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THE ESTIMATION OF EFFICIENCY OF THE UNIVERSITY INNOVATION ACTIVITY: SYSTEMS OF INDICATORS AND BIBLIOMETRIC APPROACH

The development of new forms of science and innovation at universities, as well as the interaction of higher education institutions with regional participants of the innovation system raises the question of evaluating the effectiveness of innovation as an independent phenomenon. Correct assessment of innovation activity helps the university to determine its strategic advantages, which is necessary in today's conditions of tough competition, uncertainty of the external environment, the lack of all types of resources, globalization of education. The authors examined the differences in interpretations of the concepts of "effect" and "efficiency" in relation to the innovation activities of the university. The authors analyzed the methodological approaches to the integrated assessment of the innovation activities of the university, presented in modern studies on this topic. The authors paid attention to approaches based on the integral index of innovation activity, as well as measurements of various types of actions within the framework of innovation activity. Among the main groups of indicators, research productivity, research quality, academic results, etc. are highlighted. The authors also pay attention to alternative approaches to assessing innovation, including the bibliometric (scientometric) approach. This approach has been rapidly developing in recent decades and is actively used in the compilation of various university rankings. The authors have shown the main advantages of the bibliometric approach, as well as the possibilities of its use for evaluating the scientific activities of both the individual scientist and the university as a whole.

Key words: university, innovation, efficiency, assessment, bibliometric approach.

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Университеттің инновациялық қызметінің тиімділігін бағалау: көрсеткіштер жүйесі және библиометриялық тәсіл

Университеттерде ғылыми және инновациялық қызметтің жаңа нысандарын дамыту, сондай-ақ жоғары оқу орындарының инновациялық жүйесінің аймақтық қатысушыларымен өзара іс-қимылы инновациялық қызметтің тиімділігін дербес құбылыс ретінде бағалау туралы мәселе қояды. Инновациялық қызметті дұрыс бағалау жоғары оқу орнының өзінің стратегиялық артықшылықтарын анықтауына ықпал етеді, бұл қазіргі заманғы қатаң бәсекелестік, сыртқы ортаның белгісіздігі, ресурстардың барлық түрлерінің тапшылығы, білім берудің жаһандануы жағдайында қажетті болып табылады. Авторлар университеттің инновациялық қызметіне қатысты «әсер» және «тиімділік» ұғымдарының түсіндірмелеріндегі айырмашылықтарды қарастырған. Авторлар осы тақырып бойынша заманауи зерттеулерде ұсынылған жоғары оқу орындарының инновациялық қызметін кешенді бағалаудың әдіснамалық тәсілдерін талдады. Авторлар инновациялық қызметтің интегралдық индексі негізіндегі тәсілдерге, сондай-ақ инновациялық қызмет шеңберінде белсенділіктің бірқатар түрлерін өлшеуге назар аударды. Индикаторлардың негізгі топтарының арасында зерттеу қызметінің өнімділігі, зерттеу сапасы, академиялық нәтижелер және тағы басқалар анықталды. Сондай-ақ, авторлар инновациялық қызметті бағалаудың баламалы тәсілдеріне, олардың ішінде библиометриялық (саентометриялық) тәсілге назар аударады. Бұл тәсіл соңғы онжылдықта қарқынды дамыды және жоғары оқу орындарының әртүрлі рейтингтерін құрастыруда белсенді қолданылады. Авторлармен библиометриялық тәсілдің негізгі артықшылықтары, сондай-ақ оны жеке ғалымның да, жалпы университеттің де ғылыми қызметін бағалау үшін пайдалану мүмкіндіктері көрсетілген.

Түйін сөздер: университет, инновациялық қызмет, тиімділік, бағалау, библиометриялық тәсіл.

