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MODELING RATING OF SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT OF THE COUNTRIES

The **subject** of the article is rating assessment and development of recommendations on management of scientific and technological development of the countries. The **purpose** of the article is to develop an index that assesses the scientific and technological potential, the results of scientific and technological activities and the pace of changes in the scientific and technological development of different countries of the world. The following **tasks** are solved in the article: the model of rating estimation of scientific and technical development of the countries of the world is developed; the countries of the world are classified depending on a level of their scientific and technical development; recommendations on development of scientific and technical potential of the countries depending on the chosen groups are given. The following **methods** are used: indexing method, ranking and grouping. The following results were obtained: the calculations possible to identify three groups of countries according to the level of their scientific and technological development: leaders, potential leaders and "overtaking" countries. Main result of the project is to promote the development of the scientific and technological potential, to demonstrate the insignificant results of the scientific and technological activity, and to reduce the low level of development of new technologies. For each of the above groups of countries, recommendations have been made for raising the level of their scientific and technological development. **Conclusions**: the current stage of the world's technological development creates new opportunities for the countries of the world to ensure their sustainable growth. Therefore, the creating and maintaining the potential of scientific and technological development, coupled with an adequate government policy of economic development, opens up tremendous opportunities for the countries to ensure global competitiveness. The study presented provides general recommendations for individual countries to improve the processes of managing scientific and technological potential of individual groups of countries. The obtained results can become the basis for the concept and strategy development of scientific and technological development of different countries of the world.

Keywords: science; scientific and technological development; countries of the world rating; simulation.

Introduction

At the moment, the economic growth of countries is largely dependent on the creation of new innovative technologies and industries based on cutting-edge advances in science and scientific knowledge. Scientific and technological development is one of the main priorities of state policy in many countries of the world, so the problem of assessing and determining the level of a country's scientific and technological development in relation to that of other countries based on ratings by various indexes is of particular importance. In the conditions of globalization of the world economy, implementation of the strategy of sustainable development of the leading economies of the world, understanding of the role of science in a particular country in comparison with that in other countries can contribute to its more dynamic development and ensuring better grounded decisions in the strategic management of the scientific and technical sphere, substantiating reasons for its support and financing.

International ratings can serve as a tool for evaluating the government performance in various aspects of their activities as compared to that of other countries. In addition, international ratings influence the governments' consistent activity for the development of their countries. International ratings show the level of a country's development and its effectiveness in various fields, such as: innovation, information technologies, national economy, the social sphere, defining the living standards, etc.

But, as a show of analysis, there is no index, which is the result of the development of science in the rest of the world. There are many indexes, which include the evaluation of the scientific development, such as the warehouse part of the foreign indexes, which characterize the scientific and technological development, the competitive ability of the region, the level of economic development, human resources, only. That is the development of the index, which is bi-imaging mill of scientific development in the situation of intensification of the scientific knowledge on the zoom of the social-economical medium and the problems of the development of science [1], and the development of recommendations for the management of the development of scientific and technological potential of the country is relevant.

Analysis of recent research and publications

The development of the region's scientific and technological level of the development of the science of the world, on the appendix, S. Anholt, A. Gani [2], M. Desai [4], M. Porter [5], M. Shahab [6] and others.

In scientific literature, technological changes have long been regarded as one of the main drivers of economic growth (Jones [7], Broughel & Thierer [8], Komkov [9]). A large number of scientists around the world have been engaged in analyzing the factors contributing to scientific and technological development at three different levels of analysis. Macro-level studies have been considered in the social, economic, and political aspects (Uzunidis & Boutillier [10], Cozzens [11]). On the mezzanine level, the influence of the distribution of state funding for research, educational attainment, and scientific training has been studied (Porter [5]). At the microlevel, the relationships between the indicators of scientific and technological progress and the level of the researchers' qualification, as well as between the organization of the research process and the age of the researcher have been looked into (Wang & Li [12]). Most scientists consider the levels of

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education, research and development and the amount of education, research and development funding to be the main drivers of technological development. Human capital and its development are seen as a source of shaping the country's scientific and technological potential (Diebolt & Hippe [13], Kyzym [14]). The influence of the level of funding on the level of scientific and technical performance has also been proven (Checchi [15], Rosenbloom [16]). The number of registered patents and the number of publications in research journals (Korzhavykh [17], Weingart [18]) are viewed by many scientists as an important factor affecting scientific results. The outcomes of scientific and technological development are influenced by a demand for high-tech products and the scope of high-tech products exports (Siyanbola, Adeyeye, Olaopa [19]).

