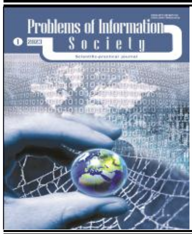


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# Analysis of intellectual potential measurement indicators

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**ABSTRACT**

Intellectual potential is the main resource for development and transformation of society. Assessment of intellectual potential is considered as an important factor in increasing the efficiency of the national economy at the modern stage development of the society of information and knowledge economy. This study is dedicated to the analysis of the existing system of indicators used for the assessment of intellectual potential. The main goal of the work is to study the international experience in the field of intellectual potential assessment and the main indicators of intellectual potential measurement. The article examines the main components of intellectual potential (scientific-technical, innovation, educational and cultural potential) and assessment levels (micro, meso and macro). It analyzes the system of indicators offered by several researchers, developed countries and international organizations for the assessment of intellectual potential. It also interprets the intellectual potential assessment indicators of the of higher educational institutions and informs about the international rating systems used for the world universities ranking. Finally, it highlights the indicators system for the assessment of intellectual potential in Azerbaijan and provides recommendations.

## 1. Introduction

The development of modern society has gradually shifted from the traditional form of economic development to the knowledge economy. Knowledge is the basis of this economy. In the knowledge economy, the intellectual potential (IP) of the population has become the main factor of social, economic and innovative development. The intellectual potential of the population, which is a component of human capital, has long been the object of studies by researchers and practitioners representing various fields of science. Moreover, the interest in studying the intellectual potential of society has increased dramatically at all levels (state, private, research). This is primarily related to the formation and establishment of a new socio-economic construction, i.e., the knowledge society, the main driving force and product of which is the production, dissemination and effective use of scientific knowledge and technologies [1-3].

Note that starting from the 60s of the former century, many notions as “human capital” [4, 5], “human resources” [6, 5], “intellectual capital” [7-10], “intellectual potential” [11-14], etc. were introduced to the economic terminology. Offering the definitions of these concepts, relating them with one another, and determining their essence and role in the socio-economic development of society became challenging for the scientific community. Today, the lack of consensus among researchers about the essence and content of these concepts in scientific sources has led to numerous definitions. Since these concepts are related to the research topic, the next section explains available approaches in this field.

The concept of IP covers not only the thinking process, but also a person’s logical ability, educational level, language skills, overall culture, moral potential and will. Many approaches to the understanding of this term in different contexts (philosophical, social, economic, etc.) are also available [8, 12-14]. Scientific literature views the essence of IP as two main concepts – “intellect” and “potential”. “Potential” (Latin “potential” means power) means existing resources and funds that can be mobilized and activated, the capabilities of an individual, society and the state in a certain area to achieve a certain goal, implement a plan and solve a problem. "Intellect" is a property of an individual (characteristic of an individual determining the probability of mental activity) [12, 15]. Until recently, IP, a combination of two words, has meant only intellectual property, including patents, copyrights, trademarks, and know-how. IP is the property of the population of a certain territory, formed by the complex effect of socio-economic, socio-cultural, educational and scientific factors, which consists of the ability of a person to grasp knowledge, generate it and acquire new knowledge, technologies, products, sustainable expanded and balanced reproduction of national wealth [12]. In the development of modern society, the role of science, education, new technologies, including information technologies, in a word, everything related to IP is increasing, and it determines the efficiency and competitiveness of the national economy. IP is evaluated by researchers as one of the main criteria for the growth of the world economy. Therefore, issues of IP monitoring, measurement, evaluation, analysis, forecasting, management, and providing recommendations on decision support at various levels are of particular importance. In this regard, the government, business institutions, as well as researchers and practitioners has increased attention to this field. International experience shows that effective management of IP is impossible without defining its assessment criteria. The problem of assessing the intellectual potential of organizations, the region and the country in general poses a number of tasks to researchers. First of all, it is vital to determine the factors characterizing the state-of-the-art of IP at different levels, and to create an indicators system reflecting the situation. In this regard, it is important to study the available system of indicators in the evaluation of IP. In general, the system of indicators has become an increasingly powerful tool for the analysis of any sphere of activity (education, science, health, budget, military, etc.), as well as an effective management tool at all levels. The terms "indicator" or "index", used synonymously, are understood as calculated values that unambiguously represent this or that characteristic of the object of monitoring, evaluation, analysis, forecasting or management. Thus, properly selected quantitative indicators and adequate calculation and analysis methodologies allow solving the following three groups of management issues [16]:

- analysis of the situation and assessment of trends;
- evaluation of the activity of systems and structures;
- planning, control and monitoring.

That is, the system of indicators is considered as a powerful control tool, along the implementation of analytical functions. Indicators for evaluation are often determined by higher authorities.

