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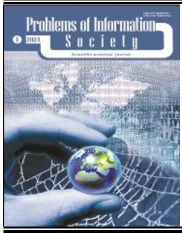

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Analysis of the current situation and identification of problems in the evaluation of intellectual potential

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ABSTRACT

This paper discusses the theoretical and methodological foundations of the study of the intellectual potential of the population. In the presented research, intellectual potential is the subject of multidisciplinary studies, particularly philosophy, sociology, economics, technology, psychology and pedagogy. To this end, this paper analyzes intellectual potential as a multidisciplinary research field, and examines the main theories, concepts and approaches in this field. Relevant scientific literature on the evaluation of intellectual potential is studied, actual research fields are determined, and their current status is analyzed. The indicators for the evaluation of research activity and efficiency of science in research institutions and organizations are determined. This work explores the international experience in evaluating the activities of scientific organizations, and analyzes the purpose, organization and results of the evaluation in some countries. In the end, it examines the state-of-the-art of scientific potential in the scientific organizations and institutions of Azerbaijan, and presents the important results of the conducted fundamental and applied research and some indicators used in the evaluation of the activity of research organizations.

1. Introduction

Information society (IS) enables people to use their full potential and realize their goals. IS a mainly aim to generate information resources and spaces for various purposes on the basis of modern information technologies to meet the information needs of society as a whole and for separate individuals individuals (Alguliyev et al., 2005). At present, humanity has left behind three industrial revolutions and is living in an era of transformation, where large-scale, complex and technological innovations are developing rapidly, and artificial intelligence is penetrating various spheres of life. Since the first decade of the 21st century, society has transitioned to the stage of the Fourth Industrial Revolution (Industry 4.0), that is, the stage of production with its own intelligence. This revolution involves autonomous decision-making of cyber-physical systems through cloud-based machine learning in manufacturing. Industry 4.0 (Fourth Industrial Revolution) has emerged due to machine learning, artificial intelligence, three-dimensional printing (3D printer), robots, unmanned aerial vehicles and cars, blockchain technology, neurotechnologies, implantable technologies, cloud technologies and other modern technologies. The process in this field has accelerated and smart factory, plant, house, city, etc. have gradually become reality. It is no coincidence that the world is already discussing the concepts of the Fifth Industrial Revolution, "Industry 5.0" or "Society 5.0". This concept implies the formation of production and society based on the joint cooperation of people and machines (Klaus, 2020). Industry 4.0, along with other fields, opens up new perspectives for the development of science. Advanced scientific and technological achievements form the basis of industrial revolutions, and industrial revolutions, in turn, help to form new scientific trends. It has a direct impact on both research processes and the use of research results, as well as the management of science and the interaction between science and society (Shakirova 2010).

Since the second half of the 20th century, science has become one of the main components of the economy of developed countries. Countries engaged in maintaining and strengthening their foreign policy and economic independence implement science and education policies that meet their interests. In the United States, which is a developed country, national science acts as one of the arguments to justify the claims of the United States to the world leadership. Recently, in other developed countries, increasing the efficiency of national science, that is, the development of clear indicators for evaluating its activity, up to the comprehensive reform of the entire system, including financing mechanisms, management methods and the structure of industrial relations, has become extremely urgent. All this equally refers to both fundamental and applied science. It should be noted that the development of research in the field of applied science depends more on the condition of production areas of the economy, because industry is the main customer and consumer of the results of applied research and technological innovations (Mindeli 2019; Koroleva et al., 2014). Today, educational and scientific potential as elements characterizing the intellectual potential (IP) of the country and society is considered indicators of global competitiveness and innovative development. The IP of the country and society include education, health, science, culture, demography, standard of living (Sultanbaeva et al., 2013). The basis of IP is the knowledge and cultural level allowing for a radical change of the competitiveness of economic efficiency. IP is a rather complex concept. Previously, this concept was used more as a category of social knowledge. Now the situation has changed. In modern society, the role of science, education, new technologies, including information technologies in relation to IP is increasing. The transition of developed countries from an industrial society to a knowledge-based economy (intellectual economy) post-industrial IS also highlights an intellectual component of human activity (Sultanbaeva et al., 2013; Ismayilov et al., 2018). The IP of a society is its ability to bring innovation to the historical process and thereby create the preconditions for moving forward. The use of human intelligence in the field of science and technology, that is, the activity of scientists, engineers, designers, technicians, highly qualified employees, becomes a decisive factor in the development of material production in the conditions of man-made civilization, where technological progress is ensured by education, scientific (new knowledge) and technical activities (inventions, design). Maintaining the proper level of civil development directly depends on the state of society's IP. The IP of the society has a direct impact on the economic development of the country. Its importance increases in conditions where the state gains greater independence in determining its own development by relying on its own resources, including intellectual ones. To justify the inclusion of the IP of the society in the system of factors of its economic development, there is a need for relevant theoretical, methodological and methodical developments on the problems of the content, structure, functions and measurement methods of IP. However, until now, in this aspect, these issues have not been studied enough; no complete research has been conducted on the formation and implementation of the society's IP, and on determining its essence and importance. In recent decades, the concept of IP has been used in relation to various social subjects and levels (society, territories, socio-economic systems, organizations, collectives, etc.) (Hashimov et al., 2014; Makasheva et al., 2011).

Recently, numerous conferences, symposia, seminars, forums dedicated to the problem of IP evaluation have been held with the involvement of prestigious international organizations, various research institutions and companies in the field of information technology. They discussed and explored various aspects of IP. Current scientific research trends and opportunities are determined in this field. These research trends lay the groundwork for the development of optimal methods for solving IP problems. Therefore, it is important and relevant to explore the scientific theoretical problems of IP and to study it as an object of scientific research. Given these important facts, this article is devoted to the analysis of the state-of-the-art and identification of challenges for IP evaluation. The research works, which are the structural components of IP evaluation, are examined, the experience of developed countries is studied, and some indicators used in the evaluation are analyzed.

2. Indicators characterizing the development of science

In the 21st century, scientific activity has taken an even more leading position, being considered the basis of the knowledge economy. Taking an economic character, science has become an object of Scientometrics to measure research, evaluation of scientific activity, achievements, i.e., articles, dissertations, monographs, reports, etc. (Aliguliyev et al., 2015). The task of the development of science is to technologically modernize the economy through the application of the latest technological equipment, on the basis of the resulting qualitative growth of scientific and scientific-technical activity, to move to the path of its innovative development, and to significantly increase the effectiveness of innovation activity. (Hasanov et al., 2011; Huseynova 2012) present following important conditions to this end:

– creation of a competitive sector of scientific research, development and their production;

– creation of an effective national innovation system in the country;

– modernization of the economy based on technological innovation;

– improvement of legislation, use of intellectual property rights and growth of security institutions;

– increasing the integration of the country into the international scientific and technical community and corporation with other countries.

