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Strategies for Global Sustainable Development in the Context the Fourth Industrial Revolution (Industry 4.0) and Transformation of the Science and Knowledge System

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Abstract. The article highlights one of the leading goals of scientometric indicators and data in the context of internationalization of higher education and scientific institutions – inclusion of the greatest possible number of relevant scientific communities, teams of scientists, the Fourth Industrial Revolution (Industry 4.0), researchers and their scientific works, developments, innovations in the international, global scientific and educational systems, and rating them according to certain objective indicators. The emergence of scientometric bases (systems, platforms) is a natural phenomenon in the development of society as an attempt to measure something that, on the one hand, is abstract, and, on the other hand, is characterized by certain quantitative features as a result of deep analysis. Scientific research leads to the accelerated development of technologies; therefore, at a certain stage it became necessary to evaluate, that is, to measure the importance of a scientist's research contribution to the development of a certain field of research. Since this need was felt in different countries with a relatively small time difference, various scientometric technologies were invented and developed.

INTRODUCTION

Global Systemic Institutional Transformations in the Context of the Needs of Sustainable Development the Fourth Industrial Revolution (Industry 4.0), of Society and Higher Education and Science

The revolution in technological processes, in turn, is the cause of significant shifts in the hierarchy of the nation, the prerequisite for which is institutional transformations for the sustainable development of society in the context of internationalization of higher education and science [1].

A country's place in the modern world today is increasingly determined by quality of human capital, state of education and degree of using science, education and technology in production.

The wealth of labor force and raw materials can be considered less and less as a competitive advantage as the share of these factors in creating the value of all products is decreasing. Because of this irreversible development, it

appears increasingly likely that developing countries can succeed solely on the basis of their minerals and, accordingly, cheaper labor [2]. However, this process is still far from identical to real universalization of the global community.

In other words, in addition to certain realities of globalization, institutional transformations for the sustainable development of society and the Fourth Industrial Revolution (Industry 4.0) in the context of internationalization of higher education and science, equally real trends of regionalization, dissociation, and even asocialization coexist in the world.

When studying social future and institutional transformations for the sustainable development of society and The Fourth Industrial Revolution (Industry 4.0) in the context of internationalization of higher education and science, the emphasis should be placed equally on the analysis of values and on the analysis of social institutions, which will allow understanding the real mechanisms of practical construction of a new society taking into account globalization processes.

Turning to the immanent content of the problems of institutional transformations for the sustainable development of society and The Fourth Industrial Revolution (Industry 4.0) in the context of internationalization of higher education and science, it should be noted that scientific reflection has always been present in the depths of globalist knowledge in a decisive way, since the discovery of its content has been connected with the discovery of understanding the unity of natural and social being, and within the latter, the unity of educational-scientific, political, economic, etc. existence. Such unity implements the target function and provides a controlling influence in relation to society in the form of practical-transformative activity or social, economic and political power over space.

In today's conditions, the "contradictions of globalism and imperialism" cannot be reduced to general formulas, such as "universal contradictions between labor and capitalism", and even more so cannot be resolved by them.

Therefore, the main goal in this context is to analyze the state of research of the perspectives and strategies for sustainable development of society in the processes of institutionalization of the world global system as a whole and multi-level sphere of interaction of economies, societies, states, social institutions, cultures, peoples, nations, worldviews and people in the context of internationalization of educational and scientific space for the purpose of developing theoretical and applied tools.

The obtained and presented results will enable the further complex and sectoral development of various aspects for sustainable development of society, internationalization of science and higher education systems in the conditions of institutional globalization, the Fourth Industrial Revolution (Industry 4.0), the appropriate methodology not only within the limits of individual scientific directions and educational disciplines, but also at the level of general scientific, philosophical and educational and pedagogical, socio-philosophical and socio-economic, political and public management analysis, may be used in developments in the fields of social, pedagogical, political, economic sciences, public administration.

