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REVIEW OF METHODS OF EVALUATION OF SCIENTIFIC AND RESEARCH ACTIVITY FOR THE CHOICE OF SELECTION OF SCIENTIFIC PARTNERS

Abstract. *The work analyzes the latest scientific researches which cover the assessment of the research activities of subjects and objects of scientific environments. The conclusions obtained from the analysis can be the basis for establishing a criterion or a set of criteria for choosing scientific partners to create collaborative projects and conduct joint research activities within consortia, scientific communities, etc. It is determined that each of the evaluation systems generates own advantages of certain criteria, defines own weight coefficients, as a result, one and the same object or subject may have different sum of points. The paper describes the main disadvantages of well-known methods for evaluating scientific activity and proposes ways of their solution.*

Keywords: method of evaluation of scientific activity; scientific project; the task of selecting a scientific partner

Introduction

The task of choosing a scientific partner to create a scientific consortium or conducting joint research is relevant, especially in the context of globalization and the intensive development of the mobility of scientific and research communities. It is important to ensure a rational choice:

1. Identify the areas of scientific research of subjects and objects of the scientific environment.
2. To evaluate the activity of these objects or subjects in accordance with the determined scientific metric method.
3. Formulate selection criteria for partners that, in addition to evaluating scientific activity over a period, include other key criteria that are relevant to the consortium leader or leader of the future scientific project.

Articles [1 – 7] describe key methods and information technologies for evaluating the research activities of subjects and objects of the scientific environment. They are considered as complex assessments that take into account different evaluation criteria with defined weighting factors and estimates that do not require weighting and the use of an expert environment to obtain adequate estimates.

In the articles [8-10] describes the structure of the processes of the institution of higher education, as well as substantiates the use of parametric models to provide training and the problems of implementing international standards for assessing the competencies of project managers and programs.

Probabilistic models for the formation of the project environment are described in [11; 12]. In these articles also features of the application of Markov chains to the formation of the life cycle of scientific publications are outlined.

The ways of integrating project management techniques and decision support using a matrix model based on key portfolio events that can be used in the task of selecting partners for collaborative research is described in [13].

In the articles [14; 15] describes key factors that influence the formation of consortia and the creation of collaborative, including scientific, projects. Among such factors is the reputation and limitations that relate to the mechanisms of cooperation between objects and entities.

The mathematical tools for choosing partners for co-operation are described in publications [16; 17]. In [18], the method of an analytic hierarchy is described for this task. In [19], it is proposed to use a genetic algorithm for this task.

Therefore, the task of choosing scientific partners for cooperation is complex, combining both methods of project management and programs, as well as mathematical methods for determining scientific areas and evaluating research activities. In order to ensure the transparency of choice, the technical component is also added to the task of selecting partners: development of an information system and technology for the search of scientific partners. The paper [20] presents the following main tasks that underlie the development of information technology for the choice of scientific partners:

1. Construction of an information model for presentation of scientific projects and their performers.
2. Construction of the method of identification of research areas of individual scientists.
3. Construction of an adequate model of the choice of potential partners from the base of active subjects of the scientific community.
4. Building a model for evaluating potential partners.
5. Creation of an information and analytical system that will form a list of potential partners for the purpose of grants for cooperation.

In [20], it is stated that one more task that influences the creation of a joint scientific project is the evaluation of competitors' activities.

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The purpose of the article

The purpose of the article is to review well-known methods for evaluating the research activities of subjects and objects of scientific environments that may be the basis for selecting parneries for the creation of joint scientific projects.

Presenting main materials

The task of evaluating research parity

The article [20] presents the problem of the choice of scientific partners. Suppose $G = (g_1, g_2, \ldots, g_n)$ – the grants or projects proposed for execution, n – the number of grants, and $P = (p_1, p_2, \ldots, p_m)$ – a set of potential partners or subjects of the scientific community, m – the number of potential partners.

The task of choosing a research partner is to build a model for evaluating the plurality of partners and building for each grant g_i, $i = \overline{1..n}$ an ordered set whose elements are monitored by decreasing the priority of the partners:

$$E(g_i) = \left(p_{k_1}^i, p_{k_2}^i, \ldots, p_{k_m}^i\right),$$

where $k_1 < k_2 < \ldots < k_m$ is a strictly increasing sequence of positive integers that determines the indices of the partners, $k_j \in 1,2,\ldots m$.

Before the selection of scientific partners, it is necessary to identify the directions of their research, as well as to evaluate their scientific activity. This assessment may be one of the criteria for selecting partners for a consortium to carry out a research project.

Therefore, before the selection of partners, it is necessary to solve the problem of identifying the directions of scientific research of these partners.