(Huseynova, 2010) characterizes important measures for the successful implementation of the issues set forth before science as follows:

– to prioritize scientific trends ensuring the main fields of the socio-economic development of the country and scientific and technical field of innovation priorities in order to support the environment of "generation of science" in basic science;

– to ensure international competitiveness of scientific researches and experimental-constructive works in the country, national security essential for the humanitarian field;

– to use modern technologies in fundamental researches claimed to be world-class, etc.

The research reveals that the evaluation of the efficiency of science is performed at different levels. (Science Indicators: 2009; Scientific and innovative activities in the Republic of Belarus. 2012) identify the most commonly used indicators for evaluating the efficiency of science in the field of research in domestic and international approaches (table 1).

(Science Indicators: 2009; Scientific and innovative activities in the Republic of Belarus. 2012) characterize these indicators as follows:

1. Financial indicators. These indicators mainly include:

– financing structure by sources (budget, foreign grants, domestic grants, farm contracts, sale of products);

– research and development expenses (the structure of internal expenses by funding sources, funding by each employee, department, department in priority fields and types for the development of science, technology and technique; the average monthly salary of employees engaged in research and experimental-constructive works RECW);

– Fixed assets of RECW (share of machinery and equipment in fixed assets; distribution of fixed assets by departments; capital and technical-labor ratio of personnel involved in RECW).

2. Personnel indicators. These indicators mainly include:

– preparation of scientific personnel in post-graduate and doctoral studies (ratio of males and females in the number of post-graduate students and graduates; distribution of the number of post-graduate students by scientific fields; admission to post-graduate studies by scientific fields; graduation of post-graduate studies by scientific fields; completion of post-graduate studies with dissertation defense in scientific fields; distribution of the number of post-graduate students by scientific fields and by age groups; ratio of males and females in the number and graduation of doctoral students; distribution of the number of doctoral students by scientific fields; admission to doctoral studies by scientific fields; graduation of doctoral studies by scientific fields; graduation of doctoral studies by defending a dissertation by scientific fields; ratio of persons who have graduated post-graduate studies and doctoral studies with the dissertation defense; distribution of the number of doctoral students by age groups; average age of postgraduate and doctoral students).

– Personnel engaged in RECW (distribution of personnel engaged in RECW by categories; personnel engaged in RECW in full-time equivalent; distribution of employees engaged in scientific research and development in full-time equivalent by departments; distribution of personnel engaged in scientific research and development by educational degrees; distribution of researchers by scientific degrees; distribution of researchers by gender; distribution of researchers by fields of science; distribution of doctors of science by fields of science; distribution of doctors of philosophy by fields of science; distribution of researchers by gender and fields of science; distribution of researchers by age groups; average age of researchers; number of full members (academicians) and corresponding members; average age of full members (academicians) and corresponding members).

Table 1. Indicators for evaluating the efficiency of science

Indicators			
Finance	**Personnel**	**Innovative**	**Bibliometric**
- expenses for science; - existing material and technical base	- number and scientific degrees of researchers; - number of supporting personnel; - personnel training. - indicators of recognition, including membership in academies, councils and implementation of grants.	- manufacture of advanced production technologies and products; - use of advanced production technologies and products.	- number of publications in international journals; - citation index and Hirsch index; - articles published by scientists, productivity of scientists; - availability of patents; - co-authorship with foreign scientists.

3. Innovative indicators. These indicators mainly include:

– creation of advanced production technologies and products;

– use of advanced production technologies and products (by types, application conditions, technology export, technology imports).

When reviewing innovative indicators, an explanation of terms used in conducting an absolute assessment is provided, including:

– *Innovation* - specialization of new scientific knowledge, products, technologies, services, equipment, personnel, organization of production.

– *Innovative-active organization* - spends on technological innovations.

– *Innovative activity* - a kind of productive force that indirectly links between actual scientific and industrial fields, combines scientific and material production and implements technical and economic needs using scientific products.

4. Bibliometric indicators. Bibliometrics is a broad, intensively developing field of science based on methods of quantitative analysis of bibliographic features of documents. Bibliometric indicators provide a basis for the qualitative assessment of the results of scientific research, the determination of the volume of scientific knowledge, its structure and dynamics. The criteria developed on the basis of bibliometrics position the scientists, research centers, universities in local and global scientific systems, and determine the productivity of research programs and the dynamics of scientific fields. In bibliometric indicators, the number of publications in international journals characterizes the quality of articles, the citation index and the Hirsh index indicate the importance of the conducted research and the recognition of scientific schools by the world community. Furthermore, the bibliometric indicators may also include the publication load of scientists, the productivity of scientists, the presence of patents, co-authorship with foreign scientists, which indicates the international cooperation. In this regard, it is based on the following indicators:

– the number of scientific publications (by authors) as an indicator of the contribution to the knowledge production;

– the number of citations to scientific publications characterizing the impact of previous studies on the development of science, especially in related fields, which allows us to talk about the formation of new research fields with a certain citation intensity;

– co-authorship - evaluation of scientific relations between scientists, organizations, administrations and sectors (as well as between science and industry), fields of knowledge and countries.

The following definitions of types of scientific activity are used for the correct evaluation of indicators (Koroleva et al., 2014; Science Indicators: 2009; Scientific and innovative activities in the Republic of Belarus. 2012; Bessarabov et al.,2010).:

– *scientific research* (scientific research work) refers to a creative performance aimed at obtaining new knowledge and their application ways;

– *fundamental scientific research* refers to theoretical and/or experimental research aimed at obtaining new knowledge about the basic laws of the development of nature, human, society and artificially created objects.

– *applied scientific research is* aimed at obtaining new knowledge to solve specific practical problems. Development is an activity aimed at creating or improving methods and tools, especially new products and technologies, for the implementation of processes in a certain field of expertise.

Scientific developments ensure the creation of new materials, products, devices, technological processes, systems and methods, as well as their improvement. Scientific and technical services include activities in the field of scientific and technical information, patents, licenses, standardization, metrology and quality control, scientific and technical consulting and other activities contributing to the acquisition, dissemination and application of scientific knowledge.

3. Current research in the field of intellectual potential

IP is determined by the development level of a certain society, education and knowledge, science, cultural system and genetic fund of the society. It is characterized by the intellectual activity of society (Sultanbaeva et al., 2013).

The use of the IP category in various scientific studies occurs in the context of transformation processes ongoing in the economy based on human activity with high IP related to the development of science and information technologies, along with widely used concepts such as human and labor potential, intellectual labor, intellectual capital, on the one hand.

Today, the lack of a single consensus on the essence and content of IP among researchers in scientific sources has led to the proposal of numerous definitions (Hajirahimova et al., 2023).