METHODS

Scientometric Systems as the Basis for Scientific, the Fourth Industrial Revolution (Industry 4.0) and Educational Internationalization

In order to identify position and improve scientometric indicators, which are used to quantitatively evaluate and compare authors and scientific institutions' scientific activity, it is necessary to publish works in foreign and domestic journals included in known scientometric databases, to register and create authors' profiles in international scientometric systems.

Scientometric indicators are indices of authors or organizations' publication activity, significance of publications depending on the scientific weight of the journal, etc. It is a tool for assessing quality of scientific work, influence of a scientist, scientific periodicals, possibility of attracting the best scientists to cooperation in certain areas or on a certain topic, forming the scientific image of a scientist and his or her demand in a particular scientific field. They are used to assess the state and prospects of scientific research activities of authors and organizations, their comparison and ranking in various ratings.

The purpose of scientist identifiers is to connect scientists and their various research and innovation achievements. For this, a scientist has to create profiles and register in ORCID, Google ScholarID, ResearcherID, and preferably in social scientometric networks LinkedIn, Researchgate, Academia.edu, etc. If a scientist has

publications in scientific periodicals that are part of the Scopus scientific reference database, a corresponding ScopusID profile is created.

The emergence of scientometric bases (systems, platforms) is a natural phenomenon in the development of society as an attempt to measure something that, on the one hand, is abstract, and, on the other hand, is characterized by certain quantitative features as a result of deep analysis. Scientific research leads to the accelerated development of technologies; therefore, at a certain stage it became necessary to evaluate, that is, to measure the importance of a scientist's research contribution to the development of a certain field of research. Since this need was felt in different countries with a relatively small time difference, various scientometric technologies were invented and developed [3, 4, 5, 6, 7; 8].

In order to increase scientometric indicators, according to which quantitative assessments and comparative analysis of the scientific activity of authors and scientific institutions are carried out, it is necessary to publish works and results of studies in foreign and domestic journals that are included in known scientometric databases, to register and create authors' profiles in the international scientometric databases.

RESULTS

Problematic Aspects of Developing Scientometric Systems in the Educational and Scientific Space of Developed and Transitive Countries and The Prospects for Strengthening Their Efficiency and Openness as A Factor for Sustainable Development

1. Decision of the Committee on Science and Education of the Verkhovna Rada of Ukraine dated March 18, 2015 (Protocol No. 8): "The requirement to publish in journals indexed in the leading international scientometric databases Web of Science and (or) Scopus does not take into account industry specificity of knowledge. The above-mentioned requirements need substantial financial support".

The Elsevier publishing concern and its scientometric division Scopus offer two types of distributing articles and other scientific results: a traditional subscription (Subscription) and a payment for publication of an article (Article Processing Charge) in case if author wants his or her work to be in the open access. Prices listed on the publisher's website range from \$500 to \$5,000. Articles the publication of which is paid for under this model are published on the ScienceDirect platform.

The Scopus classification system includes:

- 1) Natural and technical sciences (32%);
- 2) Medical sciences (31%);
- 3) Biological, agricultural, neurophysiological sciences (20%);
- 4) Social and humanitarian sciences (only 17%).

2. We also would like to note that the commercial nature and corresponding goals of these databases (to a greater extent – Scopus, to a lesser extent – Web of Science) do not allow to fully ensure

- 1) free (free of charge) access even for viewing the materials posted in them, which in turn
- 2) cannot provide effective and comprehensive citing, and, as a consequence, ranking and indexing of both these materials and their authors.

We would like to give just one example: the world's largest international scientometric and bibliometric search system Google Scholar, according to which the most complete scientometric profile of a scientist is formed, regardless of his or her continental, linguistic, national, state and other affiliation – the Hirsch index (h-index) – is unable to rank (evaluate citations, demand, use, etc.) materials posted in Scopus and Web of Science.

It should be noted that, starting from 2015-2016, the management apparatus of WoS, understanding this problem and striving for scientific openness and global distribution, carries out active integration with national and continental-regional scientometric bases, forming joint scientometric platforms for placing the best materials from them (and not necessarily English-speaking materials) with the subsequent transfer of them to the so-called "WoS Core Collection".