Thus, it is possible to reach a conclusion that the level of the scientific and technological development of the countries of the world is influenced by a number of factors. In the meantime, all the factors of the scientific and technological development of the economy and the visa were not conducted.

The purpose and objectives of the publication

The purpose of the article is to develop an index that assesses the scientific and technological potential, the results of scientific and technological activities and the pace of changes in the scientific and technological development of different countries of the world.

To achieve this goal, the following tasks were solved:

- to develop a model of rating assessment of scientific and technical development of countries of the world;
- to classify the countries of the world depending on their level of scientific and technological development;
- give recommendations on the development of scientific and technological potential of the world countries depending on the selected groups.

This will allow not only to rank and group the countries of the world by these parameters, but also to suggest recommendations for their further scientific and technological development, which is very important in the modern globalized world.

Materials and methods

The method for calculating the Scientific and Technological Development Index, which is proposed in this paper, is based on the determining its three main components (fig. 1): the sub-index of the potential of scientific and technological development, the sub-index of the results of scientific and technological development and the sub-index of scientific and technological growth.

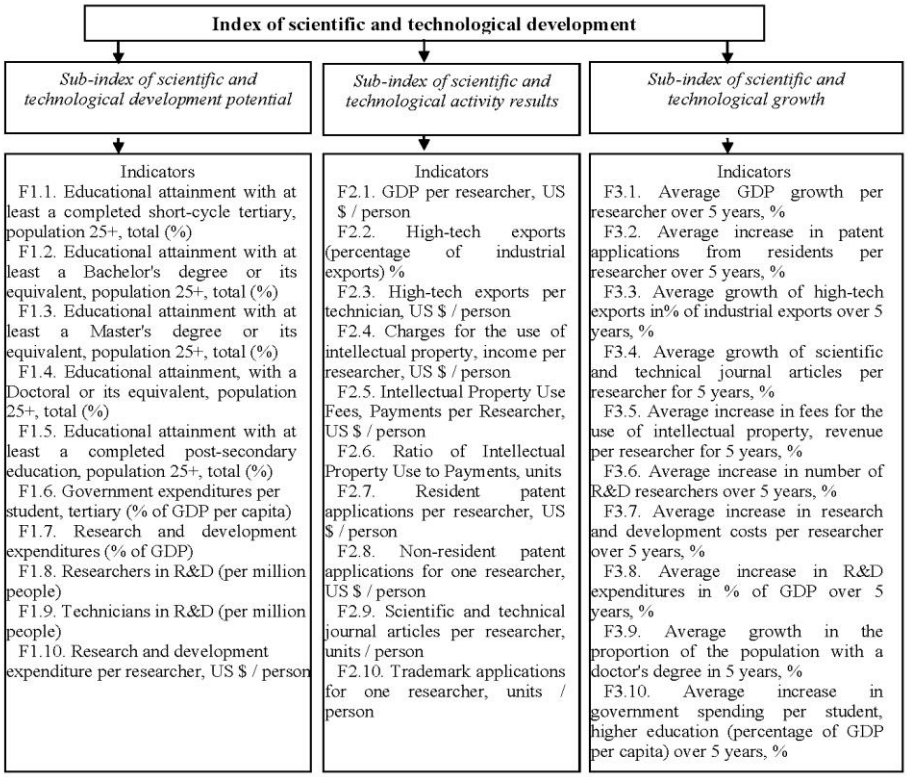

Fig. 1. Model of calculating the index of scientific and technological development
Source: own modelling

The sub-index of the scientific and technological development potential characterizes potential opportunities in the formation of scientific resources through two components: education (opportunities for training highly qualified specialists) and science (opportunities for the development of scientific potential due to availability of highly qualified specialists and the funding of scientific research).

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The sub-index of the scientific and technological activity results characterizes the results of scientific activity through the creation of a scientific product (patents, articles in scientific journals), the use of results of intellectual property and income from high-tech exports) characterizes the results of scientific activity through the creation of a scientific product (patents, publications in scientific journals), the use of the results of intellectual property and earnings from high-tech exports).

The sub-index of scientific and technological growth characterizes the dynamics of the scientific and technological potential growth and the results of scientific and technological activity.

In calculating The Science and Technology Growth Index (ISTD), only the hard data of 21 variables are used, based on the quantitative data available from the open World Bank database. The World Bank database provides data for 217 world economies. However, not all of the indicators that were singled out for the purpose of index calculation contain information on all the countries of the world included into the database. Also, for some indicators the data for after 2016 are missing. When calculating index indicators, the following assumption was made: if there are no data for more than 4 indicators across the country, then it is excluded from further ranking; if there are no data for less than 4 indicators - the calculation is adjusted depending on the number of indicators included in the calculating indices and sub-indices for the given country.