In the conducted studies, intellectual potential is explained with a number of concepts (Hashimov et al., 2014; Makasheva et al., 2011; Leonidova 2014; Orlova 2008):

– *IP* is a common intellectual resource collected by society, capable of being involved in production processes and bringing income to its owner;

– *IP* is a set of opportunities used in the formation of new approaches for the society as a whole and for its subsystems to reproduce the knowledge collected by individuals and collectives and to evaluate the changes occurred for the development of innovations;

– *IP* is a complex characteristic of the development level of intellectual and creative capabilities and resources of the country, industry, and personality;

– *IP* is a feature of the population of a certain territory to acquire knowledge under the complex influence of socio-economic, socio-cultural and scientific-educational factors of people, to produce new knowledge, technologies, products creatively, and to ensure the sustainable, expanded and balanced reproduction of national wealth.

Current definitions of IP show that there is no commonly accepted definition of this category in modern science. In these definitions, the authors mention the elements that are important for understanding the essence of this category, such as the relationship with the socio-economic development of society, the factors of property formation, including the need for socio-economic development. Moreover, the authors also focus on the factors of raising (expanding), psychological aspect (abilities) and bearers of IP (Sultanbaeva et al., 2013).

Analysis of the essence of IP shows that the current level of intelligence is the product of its development. This means that social institutions such as the family, education, and the state contribute not only to the formation of intelligent people, but also to the realization of their potential intellectual capabilities in production, the creation of cultural values, the management of society, education, etc. With this approach, intelligence ceases to be an object of study of related subjects, acquires a social content and becomes a socio-economic category (Sultanbaeva et al., 2013; Ilyin et al., 2010; Kudina 2010).

Authors of (Shakirova 2010; Leonidova 2014; Chebotarev 2007) distinguish the following elements as a component of individual IP:

– developed abilities;

– a system of spiritual formations which personally represents the results of human activity transforming the knowledge, skills, that is, cognition and active;

– the ideals, beliefs, values, interests, which are the result of the intellectual understanding of a person's surrounding world, his/her position in it.

At present, several methodological approaches are mainly defined in the study of IP category (Levashov et al., 2000; Igorevna et al., 2020; Agranovich 2009):

– *philosophical approach* interprets IP as a kind of abstract category that does not change over time, but has an initial creative power;

– *psychological-pedagogical approach* defines IP as "the ability to learn" and attributes competence, initiative, creativity, a unique way of thinking, self-regulation to the intellectual qualities of a person;

– *socio-economic approach* relates IP with the complex characteristics of the development level of intellectual and creative resources of the country, industry, personality and the activity of educational and scientific fields and the acceleration of scientific and technical progress. This approach examines society's IP as a set of conditions under which the system (country, region, enterprise) can find solutions to achieve certain results;

– *social approach* studies the intellectual potential of the individual and its content, including the main components of the intellectual life of society, especially science and education, are studied;

– *economic approach* defines IP as a set of human knowledge and intellectual abilities that support the creation and implementation of a new product.

(Leonidova 2014; Nimtrakoon 2015) propose methodological approaches to the evaluation of IP of the population, and disclose the procedures and research methods used. As an indicator of the innovative development of the society and the efficiency of the state administration, methodical approaches to the organization of the monitoring of the IP of the population are proposed. Supporters of this approach identify intellectuals as bearers of IP. On the one hand, intellectuals really concentrate a significant part of IP, and on the other hand, it is wrong to reduce the essence of the studied concept only to the creative activity of people of this category, because the intellectual potential is not only complex intellectual work, but also includes the knowledge of the entire population that performs certain economic, social, political and cultural functions.

Moreover, conducted studies do not provide an unambiguous, accurate concept of the components of IP, and its structure, because everything depends on who owns this potential - an individual, a company (organization) or society as a whole (country, region, etc.). In (Hashimov et al., 2014; Makasheva et al., 2011; Leonidova 2014), the authors propose to distinguish the following features of IP: labor, education and scientific research. Labor characteristics represents the level of use of IP directly in labor activity. Quantitatively, this feature is expressed in the number of people who can realize their intellectual potential.

Education, which is the next feature of IP, determines the level and quality of education of employees with the opportunities to perform labor activities. Thus, for people working in a socio-cultural environment full of numerous mechanisms, it is necessary to have elementary technical literacy.

The scientific research characteristic of IP is manifested in inventions, patents, efficiency proposals that directly affect the increase in labor productivity. These complementary features of IP form the basis of its structure. Consequently, some studies present the structure of IP as *physical potential, educational potential, scientific research potential* (Hashimov et al., 2014; Makasheva et al., 2011).

Physical potential is characterized by indicators such as the number of people capable of realizing their intellectual potential, average life expectancy, and the share of healthcare expenses in the gross domestic regional product.

Educational potential is characterized by the fact that the education, professionalism and high qualification of employees determine the possibilities of modernizing the current economy and increasing labor productivity. Scientific potential is interpreted as scientific research potential. Because the aim of presenting this indicator is to show the impact of the IP's research competence on the final results of labor activity. Accordingly, scientific literature presents IP sometimes with three (*science, education, innovation potential*), sometimes four (*science, education, innovation, cultural potential*), and sometimes five (*science, education, cultural, health, information potential*) structural components (Hajirahimova et al., 2023; Leonidova 2014; Ilyin et al., 2010).

In this case, indicators of preparation of scientific personnel in the specified research fields, general and special costs for scientific research works and work for each researcher, and the development degree of the material and technical base of science in a certain area (country, region) are used. This determines not only the current position of the country in the world community, but also the vector of the future economic development of the society by creating an appropriate macroeconomic environment for improving the quality of intellectual resources.

Some methodological differences in approaches to IP analysis and evaluation are also distinguished by researchers. Some studies clearly follow a *resource approach* (Kudina, 2010).

It follows from the fact that public IP is a set of special resources (material, natural, labor, financial, information) of public production and represents the characteristic of the national economy to use scientific and technical knowledge for technological and commercial purposes for socio-economic development.

Other researchers use an *effective approach* based on the evaluation of intellectual activity in their research (Leonidova, 2014; Levashov et al., 2000). This approach analyzes financial outcomes obtained by the national economy from the sale of goods containing intellectual property objects in foreign markets at the macro level.

Many studies combine resource and efficiency approaches (Levashov et al., 2000; Igorevna et al., 2020). In this case, the evaluation of IP is based on an integral indicator that combines both the results of intellectual activity (volume of obtained results/volume of applied innovations) and resources (depreciation of fixed assets, turnover of working capital, productivity of investment, the share of the salary of scientific workers in the cost of the product). With this approach, the category of intellectual potential of the population is understood as a measure of the efficiency of the economy, expressed by the ability to realize the IP of a person and society for the socio-economic development (Leonidova 2014; Levashov et al., 2000; Igorevna et al., 2020).

