports, links to analogues in the description, links occurred during the examination, and they are divided into patent and literary links. Therefore, for the sake of homogeneity, this parameter was removed. As a result of the analysis, we assume that the patents maintenance index in the SB RAS and in NSU in general is not high, and is in the range of 1.24 - 2.2 (Table 9).

Table 9: Main patent indexes of institutes of SB RAS, NSU and companies.

		Number of patents N	Main patent Index, I_p	Average maintenance patents index P
1	Institute of Geology and Mineralogy of the SB RAS	36	49.5	1.38
2	Institute of Mining of the SB RAS	36	60.25	1.67
3	Institute of Petroleum Geology and Geophysics of the SB RAS	13	16.1	1.24
4	Geophysical Center of the SB RAS	1	2.15	2.15
5	Institute of Inorganic Chemistry, SB RAS	27	46.55	1.72
6	Federal Research Center "Institute of Catalysis" of the SB RAS	264	554	2.09
7	Institute of Laser Physics of the SB RAS	7	14.15	2.02
8	Institute of Nuclear Physics of the SB RAS	39	57.45	1.47
9	Institute of Molecular and Cell Biology of the SB RAS	2	2.75	1.38
10	Federal Research Center "Institute of Cytology and Genetics" of the SB RAS	39	63.9	1.64
11	Federal Research Center for Information and Computing Technologies of the SB RAS	2	4.35	2.2
12	Institute of Thermophysics of the SB RAS	92	138.7	1.51
13	Indian Institute Technology Delhi	51	187.7	3.68
14	NSU	151	252	1.68
15	Sibur Holding	79	252	3.19

Separately, the experience of the Institute of Catalysis SB RAS (IC SB RAS) should be noted, the average patents maintenance index of the SB RAS is 2.09, and the foreign patents maintenance index of this institute is 5.0. In particular, the Institute international applications and foreign patents have much greater "strength", and as a result, have the highest rates of commercialization and distribution. NSU has 151 patents of the Russian Federation, the average strength of which is 1.68. Except for the Federal Research Center "Institute of Catalysis" of the SB RAS, other institutes and NSU have no foreign patents. For comparison, the main patent index of the

Indian Institute of Technology Delhi was calculated for patents from the Espacenet database. As at August 30, 2019, the institute owned 51 patent families, the main patent index was 1 87.7, the average patents maintenance index was 3.7.

According to the World Intellectual Property Organization, among the first 10 Russian companies applying for patents under the PCT system there is PJSC SIBUR Holding (Tomsk). The company has 79 patents of the Russian Federation, 37 international applications and patent families. In general, the average Russian patents maintenance index is 3.19.

Thus, the research institutes and universities intellectual property protection is poor, which explains its low demand on the market. It is possible to correct the situation if the main patent index and the average patents maintenance index are included in the reporting indicators of research institutes and universities as a measure of the intellectual property management effectiveness.

3 CONCLUSION

The range of goods and services innovative improvement should be carried out on the basis of scientific achievements and high-tech production. As a result of the analysis, it turned out that the quality of patents protected by Russian companies and state research institutes and universities is low, which explains their low demand in the market. Therefore, improving the quality of patents can be included in the research institutes and universities tasks for the intellectual property management, and the main patent index and the average patents maintenance index can be recommended as reporting indicators of the effectiveness of activities in this area. Improving the patents quality will lead to the use of the intellectual activity results created in research institutes and universities by companies in the business sector, and will allow to achieve a positive economic effect by increasing the share of high-tech products.

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