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Оценка эффективности инновационной деятельности университета: системы показателей и библиометрический подход

Развитие в университетах новых форм научной и инновационной деятельности, а также взаимодействие высших учебных заведений с региональными участниками инновационной системы ставят вопрос об оценке эффективности инновационной деятельности как самостоятельного явления. Правильная оценка инновационной деятельности способствует определению вузом своих стратегических преимуществ, что является необходимым в современных условиях жесткой конкуренции, неопределенности внешнего окружения, дефицита всех видов ресурсов, глобализации образования. Авторами рассмотрены различия в трактовках понятий «эффект» и «эффективность» применительно к инновационной деятельности университета. Авторами проанализированы методологические подходы к комплексной оценке инновационной деятельности вуза, представленные в современных исследованиях по данной тематике. Авторами уделено внимание подходам на основе интегрального индекса инновационной деятельности, а также измерений различных видов активности в рамках инновационной деятельности. Среди основных групп индикаторов выделены продуктивность исследовательской деятельности, качество исследований, академические результаты и др. Также авторы уделяют внимание альтернативным подходам оценки инновационной деятельности, среди которых библиометрический (саентометрический) подход. Данный подход получил стремительное развитие в последние десятилетия и активно применяется в составлении различных рейтингов вузов. Авторами показаны основные преимущества библиометрического подхода, а также возможности его использования для оценки научной деятельности как отдельного ученого, так и университета в целом.

Ключевые слова: университет, инновационная деятельность, эффективность, оценка, библиометрический подход.

Introduction

The course on the development of an innovative economy in the republic sets new challenges for higher education institutions. Among them, the most important are the development of research and innovation activities, involvement in the economic and social processes of the region, as well as the commercialization and implementation of scientific research (Turginbayeva, 2018).

The intensive development of science and technology in recent years has led to a tremendous increase in the investment of material and non-material resources for the development of innovative structures in various sectors of the economy. The universities that play a crucial role in the development of national and regional innovation systems and the creation of qualitatively new products and technologies did not remain aloof from this trend.

Along with the development of innovation, at present, universities have begun to pay significant attention to issues such as the effectiveness of innovation processes, the quality of the results and effects, as well as the problem of evaluating the effectiveness of any type of activity. The latter problem is of particular relevance at the present stage of development of higher education in the face of fierce competition, the uncertainty of the external environment, the shortage of all types of resources, and the globalization of business. Therefore, higher education institutions are faced with the task of not only activating, but also increasing the effectiveness of research and innovation.

In this connection, the question of what is meant by the notions of "effect" and "effectiveness" of scientific innovation activity is a crucial one.

In the article, the object of the research is the approaches to the evaluation of research and innovation activities of the university. The aim of the study is to identify the features of various assessment approaches for their use in the practice of domestic universities. We used such research methods as analysis, synthesis, comparative approach, dialectical-logical approach, deduction, study and analysis of domestic and international experience.

Methodology

The works of scientists and economists of CIS and foreign countries on the issues of innovation activity efficiency became the theoretical and methodological basis of this article. As a methodological

base of the research methods of systemic, functional and statistical analysis were used. The information base of the study was domestic and foreign methodical reference materials, official information of the QS World University Rankings, Academic Ranking of World Universities, data published in the materials of the periodical press. To assess the effectiveness of innovative activity of the university a systematic approach was used.

The article uses the theory of the "triple helix", created in England and Holland at the beginning of the XXI century by the professor of the University of Newcastle Henry Itzkowitz and the professor of the University of Amsterdam Loiet Leydesdorf. The triple helix symbolizes the union between government, business and university, which are key elements of the innovation system of any country. The "triple helix" model shows the inclusion of certain institutions in the interaction at each stage of creating an innovative product.

A bibliometric approach is also used, which is based on the application of mathematical and statistical methods to the study of books, periodicals and other publications. Within the framework of the approach, methods of quantitative analysis of bibliographic characteristics of documents that provide the basis for their qualitative assessment are used.

The article provides a comparative analysis of traditional systems of indicators and a bibliometric approach for assessing scientific activity. Authors used the methodological publications of the Organization for Economic Co-operation and Development (OECD), the methodological notes for the Science and Engineering Indicators yearbook published by National Science Foundation (USA) as well as h-index measurement methodology.