The Science and Technology Development Potential Index includes 10 indicators available from the World Bank database. Indicators F1.1 – F1.9 are directly indicators presented in the World Bank database. Indicator F1.10 (Research and Development expenditure per researcher, US $ / person) calculated on the basis of World Bank data as:

$$F1.10 = \frac{x_1 \cdot x_2}{x_3 \cdot x_4}, \quad (1)$$

where x_1 – is the Research and development expenditure (% of GDP), x_2 – is the GDP (current US $), x_3 – is the Researchers in R&D (per million people), x_4 – is the Population (in millions of people).

The sub-index of the results of scientific and technological activity includes 10 indicators, whose characteristics and sources, regarding the calculation of the indicators, are given in table 1.

Table 1. *Characteristics of the indicator and the source of information pertaining to the calculation of indicators included into the sub-index of the scientific and technological development potential*

Indicator	Calculations	Comments
F2.1. GDP per researcher, US $ / person	$F2.1 = \frac{x_2}{x_3 \cdot x_4}$	where x_2 – is the GDP (current US $), x_3 – is the Researchers in R&D (per million people), x_4 – is the Population (in millions of people)
F2.2. High-technology exports (current US$), %	$F2.2 = x_5$	where x_5 – is the High-technology exports (current US $)
F2.3. High-tech exports per technician, US $ / person	$F2.3 = \frac{x_5}{x_3 \cdot x_4}$	where x_5 – is the High-technology exports (current US $), x_3 – is the Researchers in R&D (per million people), x_4 – is 1 million people
F2.4. Fees for Intellectual Property Use, Researcher Revenue, US $ / person	$F2.4 = \frac{x_6}{x_3 \cdot x_4}$	where x_6 – is the Charges for the use of intellectual property, receipts (BoP, current US$), x_3 – is the Researchers in R&D (per million people), x_4 – is the Population (in millions of people)
F2.5. Intellectual Property Use Fees, Payments per Researcher, US $ / person	$F2.5 = \frac{x_7}{x_3 \cdot x_4}$	where x_7 – is the Charges for the use of intellectual property, payments (BoP, current US$), x_3 – is the Researchers in R&D (per million people), x_4 – is the Population (in millions of people)
F2.6. Ratio of Intellectual Property Use to Payments, unit	$F2.6 = \frac{x_6}{x_7}$	where x_6 – is the Charges for the use of intellectual property, receipts (BoP, current US$), x_7 – is the Charges for the use of intellectual property, payments (BoP, current US$)
F2.7. Patent applications from residents for one researcher, unit / person	$F2.7 = \frac{x_8}{x_3 \cdot x_4}$	where x_8 – is the Patent applications, residents), x_3 – is the Researchers in R&D (per million people), x_4 – is the Population (in millions of people)
F2.8. Non-resident patent applications for one researcher, per person	$F2.8 = \frac{x_9}{x_3 \cdot x_4}$	where x_9 – is the Patent applications, non-residents, x_3 – is the Researchers in R&D (per million people), x_4 – is the Population (in millions of people)
F2.9. Scientific and technical journal articles per researcher, unit / person	$F2.9 = \frac{x_{10}}{x_3 \cdot x_4}$	where x_{10} – is the Scientific and technical journal articles, x_3 – is the Researchers in R&D (per million people), x_4 – is the Population (in millions of people)
F2.10. Trademark applications for one researcher, unit / person	$F2.10 = \frac{x_{11}}{x_3 \cdot x_4}$	where x_{11} – is the Trademark applications, total x_3 – is the Researchers in R&D (per million people), x_4 – is the Population (in millions of people)

Source: own compilation

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The Science and Technology Growth Sub-index is calculated on the basis of World Bank data from 5 years as the geometric average of growth.

In order to correct the differences in the units of index indicators and ranges of variation, all the 30 variables are normalized in the range [0, 1] with higher scores that represent better results.

Data normalization and scaling is performed with regard to the minimum and maximum values for each variable in the index indicators. For variables in which higher values indicate higher results, the following rationing formula was applied:

$$I_{indicator} = \frac{x_f - x_{\min}}{x_{\max} - x_{\min}}, \quad (2)$$

where $I_{indicator}$ – is the index of the indicator calculated for the individual index indicators, x_f is the actual value of the individual indicator, $x_{\min}$ is the minimum value of the indicator observed in the countries surveyed, $x_{\max}$ – is the maximum value of the indicator observed in the countries surveyed.

Sub-indices of the potential of scientific and technological development (STP), results of scientific and technological activity (STA) and scientific and technological growth (STG) are calculated as the arithmetic mean of the obtained values of the individual indicators that characterize them.