Unfortunately, we have to state that the Scopus database does not implement such a strategy, but on the contrary, reinforces the policy of scientometric "closedness" and obtaining commercial benefits even for a review of any material. Of course, under these conditions, access, use in research activities, citation, etc. of the materials posted in Scopus is available only to a separate group of (well-funded) institutions, organizations, scientists. And this in no

way contributes to the objective display of the citation index and the index formed on its basis, the rating of a scientist.

3. As a result, more and more representatives of the scientific community, scientific and educational institutions, organizations of developed countries of the EU, OECD refuse to cooperate with Scopus.

In order to get closer to the goal set by the governments of the EU countries in the strategy of the general practice of the publication policy of the EU scientific programs (full open access to scientific research), Sweden and other states refused to continue any agreements with this corporation and its structures.

Also, in 2012, the leading representatives of science in Europe and the USA formed a community and sent information to the world scientific environment that physicists and technical scientists at their meeting in GSI Darmstadt on May 25, 2012 decided to ask all representatives of these sciences to join the initiative of a group of leading mathematicians to boycott "Elsevier" and join the declaration: "<http://thecostofknowledge.com/>" The cost of Knowledge, which aims to implement open access for research users and readers of scientific articles and against unreasonable payments from authors or their institutions. The movement asks individual scientists to refrain from publishing articles in Elsevier journals (and, accordingly, in the Scopus database). This movement at the global level has already achieved notable success and currently tens of thousands of leading scientists of developed countries have joined the action. Medical scientists, including Nobel laureates, also joined the movement.

Many EU member states are opposed to Elsevier and its scientometrics products because of its closed business, high and ever-increasing prices, and the potentially dangerous number of commercial publishers. A number of countries have resorted to boycotting Elsevier and withdrawing their journals and products such as Scopus.

Research institutes in Sweden and Germany refuse any subscriptions to Elsevier due to concerns about sustainability, unfair pricing mechanisms and a general lack of moral values (for example, Elsevier's metric data in the form of CiteScore, which is an indicator of the influence of journals that compete for an impact factor based on citations from Scopus, is not honest: as evidenced by an unbiased analysis, periodicals published by Elsevier's competitors receive 40% lower metrics, and Elsevier publications score 25% higher using CiteScore than other journal impact factor systems [9]).

Also, due to the constant increase in the price for using Scopus access services and for subscriptions to journals owned by Scopus, the publishing concern "Elsevier" - only in the USA, there was a refusal to use its services by: the world's largest Library of Congress, Harvard University, Massachusetts Institute of Technology, Cornell University, Florida State University, North Carolina State University, University of California, etc., leading universities in Western Europe, a significant number of the Academies of Sciences of these countries (in particular, the Max Planck Society [German Academy of Sciences], the Association of Universities of the Netherlands (VSNU), a consortium of universities and institutes DEAL of Germany and many other institutions and organizations of developed countries.

4. Officials declare an increase in the Hirsch index, quartiles of publications and impact factors as almost a panacea for science and education in Ukraine. Meanwhile, in science, results are important, not ratings.

Back in 2012, the Declaration on Research Evaluation [10] was adopted in San Francisco, the main recommendation of which is: "Do not use journal-based metrics - in particular, such as impact factors - as a surrogate measure for evaluating the research articles of an individual scientist, for judging the contribution to science or when hiring, promoting, or making funding decisions," as these are attempts to replace scientific criteria for evaluating research with bibliometrics. The declaration was signed by dozens of scientific organizations and institutions, many editors of scientific journals, and hundreds of scientists, namely: the American Association for the Advancement of Science, the European Mathematical Society, the Howard Hughes Medical Institute, the Czech Academy of Sciences, the American Society of Petrochemists, the United States Agricultural Society, the Association of Australian Medical Research Institutes, the European Society for the History of Science, and others.