Literature review

In the process of research, scientific works of foreign scientists on the problems of efficiency of higher education innovation activity were considered: Hirsch J. E., Chu Ng Y., & Li S.K., Johnes G. & Johnes J., Larionova F.F. et al, Kabakova Ye.A. and others.

In his work Hirsch (2005) offered the h-index for quantifying a scientist's publication productivity based of several scholar indices. Johnes G. & Johnes J. (2009) examined the possibility of measuring efficiency in the context of higher education. Their works explored the advantages and drawbacks of the various methods for measuring efficiency in the higher education context including innovation and research activity. On the example of English universities he showed opportunities of measuring technique known as data envelopment analysis (DEA). In their turn, Chu Ng Y., & Li S.K. examined the efficiency in research of higher education institutions in China using indicators of nonparametric estimation technique.

Russian scientists Larionova F.F. et al (2011), Kabakova Ye.A. (2014) tried to compose the combination of quantitative indicators which can fully characterize the research activity of the higher educational institution. In their research they compared different sets of indicators which can characterize both research inputs and outputs.

Various aspects of the problems of enhancing the university innovation activity were considered by Kazakh scientists: Sabden O.S., Dnishev F.M., Kenzheguzin M.B., Alzhanova F.G., etc. Sabden (2007) reviewed the main directions for assessing the country's innovative development, including evaluations of the science and innovation complex. Dnishev (2001) substantiates the main strategies for the development of the country's scientific potential in the transition to an innovative economy. Kenzheguzin *et al* (2005) considered the peculiarities of the development of higher educational institutions of the Republic of Kazakhstan in a market economy, their ability to integrate into the innovation processes of the economy. The role of higher educational institutions in regional innovations processes on the example of Kazakhstan universities is described in work by Sitenko & Yessengldina (2018).

Issues of effect and effectiveness are discussed in McMillan et al (2006); Gafforova et al (2014). In their works, they substantiated the application of the concept of effectiveness to the scientific work of higher educational institutions.

However, this topic has not found complete coverage in the context of modern realities and is at the stage of searching for conceptual solutions. Analysis of approaches to the assessment of university innovation is an important task for the development of a knowledge-based economy in the republic. A review of the literature revealed a lack of knowledge about the application of various approaches to the assessment of the innovation activity of universities, as well as its components. In this regard, the purpose of the article was to identify the features of various methods for assessing the results of innovation activity, including the relatively new bibliometric approach.

Results and discussion

Assessment of efficiency of innovation activity of the university is a necessary element of the whole system of management of innovation activity of the organization. Without a clear understanding of the results of scientific and innovative work of all departments of the university, it is impossible to adopt managerial decisions and implement the strategic and tactical planning. This issue is important now especially because of developing different types of universities like entrepreneurial university, engaged university and others (Tayauova & Bektas, 2018).

To assess the effectiveness of research and innovation activities of the university it is necessary to define what is meant by the terms "effect" and "efficiency" in relation to the innovation activity of the university.

According to scientists (McMillan et al, 2006; Gafforova et al, 2014) in the evaluation of innovation activities of the university two aspects can be distinguished:

– if we talk about the efficiency of management of scientific and innovation activity, then it is advisable to consider effectiveness as the degree of achievement of the objectives.

– if we talk about the efficiency of the results which, in particular, are products of innovation activities, it is advisable to consider efficiency from the standpoint of the relationship of the result (effect) to the cost.

In the traditional point of view, the meaning of "efficiency" is that the whole process of functioning of any entity shall be conducted with the least cost or greatest effectiveness (performance). Material, labor, information and other resources must be transformed into goods and services. The university, organizing its innovation activity, provides this transformation not only with benefit for the consumer, but also for itself.

