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*ANALYSIS OF EFFICIENCY OF SCIENTIFIC RESEARCH IMPACT INDICATORS IN THE ESTIMATION OF SCIENTIFIC ACTIVITY**

SUMMARY. The article is concerned with the analysis of efficiency of the main scientific research impact indicators: the quantity of publications, citing index, Hirsch index, the impact-factor of scientific edition. Their efficiency is analyzed according to the results of the qualitative and quantitative analysis. The history of genesis of the standards of scientific citing and the process of formation and development of the Russian index of scientific citing system are studied.

KEY WORDS. The Russian index of scientific citing, Hirsch index, reviewing, citing, impact-factor, co-authorship.

The adequate estimation of scientists' contribution to science still stays a problematic issue in scientific community. Current means of scientific research estimation include the analysis of bibliometric figures and scientific expertise (reviewing). Let us focus on the analysis of the current state and the prospects of development of both of them.

The practice of using citation indexes appeared in the second half of XIX century with the creation of Shepard's Citations (in the legal science) and Index Medicus (in the medical science) systems. Also there are national citation indexes in many countries of the world: in China (Chinese Science Citation Database; China Scientific and Technical Papers and Citations), Taiwan (Taiwan Humanities Citation Index) and many others. The review of the establishment and development of the institution of scientific citation can be found in [1].

The attention to the citation indexes and amount of staff's publications in the leading scientific periodicals is a very important point for many higher education institutions. These figures directly correlate with the image of institution.

In the Prognosis of socio-economic development of the Russian Federation for 2012 and the planning period of 2013-2014 (in the chapter "Current state and trends of scientific-technical and innovative spheres") the low representation of Russia in

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the global science is marked. This conclusion is based on the analysis of key indicators that are considered as objective criteria of performance and quality of scientific research all over the world. These criteria are: the amount of publications in scientific periodicals and values of citation indexes. Russian scientists have less than 2% of citations in scientific magazines that are indexed in the leading foreign and Russian databases and this number does not increase from year to year.

There are several universally accepted databases that are used to esteem citation index: Web of Science (Science Citation Index Expanded, Social Sciences Citation Index, Arts and Humanities Citation Index), Scopus, Google scholar citation counter, Astrophysics, PubMed, Mathematics, Chemical Abstracts, Agris, GeoRef and some others.

Russia is not found in the new edition of bibliometric ratings created by Nature Publishing Group (NPG). It means that Russian authors make the smallest contribution in the total number of articles that are published in the periodicals of NPG for the 2011 (such as "Nature" and other periodicals under NPG's brand name), while the trustworthiness and high impact-factor of them is known over the world [3]. The leaders of Global Top 100 beta are Harvard and Stanford (USA), and Max Planck Society (Germany). Oxford takes the 12th place, and Cambridge takes the 14th [4]. According to ScopuS, in 2011 Russian scientists published 26 articles in 10 NPG magazines.

And what does Russia do? In 2005 on the basis of Scientific Digital Library the creation of the national informational and analytical system of Russia called the Index of Scientific Citation (RISC) started. This system stores scientific publications and information about their citation. The main aim of RISC was to create an objective system of estimation and analysis of publication activity and citation of Russian authors, periodicals and organizations.

The preconditions of creating a Russian scientific citation index are: the absence of full-scale search on Russian magazines in foreign databases, the current orientation on the quality improvement (and as a consequence — citation improvement) of articles in Russian magazines that may result in the improvement of their academic prestige (the magazines with high impact-factor are considered more affluent), and also the representation of Russian periodicals in international databases due to the language barrier. According to the analysts, only 5% of Russian magazines are represented in foreign citation index databases [7], and it renders a difficulty for them to compete; and also there is isolation of Russian research projects in the number of scientific directions.

Nowadays the RISC system is the main source of information for estimation of scientific effectiveness of individual scientists and organizations engaged in scientific research and development, and the popularity of scientific periodicals (the frequency of citations of articles published in them).

Quite often the experts note certain shortcomings of Russian database, but it is still being perfected. The Scientific Digital Library plans to create the data archive (2003-2013) that is based on the processing of 1500 most reputable scientific magazines; this archive will be the basis for the informational and analytical system Science Index [8].

Generally the scientific association complains to databases about the distortion of key indicators: some magazines are present in quite a few databases, whereas

others are present only in some of them. Some scientists note the fact that the Russian database holds incomplete information on their publication activity. Indeed, the results of some scientist's activity will not be taken into account properly, if the magazines (national or international) are not included, for example, in the list of WoS. As a result, we face the distinctive distortion of scientific database search results comparing to the real amount of publications.

In addition, there is still "a problem of taking into account articles that are published not in the scientific magazines but in the monographs or festschrifts. <...> Russian social sciences are underrepresented in foreign databases, that is why an average number of links to the articles devoted to these sciences is many times smaller than the number of links to the natural science articles" [8].

