International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 24 (2017) pp. 15337-15346

Evaluation of Factors Having a Significant Impact on the Development of Scientific Organizations in the Field of Engineering

A. Maltseva [1], I.Veselov [2], I.Monakhov [3] and L.Karasyova [4]

[1]*Associate Professor, Lurye Scientific and Methodological Center for Higher School Innovative Activity of Tver State University, Tver, Russia.*

[2,3] *Senior Researcher, Lurye Scientific and Methodological Center for Higher School Innovative Activity of Tver State University, Tver, Russia.*

[4]*Professor, Head of Economic Theory Department, Tver State University, Tver, Russia.*

[1]*Orcid: 0000-0003-4347-5586 & Researcher ID: A-8443-2016*

Abstract

The centerpiece of the research in the article are the research institutions, which are surveyed within the Russian federal system for monitoring scientific organizations performing R&D activities and technological works primarily in the field of engineering. The system can be used as a source of data on the various indicators needed for the evaluation of the effectiveness of the research organizations. Using statistical analysis and correlation study between these indicators and World Research Institution Ranking (WRIR) conducted by the European Scientific-Industrial Chamber, the most significant factors affecting the efficiency of the activities of scientific organizations are identified.

The mean value of the correlation coefficients of the efficiency factors calculated for the period from 2014 to 2016 allowed to identify indicators that demonstrated the meaningful importance for the development of scientific organizations. These include human capital, financial indicators, labour costs, etc.

Keywords: scientific organization, development management, organizational development, criteria, factor, model

INTRODUCTION

To date, scientific organizations are generators of new knowledge and technology providers that create long-term competitive advantages of countries in high-technology product markets. According to the U.S. National Science Foundation, Russia's share in this segment of the world market in 2014 was 0.3 percent. At the same time India, which is one of the BRICS countries, has outstripped the Russian Federation by almost 4 times on the indicator [1]. If the current situation is allowed to continue, the "catch-up" model of the development of the Russian economy, which relies on the use of Western technologies primarily as the main driver of growth and labor productivity, will have a long-term character and carries risks in ensuring the economic and national security of the country.

In addition, ineffective management of science is an obstacle to the scientific, technological and innovative development of the country in the face of the emergence of so called "Grand Challenges", which are used for selecting the goals and objectives of state scientific policy.

In recent years, the science and education policy of the Russian Federation has been oriented towards the solution of the task related to the strengthening of the technological vector of the country's development in order to break the “raw stalemate” of the Russian economy and reduce the risk of technological dependence on the leading countries. For this purpose, steps have been taken to increase quotas of admission of STEM (Science, Technology, Engineering, Math) students to state-financed places at universities. Government programmes were set up to develop innovative infrastructure of leading universities and scientific organizations. Within the framework of the National Technology Initiative (NTI) key technologies were identified by an analysis of the latest developments of high-tech world market.

For instance, the state programme of the Russian Federation "Development of Industry and Enhancing Its Competitiveness in the Period to 2020" includes the main event to stimulate the creation and development of engineering centers in higher educational establishments (HEI) and scientific organizations subordinated to federal executive bodies. From 2013 to the present time, the Ministry of Education and Science of the Russian Federation held 6 competitions among HEI to create engineering centers.

The engineering centers are designed to serve as intermediaries between science and production, ensuring the promotion of technology to the market. Industrial partners of the Centers thus gain access to scientific and technological, human resources, infrastructure of universities and scientific organizations. Experience has shown that R&D institutes and academic organizations actively participate in their development. For instance, the Federal Research Centre “Fundamentals of Biotechnology” of the Russian Academy of Sciences (Moscow) and Research Institute of Synthetic Fiber with the Pilot Plant (Tver) created partnership in order to establish the engineering center "Green Chemistry" of Tver State University.

Likewise, the need to prepare a generation of tomorrow's "super-engineers" who have deep engineering spatial thinking to solve complex scientific and technical problems underlies NTI.