In [20], it is stated that the identification of scientific research directions is the process of establishing a correspondence between a particular scientist and the scientific directions in which this scientist works and publishes scientific publications within the framework of these directions. That is, you need to find a reflection $F : P \to C$, where $P = (p_1, p_2, \ldots, p_m)$ – the set of scientists, m – the number of scientists, $C = (c_1, c_2, \ldots, c_d)$ – the set of directions of scientific research, d – the number of directions of scientific research.

Another task is to evaluate the activities of scientific partners or objects and subjects of scientific activity (institutions of higher education in individual scientists).

Igor Sikorsky Kyiv Polytechnic Institute first started the calculation of the rating of higher education institutions more than 10 years ago. According to their concept of evaluation, the rating of a scientist is defined as the sum of the coefficients of the performance of certain tasks: methodological, educational, scientific, organizational and educational. These coefficients are defined as the ratio of the sum of values of the time norm for performing certain types of work to the basic value of the work direction. In determining the ranking of the heads of departments, the average value of the ratings of the scientific and pedagogical staff of the department with the determined coefficient is additionally calculated. In [21], it was stated that the introduction of such a system for determining the rating of scientists will increase the efficiency and effectiveness of scientific and educational activities, provide competition, and increase the motivation of employees. However, this evaluation system is based on numerous coefficients, the change of which may lead to a change in the result of the evaluation.

The most popular international indexes for evaluating the activities of universities and research institutes are:

– rating of the British consulting company Quacquarelli Symonds (QS);

– academic rating of universities of the world, compiled by the Shanghai Institute of Higher Education, Jiaotong University (Shanghai Rating) [22].

When calculating QS ranking, the following indicators are taken into account:

1. Academic reputation index.
2. Reputation index among employers.
3. The ratio of the number of teachers and students.
4. Index of citation of scientific articles of teaching staff in science-based bases (Scopus) in relation to the number of teaching staff.
5. Part of foreign teachers with regard to the teaching staff (equivalent to the full rate).
6. Part of foreign students relative to the number of students (full-cycle study programs).

The Shanghai rating is calculated on the basis of the following indicators:

1. Number of articles published in Nature or Science.
2. Number of quoted publications (SCIE citation index – Science Citation Index – Expanded and SSCI – Social Science Citation Index).
3. The number of teachers who received the Nobel Prize or Fields Award.
4. Number of publications cited in scientific journals.
5. The number of university graduates who received the Nobel Award or the Fields Award.
6. The ratio of the above indicators to the number of staff in the institution of higher education.

The dynamic development of the scientific environment of any country is an extremely important factor contributing to its prestige, economic development, the emergence of new technologies in various fields of human activity.

An important task that researchers have solved in recent decades is the creation of mechanisms for effective management of the development of the scientific information environment. This can be done through the involvement of private organizations, financial support of government bodies of different levels, and the expansion of international cooperation within certain scientific and educational projects (Horizon 2020, Erasmus +).

Therefore, an important task for private companies interested in developing technology-intensive technologies and foreign partners is to create effective criteria for evaluating the results of scientific research activities of scientists, higher education institutions, and structural subdivisions of these educational institutions [23; 1]. These criteria allow the formation of a high-quality scientific information environment that will be characterized by a significant level of self-organization and efficiency, and may also be the basis for solving the problem of choosing scientific partners for the organization of joint activities.

Evaluation of the results of research activities provides an opportunity to verify the relevance of the research process to the goals that were noted at the planning stage and, if necessary, adjust the course of these studies. One of the components of evaluation of research work is the evaluation of the main results of this work – scientific publications. The criterion for the significance of publications may be the use of the results of these publications in other scientific studies. That is why the evaluation of the results of research work can be carried out by finding different bibliographic indexes of publication citation [23].

Evaluation of research work in general can be based on personal assessments of scientists working on it. The generally accepted criteria for evaluating the results of scientific research work of scientists are the citation rates of publications published by these scholars. These indicators are mostly scalar quantities. The approach to constructing such variables has a number of advantages, but at the same time there are shortcomings. Among these drawbacks is the loss of some inputs and the existence of such limiting cases, when the parameter does not change its value with an increase in the number of quotes and publications. This situation arises for many well-known citation calculation indices: the Worst index, the index I-10, the g-index. Here is an example of this situation.

Let the scientist publish n' publications that subsequently became fundamental in a certain direction of research, and completed his career. These publications are often used in research and they are cited di times each. If $di > n'$, then the traditional bibliometric indices will be n', that is, the result of the research work of this scientist is not very successful and important, but such an assessment is not adequate. Therefore, new methods should avoid such cases when research is being carried out, there are new publications that are quoted, and the evaluation of research results does not change [23].

That is why the main principle that ensures the formation of effective scientific information media is the development of new or modification of existing methods for evaluating the results of scientific research activities of scientists who do not have the drawbacks.