The editor-in-chief of the world's leading scientific journal "Science" Bruce Alberts, an outstanding biochemist, president of the US National Academy from 1995 to 2009 and one of the co-authors of DORA, in this connection published an article "On distortions associated with the impact factor". The main point of the article is "the impact factor mania is pointless" [11].

Regarding the harmfulness of overestimating bibliometric indicators and the use of the so-called "indexes", "quartiles" and "impact factor" (which are used by Scopus and Web of Science) as criteria for "quality" of scientific results and publications, in 2017, this system was jointly opposed by the French Academy of Sciences, Léopoldin (National Academy of Sciences) Germany), the Royal Society (Academy of Sciences of Great Britain), which noted that some expert communities rely too much on bibliometric indicators when assessing the significance of works, which can lead to a superficial, simplified and unreliable assessment of scientific results. Thus, the predominant use of bibliometric indicators in the evaluation of scientific research has become a cause of serious concern. The

widespread use of journal impact factors, which are more an assessment of the journal itself than an assessment of the scientific significance of the articles published in it, is of particular concern.

Also, excessive trust in citation indices as indicators of quality can lead to the formation of groups of researchers who "screw" each other's indicators with the help of cross-citations (in other words, the so-called "citation lovers' clubs" appear). Thus, it is important to focus on the methods, goals and results of scientific activity that contribute to the promotion of qualitative and innovative research in various fields of knowledge [12].

5. Strict enrollment requirements for the awarding of scientific degrees and the awarding of scientific titles of publications exclusively in publications present in the WoS databases, and even more so, Scopus, also violate the principles of academic freedom and academic integrity. They limit scientists' choice of specialized journals for publishing the results of their research, taking into account the relevance of the specialized journal to the issues of their scientific research, and due to the difficulty of fulfilling these requirements, they can stimulate the emergence of so-called "scientific mills" that offer to prepare an article for publication for a scientist for money in journals indexed in the WoS and Scopus databases, and provide support for such publication. Proposals for the provision of such dubious services are already being received by representatives of the scientific community and "consortia" have already been created that provide such services on a paid basis.

6. The actual strict requirement to publish a significant number of one's articles in a foreign (mainly English) language in foreign journals indexed in closed databases may lead to inhibition of the development of national science, national scientific schools, national scientific journals, and the national scientific language. A high-quality scientific article, if it is of interest to the international community, can be translated into a foreign language and thus become available to scientists around the world.

Internationalization and European Integration of the Systems of Science and Universities as a Component of the Philosophy of the Strategy of Global Sustainable Development

The main priority of Ukraine's development is the integration in the European Union (including the application of research, scientific and publishing approaches).

In this regard, it is necessary to take into account that the so-called "Plan S" is implemented in the EU space.

"Plan S" is an initiative aimed at consolidating efforts to move to such publication models that provide full, immediate, open and free access to the results of scientific research as soon as possible.

The initiative was launched on 4 September 2018 by a number of large national foundations from twelve European countries, as well as the European Research Council. These agencies formed a consortium called "cOAlition S" (in the name: S - science, OA - open access, coalition - association).

The main goal of "cOAlition S" is that after January 1, 2020, the results of scientific research should be published in relevant open access journals or on relevant open access scientometric platforms.

- Under the terms of "Plan S", leading European scientific organizations will be required to publish research results in journals with immediate open access and under a license that grants the right to free, free and re-use and distribution of the material.
- "Hybrid model" of publication is not allowed, as it does not correspond to the above-mentioned principles ("Hybrid model" - involves 1. full or partial payment for publications by authors and 2. payment for its further review or download by scientists).
- "Plan S" leaves copyright in the hands of authors and lifts publishing embargoes on open access publishing.
- These principles apply to all types of scientific publications, however, the achievement of open access for monographs and books began to be implemented from January 1, 2021, as part of the "Open Science" strategy [13].