The economic effect refers to the difference between the results of economic activity and their costs. It is obvious that to change the value of effect it is necessary to influence the factors determining it. However, various results of activities do not always provide the economic effect. Traditionally, management practices distinguish between these types of effect as economic, social and socio-economic. In relation to research and innovation activities in the modern research along with the traditional, there are also additional types of the effects. First and foremost, this is a commercial effect obtained by the participants in the innovation process when using the results of research and innovation activities. Also of great importance scientific and technical effect, which is expressed in possibility of use of results of performed studies in other research and development activities and obtaining information needed to create new products. Innovations may also have environmental effect – the impact of the result (product of activities) on the environment (noise, electromagnetic field, lighting (visual comfort), vibration, etc.

Regarding innovation activity of the university, it can be noted that its results are products that are created during certain processes of university activity and necessary for certain stakeholders (the state, educational activity of the university, etc.). During the use of innovative products stakeholders receive different types of effects mentioned above.

In practice the university faces with the challenge of improving the efficiency of research and innovation activity. Thus, according to popular belief, efficiency, in contrast to the effect, defined as the relative value is equal to the ratio of the result, purpose or result (effect) to inputs that lead to this result (Glass et al, 1995). In turn, the effectiveness of innovation activity of the university can be considered within a single concept of "efficiency", implying a degree of achievement of objectives in the field of science and innovation. This should be taken into account as the obtained results characterize the achievement of the goals and the spent resources.

Based on this, efficiency of innovation activity of the university can be considered as the ratio between of the results of scientific innovation that characterizes the degree of achievement of the goal of creating of scientific and innovation products to meet the requirements of stakeholders and cumulative resources used for that (Gafforova et al, 2014).

Definition of the terms of effect and effectiveness of IA is the basis for the analysis and choice of methodology for assessing the effectiveness of IA as a key component in the management of IA of the university.

Currently, the literature presents different methods of complex estimation of innovation activity of the university. So, researchers (Grebeniuk et al, 2012; Sychev, 2012) developed the methodology, which includes 4 interrelated stages:

Stage I – definition, classification and grouping of indicators to assess the innovation activity of the university;

Stage II – comparative analysis of innovation activity of the university;

Stage III – definition of tendencies of development of innovation activity of the university;

Stage IV- a comprehensive assessment of the innovation activity of the university.

The first stage of evaluation of the university IA includes the grouping of evaluation indicators of innovation activity in three areas: statistical study of innovation activity, learning innovation and educational activity, stimulating the development of innovation. The second stage includes use of the method of T. L. Saaty (Saaty, 2013) and scale of desirability by E. Harrington (Harrington, 1965) for the comparative analysis of indicators of innovation activity of universities. The analytic hierarchy process by T. L. Saaty allows to make the ranking of indicators of innovation activity of universities, and along with the Harrington's scales of desirability establishes the correspondence between the physical and the psychological parameters of innovation activity of the university. For ranking indicators in selected areas of research a pass grade is provided (in the range from 0 to 1) on the rating scales presented for each indicator of innovation activity (table 1).

Table 1 – The standard mark on the scale of desirability by E. Harrington

Desirability	Mark on the scale of desirability
Very good	1.00-0.80
Good	0.80-0.63
Satisfactory	0.63-0.37
Poor	0.37-0.20
Very poor	0.20-0.00

The indicators of innovation activity are evaluated in the third stage according to the formula:

$$K_i = a_i * A_i \quad (1)$$

where

K_i – evaluation of the i-th measure of innovation activities of the university;

a_i – the priority of the i-th index by T. L. Saaty;

A_i – scoring of the i-th indicator on the scale of desirability by E. Harrington.

The developed method simplifies the process of evaluation of innovation activities of the university and provides an objective view of the situation, as this assessment provides for the identification of a sufficiently large number of quantitative and qualitative indicators.

Then, the integral index of innovation activity of the university is calculated, taking into account the importance of each direction according to the formula:

$$I = \sum_{j=1}^{n} K_i \times a_j \quad (2)$$

where

I – integral index of innovation activity of the University;

K_i – evaluation of the i-th measure of innovation activity of the university in the framework of the innovation project;

a_j – the priority of the j-th directions of innovation activity of the university.