Human capital theory, one of the main theories used in IP evaluation, is studied in more depth. Because according to this theory, knowledge and skills directly constituting the essence of a person's intellectual characteristics bring income to him/her (Sultanbaeva et al., 2013). It should be noted that there are evaluation methodologies using different indicators at the international level. The measurement system of the society's IP is created on the basis of available reliable sociological and statistical data. In a broad approach, intellectual resources are considered to be very close to the category of human potential. There are serious arguments to this end, based on international methods for evaluating and calculating the human development index (HDI). HDI is an indicator that represents the well-being of the population in the countries of the world accepted by the UN since 1990 and characterizes the development level of the population's intelligence. This index covers population's well-being more broadly than Gross Domestic Product and uses estimates *of population's education* (literacy), health (life expectancy) and *economic indicators* (income per capita) to compare across countries. The development index of IP of society is conceptually the most important component of the more general indicator of HDI (Hajirahimova et al., 2023).

The indicators of 2021-2022 rate Switzerland, Norway, Iceland, China and Australia as the countries with high human development among 191 countries around the world. Azerbaijan is ranked 91st in this ranking. The index is published by the UN Development Program (Human Development Index 2022).

In the studies carried out in (Leonidova, 2014; Nimtrakoon, 2015), along with HDI, the evaluation of the intellectual development of many countries includes other methods too. The first is the knowledge economy index, which shows the extent to which knowledge is effectively used in ensuring economic development. This index measures a country's ability to produce and disseminate knowledge within its territory. The index is calculated as an average score by four parameters: *economic incentives, institutional regime, education, innovation, use of information technologies.* They also mention an international indicator such as the Global Competitiveness Index (GCI, IMD World Competitiveness Ranking), which consists of components combined into nine main groups, that is higher education and training. The intermediate level between the micro and macro level, corresponding to the entire national economy as a whole, is the measurement of IP among certain professional teams (company, firm, enterprise and organization) (Leonidova 2014; Kudina 2010; Nimtrakoon 2015; Turysbekova 2020).

Nine main groups include: *institutional environment, state of infrastructure, macroeconomic indicators, development of health and primary education, higher education and vocational training, market efficiency, technological adoption, business organization and work experience.* In this case, the estimated indicators include a set of the company's existing intellectual assets (intellectual property, accumulated knowledge bases, beneficial relations with other subjects), human (professional and creative abilities of employees), management (management ideology, its formal and informal relationships whether inside or outside the organization or the company, the level of organizational development and the level of individual development of each employee, awareness of employees, information carriers and methods of its dissemination) potentials, as well as information elements (availability of an information system in the organization and well-established information flows) and innovative potentials of the organization and the company.

The complexity of defining the essence and parameters of IP is related to the fact that it includes, on the one hand, obvious and, on the other hand, broad abstract concepts, i.e., knowledge (theoretical, applied, experimental), abilities (mental, creative), and intuition. Moreover, the IP of the population dynamically changes over time under the influence of many factors, since there is an active demand for science in practice, it is developing rapidly and the efficiency of its use is increasing (Leonidova 2014).

(Leonidova 2014; Nimtrakoon, 2015) mention that the characteristics of IP research give reason to talk about the differences in its measurement at the *macro* and *micro* level. Accordingly, at the macro level, based on official statistics, it's more about public IP. At the micro level, based on empirical data, more attention is paid to the assessment of the IP of the individual, while the research methodology evaluates the IP of the population of any area or organization, if there is a significant advantage. Evaluation of IP is the most important means of effective management of its quality in terms of innovative development of socio-economic systems. Thus, IP in the innovative economy is one of the main features that ensure the efficient operation and development of the country. (Leonidova, 2014; Loseva, 2016) mention the following approaches for IP evaluation at the country level:

– *production-industrial approach.* The IP of the predominant sectors of the regional economy significantly contributing to the country as a whole is evaluated. This requires the development of an appropriate industrial indicators system. This approach is applied to all regions with characteristic natural, geographical and climatic conditions that create city-building enterprises, established industrial, scientific, technical or innovation clusters, as well as certain types of activities;

– *statistical approach.* IP is evaluated on the basis of available statistical data accepted by the country's statistical service institution, as well as specifically developed indicators characterizing both the conditions and results of the country's intellectual activity aimed at innovative development. This approach is more universal, but sometimes may not take into account the characteristics of a certain region.

Thus, as a result of the research carried out in the field of IP evaluation, it is determined that monitoring, by simultaneously studying the indicators characterizing IP and external factors affecting it, can solve the following issues:

– organization of observation, obtaining reliable and objective information about changes in the state-of-the-art of IP of the country or region;

– evaluation and systematic analysis of obtained data, determination of the causes of IP deterioration;

– preparation of recommendations for state and administrative bodies to eliminate negative trends;

– provision of managing bodies with obtained monitoring information, etc.

The methodological basis of the evaluation of population's IP can be one of the tools for studying the efficiency of public administration in the conditions of the formation of the knowledge society.

4. Evaluation of the activity of scientific organizations

A scientific organization is a legal entity that operates regardless of organizational-legal and ownership form, as well as a public association of researchers who perform the main scientific and scientific-technical activity, the training of researchers (Aliguliyev et al., 2009). The state higher scientific organization organizes and ensures the development of science in the Republic of Azerbaijan, implements the scientific and scientific-technical policy of the state, coordinates and directs the scientific research activities of research institutions and organizations and higher education institutions across the country, and represents the Republic of Azerbaijan in foreign countries in the field of scientific-technical activity. is a scientific organization determined by the relevant executive authority. The structure of the state higher scientific organization involves research institutions and organizations performing fundamental, applied and scientific innovative research in various fields of science (Law of the Republic of Azerbaijan on Science 2016). (Huseynova 2020) highlights the following trends for a comprehensive analysis of the development of science, based on the analysis of scientific organizations:

– general characteristics of research organizations;

– study of the main fields of science;

– analysis of the main funds of science policy.

Evaluation of scientific organizations refers to an analysis of its ability to work efficiently and usefully, to fulfill the tasks assigned to it by the founder. The purpose of such a systematic evaluation is to determine the strengths and weaknesses of the internal processes of the organization, as well as the system factors that significantly affect the scientific results and reliability of the organization (Kulagin 2018). The evaluation of the activity of scientific organizations *aims* to form an efficient system of scientific organizations, to increase their contribution to the socio-economic development of the country, to develop international cooperation in the field of science, to promote the reputation of science in the country, and also to increase the efficiency of management decisions in the field of science (Kulagin, 2018;

Bilan et al. 2020). In economic literature, the term "evaluation of a scientific organization" often refers to the definition of its capitalization or market value, and indicates the analysis of its activity and effectiveness (Bilan et al. 2020; Lavrentyev et al., 2009).