Under these circumstances, we consider it inexpedient to form strict conditions for awarding scientific degrees and scientific titles with the fixation of requirements to publish articles in journals indexed in the WoS and Scopus databases.

There is the proposed classification of international citation systems (scientometric systems and bibliographic databases):

- 1) universal (trans-scientific, interdisciplinary) abstract databases - Web of Science, EBSCO, Scopus, DOAJ, OCLC WorldCat, MIAR, Genamics JournalSeek, Springer, Open Academic Journals Index, Academic

- Resource Index (Research Bib), Directory of Research Journals Indexing, Index Copernicus, Global Impact Factor, Genamics JournalSeek, etc.;
- 2) specialized (branch) databases – Astrophysics, ERIH PLUS, PubMed, MathSciNet, Mathematics, Chemical Abstracts, Agris, GeoRef, etc.
 - 3) scientometric electronic libraries/repositories/indexing catalogues of international scientific journals and materials – Ulrich’s Periodicals Directory, ROAR (Registry of Open Access Repositories), Directory Indexing of International Research Journals, International Scientific Indexing, Directory of Research Journals Indexing, CiteFactor, Kiberleninka, Universal Impact Factor, NewJour, International Scientific Indexing, etc.
 - 4) international systems of academic resources/social scientific and scientometric networks – ResearcherGate, SciPeople, Mendeley, LinkedIn, Academia.edu, etc.
 - 5) Google Scholar (Google Academy) is a freely available international scientometric and indexing-rating and search system that indexes full-text scientific publications of all formats, from all research areas and disciplines. Google Scholar indexes most electronic resources (databases, libraries, repositories, storages, etc.), peer-reviewed online journals of the world and the largest scientific publishing houses. Google Academy is a global scientometric search and international indexing system and bibliometric database that indexes metadata of scientific publications from all fields of knowledge, published in various formats. The Google Academy index contains most of the peer-reviewed journals of the largest scientific publishing houses in Europe and America. This product has a toolkit for tracking scientific citations of indexed publications. Although Google does not officially disclose the volume of the Google Academy index, experts estimate this volume to be approximately 160 million documents.

DISCUSSION

Urgent Questions and Suggestions on The Development of Integration of Higher Education and The Fourth Industrial Revolution (Industry 4.0) In the Modern Global and International System of Scientometric Quality Tools

Question:

What should be done for Ukrainian universities to be included in the main world rankings?

What steps should be taken in order to move from the declarative state of implementing internationalization strategy at the national, regional, local and institutional levels to the practical implementing defined ideas, set goals from the use of best practices of national and international scientific spaces in the field of internationalization?

How to direct and encourage domestic scientists to perceive internationalization as essence of scientific life, opportunity for professional growth, formation of an international image, significance and demand in the national and international research world?

Offers:

The higher education institution should develop an effective comprehensive strategy for internationalization of the institution with a plan of specific practical measures and principles for evaluating quality of its implementation and determining the sustainability of the results obtained and further impact.

National research networks of the best scientists and their active cooperation with foreign and global scientific institutions and networks, conducting joint research and joint publication and dissemination of results using the main scientometric databases, should be created.

National scientometric bases using basic scientometric indicators should be created and brought to the international level due to active international scientific cooperation and involvement of foreign scientists in national research projects.

Scientific international mobility should be used to establish new scientific contacts, adopt the best global scientific practices and develop joint scientific products.

A national platform for scientists should be launched, which will carry out the following areas of activity:

- organization of trainings and scientific and practical seminars on specific topics, for example;
- marketing of scientific activities and publication of scientific developments;
- practical steps in the field of international scientific activity and the use of scientometric resources and technologies;

- how to navigate in the world of scientific Internet resources and use the world practice of forming one's own scientific portrait, etc.;
- conducting a forum of scientists for the exchanging the best practices, formation of temporary creative teams with the involvement of foreign scientific connections, presentation of scientific developments, implementation of joint scientific projects;
- organization of webinars, scientific Internet bridges for studying and discussing scientific innovations, approaches and methods in the field of internationalization of scientific activity;
- strategic activity for the formation of a critical mass of international scientists capable of advancing national science into the international scientific space the Fourth Industrial Revolution (Industry 4.0) and freely using the world's scientometric tools.