The Sirius Educational Center in Sochi city, Youth Creativity and Innovation Centers, working to promote additive technologies, various competitive technical events and other initiatives, which were designed in recent years, are aimed at identifying, developing and further supporting gifted children who have demonstrated outstanding abilities in STEM, and also succeeded in technical creativity.

As a result, the balance between fundamental and applied science in Russia was shifted in favor of the latter. The share of gross domestic expenditures on R&D (GERD) to fundamental research decreased in the RF from 26% in 2008 to 17% in 2013 [2].

In view of the foregoing, the relevance of this study is due to the need to improve the efficiency of the management of scientific organizations, taking into account changes in the volumes and priorities of the state financing, including for solving the country's strategic tasks in the development of high technologies. To achieve this goal, it is necessary to identify key factors that influenced on the effectiveness of the scientific organization and determined its successful development. Thus, the applied value of this study is that the findings can be used by the management of scientific organizations to prioritize resource support for the development indicators of the institution, which serve as its "growth points".

LITERATURE REVIEW

The subject of this study is the assessment of the activities of a scientific organization from the perspective of management.

To date, studies on the various aspects of the evaluation of scientific activity at both the organization and the individual researcher level were undertaken in Russia and abroad.

Some researchers have focused on the development of systems of scientometric indicators for assessing the scientific organizations with regard to the management-related aspects: Garfield [3] (the development of the Web of Science system), Small [4] (the study of citation as a mechanism of dialogue in science), Pislyakov and Lyubushko [5] (analysis of reading, citation and publication activities for modeling information needs of scientists and optimization of the process of acquisition of electronic resources), Silina [6] (development of a system index of publication activity for solving practically important tasks by adapting it to other areas of the social system, including the evaluation of the work of the manager or other employees operate in the financial sector of the organization), Opel [7] (development of a model for assessing the effectiveness of non-profit biomedical research institutes on the basis of indicators of financial activity, patent activity, publications and citation), Kanellopoulos [8] (study of the possibility of using business management models for academic organizations), etc.

Scientmetric analysis as a tool for studying the research activity of countries in the natural, social and human sciences is examined in the book by Marshakova-Shaikevich [9]. The study by Esterle & Theves [10] showed the main features of various European scientometrics systems. The new model of the work of scientific groups, as well as the procedures for monitoring and evaluating scientific laboratories are presented in the work by Dezhina & Ponomarev [11].

The books by Moskowitz [12], Lastres [13], Narula [14], Abbott [15] are devoted to the study of the role and sources of the development of advanced technologies in the modern world.

Thus, in spite of the fact that the study of the activities of scientific institutions and their evaluation have long been in the focus of researchers, this issue is in most cases considered through the prism of scientometric methodology, in which indicators of public activity play a major role. Meanwhile, the research of scientific organizations requires an integrated approach, which takes into account various aspects of their activities with a view to identifying the most significant factors affecting their development.

In addition, while the above-mentioned works address those aspects of strategic management that, from the point of view of Steiss's [16] methodology, can be attributed to the level of control and evaluation (the last stage in the strategic management process), this study contributes to the study of the organization's resource management (allocation of funds to fulfill its strategic goals and objectives).

MAIN TEXT

Management of scientific organizations development should be based on a system of the most significant factors, which the influence provides the most important contribution to the achievement of their results. If we use them as basic "levers of influence" we can create a faster and less costly effect for achieving stated goals of development.

Statistical methodology which allows us to identify the most generalizing factors for a set of scientific organizations is used as a basis for determining the most significant development factors.

Statistical research was preceded the creation of factor models that represent the dependence of the resulting indicator on the factor indicators.

For the creation of factor models for assessing the most significant factors affecting the development of scientific organizations we used data from reports from the Russian federal system for monitoring scientific organizations performing R&D activities and technological works (FSMSO) for 2014-2016.