Such an analysis conducted by the founder determines the ability of the scientific organization to qualitatively perform the tasks assigned to it (by the founder). The organization that solves the relevant tasks at a high scientific-methodical level must ensure the reliability of the results it achieves. The purpose of the self-evaluation of the scientific organization performed by the management of the organization is to identify weak and strong system factors that significantly affect its scientific potential, as well as vulnerabilities in internal processes (Kulagin, 2018; Vasilyev et al., 2014). As noted in (Huseynova, 2020; Kulagin, 2018; Borovikova et al., 2014) previously the main mission of a scientific organization was the satisfaction of the founder, scientific results, satisfaction of the scientific community, now the modern idea of the mission of a scientific organization has become even more complicated. Consequently, satisfaction of interested parties and evaluation of their (founder, collective, customers, business partners) contribution, scientific results, fulfillment of the scientific community is estimated to be the main and current mission of the scientific organization.

(Huseynova, 2020; Kulagin, 2018) offer to complete the full and detailed application of the universal model of evaluation of scientific organizations at the state level with the following measures:

– identification of scientific fields that need to be restored or reorganized (which takes a lot of time);

– drawing up a detailed action plan for the involvement of specialists, the improvement of the activity of the scientific field of each organization separately and as a whole;

– organization of control over the execution of the plan drawn up;

– coordination of the activities of various branches of the government (state) requiring huge financial resources.

However, this high cost will soon succeed not only by increasing the efficiency of the scientific field as a whole, but also by optimizing the state regulation of the economy. The evaluation of the activity of scientific organizations is realized through expert analysis, as well as the comparison of indicators for the evaluation of the activity of scientific organizations according to the fields specified in table 2 (Huseynova, 2020; Kulagin 2018; Huseynova, 2013; Huseynova, 2023).

Table 2. Indicators used in the evaluation of the activity of scientific organizations

Fields	Indicators
Scientific potential, effectiveness and relevance of scientific research	- general characteristics of scientific potential; - publication activity; - intellectual property objects.
Integration into the global scientific community, dissemination of scientific knowledge and increasing the reputation of science	- involvement in international scientific and technical cooperation; - integration of science and education.
Development of human resource potential	provision with researchers and their structure; - training of scientific personnel.
Commercialization and application of research results	use of innovative technologies; - interaction with the real sector of the economy; - innovation infrastructure.
Resource support for the activities of the scientific organization	provision of scientific work with scientific equipment and necessary conditions; - use of advanced technologies and products.
The state of the scientific organization's financial activity, financial sources, material and technical potential to perform scientific research	income of the organization; - expenses of the organization; - structure of internal costs for research and development; - spending on science and innovation.
Development prospects of scientific organization	- long-term strategy of the development of the scientific organization.

(Huseynova, 2013; Huseynova, 2023) present the stages of evaluating the activity of scientific organizations as follows:

– evaluation of the activity of the scientific organization;

– appointment of the expert group of the scientific organization;

– determination of evaluation scores of indicators;

– calculation of the integral value of the organization's effectiveness;

– formation of assessment results;

– preparation of the evaluation conclusion of the activity of the scientific organization.

Taking these into account, first of all, it is necessary to promote the influence of scientific institutions and organizations on the socio-economic development of the country. To this end, the activity of scientific organizations shall be analyzed according to the indicators listed above and their efficiency evaluated. Evaluation of the activities of scientific organizations will determine the main fields of scientific research.

5. International experience in the evaluation of the scientific organizations' activity

Foreign experience is of great value when developing criteria and methods for evaluating the efficiency of scientific research institutions, as well as IP. In leading industrial countries with developed traditions, the evaluation of research groups and programs is performed mostly on bibliometric indicators. Such indicators characterize the evaluation of IP in scientific organizations, the efficiency of scientific activity and the country's position in global science, the development of scientific fields, the impact of research results on the progress of science. These data are not only used for analytical purposes, but also necessarily accompany the decision-making process related to the financing of certain projects and organizations (Koroleva et al., 2014). Below is the experience of some developed countries in the field of evaluating the activities of scientific organizations.

European Union. Evaluation of the activities of scientific organizations in the European Union (EU) countries has been applied since 2002 within the European current research information systems (euroCRIS) (Kulagin 2018; Bilan et al. 2020). There are some differences in the evaluation system for each EU member state. For example, in the UK, evaluation is carried out every five years, while in most other EU countries, they are carried out annually. Nevertheless, the general principles of evaluation are the same for everyone (Bilan et al. 2020):

– evaluation of scientific organizations is performed according to the plan;

– evaluation criteria are known in advance and are mandatory for all scientific organizations and universities;

– criteria should be clear, not contradictory, qua–tifiable and related to the evaluation goals.

The evaluation goals are formulated as follows (Kulagin 2018; Bilan et al. 2020):

– to evaluate the efficiency of institutions in the field of research and development;

– to evaluate the results of all institutions in relation to the total amount of expenses from the state budget during the reporting period.

Two extremely important facts are emphasized here. First, no EU country defines performance evaluation categories. It is believed that giving a category can negatively impact the creative activity of the collectives of scientific organizations. The EU believes that determining the rating of scientific organizations on each of the estimated parameters is sufficient to stimulate scientific activity (Kulagin, 2018). Second, the entire performance evaluation system is accepted as a system of state support for scientific research, improvement and innovation development. This fully coincides with our views on the need to focus the entire evaluation system on improving outcomes (Bilan et al. 2020).

The Czech Republic. Let's take a closer look at the European Current Research Information Systems (euroCRIS) on the example of the Czech Republic (CR). Research and development Board (R&D) with seventeen members realizes all work on the organization and completion of the results of the evaluation of the scientific organization activities in CR. It is an advisory body to the Czech Government in the field of scientific research and development. The board includes leading experts in fundamental (Czech Academy of Sciences and universities) and applied research, as well as experts from corporate research organizations. The chairman of the board is the prime minister, and the technical support of his functions is implemented by the government apparatus (Kulagin 2018; Bondarenko et al., 2022; Gokhberg et al., 2022).

France. In France, the activity of the laboratories of the research institution is evaluated according to a certain scheme (the laboratory prepares a report representing various indicators, such as the number of articles, the list of theses at conferences, the number of graduate students, patents, etc.) after four years of work. The evaluation committee includes not only representatives of the National Center for Scientific Research (Center National de la Recherche

Scientifique, CNRS), universities, and industry, but also foreign experts (Koroleva et al., 2014).

The evaluation itself often takes place at the end of the third year of operation, so that the necessary changes in the laboratory structure (mergers, divisions, etc.) have a year to be made. Often laboratories operate for eight years without structural changes. In general, this is a fairly flexible scheme for the activity of the scientific department.