If it is not possible to calculate individual indicators for some countries, these countries are removed from the ranking, provided that such indicators are more than 3 out of 10 for each sub-index.

The Science and Technology Growth Index (ISTD) is the geometric mean of these three sub-indices:

$$ISTD = \sqrt[3]{STP \times STA \times STG}, \quad (3)$$

where STP is the sub-index of scientific and technological potential; STA – the sub-index of scientific and technological activities; STG – the sub-index of scientific and technological growth.

On the basis of the proposed method, the index of scientific and technological development for different countries of the world was calculated and their rating established.

Results of the studies and their discussion

In accordance with the proposed method, the sub-indices of scientific and technological potential, scientific and technological results and scientific and technological growth, as well as the index of the scientific development of the countries of the world were calculated.

First, 217 countries, represented in the World Bank database [20], were considered. As a result of collecting data on the previously identified indicators and their analysis, 72 countries were selected for which the information was most complete. The remaining countries were not included in the ranking because of the lack of practical data that would allow the proposed model to be used to calculate indicators, sub-indices and the overall index. Further, each indicator was normalized, which made it possible to calculate the corresponding sub-indices, according to the formulas above.

The calculation of the Science and Technology Potential Sub-index (STP) allowed ranking 72 countries of the world according to their scientific and technological potential, which was assessed by their educational potential from the point of view of possibilities of training their personnel, including top-level personnel, as well as their scientific potential, which reflects the number of researchers and technicians engaged in the economy of the country and the scale of financing.

The ranking of the countries of the world on the basis of the calculated sub-index of scientific and technological potential is given in table 2.

Table 2. *Ranking the countries of the world by the sub-index of scientific and technological potential*

Position	Country	Evaluation	Position	Country	Evaluation	Position	Country	Evaluation
1	Sweden	0.742	25	Spain	0.383	49	Bulgaria	0.235
2	The USA	0.637	26	The Czech Republic	0.380	50	Serbia	0.233
3	Denmark	0.615	27	Lithuania	0.358	51	Tunisia	0.222
4	Sweden	0.591	28	Italy	0.350	52	Columbia	0.218
5	Singapore	0.572	29	Poland	0.342	53	Uzbekistan	0.212
6	Republic of Korea	0.570	30	Portugal	0.330	54	Chile	0.211
7	Israel	0.567	31	Cyprus	0.323	55	Madagascar	0.208
8	Luxemburg	0.561	32	Georgia	0.319	56	Moldova	0.207
9	Norway	0.557	33	Lithuania	0.318	57	Argentina	0.207
10	Finland	0.550	34	Hong Kong. China	0.302	58	Mexico	0.199
11	Germany	0.543	35	The Republic of Slovenia	0.289	59	Malaysia	0.194
12	The United Arab Emirates	0.538	36	Greece	0.284	60	India	0.187
13	Japan	0.537	37	Hungary	0.283	61	Romania	0.179
14	Australia	0.529	38	Costa-Rica	0.279	62	Montenegro	0.157
15	Belgium	0.523	39	The Russian Federation	0.279	63	Uruguay	0.148

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End the **Table 2.**

16	Austria	0.520	40	China	0.279	64	Egypt	0.135
17	Canada	0.510	41	Brazil	0.267	65	Philippines	0.134
18	The Netherlands	0.509	42	Ecuador	0.260	66	Morocco	0.119
19	Slovenia	0.495	43	Malta	0.257	67	Kazakhstan	0.090
20	The UK	0.473	44	Panama	0.254	68	Pakistan	0.087
21	Ireland	0.452	45	Croatia	0.249	69	South Africa	0.084
22	France	0.447	46	Turkey	0.249	70	Salvador	0.067
23	New Zealand	0.407	47	Ukraine	0.238	71	Bosnia and Herzegovina	0.050
24	Estonia	0.388	48	Venezuela	0.236	72	Guatemala	0.043

Source: own compilation

According to the data calculated on the sub-index of the country's scientific and technological potential, the countries were divided into 3 subgroups, namely: leaders (STP> 0,5), potential leaders (STP 0,49-0,2), and "overtaking" countries (STP <0,2).

Leaders are countries with a high scientific and technological potential, they have an advanced system of training of highly qualified personnel, the governments of those countries allocate considerable funds for financing their educational and scientific activities. Those countries have a high scientific and technological potential to develop and implement the results of their own scientific and technological activity.

Potential leaders are countries with a sufficient scientific and technological potential, they realize the importance of training highly qualified personnel, the governments of these countries allocate funding for educational and scientific activities, but not enough to make them leaders in scientific and technological development, for training highly qualified personnel is not a major priority for the country's development. These countries have a sufficient scientific and technological potential to develop and implement their own scientific and technological output, but they need increased funding to build and strengthen their scientific and technological potential.