The usage of the system data is conditioned by the principles of accessibility, unification and adequacy of indicators, since it contains the largest number of uniform indicators of scientific organizations for the selected period.

As factor indicators which impact of on the result will be investigated during the analysis their maximum list was suggested (Table 1).

Table 1: List of indicators characterizing the activities of scientific organizations, - factors

Indicator	Notation
Effectiveness and relevance of scientific research	
Number of organization's publications indexed in Russian and international information and analytical systems of scientific citation	
Web of science	x1
Scopus	x2
Russian Scientific Citation Index	x3
Google Scholar	x4
ERIH (European Reference Index For Humanities)	x5
Specialized information and analytical system	x6
Cumulative citation of organization's publications indexed in Russian and international scientific citation systems	
Web of Science	x7
Scopus	x8
Google Scholar	x9
Russian Scientific Citation Index	x10
The cumulative impact factor of journals in which the articles of the organization were published	x11
The total number of scientific, design and technological products, including:	x12
published works	x13
published periodicals	x14
realised design and technological documentation	x15
unpublished scienetific works	x16
Number of created results of intellectual activity, including	x17
accounted in public information systems	x18
having state registration and (or) legal protection in the Russian Federation	x19
having legal protection outside the Russian Federation	x20
Number of used results of intellectual activity, including:	x21
confirmed by acts of use (implementation)	x22
transferred under a license contract (agreement)	x23
transferred under an alienation contract including pledged as collateral	x24
submitted as a contribution to the registered capital	x25
Number of small innovative enterprises created with the participation of the organization	x26
cumulative average number of employees of small innovative enterprises	x27
aggregate income of small innovative enterprises	x28

The financial performance of a scientific organization on sources of income aimed at science financing, including funds received:	x29
on the performance of government tasks	x30
on a competitive basis from budgets of all levels	x31
on a competitive basis from extrabudgetary sources	x32
from foreign sources	x33
from extrabudgetary sources for other purposes	x34
Financial performance of a scientific organization by types of performed works and provided services, including	
research and development	x35
scientific and technical services	x36
from the use of the results of intellectual activity	x37
educational services	x38
goods, works and services of an industrial character	x39
other incomes not related to scientific, scientific and technical services and developments	x40
Human resource development	
Number of students performing qualification work on the organization's basis	x41
Number of post-graduate students and doctoral students	
post-graduate students	x42
doctoral students	x43
Number of researchers aimed at working in leading Russian and international scientific and scientific-educational organizations	x44
Number of defended dissertations	
candidate's dissertations	x45
doctoral dissertations	x46
Integration into the world scientific space	
Number of articles prepared jointly with foreign organizations	x47
The number of foreign scientists working in a scientific organization	x48
Number of scientific conferences with international participation held by the organization	x49
Number of popular scientific publications performed by the organization's employees	x50
The number of positive and neutral references to the organization in the federal mass media, including	x51
in federal print media, television and radio media	x52
in online publications	x53
The number of visits (attendance) of official sites and / or pages of the organization located in the Internet	x54
Resource support of the scientific organization	
Average number of employees	x55
Number of employees performing research and development, including:	x56
researchers, among them	x57
candidates of sciences	x58
doctors of Sciences	x59
aged under 39 years	x60

working in a part-time position and performing civil-law contracts	x61
pedagogical workers belonging to higher-education teaching personnel	x62
technicians	x63
support staff	x64
other	x65
The cost of fixed assets and intangible assets, including:	x66
buildings and structures	x67
machinery and equipment	x68
intangible assets	x69
Internal current costs for research and development, including	x70
basic research	x71
exploratory research	x72
applied research	x73
experimental development	x74
External costs of research and development	x75
Labor payment expenditures for workers engaged in research and development	x76

As a resulting indicators of scientific organizations development the rating of research institutions WRIR (Y) was proposed [17].