IP assessment is a complex and multifaceted process, both quantitatively and qualitatively. Various researchers (e.g., L. Edvinson, Drucker P., J. K. Galbraith, T. Schulz, G. Becker, F. Machlup, N. Bontis, E. Brooking, C. Swaby, M. Malone, A. Toffler, T. A. Stewart, Russian researchers Leonidova G. V., Levashov V. K., Rutkevich M. N., Stukalova I. B., Doctorovich A. B., Kazakh researchers Turysbekova A. B., Zhangaliyeva K. N., Azerbaijani researchers Muradov A. N., Naghiyev E. etc.) dedicate theit studies to this field. However, questions about IP assessment still remain unsolved.

The main goal of this work is to study the international experience in the field of IP assessment and to study the systems of indicators used for the IP measurement. The goal is to collect and systematize materials as a source for further analysis and evaluation of the formation processes of the intellectual potential of society. To compare the development of different countries (including Azerbaijan), we have to study the common criteria and methodological bases for measuring their IP.

This article analyzed the main concepts on the subject and the existing approaches to understanding these concepts. It highlights the main components of the IP and the evaluation levels. We also review related studies on IP evaluation. Evaluation indicators of IP in science and higher education institutions are explored. The system of indicators proposed by developed countries and international organizations for IP evaluation is considered. Finally, the results of the research are discussed and some conclusions are summarized.

## 2. Basic consepts

As already mentioned in the introduction, many terms related to the subject field are encountered in the course of the study, and it is appropriate to highlight existing approaches to understand some of them. Because even though these concepts are sometimes equated, they have different aspects.

The main provisions of the theory of "human capital" were formulated by G. Becker in the 60s of the previous century and developed by T. Schultz [4, 5]. They used the term "human capital" to refer to all the physical and intellectual abilities (knowledge, skills, know-how, competence, etc.) of human resources available for economic production. According to this concept, a person receives income from his knowledge, skills, basic experience, that is, everything that is the intellectual characteristics of an individual.

The concept of human resources (HR) related to management issues were proposed by Raymond Miles [6]. HR theory declares that all workers are a warehouse of unexploited resources, and these resources include not only physical skills, but also creativity and the capacity for responsible, self-directed behavior. HR theory uses the term "human resources" as a general notion for the strategies, tactics, and objectives used by business owners and managers to accomplish employee policies and procedures. Recently, the studies dedicated to the issues of optimal management of human resources in the electronic state environment are noteworthy [17, 18].

Intellectual capital (IC) is the total value of all intangible assets of the organization [8]. This includes, but not limited, human capital. Various definitions of HC have been given in studies, but there is still no standard definition for it. [19] broadly reviews existing approaches to understanding of HC and classifies them. In general, most definitions show that HC is a non-monetary asset without any physical essence, but has value or is a set of intangible objects applicable in economic activity and bringing income to the owner. [9, 10] present HC as "market assets, human-oriented assets, intellectual property assets and infrastructure assets". T. Stewart defines an intellectual capital as an "intellectual material that can be used to produce wealth, i.e., knowledge, information, intellectual property, and experience" [7]. Another source [20] states that "HC is knowledge that can be turned into profit."

Interest in understanding the essence of the concept of "intellectual potential of the population" has increased since the middle of the 20th century, since there is an urgent problem of raising the IP of the population in the knowledge-based economy. The reason is the presence of the above-mentioned theories, as a labor potential, knowledge economy, human capital, etc. IP is known as the concept of further development of intellectual capital using certain principles [11]. The concept is a tool for strategic management of an organization's non-material assets to increase its long-term profitability.

Edvinson et al. believe that IP should be defined as "the possession of knowledge, applied experience, technologies, customer relationships, and professional skills providing a competitive advantage in the marketplace" [8]. IP "should represent the development level of two closely related areas of the intellectual life of society, that is, the situation of science and education in a generalized form" [14]. [21] defines IP not only as a measure of human intellectual abilities to generate new knowledge, but also as a measure of business efficiency. [22, 23] present IP as the value of non-material assets collected by the company. David P.A., in his study, explains IP as intellectual material consisting of knowledge, information, logical property and competence that can be used to create wealth [23]. In [24, 25], the authors describe IP in terms of human capital and structural capital.

Human potential (HP) is a systematic set of physical and intellectual qualities (including abilities) ensuring the life activity of an individual, social group or society. When we analyze the concepts of "human potential" and "intellectual potential", we see that these concepts are similar, and since the first is more general, the latter is included in the first. Moreover, since "human potential" contains the main features of "intellectual potential", the methods for the examination of their analytical components should be related to each other [13].

## 3. The main components of intellectual potential and assessment levels

In scientific literature, the IP is often composed of three (science, education, innovation potential), sometimes four (science, education, innovation, cultural potential), and even five (science, education, cultural, health, information potential) structural components [12]. All of these groups include scientific-technical and educational components. [12, 26, 27] present the structure of IP consisting of four components is as in Fig. 1.