Currently authors registered on the web-site www.elibrary.ru may name articles that were not for some reason noted in the list of their publications. Unfortunately, now the search can be performed only among the publications that are present in the RISC base, and authors still can not add their articles, monographs and other results of scientific work in the list. But in a short while a new service "Science Index for organizations" will be created. The universities and SRIs will get an opportunity to add the publications of their employees, so they would be responsible for the reliability of the data.

Now the data that is stored in RISC system and free to use gives the information on the following things: the presence of scientific ties and their strength (frequency and stability of co-authorship), the direction of scientific work and its dynamics, the citation index of authors that are affiliated only with some special institutions (higher education institutions, research institutions and so on), Hirsch index, the total number of articles published by the employees of the institution (the quantitative contribution to the science) and some other things.

Accessing scientometric data, it is also possible to find the vector of interest of scientific societies: what topic now arouses the biggest interest (and as a result — "explosive" growth in number of publications), and what topic loses its influence on scientific minds, which results in reduction of frequency of appearing in scientific periodicals. The dynamics of growth of publications in number allows to estimate the scientific interest to some problem: when did it appear, who was the initiator, and who was the follower.

The founder of the sociology of science R. Merton noted a high importance of author's links to other scientists and the frequency of citations; today these criteria are the main ones in scientometrics. It is important to take into account the author's sphere of science while estimating the individual citation index that characterizes scientific productivity. For example, in the MSU an employee that works at the Departments of physics, chemistry, biology, geology, materials science, bioengineering, bioinformatics and fundamental medicine can be called highly cited when the total number of links to his/her works for the entire career exceeds 1000, or the number of links to his/her works published for the last 10 years exceeds 200. For other structures of the MSU the threshold is four times lower: 250 and 50 cites respectively.

The key indicator of scientific magazine in scientometrics is impact-factor. The notion "high impact-factor" of the magazine can be taken differently according to the sphere of scientific periodical and it is applied only if some special threshold

is exceeded. So, the sciences of living systems consider 6 a high impact-factor, social sciences consider 3 high enough, and historical ones — more than 1 (according to the Web of Science database).

The experts in the sphere of scientometrics also pay a lot of attention to the indicator of "citation half-life". It is defined as a period during which a half of the total number of links to the article appears.

According to the data in the beginning of September, 2012, the database of scientific digital library contained 21 thousand of magazine items presented in the form of nearly a million issues. The total number of full text articles comes to 16 million. There are 1676 organizations and 600 thousand of users, registered on the site. 86.2% of them are Russians, including 11.6% users from Moscow, 4.8% users from Saint-Petersburg, 2.7% users from the Moscow Region. The Tyumen Region is on the 25th place with 0.7%. Belarus and the Ukraine show the biggest interest to RISC system among the foreign states (2.7% and 7% of registered users) respectively.

The leaders of RISC system among the TSU employees by the number of citations are V.I. Zagvyazinskiy (1213 cites), N.P. Matveeva (335), O.V. Andreev (313), N.M. Dobrynin (294), V.E. Borisenko (263). The rating by the number of articles is different: O.V. Andreev (124 publications), N.M. Dobrynin (75), L.P. Panicheva (72), B.A. Bezugliy (67), V.I. Zagvyazinskiy (57).

Along with the importance of quantitative data recorded by the RISC system and other scientific databases, the problem of losing the insistence on high standards of articles by magazines becomes obvious. V.V. Radaev [10] mentions funding cuts among the reasons of it; also he mentions the lack of periodicals' autonomy from the founders, editing expenses, insufficient level of methodological culture of authors. All these factors cause the low quality of articles.

Also the shortcomings of the scientific reviewing institutions are noted. "The articles are exposed to obligatory anonymous dual reviewing, and the reviewers submit written reports; in cases, when there are some remarks, the texts are sent for revision to their authors. The anonymous reviewing is a suitable mechanism of publications selection, and also it is a communicative channel that gives the author an opportunity to get a feedback from the expert community" [10].

This problem is also mentioned in the report of editorial board of "Herald of the TSU". It is stressed that "the weak point of magazine's editorial board is the quality of article reviewing. There prevails a complimentary mood of reviews that are usually written at authors' request, and sometimes these reviews are even written by the authors themselves. It is necessary to distinctively organize, despite of the significant time expenditure, the internal <...> and external reviewing of received manuscripts" [11].

It is the reviewing level, the objectiveness and the exactingness of editors and reviewers to the maintenance of high level of quality of the materials provided by the authors that serves the basis of estimation of every scientific article.

The number and the quality of scientist's publication are widely spread scientometric indicators. With the adaptation of the scientific world to the citation indexes and ratings, and the formation of their reliance, meeting the requirements allows to claim for some bonuses.