WRIR is the world ranking of research institutions in terms of the level of research. This rating conducted annually by the European Scientific and Industrial Chamber (European non-profit, non-political association, the goal of which is to strengthen international scientific, cultural and economic ties) among scientific organizations from around the world (more than 15 thousand scientific organizations took part in the rating in 2014). The rating is made on the basis of the questionnaire data which takes into account the publication activity, the staffing, the availability of technologies for management of scientific activities, outstanding achievements of employees. The rating was carried out on 4 levels: "high quality research" level (from A to AAA), "good quality research" level (from B to BBB +), "quality research" level (from C to CCC +) and "low quality" or "defective" level (from D to DDD +).

According to the authors, the rating is a characteristic of development level of scientific organizations, since it expresses belonging to a particular group of research quality. Since both quantitative and qualitative characteristics are used in making the rating, and the obtained results formed groups listed above, it seems reasonable and justified to conduct a correlation analysis and to identify specific quantitative factors that ultimately has the most significant effect on the obtained result.

Thus, the basic model that will be used to identify factors' influence will be:

$У=f(x_1,x_2,...,x_{75})$.

EXPERIMENTS

At the time of the study there were reported data of 789 scientific organizations in the FSMSO system that worked in the field of engineering and provided full information every year during 2014-2016. In the WRIR rating the following number of organizations were participated and rated "C" or higher in different years: 2014 - 274 organizations; 2015 - 376; 2016 - 402. 229 scientific organizations received an assessment during all three years. This fact determined the sample size.

A correlation analysis that ensures the detection of the degree of factors's influence on the result based on the correlation coefficients was chosen as a basic methodology. Since the indicators are presented in a continuous scale and the performance indicators are in the ordinal scale, the Spearman rank correlation coefficient was used to determine the degree of interrelation. The correlation coefficients between the indicators and the rating were calculated by periods.

For the purpose of the research the data of the rating which is the assignment of a scientific organization to a particular group and their representation in a numerical format which is necessary for establishing a correlation dependence was formalized. In the study the assumption was made that the scale interval was equivalent: each group was given a numerical value with step "1" according to the rank order.

Below is the scale of correspondence of rating groups and numerical values: “C” – 1; “C+” – 2; “CC” – 3; “CC+” – 4; “CCC” – 5; “CCC+” – 6; “B” – 7; “B+” – 8; “BB” – 9; “BB+” – 10; “BBB” – 11`; “BBB+” – 12; “A” – 13; “A+” – 14; “AA” – 15; “AA+” – 16; “AAA” – 17.

The results of the correlation analysis to establish the relationship between the factor indicators and the result (the value of the WRIR rating) are shows in the Table. 2.

Table 2: Evaluation of the correlation between the factor indicators and the result (the value of the WRIR rating)

