Greening of business activities in the E-7 and G-7 countries as a vector for improving their environmental safety

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Abstract. The research paper discusses the importance of using the environmental safety for the global economy. The article describes the impact of greening of business processes on the environmental safety. The study analyzes the implementation of greening of business activities in such groups of countries as E-7 and G-7. The paper presents the results of a cluster analysis of the features of environmental safety in the E-7 and G-7 countries.

1. Introduction

Relevance of the topic of the study. Nowadays environmental development is accompanied by an increase in the crucial impact on our planet. The growth of the population of the Earth, the expansion of the scale of production with limited natural resources requires the involvement of more natural materials. However, such way of development inevitably leads to deterioration of living conditions of people. This leads to a decrease in soil fertility and ecosystem biodiversity, air pollution and climate change [1].

There is an urgent need to review environmental safety. One of the ways to improve the environmental safety of the world can be the implementation of such a concept as a green economy. Green economy is a new paradigm aimed at the rational use of resources, application of energy from renewable energy sources, reduction of anthropogenic load, development of environmentally friendly industries, ensuring continuous economic development for social integration and improvement of the quality of life [2]. There are specific measures, including the adoption of legislative, organizational, fiscal and other decisions for effective improvement of environmental safety. The implementation of these measures will accelerate the process of development of environmental safety in the world [3-9]. In accordance with this, the relevance of the study is determined by the need to ensure sustainable development on the basis of a change in the world order in the direction of environmental protection.

2. Materials and methods

This research proposes to perform a cluster analysis using the STATISTICA 12 statistical package and to identify patterns of implementation of environmental safety by the G-7 and E-7 countries.

In particular, it is proposed to consider the environmental safety initiatives implemented by them from two perspectives:

- Reduction of carbon dioxide emissions;
- Increasing the use of renewable energy sources and low-carbon energy sources.
The implementation of the above study involves four stages:

- Clustering of countries by the value of GGEI. It allows judging what cluster a country belongs to, whether it is effectively implementing green business activities or not.
- Clustering using synthetic indicators, the denominator of which is the value of CO₂ emissions. The resulting clusters will make it possible to divide countries into those in which activities are organized with the maximum reasonable economic benefit per ton of greenhouse gases and those which still follow the extensive path of economic development without taking into account the impact of CO₂ emissions.
- Clustering by low-carbon electricity production and primary energy consumption from renewable sources. The results give an indication of which countries actively use clean energy sources and which do not.
- Interpretation of the results.

The GGEI is used to analyze the effectiveness of the implementation of greening of business activities by the countries of the world. This indicator was first published in 2010. Today it is widely used by international organizations, civil society, and businesses. The GGEI is published every 2 years by Dual Citizen LLC. The GGEI demonstrates a comprehensive measurement of how each country is performing with respect to climate change, decarbonizing of business activities and stabilizing the overall environment. Quantitative and qualitative indicators are used to calculate the GGEI [6].

The use of synthetic indicators, the denominator of which is the value of CO₂ emissions, due to the need to determine the feasibility of these emissions into the atmosphere. Thus, the volume of gross value added of industrial production (including construction) per 1 ton of CO₂ emissions demonstrates how many monetary units were earned due to the emission of 1 ton of carbon dioxide into the atmosphere. In turn, the number of people employed in industry per 1 ton of CO₂ emissions demonstrates how many people in their occupation have caused the emission of 1 ton of carbon dioxide.

The sources of these indicators will be data from the World Bank and the International Energy Agency, data from the statistical-analytical website Our World in Data, data from the Global Carbon Atlas website, etc.

3. Results
To perform the first clustering, we imported data from an MS Excel file into the Statistical Analysis Package Workbook. It contained the GGEI values for 2018 and 2016 for the 14 countries included in the G-7 and E-7. Then, the data were standardized due to the significant variation in the values of the variable, due to the peculiarities of the index calculation methodology in different years. After the standardization procedure, we performed tree clustering and constructed a dendrogram for 14 countries on 2 variables using hierarchical classification using Ward's method and Euclidean distance. It is presented in figure 1.