Germany. Germany has a multidisciplinary research system. State institutions are financed not only by state funds, but also by additional funds from external organizations, and private research also receives state support. State financial support for research activities is provided on two bases: institutional support and project support (Koroleva et al., 2014). Institutional support is characterized by direct state funding of research institutions. Project support is aimed at targeted financing of specific research projects in research areas and is implemented within the framework of relevant programs. Unlike institutional support, it is intended for short and medium terms. Financing is provided for specific projects for a period of two to five years (Bessarabov et al., 2010).

The scientific system of Germany is structured as follows: the departments engaged in scientific research operate on the basis of universities and technical schools. These may include the Max Planck, Fraunhofer, Leibniz and Heimholtz communities (Max-Planck-Gesellschaft zur Förderung der Wissenschaften e.V., Helmholtz-Gemeinschaft Deutscher Forschungszentren, Wissenschaftsgemeinschaft Gottfried Wilhelm Leibniz e.V., Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V.). The academic board annually evaluates only universities. Based on the evaluation results, annual ranking list or ranking list of universities is published. The Heimholtz, Max Planck and Fraunhofer communities do not have a regular evaluation system. Institutions attached to them can only be subject to peer review if the government requests a review of the activities of an institution or community as a whole, but this happens extremely rarely. If an inspection is planned, then an expert commission in a certain field visits the institute and evaluates the efficiency of the activity of this research unit or institute. The expert commission is required to be consisted of not only of German experts, but also of foreign experts (Mindeli 2019; Koroleva et al., 2014).

Scientific research institutes in Germany are primarily evaluated in terms of the relevance and innovative direction of the research program. Here, the number of publications, the participation of the scientific research institution in conferences, as well as the patents received by this institution are taken into account. Quality assessment is also considered important, i.e., the involvement of financial resources from both internal and external partners or third parties. This indicates how attractive the scientific research enterprise is as a partner in joint projects. Then cooperation, that is the interaction with other institutions, universities, involvement of foreign specialists and the reputation of this institution at the domestic and international level are evaluated. There are also evaluation criteria for consulting and other services provided by scientific research institutions (Mindeli, 2019). Quality assessment and bibliometric method are used by the expert group in the process of evaluating the activity of scientific research institutes. It should be noted that in Germany there is a debate about the appropriateness of bibliometric methods used in the evaluation of the institutions' activities, because each scientific field has its own history and a number of important characteristics, consequently the evaluation methods of units engaged in specific scientific activity should also be distinguished (Koroleva et al., 2014).

Great Britain. In Great Britain, science is mostly concentrated in universities. The government often supports low-income projects, funds the training of specialists, provides the necessary equipment and tries to attract foreign scientists and researchers to work in the British scientific base. To get funds for research, it is required to apply for grants. Applied research is more easily funded. Thus, scientists decide themselves to spend money on research areas they wish. Funding is typically provided by the British National Science and Technology Council (Koroleva et al., 2014).

United States of America. In the United States of America (USA), every four years, the management is reported on increasing the funding of the project or closing the laboratory completely as a result of a rigorous evaluation by experts, the government, the Ministry of Economy, the Ministry of Defense, and the Defense Advanced Research Projects Agency (DARPA). That is, in order to stay afloat, the scientific department must withstand constant strong competition in the scientific environment. The situation is similar at US universities, jobs depend on grants, but permanent positions of scientists are maintained (Koroleva et al., 2014).

Sweden. The funds allocated to science and higher education in Sweden is planned to increase by 15% compared to last year (Mindeli, 2019; Koroleva et al., 2014). At this time, significant attention is paid to the competitive allocation of the scientific budget (increasing from 10 to 20% of the total volume) based on quality indicators such as the citation index and the impact of publications, as well as the appointment of international experts to evaluate grant applications and reports on their international peer review performance. In order to provide additional opportunities for long-term and risky projects, it is planned to allocate up to 45.8 million dollars annually to the best researchers of the country within the framework of the program. Furthermore, it is planned to allocate up to 38 million dollars annually to attract highly qualified researchers from other countries to Sweden and ensure their effective scientific activity. The plan also calls for increasing university budgets by 137 million dollars per year, with no restrictions on how these additional resources are spent (Koroleva et al., 2014).

Russian Federation. Russian Federation (RF) adopts the approach proposed by the Ministry of Education and Science to evaluate the activities of scientific organizations. This approach uses known parameters of scientific efficiency (structure of scientific organization, scientific results, financial results, personnel structure) (Mindeli 2019; Koroleva et al., 2014; Science Indicators: 2009).

Here, in general, bibliometric indicators are grouped in three directions. The first trend includes the resources of the organization, which involve the availability of human resources, material, technical and financial base. In the recent period, the studies dedicated to the issues of optimal management of human resources in the electronic government environment are becoming popular (Jabrayilova 2015; Mammadova et al., 2016).

The second trend includes scientific effectiveness evaluated on the basis of the bibliometric indicators of the organization, the availability of patents, involvement in the scientific community (for example, participation in conferences, organization of international forums, joint publications with foreign scientists, etc.), developed design and technological documents, standards, regulations, etc. The third trend is the stability of the organization, which includes the existence of the orders' portfolio and its composition (main customers). An important indicator is the presence of a certain strategy for the continuous renewal of scientific personnel and the development of the organization, as well as the presence of plans for attracting funding for scientific orders.

Several basic assumptions are formed based on these three trends, resources, effectiveness, and sustainability. If the organization has the resources, but does not show enough scientific results, then it needs to be restructured. If the organization shows high scientific results, but does not have enough resources, then two options are possible: either to increase funding from the budget, or to promote some cooperation with other institutions. Experts should view and decide. Finally, the classic form is that if an organization has neither resources nor results, then it seems must be a candidate for dissolution of some sort. This is the statistical phase of the survey.

The second stage of this work is conducting expert surveys. The Russian Federation takes as its basis the Anglo-Saxon countries or Germany, which have a fairly large and positive experience in this field.

A very important point in the evaluation of scientific organizations is that the evaluation results should be connected with the provision of funding from the budget. Different countries do this in a different way. In the UK, the organization's score is directly related to funding, while in Germany, the assessment is conducted where funding is scarce. That is, if the scientific organization works, but the funds are not enough, then the evaluation process begins, and funding decreases for a weaker organization (Mindeli 2019; Koroleva et al., 2014; Science Indicators: 2009; Bessarabov et al., 2010).

6. The state of scientific potential in scientific organizations and institutions of Azerbaijan

In Azerbaijan, the development of education and science is in the focus, and the further development of the country's human capital and strengthening of IP is one of the priorities of the state's policy. In recent years, many orders and decrees on the development of science and the complex solution of problems in this field have been signed, and several important decisions regarding the development of the field of science have been made.