Indicators	**2014**	**2015**	**2016**
Effectiveness and relevance of scientific research			
Number of organization's publications indexed in Russian and international information and analytical systems of scientific citation			
Web of science	**0,3106**	**0,3166**	**0,3580**
Scopus	0,2164	0,2583	0,2751
Russian Scientific Citation Index	0,2138	0,2195	0,2655
Google Scholar	-0,0776	-0,0674	-0,0379
ERIH (European Reference Index For Humanities)	-0,0580	-0,0425	-0,0578
Specialized information and analytical system	0,1858	0,1832	-0,0219
Cumulative citation of organization's publications indexed in Russian and international scientific citation systems			
Web of Science	0,2786	0,2835	0,2919
Scopus	0,1485	0,1962	0,2239
Google Scholar	-0,1259	-0,0395	-0,0602
Russian Scientific Citation Index	0,2770	0,2799	**0,3172**
The cumulative impact factor of journals in which the articles of the organization were published	**0,3040**	**0,3716**	**0,3452**
The total number of scientific, design and technological products, including:	0,2047	0,1782	0,2192
published works	0,2067	0,1746	0,2192
published periodicals	0,2371	0,2731	**0,3104**
realised design and technological documentation	0,0649	-0,0438	-0,0842
unpublished scienetific works	0,1066	0,0621	0,0854
Number of created results of intellectual activity, including	0,2010	0,0953	0,1288
accounted in public information systems	0,2109	0,1106	0,1098
having state registration and (or) legal protection in the Russian Federation	0,1341	0,0827	0,1492
having legal protection outside the Russian Federation	0,1406	0,0441	0,0717
Number of used results of intellectual activity, including:	-0,0720	-0,0230	0,0232
confirmed by acts of use (implementation)	0,0557	0,1038	0,1402
transferred under a license contract (agreement)	-0,1046	-0,0590	-0,0630
transferred under an alienation contract including pledged as collateral	0,0869	0,0222	-0,0986
submitted as a contribution to the registered capital	-0,1605	-0,1195	-0,1670
Number of small innovative enterprises created with the participation of the organization	-0,0506	-0,0411	-0,1225
cumulative average number of employees of small innovative enterprises	-0,0416	-0,0216	-0,1406
aggregate income of small innovative enterprises	-0,0535	-0,0034	-0,1258
The financial performance of a scientific organization on sources of income aimed at science financing, including funds received:	**0,3481**	**0,3626**	**0,3600**
on the performance of government tasks	**0,3279**	0,2835	0,2874
on a competitive basis from budgets of all levels	0,2784	0,2568	0,2818

on a competitive basis from extrabudgetary sources	0,1221	0,1749	0,0870
from foreign sources	0,1847	0,1038	0,1231
from extrabudgetary sources for other purposes	0,1765	0,2623	0,2055
Financial performance of a scientific organization by types of performed works and provided services, including			
research and development	**0,3293**	**0,3426**	**0,3415**
scientific and technical services	0,0211	0,0935	0,0959
from the use of the results of intellectual activity	-0,1172	-0,1043	-0,0385
educational services	0,1128	0,1190	0,2428
goods, works and services of an industrial character	-0,0113	-0,0588	-0,0675
other incomes not related to scientific, scientific and technical services and developments	0,2513	0,1816	0,2059
Human resource development			
Number of students performing qualification work on the organization’s basis	0,2065	0,2425	0,2718
Number of post-graduate students and doctoral students			
post-graduate students	**0,3086**	**0,3326**	**0,3422**
doctoral students	-0,0275	0,0699	0,1324
Number of researchers aimed at working in leading Russian and international scientific and scientific-educational organizations	0,1460	0,1605	0,1714
Number of defended dissertations			
candidate's dissertations	0,2491	**0,3459**	0,2948
doctoral dissertations	0,1517	0,2850	0,1735
Integration into the world scientific space			
Number of articles prepared jointly with foreign organizations	**0,3195**	**0,3271**	**0,3563**
The number of foreign scientists working in a scientific organization	0,0963	0,0600	0,1255
Number of scientific conferences with international participation held by the organization	0,0465	0,1477	0,1208
Number of popular scientific publications performed by the organization’s employees	0,0896	0,1582	0,1336
The number of positive and neutral references to the organization in the federal mass media, including	0,0155	0,0803	0,1289
in federal print media, television and radio media	0,0147	0,0805	0,0915
in online publications	-0,0567	0,0799	0,0741
The number of visits (attendance) of official sites and / or pages of the organization located in the Internet	0,2302	0,1651	0,1851
Resource support of the scientific organization			
Average number of employees	**0,3812**	0,2904	0,2889
Number of employees performing research and development, including:	**0,3621**	**0,3040**	**0,3215**
researchers, among them	**0,4183**	**0,3731**	**0,3931**
candidates of sciences	**0,3691**	**0,3295**	**0,3527**
doctors of Sciences	**0,4377**	**0,3917**	**0,4485**
aged under 39 years	**0,3755**	**0,3276**	**0,3024**
working in a part-time position and performing civil-law contracts	**0,3200**	**0,4034**	**0,3258**
pedagogical workers belonging to higher-education teaching personnel	-0,1036	0,0240	0,0428
technicians	0,1339	0,0403	0,0668