"Overtakering" countries are countries with a low scientific and technological potential, they have an underdeveloped system of training highly qualified personnel, the governments of these countries do not allocate sufficient funds to finance their educational and scientific activities, and higher education is not well-developed.

Such countries do not have sufficient scientific and technological capacity to develop and implement the results of their scientific and technological activity and their governments need to pay more attention to financing and training highly qualified personnel.

According to the ranking and grouping of the countries of the world, Ukraine is ranked 47th out of 72 countries. Ukraine has been classified as a country with a sufficient scientific and technological potential for development, whose government is not paying attention to the system of training highly qualified personnel, but does not allocate funding for its development sufficient for the country to become a leader in scientific and technological development.

Calculation of the Sub-Index of Scientific and Technological Activities (STR) allowed to rank 72 countries in accordance with the scientific and technological results obtained, which were evaluated by the results of the scientific and technological activity of their researchers on the basis of calculating the number of applications for patents by residents and non-residents of the country, applications for trademarks, the number of articles in scientific and technical journals, the revenues and payments gained from the use of intellectual property per researcher, as well as the share of high-tech export in the structure of the products trade calculated per one technician. The ranking of the countries of the world on the basis of the calculated sub-index of the results of scientific and technological activities is given in table 3.

Table 3. *Ranking of countries in the world by the index of the results of scientific and technological activity*

Position	Country	Assessment	Position	Country	Assessment	Position	Country	Assessment
1	The USA	0.286	25	Chile	0.102	49	Montenegro	0.061
2	Singapore	0.278	26	Italy	0.098	50	Spain	0.060
3	Luxemburg	0.257	27	Belgium	0.097	51	Greece	0.060
4	Ireland	0.230	28	Hungary	0.094	52	Poland	0.058
5	Switzerland	0.213	29	Bosnia and Herzegovina	0.093	53	India	0.057
6	China	0.190	30	Uruguay	0.089	54	Lithuania	0.056
7	Malta	0.187	31	Australia	0.088	55	Estonia	0.052
8	Panama	0.182	32	Izrael	0.086	56	Venezuela	0.049
9	Finland	0.167	33	New Zealand	0.083	57	Turkey	0.049
10	Japan	0.164	34	Cyprus	0.081	58	Ecuador	0.045
11	Republic of Korea	0.155	35	Costa Rica	0.080	59	The Russian Federation	0.041
12	The Netherlands	0.154	36	Kazakhstan	0.080	60	Portugal	0.040

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End the **Table 3.**

13	Columbia	0.153	37	Austria	0.078	61	Argentina	0.038
14	El Salvador	0.143	38	Hong-Kong, China	0.077	62	Madagascar	0.037
15	The Philippines	0.140	39	Canada	0.076	63	Bulgaria	0.036
16	Guatemala	0.140	40	The Czech Republic	0.073	64	Ukraine	0.035
17	Malaysia	0.136	41	Croatia	0.071	65	Serbia	0.035
18	The United Kingdom	0.133	42	Romania	0.070	66	United Arab Emirates	0.031
19	Sweden	0.131	43	Slovenia	0.068	67	Moldova	0.030
20	Germany	0.124	44	Tunisia	0.067	68	Georgia	0.020
21	Mexico	0.113	45	Latvia	0.065	69	Morocco	0.018
22	France	0.113	46	South Africa	0.063	70	Egypt	0.018
23	Denmark	0.107	47	The Slovak Republic	0.062	71	Pakistan	0.016
24	Norway	0.107	48	Brazil	0.061	72	Uzbekistan	0.011

Source: own compilation

According to the data calculated for the sub-index of scientific and technological activity, the countries ranked were divided into 3 subgroups, namely: leaders (STA> 0,1), potential leaders (STA 0,09-0,05), and "overtaking" countries (STA<0,05).

Leaders are countries with significant scientific and technological results, are characterized by a high share of high-tech products exports, significant scientific results, active in publication and patent registration activities, and have high revenues from intellectual property.

Potential leaders are countries with a medium-sized scientific and technological output, these countries have a small share of high-tech exports, not very significant scientific results manifested in publication and patent-registration activity, and also have higher payments than benefits from intellectual property.

"Overtaking" countries are those with low scientific and technological results, these countries have a low share of high-tech products exports, insignificant scientific results, manifested in terms of publications and patent registration activity, and also have to pay a lot for intellectual property.

Ukraine has been placed with the countries with low scientific and technological results, a low share of high-tech products exports, insignificant scientific results per researcher, both in terms of publications and patent activity, and with high intellectual property payments.