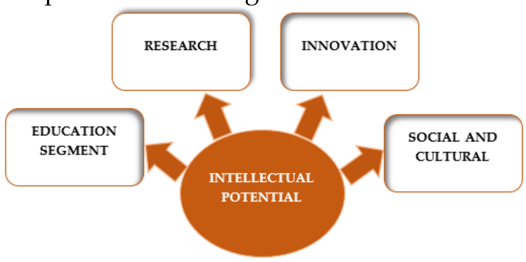


**Fig. 1.** Structural components of intellectual potential

[26] characterizes the main components of IP as follows:

1. Scientific and technical potential is a set of

scientific knowledge, results of scientific and technological activity, results of scientific researches achieved at different stages of the scientific and technical period, various innovations and high-tech production complex, unexploited reserves of new technologies and scientific and technical base.

2. Innovation potential is the process of turning scientific knowledge into a new product, technology or service, as well as implementing a complex of management, organizational and economic measures ensuring innovation in various fields of activity. The main driving force of innovative potential is a person who is capable to think creatively and develop ideas.

3. Educational potential involved in the generation and use of knowledge consists of several components such as, development trends in the educational system in the country; quality of vocational education; systems of requalification of specialists for improvement; motivation in self-development.

4. Cultural potential is realized through activities aimed at the spiritual development of a person and society. The result of such activity is new ideas, new knowledge and moral values to produce spiritual culture.

5. Health potential is the level of health condition expressed by life expectancy.

The research shows that the assessment of IP is implemented at different levels. In [12], the author distinguishes three levels of IP assessment (micro - individual, meso- organizational, macro - national or country) (Table 1). As Table 1 illustrates, each assessment level has its own indicators.

**Table 1.** Assessment levels of intellectual potential

| Individual (micro) | Organizational (meso) | Country (macro) |
|---|---|---|
| - level of edication;<br>- knowledge sourcec;<br>- attitude to edication knowledge;<br>- assesment of human creative activity;<br>- attitude to creative activity (investion). | - level of edication, vocational training and additional training;<br>- salary rates of employees;<br>- combination of existing intellectual assets (intellectual property, knowledge base;<br>- management ability (ideology, formal and informal relations within the company and with the external environment);<br>- organizational development level (information carriers and its dissemination methods);<br>- information elements (availability of information systems in the company and efficient information flow) and innovation potential of company employees. | - general education level of employ population (average number of years edication);<br>- share of students in the population;<br>- share of education cost in the Gros Domestic Product (GDP);<br>- number of people with a scientific degree;<br>- specific weight of those working in the field of science and scientific services;<br>- share of R&D (Research and Development) costs;<br>- number of doctoral students per 10,000 people;<br>- number of patent applications for inventions;<br>- - share of Information Communication Technologies (ICT) costs in GDP;<br>- share of enterprises using ICT;<br>- share of enterprises with a website on the Internet;<br>- publication of research results;<br>- reference index of works, etc. |

The studies in [28, 29] are conducted at the macro level, in [30, 31] - at the meso level, and in [32] - at the individual level. Note that there are evaluation methodologies using different indicators at the international level. The measurement system of society's IP is developed on the basis of available reliable sociological and statistical data. Indicators of two main areas are considered for the metrics: science and education, which directly represent the IP of the whole society. The development index of a society's IP is conceptually the most important component of a more general indicator called the human development index (HDI). The HDI has been calculated annually at national and regional levels since its introduction in 1990. Switzerland, Norway, Iceland, China and Australia share the 1st-5th positions in the human development ranking of 191 countries according to HDI. Azerbaijan is ranked 91st [33].

[3] distinguishes two main features for measuring the IP of society: science and education. The measurement of educational potential is achieved by three indicators: 1) the general education level of the "mature" (elderly) population (representing the main part of the population who have completed their studies in educational institutions and are employed); 2) number of university students (per 10 thousand population); 3) the share of education costs in GDP. Consequently, the educational potential index is calculated as the average value (EP) of these three indicators:

$$EP = \frac{e_1 + e_2 + e_3}{3} \, .$$

Here, $e_1$ - denotes the general education level of the "mature" population, $e_2$ - the specific weight of students in the total population (the number of students per 10,000 people), and $e_3$ - the index to show the share of education costs in GDP.

Two following indicators are used to measure the scientific potential: 1) the share of personnel working in the field of science and scientific services; 2) the share of scientific costs in the gross national product (GNP). The scientific potential index characterizing the general scientific potential of the country is also calculated as the average value (SP) of these two indicators [3]:

$$SP = \frac{s_1 + s_2}{2} \cdot$$

Here, $s_1$ - denotes the share of personnel working in the field of science and scientific services, $s_2$ - the share of scientific costs in the GNP. IP is denoted as the average value of the sum of educational potential (EP) and scientific potential (SP).

$$IP = \frac{EP+SP}{2} \cdot$$

## 4. Related studies

IP is the main driving force of a new type of economic development. Initial studies on the evaluation of IP can be found in the studies of the American scientist and economist Drucker P. His assessment methodology includes three indicators [34]:

- assessment of the institutional regime that helps motivate the efficient mobilization and distribution of resources, stimulation of creativity, generation, dissemination and use of new knowledge;
- availability of educated and qualified personnel capable to constantly improve and adapt their skills for the generation and efficient use of new knowledge;
- efficiency of innovation system of companies, research centers and universities.