support staff	0,1752	0,1449	0,2138
other	0,1279	0,1493	0,1287
The cost of fixed assets and intangible assets, including:	**0,3091**	0,2591	0,2461
buildings and structures	**0,3099**	0,2340	0,1798
machinery and equipment	0,2580	0,2521	0,2385
intangible assets	0,2206	0,2438	0,1873
Internal current costs for research and development, including	**0,3672**	**0,3540**	**0,3569**
basic research	0,2412	0,2382	0,2354
exploratory research	0,1380	0,1936	0,0423
applied research	0,2394	0,2200	0,1802
experimental development	0,2616	0,1360	0,0499
External costs of research and development	0,2159	0,1891	0,2835
Labor payment expenditures for workers engaged in research and development	**0,3660**	**0,3366**	**0,3417**

The presence of correlations between individual indicators of the sample and the result was fixed. As a criterion minimum of the value of the correlation coefficient was set the value 0.3, since the correlation with the lower indicator value is interpreted in the literature as weak.

Below is a list of factor indicators demonstrating the average level of correlation with the result (Table 3).

Table 3: List of indicators demonstrating a significant relationship with the effective indicator of the model

Indicators	**2014**	**2015**	**2016**
Number of publications in the Web of science	0,3106	0,3166	0,3580
The cumulative impact factor of journals where the articles of the organization were published	0,3040	0,3716	0,3452
The financial performance of a scientific organization on sources of income aimed at financing science	0,3481	0,3626	0,3600
Financial income from research and development	0,3293	0,3426	0,3415
Number of post-graduate students	0,3086	0,3326	0,3422
Number of articles prepared jointly with foreign organizations	0,3195	0,3271	0,3563
Number of employees performing research and development	0,3621	0,3040	0,3215
Number of researchers	0,4183	0,3731	0,3931
Number of candidates of sciences	0,3691	0,3295	0,3527
Number of doctors of sciences	0,4377	0,3917	0,4485
Number of employees aged under 39 years performing research and development	0,3755	0,3276	0,3024
Number of employees working in a part-time position and performing civil-law contracts	0,3200	0,4034	0,3258
Internal current costs of research and development	0,3672	0,3540	0,3569
Labor payment expenditures for workers engaged in research and development	0,3660	0,3366	0,3417

Data analysis of the table shows the most important significance for the development of scientific organizations the indicators of human capital, primarily personnel of higher qualification. This is due to the defining role of knowledge capital in the formation of scientific-technical products constituted by researchers, including those with a degree.

Financial performance (financial performance, internal expenditures on research and development, financial revenues from research and development) also play an important role because of characterized the achieved results and the possibility of increasing the potential of scientific organizations.

Among the factors highlighted in the result of the analysis also includes an indicator of the number of employees who work part-time and contracts of civil nature which demonstrates the extent of involvement in activities of scientific organizations representatives of the external environment. This ensures the development of interdisciplinary research using experience and results of other scientific schools, lowering the inbreeding risk of the scientific organization staff.

Other important indicator remains the amount of salary because at the present stage in connection with advancing growth of research structures (units) in the commercial sector of the economy competition for intellectual capital research workers increases that the importance of financial incentives for results and ensuring a decent level of pay in the scientific organizations is determined.

CONCLUSION

Thus, the conducted research showed that the main factors of the development of a research institution are indicators used in FSMSO to measure qualitative and quantitative changes in the organization's human capital, indicators of its financial stability, labor incentive measures aimed at the creation of a positive working environment.

In terms of management, this means that despite the importance of material support for scientific organization (especially operating in exact and natural sciences) and efforts which are directed to broaden its instrument base, the intellectual capital that is determined in the context of this study by the indicators of human capital (number of scientists, post-graduate students, employees aged under 39 years performing research and development, research fellows, part-time employees), reputational capital (number of organization's publications indexed in the Web of science, articles prepared jointly with foreign organizations, the cumulative impact factor of journals in which the articles of the organization were published) and the corporate culture, which is implicitly included in indicator “Labor payment expenditures for workers engaged in research and development”, is the key factor that exert a major influence on the development of the research institutions.