The resulting value of the integrated assessment allows you to judge the condition of innovation activities of the university. For the criteria of integral evaluation a scale of table 9 can be used. State of innovation is determined absolutely from very poor to very good.

The poor state of innovation activity of the university (0-0,37) is characterized by the following indicators: low performance in the creation of innovations determine the inability of the university to participate in the innovation cycle; training for innovation activities is at a low level, educational activity does not promote innovation. Strategy of development of innovation of that university should pay attention to the educational component of its work, which includes: training, retraining and skills upgrading of scientific-pedagogical staff; creation of centres for postgraduate education, research labs, sessions on innovation activities of the science sector on the basis of innovative enterprises; increasing qualification of the university teaching staff.

To improve the performance of innovation, it is necessary to plan a new cycle of improving in other indicators. It is necessary to consider that the university must set goals that can be realistically achieved, i.e. in the beginning it is better to focus not on the best indicators of innovation activities of the university but on its average level.

Satisfactory state of innovation activity (0,37 – 0,63) is characterized as follows: working towards the creation of innovations is conducted at the secondary level; training for innovation activities carried out in the statistical average indicators; educational activity, stimulating the development of innovations, is carried out at a very high level as it has not a significant impact on the level of assessment. Planning the innovation activity of such

university, it is reasonable to redistribute efforts to the process of creating innovations, as it will most effectively strengthen the innovative component of the university's activity.

Good and very good states of innovation activity (0,63 – 1,0) are characterized as follows: high level of activity in creation of innovations, respectively, and there are intense processes of learning of innovation activities and as a consequence consistently high level of educational activity, which stimulates the development of innovation.

The strategic task of such universities is to hold leading positions in the industry of the country and perhaps in the world. Perhaps these universities should be attributed to the leading ones with the opportunities of creation on the base of them the centres of development of innovation branches of the national economy.

Another approach for measurement of innovation activity of university was made by Larionova (2011). The researcher, based on a comparative analysis of methodological approaches to assessing the results of innovation and research activities of universities from different countries, proposed the following system of indicators (table 2).

Table 2 – Indicators of basic measurements of innovation activity of universities

Indicator	Description
1	2
Productivity (effectiveness) of research activity	
Publications and other results	Number
Number of publications (and other results) per researcher	Equivalent of a full-time researcher («academic researcher»)
Quality and academic result	
Number and percentage of publications in highly-cited journals	Number of publications, impact factor
Citation	Citation indexes (Web of Science, Scopus, Google Scholar)
Reports at national and international conferences	Number of reports
Number of prestigious awards	Number of prestigious national and international awards in total or per researcher
Temporary international «appointments»	The number of positions held temporarily in other academic (non-academic) institutions (organizations)
Participation in editorial and expert councils of national and international journals	Number of positions held temporarily in the editorial councils and expert councils of national and international journals
Innovative and social achievements	
Income from research	External attracted funding
Percentage of grants received	Indicator of income from research
Employment of defended graduate and doctoral students	Indicator of contribution to the formation of labor market quality
Recognition of the user	Orders, contracts for various activity
Level of income per equivalent of one full-time researcher	The indicator provides an opportunity for interuniversity comparison
Commercialization of Intellectual Property	Indicator of income from patents, licenses and new businesses
Percentage of financing from contracts	Measure of profitability of recognition
Stability and scale	
The number of graduate and doctoral students	The ratio of the number of graduate and doctoral students to the equivalent of a full-time researcher
Inclusion of young researchers in teams	Number or percentage of young researchers included in projects and teams
Number of partnerships	Number of partnerships with national and international universities (from abroad) and organizations