One of the components of assessments of higher education institutions worldwide is the definition of a generalized indicator of the quality and results of scientific research by a separate scientist, faculty, faculty and institution of higher education in general. In the modern world of information technology, the plurality of publications available in the web-space allows us to assess the scientific level of research. However, the lack of uniform requirements and standards for the placement and management of scientific works creates real obstacles on the way to a qualitative assessment of the results of the activities of science-economic entities. Solving this problem requires:

1. Determination of the basic essence of subjects of science and communication between them;
2. Creating an adequate degree of formalization of the processes of managing scientific publications at different stages of their processing;
3. The final stage of model development is the creation of a global database of scientists, scientific publications, scientific journals, institutions for determining the ranking of citation and popularity of the above-mentioned subjects [24].

The results of research activities of scholars can be evaluated based on the citation rates of publications published by these scholars. In [25], an overview of the science-based bases and methods for obtaining the main citation indicators was made. The most common bibliometric index is currently the Worst Index. The principle of its construction is described in [26]. The Worse index is calculated as follows: a scientist receives the index h in the event that at least h articles have been published, each of which is quoted at least h times. In [26], it is proposed to use the so-called g-index. This index is the largest number g, which corresponds to the number of articles that were quoted in aggregate at least g^2 times. In [27], the basic deficiencies of the h- and g-indexes, which consist in the loss of information about the citation of the most popular publications of the author, are proposed and the use of the e-index to address these shortcomings is indicated. In [28], several modifications are proposed for the calculation of the h-index, including taking into account self-citation. In [29], the correlation of the Hirsch index with the g-index is considered, taking into account the various samples of scientists and scientific collections, where the results of scientific research were published.

The main disadvantage is that each of the following indices loses some quoting information, namely:

- The h-index loses information beyond the core of the hierarchy (h-core): does not take into account information about quotes less than h times and citing posts made more than h times;
- The g-index loses information beyond g-core depending on the ratio of citation to the number of author publications;
- The e-index loses information about quoting publications that are quoted less than h times;
- Index I-10 loses information about publications that are quoted less than 10 times.

In the articles [23; 1] proposed integral methods for evaluating the results of scientists, the characteristic feature of which is the construction of vectors, whose components are scalar estimates of the results of scientific activity. These vectors are located in a multidimensional metric space. Also, the so-called ideal point is constructed, which consists of scalar assessments, the best in terms of achieving maximum performance. The metric distance between the ideal point and the point determined by the vector of estimation of the scientific activity of a scientist determines the integral estimation of this scientist. The condition of applying the method is the availability of sufficient information about the citation of the publications of scientists. The advantage of the method is that the estimation of the results of a scientist's work by the integral method is calculated in a complex manner, taking into account the estimates of other indices. Also, the preference is to set the metric space, which allows you to extend the range of estimated values of estimates using different formulas for metric distances. The disadvantage of the integral method is the problem of selecting and correcting the ideal point. Also, the disadvantage is that the components of the constructed vectors for evaluating the results of research activities have components that are clearly correlated. This is due to the fact that the calculation of these components is based on the same data on the citation of scientific publications.

Conclusions and perspectives of further research

The article gives an overview of well-known methods for evaluating the research activity of objects and subjects of scientific activity. It has been found that the criteria that underlie these methods do not fully reflect the characteristics that potential scientific partners need to have for creating a consortium and joint activity. An important task for further research is the formation of a list of significant criteria that directly influence the choice of a rational scientific partner.

Described are known methods for evaluating the research activities of scientific institutions and universities, as well as individual scientists. It is indicated that most institutions conducting an assessment base their rating system, which makes it difficult to compare objects and subjects of scientific activity with each other.

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ОГЛЯД МЕТОДІВ ОЦІНЮВАННЯ НАУКОВО-ДОСЛІДНОЇ ДІЯЛЬНОСТІ ДЛЯ ЗАДАЧІ ВИБОРУ НАУКОВИХ ПАРТНЕРІВ

Анотація. *Проаналізовано останні наукові дослідження, які полягають у оцінюванні науково-дослідної діяльності суб'єктів та об'єктів наукових середовищ. Отримані за результатами аналізу висновки можуть бути основою створення критерію або комплексу критеріїв з вибору наукових партнерів для створення спільних проектів та проведення спільної науково-дослідної діяльності в рамках консорціумів, наукових спільнот тощо. Визначено, що кожна із систем оцінювання формує власні переваги тих або інших критеріїв, визначає власні вагові коефіцієнти, в результаті один і той же об'єкт або суб'єкт може мати різну суму балів. В роботі описано основні недоліки відомих методів оцінювання наукової діяльності та запропоновано шляхи їх вирішення.*

Ключові слова: метод оцінювання наукової діяльності; науковий проект; задача вибору наукового партнера

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