Approaches to IP evaluation based on the number of publications, patents, and R&D funding have also been offered by researchers [35, 36]. [37] proposes a more rigorous method based on five components (human capital, market capital, organizational and technological capital, material capital and financial capital) to evaluate the IP of the region. [13] presents a new methodology for calculating the development index of IP. Note that the proposed approach is adequate to the HDI evaluation methodology at the international level.

Japanese researchers Niwa F. and Tomizawa H. present methods by performing structural analysis and integration of a large number of quantitative indicators for the general evaluation of national scientific and technological activity in 5 countries (USA, Japan, Germany, France and Great Britain), that is the number of bachelor's degrees in engineering, the number of R&D scientists and engineers, research-technical budget of the government, total domestic cost on R&D, technology import and export (amount of payment to countries for technology rights), number of scientific articles, number of scientific citations, number of domestic and foreign patents, etc. [38, 39]. This methodology uses multivariate factor analysis to investigate the structure of the selected indicators and principal component analysis methods to integrate the indicators. Principal component analysis constructs a new integrated variable using a small number of integrated variables. Finally, the science and technology performance of each country is described using the achieved integrative variable.

Frank Pfetsch, a scientist from the University of Heidelberg, Germany, proposes mathematical formulas for measuring the current development level of the national science and technology potential using income per capita and population size indicators. The main goal of the study is to apply the proposed formulas to different regions and countries of the world and to provide a comparison of the ranking of different states or regions [39].

[40] compares the literature (articles) and patent indicators (in relation to academic and other public research) on telecommunications R&D in Germany at the national (macro) level and the institutional R&D actors at the micro level. Furthermore, it summarizes the international views on related technometric and trade indicators.

[41] analyzes the dynamics and regional characteristics of IP as indicators of sustainable economic growth and living standards of the population in the European Union (EU) countries. The research group consists of the population with higher education, as well as entrepreneurial activity and the required professional competences. In order to identify the factors affecting IP, the research uses an approach that allows distinguishing the potential of human resources from intellectual capital. Primary statistical indicators to assess the factors characterizing IP are selected: number of employed population with high education, managers, professionals, technical and support specialists with high education, employed ICT specialists with high education, overall R&D workers, researchers, etc.

[12] presents a system of indicators used to evaluate the educational, scientific and innovation

components of IP (Table 2).

Other study presents a system of indicators (Table 3) used to evaluate the educational, scientific potential, and innovation components of IP [26].

**Table 2.** Indicators for educational and scientific innovation potential evaluation

| Indicators |
|---|
| **Educational potential**<br>- number of university students per 10,000 economically active population;<br>- number of students of secondary educational institutions per 10,000 economically active population;<br>- share of educational expenses in GDP, in %. |
| **Scientific and innovation potential**<br>- - share of R&D expenses in GDP, in %;<br>- - number of scientists and engineers per 10,000 people;<br>- - number of patent applicants per 1 million people;<br>- - number of personal computers per 100 families. |

**Table 3.** Indicators for IP components evaluation

| Indicators |
|---|
| **Educational potential**<br>-share of students receiving full-time education;<br>- specific weight of students receiving part-time education;<br>- share of those studying in requalification and professional development courses, that is, the share of young people as a reserve for the increase of intellectual labor specialists in all spheres of society. |
| **Scientific potential**<br>- number of doctoral students per 10,000 people (an indicator of targeted training of scientific personnel);<br>- number of people engaged in scientific-research and experimental-constructive work per 10,000 people (indicator of the volume of employment in scientific research);<br>- the share of domestic R&D expenses in relation to the total regional product (an indicator of the intensity of scientific research). |
| **Innovation potential**<br>- number of patent applications submitted for inventions;<br>- number of patent applications submitted for utility models. |

[42] offers an integral indicator using four block indicators (scientific-technical, scientific, educational, communication potential): a methodology for evaluating the region's scientific-technical potential index. The proposed methodology allows to analyze the state of the scientific and technical potential of the region, to assess the realization scale of the scientific and technical potential in the considered area, to identify the problems, and to form the trend of the scientific and technical development of the region.

**Indicators for evaluating the intellectual potential of research and higher education institutions.** Currently, the state-of-the-art and development of modern higher education institutions, that is universities, are actively discussed as one of the main factors affecting the level and pace of socio-economic growth of countries. The intellectual potential of the university (IPU) is a set of skills of employees and students of the higher education institution. IPU has a number of specific features. First, higher education is a highly intellectual area of the economy. Second, the IPU consists of the interaction of the intellectual resources of the subjects and objects of scientific and educational activities, as well as the resources of the university's strategic partners. Thirdly, the structure of the IPU is related to the characteristics of the product produced by the university [12, 26, 43].