Continuation of table 2

Indicator	Description
1	2
Number of dissertations	Number of defended works
Research Infrastructure	
Research activity of academic staff	The number of active researchers in the total number of academic workers. It is determined through the establishment of a number of performance indicators
Percentage of academic staff involved in research activity to the total number of academic staff	Ratio of academic staff involved in research activity and total number of academic staff
Total investment in research and development	The volume of total investment in research and development, from all sources, including salaries and additions
Research infrastructure	Number of laboratories, books and electronic resources, their level of accessibility
Research Ethics	Processes providing promotion and use of ethical principles in research practice
Note – adapted from (Larionova, 2011)	

Today bibliometric (scientometric) approach to the study of efficiency of scientific activity becomes more and more popular among the scientific community. It appeared in the 60-70 years of XX century, however, began to be actively used only in the 90s of the last century. The popularity of this method began to grow due to the creation of a database of citations of scientific papers – the Science Citation Index (SCI) in the 1970s. (Okubo, 1997). The development of the global information and communication technologies also gave the impetus for the development of this method of assessment of scientific activity. National Science Foundation (the United States) included bibliometric indices for measuring the growth of science into its first Science & Engineering Indicators issue in 1972. OECD in 1989 added a chapter of the Frascati Manual supplement to the higher education sector with bibliometrics, confirming its status in science analysis. However, it took several more years for bibliometric indices to be accepted by the scientific community around the world. Countries such as Australia (1990), Canada (1991), Japan (1991), following the example of the United States, began to include bibliometric indices in Statistical yearbooks on Science and Technology. Also, a number of journals (Research Policy, Scientometrics, Research Evaluation and etc.) began to include articles using the bibliometric methods.

The term «bibliometrics» is more general and means a method for quantitative studies of documentary flows. As for the term «scientometrics», it is used to denote the applied research stream of scientific information taking into account its specificity. Despite the different definitions in literature, the researchers (Van Raan, 2005; Marshakova-Shaikevich, 2013; Gordukalova, 2014) agree that the terms «bibliometrics» and «scientometrics» largely mean the same. Thus, later in the article named concepts are treated as identical.

Scientometrics annually develops and tests in practice a large number of indicators that can be used to assess scientific performance. The results of the evaluation depend on how indicators are used and for what purpose.

Indicators conventionally are divided into three main groups:

– indicators based on the number of publications;

– indicators based on the number of citations;

– indicators based on the number of citations and number of publications.

The most generalized indices are based on the number of publications is the total number of publications of a researcher or organization that can be extracted from bibliographic databases and shows the number of works that went into a database of appropriate information retrieval system. Often they take into account the number of publications in international databases Scopus and Thomson Reuter.

Currently the leading scientometric indicator based on the number of citations is citation index. It is a total number of references to the number of works of the author in scientific publications. Citation index shows:

– the degree of the relevance and importance of the studies for those areas of knowledge in which specific scientists or research teams work;

– high citation index to a certain extent serves as the official recognition of a particular academic research community and confirmation of its priority;

– availability of scientists in scientific and educational organizations with a high index indicates a high efficiency and effectiveness of the organization as a whole (Kabakova, 2014).

The citation index is calculated within the specific database, which may be national or international one.

The indicators based on the number of citations and number of publications include the h-index and its modifications. However, the key indicator is the classical h-index, developed by J. Hirsch in 2005. The index is denoted by h and is calculated by the most databases. According to J. Hirsch, the index is more preferable than such criteria as the number of works divided by the total number of citations or the number of citations per one paper. According to the definition of h-index, a scholar with an index of h has published h papers each of which has been cited in other papers at least h times (Hirsch, 2005).

The h-index allows to take into account not only the number of publications of a particular author, but it also shows the demand for them from the scientific community. Thus, the index indicates the balance between the number of publications and number of citations received by each publication (Kabakova, 2014).

The citation indexes as main indicators of efficiency of innovation activity of universities are included in the criteria for the various international University rankings.

Thus, the methodology of the ranking of the best universities in the world QS World University Rankings includes the assessment by six criteria, one of which is the citation index, which is used to assess the research and innovation activity of the university. Its weight in the overall assessment of the institution is 20%.