The calculation of the Science and Technology Growth Sub-Index (STG) has allowed to rank 72 countries according to the dynamics of their scientific and technological results and growth of their scientific and technological potential.

This sub-index estimates the country's growth rate in the areas such as the results of the scientific and technological activity of researchers based on an estimate of the growth rate of their both residents and non-residents applications for patents and for trademarks, the number of articles published in scientific and technical journals, revenues from the use of intellectual property per researcher, and a growing rate of high-tech exports in food trade. Also included in the assessment, are an increase in the PhD degrees obtained in economics and the funding of higher education, research and development. The ranking of the countries of the world on the basis of the calculated sub-index of scientific and technological growth is shown in table 4.

Table 4. *Ranking countries by the sub-index of scientific and technological growth*

Position	Country	Assessment	Position	Country	Assessment	Position	Country	Assessment
1	China	0.604	25	Georgia	0.460	49	Israel	0.423
2	The United States	0.545	26	The Czech Republic	0.458	50	Canada	0.422
3	Slovakia	0.542	27	Turkey	0.457	51	Austria	0.421
4	Lithuania	0.539	28	The Netherlands	0.452	52	Estonia	0.420
5	Hong Kong, China	0.529	29	France	0.451	53	Columbia	0.414
6	Spain	0.514	30	New Zealand	0.447	54	Republic of Korea	0.413
7	Denmark	0.509	31	Latvia	0.447	55	Greece	0.410
8	Luxembourg	0.505	32	Finland	0.447	56	Philippines	0.409
9	Costa Rica	0.502	33	Morocco	0.446	57	Malaysia	0.403
10	Portugal	0.499	34	Chile	0.445	58	Croatia	0.398
11	Cyprus	0.491	35	Guatemala	0.444	59	Japan	0.395
12	Bulgaria	0.490	36	Malta	0.444	60	Pakistan	0.393

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End the **Table 4.**

13	Romania	0.486	37	Bosnia and Herzegovina	0.443	61	Argentina	0.390
14	Slovenia	0.485	38	Uruguay	0.443	62	Panama	0.388
15	El Salvador	0.484	39	Tunisia	0.442	63	Montenegro	0.388
16	Moldova	0.484	40	Italy	0.438	64	Madagascar	0.382
17	Singapore	0.483	41	Hungary	0.436	65	Ireland	0.375
18	Poland	0.481	42	The Russian Federation	0.435	66	Australia	0.373
19	Brazil	0.474	43	Belgium	0.434	67	Serbia	0.363
20	Mexico	0.470	44	Sweden	0.433	68	South Africa	0.362
21	The United Kingdom	0.467	45	Kazakhstan	0.426	69	Uzbekistan	0.348
22	Switzerland	0.465	46	United Arab Emirates	0.425	70	Venezuela, RP	0.342
23	Norway	0.463	47	Ukraine	0.424	71	Egypt	0.336
24	India	0.461	48	Germany	0.423	72	Ecuador	0.324

Source: own compilation

According to the data calculated on the sub-index of scientific and technological growth, the countries were divided into 3 subgroups, namely: leaders (STG> 0,5), potential leaders (STG 0,49-0,4), and "overtaking" countries (STG <0,4).

Leaders are countries with high growth rates in increasing scientific and technological potential and results of scientific and technological activity. These countries may have a medium or low scientific and technological potential or scientific and technological output, but they are growing at a fairly rapid pace, which is promising for the future.

Potential leaders are countries with average growth rates of scientific and technological potential and scientific and technological activity. These countries may have a high or average scientific and technological potential or scientific and technological output, their average rates of growth, however, may be fraught in the future with slowing down the country's scientific development, as well as the development of the economy as a whole.

These countries may have a high or average scientific and technological potential or the results of scientific and technological activity, but the low growth is fraught with the risk of losing the status of a scientifically developed and innovative country. These may be "old" economies that use their scientific potential but do not increase it at a high rate; or they may be countries that do not conduct their scientific or technological activities on a regular basis, or such activities may not be among the priorities in the country's development. According to the ranking and grouping of the countries of the world, Ukraine ranked 47th out of 72 countries that were rated. Ukraine was classified as a country with a low growth rate of its scientific and technological potential and low results of scientific and technological activity. This reflects the current situation in the country, in which the number of researchers in recent years has been decreasing, with the results of their scientific activities and the share of high-tech exports of food production decreasing, too.

Also, the general index of scientific and technological development was calculated on the basis of the sub-indices calculated previously. The results of the ranking of the countries of the world in accordance with the calculated index of scientific and technological development are given in table 5.