[43] classifies the composition of IPU by three main components:

- intellectual potential of scientific workers and teachers;
- intellectual potential of students at all levels of education (bachelor's, master's and doctoral students);
- IP of the university, including its intellectual property in the form of non-material assets, marketing and infrastructure assets.

[44] presents the following system of indicators to measure IPU (Table 4).

Another study uses the following indicators to evaluate IPU [45]:

**Table 4**. IPU evaluation indicators

| Indicators |
|---|
| *Intellectual potential of the university's teaching staff* |
| ▪ number of doctors of sciences;<br>▪ total number of professors and teachers aged from 30 to 49;<br>▪ persons educated in leading research and university centers of the world. |
| *Intellectual research potential of the university* |
| ▪ number of articles in scientific journals indexed in Web of Science, Scopus databases;<br>▪ income from R&D works;<br>▪ number of master's and doctoral students defending their dissertations;<br>▪ number of intellectual property objects registered in accounting;<br>▪ number of small innovation enterprises;<br>▪ share of R&D in total R&D, in %;<br>▪ number of scientific laboratories and departments equipped with high-tech equipment;<br>▪ income from R&D works within international scientific programs. |

• *personnel potential* (total number of educational institution employees; total number of scientific employees; specific weight of scientific and pedagogical employees with PhD and Doctoral degrees in the total number of scientific and pedagogical employees, etc.);

• *scientific and technical potential* (number of publications in journals indexed in Web of Science, Scopus, РИНЦ databases per 100 scientific and pedagogical workers of the organization; total volume of R&D works);

• *information potential* (number of scientific journals, including electronic journals published by the educational institution; presence of an electronic library, distance education system; share of personal computers with Internet access; total number of publications per 100 scientific and pedagogical workers; income achieved from beneficial activities per scientific and pedagogical staff of the educational institution);

• *resource potential* (total area of buildings; area of academic and laboratory buildings; area allocated to research units; number of personal computers);

• *organizational potential* (number of dissertation councils; average salary of teaching staff and scientific workers, etc.).

[32] considers the evaluation of IPU according to four criteria. Table 5 presents the system of indicators for the intellectual potential of personnel and intellectual scientific potential criteria.

**Table 5.** System of indicators in the IPU evaluation model

| Indicators | |
|---|---|
| **Intellectual potential of university personnel** | **Intellectual scientific potential** |
| ▪ number of doctors of sciences;<br>▪ number of professors;<br>▪ number of doctors of sciences and professors aged under 50;<br>▪ number of PhD;<br>▪ number of PhDs aged under 30;<br>▪ number of members of foreign academies;<br>▪ number of laureates of state awards;<br>▪ number of laureates of state knowledge;<br>▪ number of honorary doctors of other universities. | ▪ number of dissertation boards;<br>▪ number of defended doctoral theses;<br>▪ number of defended PhD theses;<br>▪ number of scientific laboratories;<br>▪ number of laboratories with industrial or interuniversity status;<br>▪ number of scientific workers;<br>▪ number of scientific workers with a scientific degree;<br>▪ number of scientific workers, members of academies;<br>▪ volume of completed scientific works;<br>▪ received authorship certificates;<br>▪ printed monographs;<br>▪ number of state awards received for scientific works;<br>▪ monographs published abroad. |

The indicators of scientific activity of universities determine its competitiveness in the market of educational services, which is one of the main criteria for determining the ranking of universities by both national and international organizations. It should be noted that various international rating systems (ARWU, THE, QS, Leiden, etc.) are available for ranking the world universities.

The Academic Ranking of World Universities (ARWU) was first published in 2003 by Shanghai Jiao Tong University. Since 2009, the Academic Ranking of World Universities has been using six indicators. Criteria include the number of alumni and collaborators who have won Nobel Prizes and Fields Medals, the number of highly cited researchers selected by Clarivate, the number of articles published in the journals Nature and Science, the number of articles indexed in the Web of Science

Expanded Science Citation Index and the Social Science Citation Index, as well as the academic indicators of the institution per capita. According to the ARWU methodology, Harvard, Stanford and Massachusetts Institute of Technology led the academic ranking in the evaluation of 2500 universities in 2022 [46].

The Times Higher Education World University Rankings (THE), which was launched in the UK in 2010 and deserved the trust of by students, academics, university leaders, industry and governments, groups indicators into five areas: teaching, research, knowledge transfer, international perspectives and industry revenues. THE is a system aimed at providing evaluation of universities using a total of 13 sub-indicators for these groups. It should be noted that the ranking table of 1799 universities from 104 countries for 2023 has already been prepared. Oxford, Harvard, Cambridge, Stanford and Massachusetts Institute of Technology share the top five positions in this table according to the applied evaluation methodology. Baku State University, Azerbaijan State University of Economics, Azerbaijan University of Architecture and Construction, Nakhchivan State University, Caucasus and Khazar private universities are ranked 1500 in this list with low scores [47].