Currently, in order to continue competition, any state does not refer to its territory, population, or natural resources, but to its IP. There are all kinds of potential opportunities to ensure the Azerbaijani science to be involved in the global arena and represent science with dignity in the international science space. The scientists and intellectual elite of the Republic of Azerbaijan, which has a high dynamic of economic development, face many complex and strategically important issues.

Currently, IP, which determines the strategy of Azerbaijan's science and education, surpasses the rich natural resources due to its importance and the dividends it brings (Maharramov 2010).

Today, the main goal of the development of science and innovation is the technological renewal of the economy and increasing its competitiveness through advanced technologies, the formation of the RECW sector and an effective innovation system, which turns the scientific potential into one of the main resources of stable economic development (Huseynova 2020).

(Huseynova, 2020; Huseynova, 2013) indicates the necessity of solving the following problems in order to form the structure of RECW in Azerbaijan:

– creation of favorable conditions for the scientific potential of Azerbaijan to find its place in the economic development of the country;

– development of a mechanism for the commercialization of RECW results;

– development of the field of applied research;

– progress of innovation infrastructure in commercialization;

– granting concessions by the state to increase the innovation activity of entrepreneurs, etc.

Azerbaijan National Academy of Sciences (ANAS) is the highest state body that implements the scientific and scientific-technical policy of the state. At present, important measures are being taken to increase the efficiency of scientific activity in ANAS, protect and develop the scientific and technical potential, ensure the application of the results of fundamental and applied research conducted in other research institutions and universities of the country in socio-economic and other fields, train highly qualified personnel, and ensure unity of science and education.

Given the orders and decisions of the state regarding the development of science, ANAS target the scientific research to solve current social and economic problems. The scientific force of Azerbaijan is directed to the development of all areas of society to achieve high results (Huseynova, 2020; Huseynova, 2013).

The field of scientific research, which is one of the structural components of the IP, is fundamental in the evaluation of the scientific potential of Azerbaijan. As mentioned, since scientific institutions and organizations refer to the field of scientific research, the evaluation of the activity of scientific organizations is performed through expert analysis, as well as the analysis and comparison of indicators for the evaluation of the activity of scientific organizations. These indicators are the basis for the evaluation of the IP of the country. The evaluation of the activity of scientific research institutions in Azerbaijan uses criteria such as the structure of scientific organizations, scientific results, financial results, personnel structure, etc. and numerous indicators (publication activity, involvement in international scientific and technical cooperation, training of scientific personnel, use of innovation technologies, innovation infrastructure, etc.) are used. To analyze the condition of IP in Azerbaijan and evaluate IP, we have to review the important results of fundamental and applied research conducted in ANAS and other scientific and educational institutions of the republic and other indicators for evaluating the activity of scientific organizations.

Statistical collection of the Azerbaijan State Statistics Committee for different years and in the report prepared by ANAS for 2022 represent the main indicators indication the state-of-the-art and level of development of education, science and culture in the Republic of Azerbaijan (Education, science and culture in Azerbaijan 2022; Report on the activities of the Azerbaijan National Academy of Sciences for 2022, Volume I; Report on the activities of the Azerbaijan National Academy of Sciences in 2022, Volume II).

The report indicates, the total number of employees working in scientific institutions subordinated to ANAS, as well as scientific institutions subordinated to the Ministry of Science and Education and the Ministry of Culture of the Republic of Azerbaijan by the relevant Decree of the President of the Republic of Azerbaijan to be 9010 people in 2022. The total number of researchers is reported to be 4456, including 582 doctors of science and 1817 doctors of philosophy. The composition of ANAS consists of 144 members, with 57 full members and 87 correspondent members (Report on the activities of the Azerbaijan National Academy of Sciences for 2022, Volume I; Report on the activities of the Azerbaijan National Academy of Sciences in 2022, Volume II) (Fig. 1).

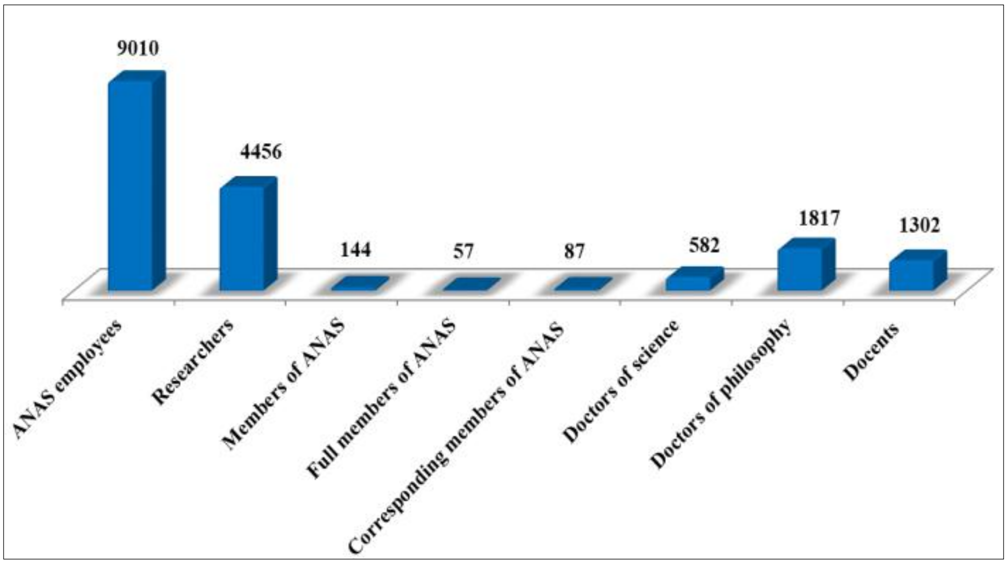

Fig. 1. Personnel potential of ANAS and other scientific organizations of the republic

The analysis of the age limits of personnel potential in ANAS and other scientific organizations of the republic shows that the total number of scientific workers aged 41-50 is 926, which is more than other age limits. The majority of scientists with the scientific degree of Doctor of Sciences are 70 and older, and the majority of scientists with the scientific degree of Doctor of Philosophy are 41-50 (Fig. 2) (Collection of reports and speeches on the report of the General Assembly of the Azerbaijan National Academy of Sciences dated March 16, 2023, report, volume III, 2023).