Accordingly, if one increases the volume of the resources for these "growth points", one can expect the enhancement of the effectiveness of the scientific organization.

The results obtained by the results of this study can be used in developing state science policy, solving management problems related to improving the effectiveness of the scientific organization operating not only in the field of applied engineering research, but also in other fields, including socio-humanitarian one.

It should be noted that the conclusions are of an intermediate nature and leave room for discussions and further research on the evaluation of the performance of scientific organizations. Attraction of additional sources and analysis of those aspects of the activities of scientific organizations that were not taken into account in the federal monitoring system is a promising research task.

ACKNOWLEDGEMENTS

The paper is the result of the research funded by the Ministry of Education and Science of the Russian Federation within the research project "Change and Development Management of Scientific Organizations in the Context of the State Policy of their Restructuring" implemented by Tver State University.

REFERENCES

[1] Exports and imports of HT products, by region/country/economy: 1999–2014

[2] UNESCO Science Report: towards 2030 – Executive Summary. P.12 http://unesdoc.unesco.org/images/0023/002354/235407e.pdf

[3] Garfild E., 1964, "Science citation index " – a new dimension in indexing ", Science, 144. pp. 649–654.

[4] Small, H.G., 1978, "Cited documents as concept symbols", Social Studies of Science, 8, pp.327-340, 1978.

[5] Pislyakov, V.V., Lyubushko, E.E., 2007, "Analysis of scientific and information activities (reading, publication, citation) of scientists of Boreskov Institute of Catalysis SB RAS", Catalysis in the industry, 3, pp. 55-63.

[6] Silina, A. Y., 2010, "Evaluation of the scientific activity of researchers for information support for the adoption of managerial decisions", dissertation of Candidate of Technical Sciences, Astrakhan state university, Volgograd, 144 p.

[7] Opel, W. A., 1998, "Financial structure and scientific productivity of nonprofit biomedical research

institutes", Thesis (Ph. D.). Claremont Graduate University, 185 p.

[8] Kanellopoulos, A., 2006, "Strategic management in academic organizations". Thesis (Ph. D.). Bartlett School of Graduate Studies University College London United Kingdom, 50 p.

[9] Marshakova-Shaikevich, I.V., 1995, "Contribution of Russia to the development of science: Bibliometric analysis", Moscow, Janus LLP, 248 p.

[10] Esterle, L. and Theves J., 2005, "Analysis of the different European systems for producing indicators", paper presented at the Lisbon Workshop on S&T Indicators Production, Lisbon, 22–23 September

[11] Dezhina, I., Ponomarev, A., 2013, "1000 Laboratories: New Principles to Organize Scientific Research in Russia", Voprosy Ekonomiki, 3, pp.70-82.

[12] Moskowitz, S.L., 2009, "The advanced materials revolution: technology and economic growth in the age of globalization", Hoboken, N.J.: John Wiley, 255 p.

[13] Lastres, H.M.M., 1994, "The advanced materials revolution and the Japanese system of innovation", New YorK: St. Martin's Press, 246 p.

[14] Narula R., 2003, "Globalization & technology: interdependence, innovation systems, and industrial policy", Cambridge, UK; Malden, MA: Polity Press, 243 p.

[15] Abbott, L.F., 2007, "Technological Development in Industry: A Business-Economic Survey and Analysis (ISR Technology, Management, and Business Growth Studies)", Industrial Systems Research; 2nd Revised edition edition, 176 p.

[16] Steiss, A.W., 1985, "Strategic management and organizational decision making", Lexington, Mass.: Lexington Books, 240 p.

[17] http://eurochambres.org/wrir/