Another prestigious international QS World University Rankings system evaluates universities on six criteria, as academic reputation - 40%; reputation of the employer - 10%; rate of citations to publications by the professor-teaching staff of the university (citations by faculty) - 20%; faculty/student ratio – 20%; share of foreign students – 5%; share of foreign teachers - 5% [43, 45]. Quacquarelli Symonds (QS) is a British company specializing in the analysis of higher education institutions worldwide. In 2023, the Massachusetts Institute of Technology of the United States is leading the ranking table of the QS system among 1400 universities in the world, being followed by Cambridge, Stanford, Oxford, and Harvard universities. Baku State University and Azerbaijan State University of Economics are ranked in last position in this list [48].

Comparative analyzes suggest that in all three rating systems of higher education institutions, the US and UK universities are leading by all indicators.

Experience of developed countries. Today, the biggest asset of any country is its IP. From this point of view, the problem of IP assessment has attracted the attention of industrially developed countries, and a number of programs and projects in this field have been implemented in different states. In general, scientific and technological indicators are the main resources for the systematic determination of scientific and technical activity based on objective, quantitative data. The situation in some developed countries in this field are viewed below.

**USA.** Since the 1960s, the United States has been actively involved in international projects to provide basic information about how the US education system is more effective than the education systems of other countries. These projects are the International Indicators of Education Systems (INES) project in the Organization for Economic Cooperation and Development (OECD); Trends in International Mathematics and Science Studies (TIMSS); Program for International Student Assessment (PISA) etc. The National Center for Education Statistics (NCES) report for 2022 approved by the Congress provides key indicators and international comparisons on the status of education at all levels, from kindergarten to high school, as well as labor force outcomes in the United States. The report provides in-depth analyzes of annually updated key indicators that are of interest to the education system, politicians, researchers and the public. Here, the system of educational indicators is organized in five sections: family characteristics; primary, secondary education; high education; population characteristics and economic outcomes; international comparisons. In the indicator system, 88 indicators are presented, including 23 indicators on crime and security topics. The statistical data in the indicators are collected from a variety of sources (primary and secondary schools, state education agencies, colleges and universities) using surveys and administrative documents. The Science and Engineering Indicators report is prepared by the National Center for Science and Engineering Statistics (NCSES) according to the law of the National Science Foundation (NSF) of the National Science Council [49, 50]. Quantitative indicators provide information on the status of the US science and engineering (S&E) enterprise over time and in a global context. The report shows that the US science, technology, engineering and mathematics (STEM) workforce accounts for 23% of the total US workforce.

**Russian Federation.** Starting from 2007, the system of indicators jointly developed by the Ministry of Science and Education of the Russian Federation, the Ministry of Education of the Russian Federation, the Federal State Statistical Service and the Higher School of Economics is published in the statistical collections of science and education [51, 52]. Education indicators are grouped in the collection as follows, and the indicators for each group are described in certain sub-indicators [51]:

- educational potential of the population (educational level of the population aged over 15 by gender, educational level of the population aged 25-64 by age and gender, etc.);
- participation of the population in lifelong education (involvement in lifelong education of the population aged 25-64 by gender, involvement in lifelong education of the population aged 25-64 by the education level, etc.);
- digitization of education (personal computers used for educational purposes in higher education institutions, use of existing software tools for students in higher education institutions, etc.);
- education and labor market (level of employment and unemployment depending on the education level of the population, etc.);
- financing of education (education expenses, etc.) etc.

Collection of scientific indicators is dedicated to various aspects of the development of science and innovation in the Russian Federation. Statistical information is given based on indicators about the composition of the organizations performing scientific research and experimental-constructive works, personnel and financing of science, its material and technical base. Moreover, intellectual property, commercialization and use of technology, innovation, etc. are discussed in separate sections. The most important indicators are grouped as R&D are research funding (share of research expenses in GDP, funds allocated to citizen science from the federal budget, etc.), scientific personnel (number of researchers, number of young researchers, etc.), material and technical base of science (cost of equipment and devices used in research), result of R&D (number of Russian publications in scientific journals indexed in Scopus and Web of Science, number of patent applications filed by residents for inventions in the country and abroad, etc.), public opinion about science and technology (majority of the country's population believes that the development of science and technology is an important condition), science in the Arctic zone (number of organizations and researchers conducting research and development in the Arctic zone of the Russian Federation, total amount of research expenses, etc.) [52]. These statistical collections serve as the main source for monitoring the status of intellectual potential both in the field of education and science across the country, identifying trends, predicting future processes, finding correlations among indicators, providing suggestions and recommendations to decision-makers with feedback on the e-government platform.