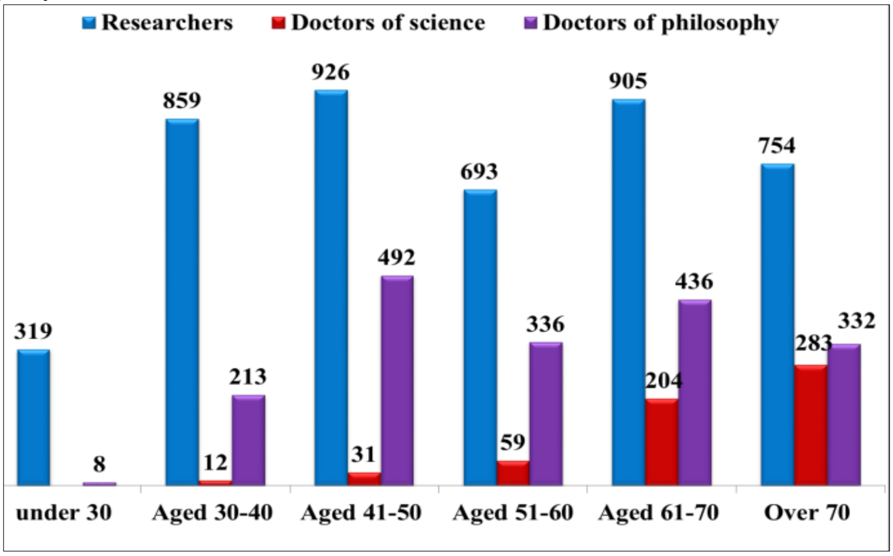

Fig. 2. Personnel potential by age in ANAS and other scientific organizations of the republic

The report indicates 1593 scientific research works to be conducted on 192 problems and 517 topics in scientific institutions and organizations, 152 important scientific results to be obtained, and 60 implementations to be applied in 2022. According to the farm contracts, 105 works were performed, 51 patents, including 6 foreign ones, were obtained. ANAS employees completed the work provided for in 76 grant projects, 29 of which were jointly with foreign scientists, the total amount of which is more than 7 million manats.

In 2022, more than 500 books and monographs, over 9,000 articles and theses, including more than 3,000 published abroad (about 1,000 of them in journals indexed in the "Web of Science" and "Scopus" databases), by scientists of the Academy were published. More than 26,500 citations were made to the works of researchers (Report on the activities of the Azerbaijan National Academy of Sciences for 2022, Volume I; Report on the activities of the Azerbaijan National Academy of Sciences in 2022, Volume II).

As mentioned, different approaches and criteria are used in the evaluation of scientific activity in scientific organizations. The number of works of scientific institutions and individual researchers, specifically the number of works published in scientific journals indexed in well-known international databases such as Web of Science (WoS) and Scopus, citations to them, indicators such as the Hirsch index are currently the most widely used criteria (Collection of reports and speeches on the report of the General Assembly of the Azerbaijan National Academy of Sciences dated March 16, 2023, report, volume III, 2023).

According to the report on the scientific activity of ANAS for 2022, table 3 presents the number of articles published by the scientific organizations of 6 scientific divisions of ANAS in 2022 (including in WoS and Scopus journals), the total number of citations to works and the number per researcher (Report on the activities of the Azerbaijan National Academy of Sciences for 2022, Volume I; Report on the activities of the Azerbaijan National Academy of Sciences in 2022, Volume II; Collection of reports and speeches on the report of the General Assembly of the Azerbaijan National Academy of Sciences dated March 16, 2023, report, volume III, 2023).

The report by the "Scimago Journal and Country Rank" database (an open access portal using data from the Scopus database to evaluate and analyze scientific fields by country) for 2022, ranked Azerbaijan 91st according to the indicators of exact and natural sciences among 233 countries in the world by all scientific fields. Compared to the South Caucasus Republics, Azerbaijan is leading for the natural sciences and exact sciences (Collection of reports and speeches on the report of the General Assembly of the Azerbaijan National Academy of Sciences dated March 16, 2023, report, volume III, 2023; SCImago Journal & Country Rankhttps 2022).

These statistical indicators provide the necessary data for the evaluation and analysis of the activities of scientific organizations. Besides, these indicators play as the main source in monitoring the condition of IP in the field of science and education, predicting the future situation, finding connections between indicators, and providing suggestions and recommendations to relevant state bodies or institutions for making decision. Science and education cannot develop without effective use of IP.

The results of the activities of scientific organizations can be beneficial in conducting theoretical research in the field of IP measurement and evaluation.

Table 3. Some indicators of scientific departments for 2022

Scientific divisions	Number of academic staff	Number of articles		Citations	
		Total	General WoS; Scopus	Total	Total per 1 scientific worker
Department of Physical-Mathematical and Technical Sciences	973	1068	531	15547	16.0
Department of Chemical Sciences	685	403	208	3750	5.5
Department of Earth Sciences	400	90	45	1610	4.0
Department of Biological and Medical Sciences	2687	1992	170	3490	1.3
Department of Humanities	683	2113	10	239	0.3
Department of Social Sciences	766	1456	84	1316	1.8
Total:	6194	7122	1048	25952	4.2

As a result of evaluating the activity of scientific organizations, the following issues can be resolved (Huseynova 2013):

– increasing the efficiency of strategic and practical management mechanisms in the field of science and innovation;

– increasing the efficiency of budget expenditures in the field of science;

– increasing the role of science and innovation in promotion of the national economy competitiveness.

Evaluation of the activity of scientific organizations increases the efficiency of management decisions in the field of science, education and innovation. Taking into account the requirements of the time and the foreign experience, there is a need to develop a general approach and principles to evaluate the activities of scientific organizations in Azerbaijan. To this end, expert methods and a special tool should be used for the evaluation.

7. Conclusion

The research conducted suggested that in developed countries, the evaluation of educational and scientific-technical activities, which are the main elements of IP, was mostly performed on the basis of bibliometric indicators. It should be noted that the most popular electronic resources that collect, systematize and calculate the main bibliometric indicators of science and education in the evaluation of scientific research institutions are Scopus and Web of Science databases. These resources are owned by commercial companies, and access to them is paid and quite expensive. As a rule, universities or research organizations subscribe to the relevant resources. Researchers working in these organizations have the right to access the database through an internal local network.

Evaluation of the publication activity of scientists with bibliometric indicators can be realized through Google Scholar. However, Google Scholar, which has a convenient interface, is not a complete database, and sometimes provides incomplete information.

When aiming at international practices and approaches, it should be taken into account that the state of IP in the field of science and education cannot be evaluated only with quantitative parameters. Reference experience taken from a purely quantitative point of view can, on the contrary, make it quite difficult to get a real picture of the labor efficiency of the currently actively developing science. When evaluating a scientific research institution, a complex system should be established to comprehensively and accurately arrange the hierarchy and ratings of the participants of the scientific process. Quantitative indicators should be only one of the factors in this system. When making decisions, scientific research should be carried out through a multidimensional analysis, taking into account a number of indicators representing various aspects of scientific activity, in view of the quality of the institution and the development stage of the institution.

Systematic studies in this field have not yet been properly conducted. In the field of IP evaluation, it is of great importance to study the main indicators of IP measurement, to study international experience, and to use the models applied in them for Azerbaijan.

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