Table 5. *Rating countries by the Index of scientific and technological development (ISTD)*

Position	Country	ISTD	Position	Country	ISTD	Position	Country	ISTD
1	The USA	0.463	25	New Zealand	0.248	49	Romania	0.183
2	Singapore	0.425	26	Italy	0.246	50	Uruguay	0.180
3	Switzerland	0.419	27	Columbia	0.240	51	Turkey	0.177
4	Luxembourg	0.418	28	Cyprus	0.234	52	The Russian Federation	0.171
5	Finland	0.345	29	The Czech Republic	0.233	53	India	0.170
6	Ireland	0.339	30	Hong Kong, China	0.231	54	Salvador	0.166
7	The republic of Korea	0.332	31	Spain	0.228	55	Bulgaria	0.161
8	The Netherlands	0.329	32	Hungary	0.226	56	Venezuela	0.158
9	Japan	0.327	33	Costa Rica	0.224	57	Ecuador	0.155
10	Denmark	0.322	34	Lithuania	0.221	58	Montenegro	0.154

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End the **Table 5.**

11	Sweden	0.322	35	Malaysia	0.220	59	Ukraine	0.153
12	China	0.317	36	Mexico	0.219	60	Argentina	0.146
13	The United Kingdom	0.308	37	Slovak Republic	0.214	61	Kazakhstan	0.145
14	Germany	0.305	38	Poland	0.212	62	Moldova	0.145
15	Norway	0.302	39	Chile	0.212	63	Georgia	0.144
16	France	0.283	40	Latvia	0.210	64	Serbia	0.144
17	Belgium	0.281	41	Estonia	0.204	65	Madagascar	0.143
18	Malta	0.277	42	Brazil	0.198	66	Guatemala	0.138
19	Israel	0.275	43	The Philippines	0.197	67	Bosnia and Herzegovina	0.127
20	Panama	0.262	44	United Arab Emirates	0.191	68	South Africa	0.124
21	Australia	0.259	45	Croatia	0.191	69	Morocco	0.099
22	Austria	0.258	46	Greece	0.191	70	Egypt, Arab Republic	0.094
23	Canada	0.254	47	Tunisia	0.188	71	Uzbekistan	0.093
24	Slovenia	0.253	48	Portugal	0.187	72	Pakistan	0.081

Source: own compilation

According to the data calculated on the R&D index, the countries were divided into 3 subgroups, namely: leaders (ISTD> 0.25), potential leaders (ISTD 0.249-0.2), and "overtaking" countries (ISTD <0.2).

Leaders in the scientific and technological development are countries that are at the forefront of independent research and implementation of technological innovations, demonstrate significant achievements in the formation and development of the country's scientific and technological potential, have significant scientific and technological achievements and provide for high growth rates of the scientific and technological potential and its results.

Potential leaders of scientific and technological development are countries that invest in the development of their scientific and technological potential, use new technologies, achieve significant scientific and technological results, but their growth rate is lower than that of the leaders.

The countries that are overtaking the others in terms of scientific and technological development are countries that do not sufficiently invest in the development of their scientific and technological potential, show modest results of their scientific and technological activity, have low rates of growth of their scientific and technological potential and insignificant results of their scientific and technological activity.

According to the general index of scientific and technological development, Ukraine ranks 59th out of 72 countries of the world.

The advantages of the proposed index consist in a possibility of evaluating the prospects of scientific and technological development for each of the countries of the world on the basis of a unified source of data provided by the World Bank, in an even distribution of indicators (each sub-index includes 10 indicators), and in dividing the countries into groups in accordance with the values obtained for each sub-index, which makes it possible to suggest recommendations to each country included in the rating for developing its scientific and technological potential.

Conclusions and prospects for further development

The current stage of the world's technological development creates new opportunities for the countries of the world to ensure their sustainable growth. Therefore, the creating and maintaining the potential of scientific and technological development, coupled with an adequate government policy of economic development, opens up tremendous opportunities for the countries of the world to ensure global competitiveness.

In accordance with the purpose of the research, the article proposes a methodology for calculating an index that evaluates the scientific and technological potential, the results of scientific and technical activities and the rate of change in scientific and technological development of different countries around the world. In order to achieve this goal, a model for rating the scientific and technological development of the world's countries was developed, which, unlike the existing models, takes into account only quantitative indicators taken from a reliable source (the World Bank), takes into account the scale of the economies of the countries being evaluated in accordance with their scientific potential (all the resulting indicators are given to the number of performers of the relevant scientific and technical works), takes into account the rate of change in scientific and technological development of the world's countries (it makes it possible to estimate the rate of change in scientific and technological development of the countries).