1. As the main condition for evaluating quality of publications for awarding scientific degrees and scientific titles, an extended list of international scientific metric systems/bases based on clear and non-monopolistic criteria should be defined and indicated on the basis of the following:

- 1.1. The volume, level (global-international) and number of scientific materials (for example, at least 1000 titles of publications presented in the database);
- 1.2. Universality, trans-scientific, interdisciplinary nature of the posted materials - that is, the absence of rigid specialization;
- 1.3. Degrees of its "indexing openness" - possibilities to form objective indicators of scientometric ratings and citations;
- 1.4. Variety of materials placed in the database (not only periodicals, but also collections of conferences, materials of symposia, collections of inventions, developments, etc.);
- 1.5. Degrees of openness and availability for using materials placed in the database.

2. According to these criteria, we propose to expand the list of international scientometric bases (along with the currently present WoS and Scopus), publications in the journals present in the following resources should be recognized:

- 2.1. Universal, transdisciplinary and interdisciplinary scientometric resources, the presence of publications in which it is mandatory for all holders of scientific degrees/academic titles.
- 2.2. Professionally specialized scientometric resources.

Taking into account sectoral, scientific, research specialization, form and include the "List of specialized and sectoral international scientometric systems/bases" in accordance with the list of specialties approved by the Ministry of Education and Science a system of academic culture.

We give an example of such specialized branch systems of indexing/scientometric databases - Astrophysics, PubMed, Mathematics, Chemical Abstracts, Agris, GeoRef, etc.

- 2.3. Additional scientometric resources.

Based on the fundamental principle of educational and scientific autonomy, specialized academic councils and academic councils of higher education institutions and scientific institutions should be allowed to add (on a permanent or temporary basis) to items 1-2 of this List a group (up to 3-5) of international scientometric systems/bases, which, from the point of view of the leading specialists of this institution, can be considered as those that additionally qualitatively reflect the level of scientific achievements of this scientist.

3. A national scientific ranking and information scientometric system, connected to international scientometric databases, should be developed and the requirement of representation of all publications of the acquirer in this system should be recorded.

CONCLUSIONS

Integration in the European Union (including the application of research, scientific and publishing approaches) has been determined as the main development priority for many countries of the world and for Ukraine in particular.

Recent decades have witnessed the growth of integration processes in the world, the development of tendencies towards joint solutions of their economic tasks by countries. Another difference is related to the scientific and

technical revolution and the formation of the "information society" and the Fourth Industrial Revolution (Industry 4.0). Since universities (and the entire system of higher education - both in the world and in Ukraine) strive to achieve high positions in ratings and quality indicators, and among the evaluation criteria, the scientific achievements of the teaching staff, including the quantitative and qualitative indicators of their scientific publications, occupy important positions, the availability of mastering scientometric technologies becomes an urgent problem. Persistence of management and forcing the process of increasing "scientific quality" lead to a) low quality of publications; b) demotivation of teachers; c) personnel decisions. The question (problem) is how to facilitate process of mastering skills of using scientometric bases by the higher education institutions academic staff.

Considering existence of a large number and variety of scientometric systems, it would be worthwhile to create a single international scientometric resource to which already existing platforms would be connected or integrated. The simplicity and accessibility of the interface in many languages, involvement of the maximum number of indices and other evaluation indicators, as well as ability to set necessary indicator or ratio according to certain, individually defined parameters would facilitate and speed up research of scientists all over the world.

Also, creation, development and introduction of a worldwide global non-commercial scientometric bibliometric and search system of an open type, reinforced at the legislative level, deserves research and justification in the academic space.

However, it should be integrated into the international system and meet the criteria and possibilities of the "Open Science" and The Fourth Industrial Revolution (Industry 4.0) strategy.

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