**Japan.** Japanese first science and technology indicator system was published in 1991 by the National Institute of Science and Technology Policy (NISTEP). Initially, NISTEP reviewed the structure of the indicator system every three years. Since 2009, it has been annually publishing the "Japan Science and Technology Indicators" based on objective and quantitative data every year. NISTEP not only publishes science and technology indicators, but also conducts relevant surveys and studies. The Japan Science and Technology Indicators report for 2021 covers five categories: R&D expenditures, R&D researchers, higher education and R&D personnel, R&D results, and scientific and technological development and innovation. Each of the categories reflects the situation in Japan using multiple related indicators. The report, published in 2021, found out that the United States (92,000), followed by China (61,000) and Germany (28,000) had the newest doctorates compared to 2000 by country. In Japan, this figure was 15,000. Compared to 2010, there was a slight decrease in the number of new doctors in Japan, while the number of articles was stable (65,742). This results in the decrease of the country's rating. China ranks first in the world for the number of articles [53].

The Japanese government proposes a methodology for the integral assessment of the country's scientific and technical potential. The proposed methodology uses eight main indicators comprehensively characterizing the resource capabilities and the results of the use of scientific and technical potential [54, 55]:

- number of scientists and engineers working in the field of scientific and technological development;
- national expenses on science;
- number of patents registered in the country;
- number of patents registered abroad;
- volume of technology trade (in terms of value);
- volume of export of science-intensive products;
- added value in processing industry;
- volume of technology exports.

**Germany.** German education policies and measures aim to provide students with a concept of "good education". The main indicators of the German education system are participation in early childhood education (from aged 3 to the age of starting compulsory primary education); early leavers from education and training (aged 18-24); higher education level (aged 25-34); Government expenditures on education in proportion to GDP, etc. In 2021, 41.2% of aged 25-34 got a high level of education, keeping on to reach the EU's 2030 target of at least 45% [36]. As the report of the World Bank shows, payments for the use of intellectual property, high technology exports, patent applications, R&D expenses, researchers in R&D, scientific and technical journal articles, technical specialists in R&D are used as indicators of science and technology in this country [56, 57]. According to the EU's 2021 Education and Training Monitor, the level of higher education in most OECD countries has increased significantly over the past two decades. Between 2000 and 2021, the share of those with higher education aged 25-34 in Germany increased by 14% accounting for 36%.

Studies show that IP, which is one of the main factors of the country's development and competitiveness, and its assessment are also in the focus of international institutions. There is a system of indicators and evaluation methodologies used by each of these institutions.

**The United Nations Development Program** (UNDP) uses the following indicators for the Human Development Index (HDI) and the Development Index of Intellectual Potential (DIIP) presented in 1990 [33].

Human Development Index:

- life expectancy;
- expected years of education;
- years of secondary education;
- gross national income (GNI) per capita;
- gross national income.

Intellectual Potential Development Index:

- average education period of the employed population;
- complete coverage of primary, secondary and higher education;
- number of graduate students per 100,000 employees;
- number of employees in research and development per 100,000 employees;
- share of internal research and development costs in GDP, in % [33].

In general, there is no generally accepted methodology for calculating IP of regions or countries. The HDI calculation methodology developed under the auspices of UNESCO can be accepted as a standard in this field. Based on this methodology, HDI evaluations are indicated by: low (<0.550), medium (0.550-0.699), high (0.700-0.799) and very high (≥0.800) scores. In the evaluation of countries by HDI, Norway is ranked the first with 0.957 scores, Ireland - the second with 0.955 scores, and Azerbaijan - the 88th in this list with 0.756 scores [HDI].

**World Bank.** Although the concept of human capital or human resources was proposed by Adam Smith in 1776, it was official two centuries later by Becker (1962). Since then, the role of human capital in economic development has been studied in the literature. For decades, human capital has been associated with education. This is true even for the most popular measure of human capital today, i.e., the United Nations HDI [58, 59, 60].

The World Bank's Development Indicators cover a period of more than 60 years starting from 1960. Worldview frames global trends with indicators on population, population density, urbanization, GDP and GDP indicators. As in previous years, Worldview online tables present the world economy and indicators measuring progress towards improving lives, achieving sustainable development, providing support to vulnerable populations and reducing gender inequality. "Knowledge for Development" (K4D) proposes the following indicators for the knowledge index within the framework of the special program [58]:

- Education index (percentage of literacy of the mature population; percentage of the population with secondary education; percentage of the population with higher education);
- Innovation index (revenues from the sale of patents, licenses, etc.; number of applications for patents and trademarks; number of scientific and technical articles in specialized journals);
- Information and communication technologies index (number of phones and computers per 100 people; number of active Internet users (100 people))

The World Bank evaluation of the human capital index rans Singapore the first with 0.88 scores, Hong Kong - the second with 0.81 scores, Japan - the third with 0.80 scores, South Korea - the fourth with 0.80 scores, Canada - the fifth with 0.80 scores and Azerbaijan – the 83rd with 0.58 scores [58, 59, 60].