Based on the visual analysis, we can conclude that there are 3 clusters and another separate cluster is Germany. In order to unify the obtained clusters, when checking by k-means method, the number of clusters was set to «3» in the field «number of clusters». Thus, cluster No 1 consists of China, USA, India, Mexico, Turkey; cluster No 2 consists of Indonesia, Russia; cluster No 3 consists of Germany, France, UK, Canada, Japan, Italy, and Brazil. In order to determine which cluster is the best, average, and worst, descriptive statistics for each of the clusters were examined. Based on the values of the average we can judge that cluster No 1 corresponds to the average level of environmental aspect implementation, cluster No 2 corresponds to the worst level of environmental aspect implementation and cluster No 3 corresponds to the best level of environmental aspect implementation.
For the second clustering, synthetic indicators such as gross value added of industrial production (including construction) per 1 ton of CO\textsubscript{2} emissions from 2002 to 2016 and the number of people employed in industry per 1 ton of CO\textsubscript{2} emissions from 2002 to 2017 were imported into the Statistical Analysis Package Workbook. A data standardization procedure was then performed due to the significant variation in the values of the variables. After the standardization procedure, a tree clustering was performed and a dendrogram was constructed for the 14 countries for 31 variables using hierarchical classification using Ward's method and Euclidean distance. It is presented in figure 2. Based on the visual analysis, we can conclude that there are 3 clusters.

Thus, cluster No 1 consists of Brazil, India, Indonesia; cluster No 2 consists of Canada, China, Mexico, Russia, Turkey, USA; cluster No 3 consists of France, Germany, Italy, Japan, and UK. Descriptive statistics for each of the clusters were examined to determine which cluster was the best, average, and worst. Based on the mean values, it can be judged that cluster No 1 corresponds to the worst level of organization of economic activities in order to reduce CO\textsubscript{2} emissions, cluster No 2 corresponds to the average level and cluster No 3 corresponds to the best level.

To perform the third clustering, we imported indicators of electricity production from low-carbon sources and primary energy consumption from renewable sources from 2002 to 2017 into the Statistical Analysis Package Workbook. Then a data standardization procedure was carried out. After the standardization procedure, a tree clustering was performed and a dendrogram was constructed for
the 14 countries for 32 variables using hierarchical classification using the Wards method and Euclidean distance. It is presented in figure 3.

Based on the visual analysis, we can conclude that there are 4 clusters. Thus, cluster No 1 consists of China and the United States; cluster No 2 consists of France, Germany, Japan, Russia and India; cluster No 3 consists of Brazil, Canada; cluster No 4 consists of Indonesia, Italy, Mexico, Turkey and Britain. Descriptive statistics for each of the clusters were examined to determine which was the best, above average, below average, and worst. Based on the values of the average we can judge that cluster No 1 corresponds to the best level of energy use from green sources, cluster No 2 corresponds to below average level, cluster No 3 corresponds to above average level, cluster No 4 corresponds to the worst level.

Table 1 was constructed based on the three cluster analyses conducted.

| Indicator                                  | Level          | E-7 | G-7 |
|--------------------------------------------|----------------|-----|-----|
| Effectiveness of environmental security    | best average   | +   | +   |
| Justification of CO₂ emissions             | worst          | +   | +   |
| Use of renewable and low-carbon energy     | worst          | +   | +   |
| sources                                    | above average  | +   | +   |
|                                            | best           | +   | +   |

4. Discussion
The following patterns can be identified. China and the United States are at the same level of implementation of environmental safety. This indicates that these countries are characterized by environmental protection takes a back seat. Such countries as France, Germany and Japan are also at the same high level of efficiency in the implementation of environmental safety. The efforts made by these countries to organize business activities in order to reduce CO₂ emissions are high. However, the use of renewable energy source and low-carbon energy sources is below average. Countries such as Italy and the UK have the best level of environmental protection effectiveness, the best level of justification of CO₂ emissions and the worst level of renewable energy source and low-carbon energy sources.
use. Mexico and Turkey are at the same level of implementation of environmental safety: average level of justification of CO\textsubscript{2} emissions, but low level of use of renewable energy and low-carbon energy sources.