This criterion includes the number of citations of published research on the number of teachers and researchers working at academia as the primary place of work for at least one semester. From 2004 to 2007 the citation was calculated based on the database of Thomson, since 2007 – based on the bibliometric database Scopus by Elsevier. Index takes into the account published in the last five years the materials, excluding self-citation.

In 2015 citation index was optimized. This was due to the introduction of system that balances the performance of different scientific disciplines. The citation index has been considered in the framework of the specific groups of scientific fields: Arts and Humanities; social Sciences, including management; Natural Sciences; Technical Sciences and Engineering; Life Sciences. This adjustment made it possible to more accurately correlate the indicators of various fields of knowledge.

Citation indexes are also used in the ranking ARWU – Academic Ranking of World Universities, known as «Shanghai». This rating takes citation into account not only in the rating methodology, but also in the selection of universities. The certain university has the right to take part in the ranking if it has among the staff of the university the scientists with high citation index according to Thomson Reuters database.

20% of the methodology of a rating is an indicator of the number of highly cited scientists, which is determined in accordance with the Essential Science Indicators (ESI) database from Thomson Reuters. Such indicators are separately considered:

– PUB – the total number of citations of the organization within Web of Science Core Collection (only «Science Citation Index-Expanded» and «Social Sciences Citation Index» databases(20%);

– N&S – the number of articles published in the journals «Nature» and «Science» by the authors from the university staff (20%).

Unlike the indicators of the QS, the ARWU measures absolute citation indexes and the publication activity of universities. The large and old universities have advantage in this ranking, because they have a large number of publications and citations.

In general, systems of indicators and bibliometric indices have many common features. First of all, both of them are quantitative indicators based on primary data of scientific activity (for example, number of publications, patents or citations). Secondly, they estimate the results of scientific activity and measure the productivity of research.

They can be used both separately and together. This is confirmed by the experience of the OECD, which publishes the Frascati manual, a document devoted to the methodology of science and innovation statistics. Also, a comprehensive methodology combining traditional indicators and bibliometric indices is used in the yearbook Science and Engineering Indicators published by National Science Foundation, USA.

The distinguishing features of the two approaches are presented in the table below.

Table 3 – Comparative analysis of approaches to the assessment of scientific activity

System of indicators	Bibliometric approach
Includes various indicators based different calculation methods	Includes standardized indicators based a single calculation method
The value of the indicator depends on the primary data	The value of the indicator depends on the database used
It is used more often for an estimation of scientific activity of the organizations / institutes	It is used more often for an estimation of scientific activity of individual researchers
The indicators are calculated for a certain period / for a certain date.	The indicator can be calculated at any time
Access to data is not always possible (difficult)	Access to data is possible at anytime and anywhere in the world through the access to a database
Note – composed by authors	

A limitation of using the bibliometric approach is that the indices take into account only publications placed in databases and, most often, published in English. However, traditional indicators may cover a wider range of publications. However, it can be assumed that the development of information and communication technologies will further contribute to the wider use of bibliometric methods, which, in turn, are constantly being developed and improved.

Conclusion

Summarizing the above, we can conclude that today traditional systems of indicators and a bibliometric method are equally used to evaluate the scientific activity of individual scientists, scientific organizations and universities. Meanwhile, in recent times there is increasing trend of the use of scientometric indicators for evaluating the effectiveness of research activity on different levels. Due to the access to digital sources (databases), the indices are easy available for scientists, investors and other stakeholders that makes them very convenient tool for quick and accurate assessment of any scientific output.

Scientometric indicators allow not only to assess the SIA of the individual university, but also to compare the results with the results of other scientific organizations. Despite the fact that some scientometric indicators were not known 10 years ago, they are already firmly entrenched in various methods of evaluation of innovation activity, including the recognized international ratings of higher educational institutions. The inclusion of bibliometric indicators in the world's leading statistical yearbooks, as well as the publication of studies based on the bibliometric method in referred journals, indicates the reliability of the use of this method in scientific research.

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