The presented method has made it possible not only to determine the place of the countries under assessment in the world scientific and technological development, but also to give recommendations on the development of scientific and technological potential of the countries of

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the world depending on their belonging to groups of countries.

Potential leaders of scientific and technological development should work on developing their own scientific potential, attract additional financial resources to fund the training of highly qualified specialists in the promising sectors of the economy, finance scientific and technological research projects, promote the development of the national innovation system, reduce dependence on technologies borrowed from the developed countries of the world, promote the scientific and technological development of industries that are capable of expanding the export of high-tech products.

"Overtaking" countries should increase funding for training specialists and improving their educational systems, develop ways of disseminating new technologies, promote their own scientific development, solve concrete problems by introducing innovative technologies, and studying the experience of the developed countries in order to build their own scientific and technological potential.

The study presented in the article provides general recommendations for individual countries to improve the processes of managing scientific and technological potential of individual groups of countries. The obtained results can become the basis for the concept and strategy development of scientific and technological development of different countries of the world.

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МОДЕЛЮВАННЯ РЕЙТИНГУ НАУКОВО-ТЕХНОЛОГІЧНОГО РОЗВИТКУ КРАЇН

Предметом статті є рейтингова оцінка та розробка рекомендацій щодо управління науково-технічним розвитком країн. **Мета** дослідження – розробити методологію обчислення індексу науково-технічного розвитку та ранжувати країни світу. У статті вирішено такі **завдання**: розробити модель рейтингової оцінки науково-технічного розвитку країн світу; класифікувати країни світу залежно від рівня їх науково-технічного розвитку; надати рекомендації щодо розвитку науково-технічного потенціалу країн залежно від вибраних груп. Застосовуються такі **методи**: індексний метод, ранжирування та групування. Отримані наступні **результати**: наведені розрахунки дозволили визначити три групи країн відповідно до рівня їх науково-технічного розвитку: лідери, потенційні лідери та країни, що «наздоганяючі». Основним результатом проекту є сприяння розвитку науково-технічного потенціалу, демонстрація результатів науково-технічної діяльності та покращення рівня розвитку нових технологій. Для кожної з перерахованих груп країн були зроблені рекомендації щодо розвитку науки та технологій. Висновки: сучасний етап світового технологічного розвитку створює нові можливості для країн світу щодо забезпечення їх сталого зростання. Тому створення та підтримка потенціалу науково-технічного рівня в поєднанні з адекватною державною політикою економічного розвитку відкриває перед країнами величезні можливості для забезпечення глобальної конкурентоспроможності. Представлене дослідження дає загальні рекомендації для окремих країн щодо вдосконалення процесів управління науково-технічним потенціалом груп країн. Отримані результати можуть стати основою для розробки концепції та стратегії науково-технічного розвитку різних країн світу.

Ключові слова: наука; науково-технічний розвиток; країни світового рейтингу; моделювання.

МОДЕЛИРОВАНИЕ РЕЙТИНГА НАУЧНО-ТЕХНОЛОГИЧЕСКОГО РАЗВИТИЯ СТРАН

Предметом статьи является рейтинговая оценка и разработка рекомендаций по управлению научно-техническим развитием стран. **Цель** исследования – разработать методологию расчета индекса научно-технического развития и ранжировать страны мира. В статье решены следующие **задачи**: разработана модель рейтинговой оценки научно-технического развития стран мира; классифицированы страны мира в зависимости от уровня их научно-технического развития; даны рекомендации по развитию научно-технического потенциала стран в зависимости от выбранных групп. Применяются следующие **методы**: индексный метод, ранжирование и группировка. Получены следующие **результаты**: приведенные расчеты позволили определить три группы стран в соответствии с уровнем их научно-технического развития: лидеры, потенциальные лидеры и страны "догоняющие". Основным результатом проекта является содействие развитию научно-технического потенциала, демонстрация результатов научно-технической деятельности и улучшение уровня развития новых технологий. Для каждой из перечисленных групп стран были даны рекомендации по развитию науки и технологий. **Выводы**: современный этап мирового технологического развития создает новые возможности для стран по обеспечению их устойчивого роста. Поэтому создание и поддержка потенциала научно-технического уровня в сочетании с адекватной государственной политики экономического развития открывает перед странами огромные возможности для обеспечения глобальной конкурентоспособности. В представленном исследовании даны общие рекомендации для отдельных стран по совершенствованию процессов управления научно-техническим потенциалом групп стран. Полученные результаты могут стать основой для разработки концепции и стратегии научно-технического развития стран мира.

Ключевые слова: наука; научно-техническое развитие; страны мирового рейтинга; моделирования.

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