The experience in implementing environmental safety by such countries as India, Brazil, Russia, Indonesia and Canada is unique. India is characterized by an average level of efficiency in environmental protection, but the worst efforts to organize business activities to reduce CO\textsubscript{2} emissions and low popularity of the use of green energy sources. Brazil is a country with high environmental safety performance, probably due to a high use of renewables and low-carbon energy sources, despite low efforts to organize business activities to reduce CO\textsubscript{2} emissions. Russia and Indonesia are characterized by low level of efficiency of environmental safety. But Russia, unlike Indonesia, is making some attempts to develop environmental protection in the country in the areas of initiatives under consideration [10-15].

5. Conclusion
According to the results obtained, it can be observed that currently none of the countries in the sample implements environmental safety equally effectively from two positions:

- Reducing carbon dioxide emissions;
- Increasing the use of renewable and low-carbon energy sources.

Regularities have been identified, dismantling the same level of environmental protection of China and the United States; France, Germany and Japan; Italy and the United Kingdom; Mexico and Turkey. At the same time, no general development trends in environmental protection among countries from E-7 and G-7 groups were identified.

In addition, the identified clusters indicate that it is not yet possible to use the experience of implementing environmental protection in any of the 14 countries under consideration as a potential model. Thus, there is an urgent need to improve the implementation of the measures to protect the environment in global practice in order to improve environmental security and reduce the anthropological burden on the surrounding world.

References
[1] Albekov A U 2017 Green Economy. Modernization of the socio-economic system of Southern Russia (Rostov-on-Don: Publishing and printing complex of Rostov State University of Economics (RSUE)) 276
[2] Allen C 2012 A guidebook to the Green Economy. Issue 1: Green Economy, Green Growth and Low-Carbon Development – history, definitions and a guide to recent publications Division for Sustainable Development (New York: UNDESA, Division for Sustainable Development) 65
[3] BP Energy Outlook, 2019 Edition Retrieved from: https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/energy-outlook/bp-energy-outlook-2019.pdf
[4] Center for Sustainable Development and Environmental Health Retrieved from: http://www.sustainabledevelopment.ru/upload/Files/ISD_UNEP_GE_Rus.Pdf
[5] Climate Policy Initiative Retrieved from: https://climatepolicyinitiative.org/
[6] Dual Citizen The Global Green Economy Index Retrieved from: https://dualcitizeninc.com/global-greeneconomy-index/
[7] Enerdata CO2 emissions from fuel combustion Retrieved from: https://yearbook.enerdata.net/co2-fuel-combustion/CO2-emissions-data-from-fuel-combustion.html
[8] Market analysis and forecast from 2018 to 2023 Retrieved from: https://www.iea.org/renewables2018/
[9] Pearce D 1990 Blueprint 2: Greening the world economy (London: Earthscan Publications Ltd) 232
[10] The World Bank World Development Indicators Retrieved from: http://datatopics.worldbank.org/
[11] Nikiforov A, Kuchumov A, Terentev S, Karamulina I, Romanova I and Glushakov S 2020 Neural network method as means of processing experimental data on grain crop yields. E3S Web of Conferences 161 01031
[12] Gnezdova J V, Semchenkova S V and Kuchumov A V 2020 State Backing of Modernization of Main Funds of Agricultural Purpose within a Matter of Increasing Food Security of Russia. IOP Conference Series: Earth and Environmental Science 459(6) 062061
[13] Terentyev S E, Gnezdova J V and Semchenkova S V 2020 Features of Machine-Technological Stations Organization in the System of Agro-Industrial Production. IOP Conference Series: Earth and Environmental Science 459(6) 062060
[14] Viyugin S M, Kuchumov A V, Viyugina G V, Terentyev S E and Karamulina I A 2020 Influence of regional technologies of varying intensity on the bioproductivity of sod-podzolic medium loamy soil in the central region of the Russian federation. Agronomy Research 18(4) 2653-2664
[15] Nikiforov A, Kuchumov A, Terentev S, Petukhov E and Kabalyk K 2019 Simulation of gas-dynamic characteristics of a centrifugal compressor vane diffuser using neural networks. E3S Web of Conferences 140 05003