The Ministry of Education and Science of Russian Federation recommends to take into account citation index, Hirsch index and other scientometric indicators of higher education institution represented in the RISC system and international databases for ranking the universities. These criteria are included in the list of effectiveness estimation of the quality of universities that are rated as "national research universities" [12] development programs, and also they may be significant indicators for the distribution of social support to doctors of sciences.

There are some examples of legal regulations for ways and measures of scientists' social support, stimulation of science development via intensification of scientific activities of scientists [13]. In the Perm Region since 2009 a doctor of science has a right for monthly money grant after meeting one of these requirements in the term of 5 years: researchers training (at least two Ph. D candidates, doctoral candidates, or applicants with defended dissertations, and publication of at least ten articles in the magazines that are included in the information-analytical RISC system); publication of no less than 3 works in the periodicals that are included in the reliable international systems of scientific citation and bibliographic bases (WoS, Scopus); reaching at least the value of 5 of Hirsch index indicator and / or having publications with at least 25 citations (according to the RISC system).

Since 2010 the law includes the criterion of "citedness" that is calculated by the one of the most world popular in the scientific society scientometric indicators of popularity and significance of scientist's ideas — the Hirsch index**, which is a kind of integral quality criterion of scientific publications which is based on the distribution of citations of one's work. After 2 years since the introduction of the law 311 scientists got some support, and in 2011 426 doctors of science met the requirements of this law.

Higher education institutions take different measures to stimulate scientific and publicational activity of their employees. In the Higher School of Economics since 2010 there are three types of economical bonuses: for the academic activity (given for 1 year), for the academic successes and contribution to scientific reputation of the National Research University «Higher School of Economics» (given for 2 years) and for the article in a foreign peer-reviewed journal (given for 2 years). The applicants may apply for it with the works, published in two previous calendar years. Only one bonus may be given simultaneously.

In the Ural Federal University since August, 2011 the practice of employees' stimulation for widening and intensification of activity of promoting publications in foreign scientific periodicals, which provides stable growth and betters status of the university, is introduced. The minimal bonus for each publication reflected in one of international scientific bases (such as Web of Science or ScopuS) is 160 thousand rubles a year. Also there are up factors.

The project "Motivation" is aimed at the stimulation of employees of Far Eastern Federal University for more effective pedagogical, scientific and research activities [15]. The promotion is made in several areas and includes articles in highly rated magazines. The scientists of the university get 100 thousand premium rubles for scientific papers published in foreign and Russian scientific magazines that are

* *The index was introduced in 2005 by the physicist Jorge Hirsch (San-Diego University, USA, California)*

indexed in Scopus database. If the article is written in cooperation, the grant is divided by all members of the team.

The initiative of employees' estimation by scientometric indicators is implemented in the Tyumen State University as an experiment to determine the individual scientific rating of teachers. For entering the data on the research activities each experiment participant registers an account on the university website. The new format of reporting allows to compare indicators of scientific activity of departments and institutions on a wide range of parameters (publications per professor, reports submitted in Russia and abroad, the amount of research and advanced development activities, etc.). The prior indicator is teachers' citation index.

The intensification of publication activity of scientists (including publications in foreign languages) in the periodicals included in international databases allows to increase the effectiveness of Russian scientists integration into the international scientific society. Now the low level of language competency of the majority of educational community representatives makes it impossible to transfer the ideas, results of scientific research and experiments to the specialists abroad without help of professional translators and interpreters, and also it limits the range of knowledge of a scientist, because the original works of foreign classics stay unknown for them, as well as recent publications devoted to the necessary sphere of knowledge.

In the conditions of informational society the scientific activities should not be limited by the borders of only one country, the work often becomes international. The articles published in foreign scientific magazines in cooperation with the representatives of international scientific family have greater prospects to get appreciation from the professional society.

According to statistics, up to 93% of Russian frequently cited publications are written by the international group. But "while analyzing the international cooperation it is important to remember that the expression "a Russian article written in cooperation with colleagues abroad" is psychologically deceitful: a big amount of these works may be written by a big international society with one or two Russian scientists within" [16].

The newspaper "Poisk" claims that on the average every 241st article in Russia becomes frequently cited, while for the articles written in cooperation with American scientists the proportion equals 1:40. The cooperation with German scientists raises the level to 1:54 [16].

It is obvious that the productivity of scientists' activity can not be limited by some universal scientometric indicators, and these indicators should not be the bases of ratings. The most objective ratings are the ones that are based on the synthesis of quantitative and qualitative indicators and characteristics of scientific activities of effectiveness of a scientist, the level of his or her works and their significance for the scientific world and people.

Does the high rating of a scientist always mean his or her great contribution to the science, the effectiveness and productivity of scientific research, authority and colleagues' respect? Definitely not. But in the statistically significant majority of cases it turns out to be the truth. The scientific significance, the importance of each publication adds prestige to the author, and the more publications an author makes, the more significant in his or her sphere of knowledge he or she becomes, and the more the expertise increases.

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