**The Organization for Economic Co-operation and Development** published "Canberra Manual" on the measurement of human resources dedicated to Science and Technology in 1995. The OECD, organized by 26 developed countries trying to promote economic growth and development in the world, uses the following indicators in the assessment of scientific and technological activity:

- availability of qualified workforce;
- education level of employees;
- literacy rate;
- admission rate to higher education institutions;
- public expenditure on science and education, etc. [61].

The European Commission proposes the following indicators for the evaluation of IP on innovation

potential [45]:
- number of patents, publications;
- availability of public projects, license and patent revenues from abroad;
- innovation costs non-related to R&D.

## 5. Research results and discussions

As a result of this research, we can say that education, science, technology and innovation play a big role in the rapidly changing world. The emergence of new sectors of the economy and the recognition of the main role of knowledge in their development have led to the emergence of the concept of the knowledge economy. Intellectual potential is the basis of the development of this concept. The system of higher education and scientific research plays an important role in the development of the country's intellectual potential. By monitoring the state-of-the-art of intellectual potential both in the field of education and science across the country, the system of indicators plays the role of the main source in monitoring, analyzing, determining trends, predicting processes, finding dependencies between indicators, providing suggestions and recommendations to decision-makers through e-government platforms.

The analysis of the criteria for measuring the intellectual potential of some developed countries and separate international organizations and the evaluation methodologies they propose have urged us to the conclusion that there is a need to conduct research in this field in Azerbaijan.

The main indicators reflecting the situation and level of development of education, science, and culture in the Republic of Azerbaijan are given based on the statistical collection of the Azerbaijan State Statistics Committee (by various years, including 2020-2022). The education section includes information on pre-school, extra-curricular, general, vocational, secondary and higher education institutions, as well as doctoral studies. The science section includes information on the number and composition of institutions and employees conducting scientific research and development, the volume of performed scientific and technical work, the expenditures on research and development, and the main resources used in research and development. The culture section publishes information on public libraries, club institutions, museums, theaters, concert organizations, cinemas, circus, zoo, culture and recreation parks (Table 6) [63]. The following indicators are crucial in IP evaluation.

The results of the study can be useful in conducting theoretical research in the field of IP measurement and evaluation. The development of IP assessment methods and approvals across the country is the subject of future research.

**Table 6**. IP evaluation indicators in Azerbaijan

| Indicators | | |
|---|---|---|
| **Educational potential** | **Scientific potential** | **Cultural potential** |
| ▪ education level of the population (per 1000 people aged 15 and over)<br>▪ number of general educational institutions;<br>▪ number of secondary specialized educational institutions;<br>▪ number of vocational training institutions;<br>▪ number of higher education institutions;<br>▪ number of students in higher education institutions;<br>▪ number of professors and teachers in higher education institutions (main staff);<br>▪ expenditure on education from the state budget (3092.2 million manats);<br>▪ number of computers;<br>▪ e-learning etc. | ▪ number of research and development organizations;<br>▪ number of staff engaged in research and development;<br>▪ number of academicians;<br>▪ number of corresponding members;<br>▪ expenses on science from the state budget (151.8 million manats), etc.<br>▪ internal costs on research and development (194.2 million manats);<br>▪ basic funds used in research and development (142.2 million manats);<br>▪ number of use of cloud services, etc. | ▪ number of public libraries;<br>▪ number of library users;<br>▪ number of professional theaters;<br>▪ number of theater visitors;<br>▪ number of museums, thousand people;<br>▪ number of museum visitors;<br>▪ number of on-line libraries;<br>▪ number of online library visitors, etc. |

As a result of the research, the following recommendations are drawn for the measurement of IP in Azerbaijan:

- first of all, international experience in IP assessment should be studied;

- appropriate indicators should be selected for Azerbaijan;

- based on the new challenges of the time, the system of indicators should be improved (new indicators should be added);

- formation of an information resource ensuring evaluation;

- monitoring based on information resource;
- a new indicator system should be created based on the existing information system;
- development of usage mechanisms;
- development of evaluation methodology using artificial intelligence, etc.

## Conclusion

The conducted studies suggest to conclude that the development of science and education today cannot be carried out without the effective use of IP. There are various conceptual approaches in the scientific literature to understand the essence of the concept of "intellectual potential", which is extremely complex and multifaceted. Research suggested that multiple indicators are needed to adequately quantify IP. In developed countries, efforts are being made to establish a system of indicators to measure educational and scientific-technical activity, which are the main elements of IP. As mentioned above, there is a large number of indicator systems proposed by individual countries and international organizations in the field of measuring intellectual potential. However, statistical methods applied to IP analysis and evaluation are not sufficient. In recent years, scientists have focused on the issues of effective use of IP in the national economy, but today there is no unified opinion on the methods of IP evaluation. Therefore, in order to improve the efficiency of the national economy, it is necessary to develop the mechanisms of using IP. Intellectual potential should be developed not only at the level of formal higher education, but also through non-formal education, which requires further development as a trend for future employment.

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