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Using the Composite EEPSE Green Economy Index to Assess the Progress of Emerging Economies in Achieving the Sustainable Development Goals

Wykorzystanie złożonego indeksu zielonej gospodarki EEPSE do oceny postępu gospodarek rozwijających się w osiąganiu Celów zrównoważonego rozwoju

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Abstract
As a concept, the green economy refers to the transition from coal to renewable energy sources to reduce pollution, the energy efficiency of production processes to achieve savings, the reuse of materials from waste in business and energy production, changes designed to stop harmful climate change and bring new opportunities for economic development. In this way, conflicts between economic development and environmental issues are resolved, with the aim of achieving sustainability of the economy and society. The aim of the study is to provide a comparative analysis of the level of development of the green economy in selected 20 emerging economies and their progress towards achieving the Sustainable Development Goals (SDGs) from the 2030 Agenda using the EEPSE Green Economy Index (EEPSE GEI), based on Quintuple Helix Innovation Model (QHIM), and examine the interdependence between each of the 5 subsystems (quality of education system, economic aspects, political system, civil society, and natural environment) with this index. The results indicate that among the group of countries observed, Estonia is the best performer, while Egypt has the lowest performance. The results, also, indicate the important role of each of the subsystems in EEPSE GEI. The study can be useful for policy makers to identify weaknesses in achieving the SDGs.

Key words: green economy; sustainable development strategies; Quintuple Helix model; EEPSE Green Economy Index; cluster analysis; correlation analysis

Streszczenie
Jako koncepcja, zielona gospodarka odnosi się do przejścia z węgla na odnawialne źródła energii w celu ograniczenia zanieczyszczeń, efektywności energetycznej procesów produkcyjnych w celu osiągnięcia oszczędności, ponownego wykorzystania materiałów z odpadów w biznesie i produkcji energii, zmian mających na celu zatrzymać szkodliwe zmiany klimatyczne i stworzyć nowe możliwości rozwoju gospodarczego. W ten sposób rozwiązywane są konflikty pomiędzy rozwojem gospodarczym a kwestiami środowiskowymi, umożliwiając osiągnięcie zrównoważonego rozwoju gospodarki i społeczeństwa. Celem artykułu jest dokonanie analizy porównawczej poziomu rozwoju zielonej gospodarki w wybranych 20 gospodarkach rozwijających się oraz ich postępu w realizacji

Celów zrównoważonego rozwoju (SDGs) wynikających z Agendy 2030 z wykorzystaniem Indeksu Zielonej Gospodarki EEPSE (EEPSE GEI), w oparciu o Model Innowacji Pięciokrotnej Helisy (QHIM) i bada współzależność pomiędzy każdym z 5 podsystemów (jakość systemu edukacji, aspekty ekonomiczne, system polityczny, społeczeństwo obywatelskie i środowisko naturalne) za pomocą tego indeksu. Wyniki wskazują, że wśród obserwowanej grupy krajów najlepiej radzi sobie Estonia, a najgorzej Egipt. Wyniki wskazują także na ważną rolę każdego z podsystemów w EEPSE GEI. Badanie może być przydatne dla decydentów w celu zidentyfikowania słabych punktów w osiąganiu Celów zrównoważonego rozwoju.

Słowa kluczowe: zielona gospodarka; strategie zrównoważonego rozwoju; model pięciokrotnej helisy; wskaźnik zielonej gospodarki EEPSE; analiza klastrów; analiza korelacji

1. Introduction

The green economy has evolved in response to the ever-increasing challenges of climate change and is attracting much scientific attention. Traditional fossil fuels, which are closely linked to economic development, have led to increasing warming of the entire planet, i.e., the occurrence of extreme weather events. With the aim of overcoming the conflicts between economic development and environmental degradation, the green economy has *imposed itself* as an inevitable requirement for sustainable economic development (Ali, et al., 2021). The green economy project at the global level gained importance in 2012, when the United Nations Conference (UN) was held in Rio de Janeiro. In the last part of the conference documents, the need for transition to the *green way* by countries around the world is emphasized, with the indication that this transition should be coordinated with national plans, i.e. sustainable development strategies (Đurić, 2021). Venkatesh (2021) draws attention to the temporal aspect, which implies that while it is important to maintain a long-term perspective, the process of sustainable development truly never ends.

As the transition to a green economy and measuring progress toward Sustainable Development Goals (SDGs) are important issues for the entire scientific community, a number of scholars (Gibbons et al., 1994; Carayannis et al., 2012; Ryszawska, 2015; Lavrinenko et al., 2019; Konig et al., 2021; Barcellos-Paula et al., 2021; Rybalkin et al., 2021) have attempted to develop and apply comprehensive indices that incorporate various indicators such as natural capital, politics, economy, education, and society. In this sense, the aim of the paper is to make a comparative analysis of the level of development of the green economy in selected 20 emerging economies and their progress towards achieving the Sustainable Development Goals (SDGs) from the 2030 Agenda using the EEPSE Green Economy Index (EEPSE GEI), as well as to determine the interdependence of each of the five subsystems (quality of education system, economic aspects, political system, civil society, and natural environment) with the EEPSE GEI.

The paper is structured as follows. The introductory presentation is followed by the research background. The methodology is provided in the next section, which is followed by the results and discussion. The main findings of the study are presented in the final section.

2. Research background

In order to simultaneously reduce energy consumption and pollution and prevent stagnant economic development, the green economy should be built on an economic model with low emissions of carbon dioxide and other pollutants (Jin, 2012). The green economy project has been adopted by nearly 137 nations, who have committed to reducing their carbon emissions - if possible, to zero - during the transition to 2050. With the aim of having zero carbon emissions by 2060, China has planned to actively cut its carbon emissions starting in 2030. The 2030 Agenda, titled *Transforming our world* for sustainable development and the future, was finally adopted in September 2015, following nearly two years of international consultations at the level of civil association organizations, academics, scientists, and citizens from around the world (United Nations, 2015). The Agenda contained seventeen SDGs and 231 indicators recommended by the UN (UNSTAT, 2022). The fundamental tenet of the Agenda is *leaving no one or nothing behind* and the comprehensive integration of the social, environmental, and economic pillars of sustainable development. Promoting a world based on the *5 P* (People, Planet, Prosperity, Peace, Partnership) idea, sometimes known as People, Planet, Prosperity, Peace and Partnership, is one of the goals of the Agenda. The complete protocol for implementing the 2030 Agenda was planned out, with the positions that it should be *strong, voluntary, efficient, participatory, transparent, and inclusive* being adopted.

For the SDGs to be implemented, agenda monitoring at the international, regional, and national levels is essential. The 17 goals of the 2030 Agenda must all be reported on consistently in order for the right actions to be taken, statistical data to be gathered, and, finally, policy flaws in the Agenda's implementation to be identified and corrected (Lafortune et al., 2020). Monitoring the accomplishment of the Agenda's objectives heavily relies on scientific research as a tool for the development of sustainable policies. Mentoied authors discussed different methodologies for analyzing the linkages between the goals and provided data and opportunities for assessing progress at the global, regional, state and sub-national levels.

The 2030 Agenda has been studied in two key areas, according to Tadashi (2022). The measurement of sustainability is the first area, which is a major concern for stakeholders, researchers, and policymakers (Miola & Schiltz, 2019). The second area is reporting on CO_2 targets, which should actually make the entire measuring process easier and offer an integrated framework for keeping track of and responding to changes in the economy, society, and environment. Collaboration between stakeholders at all levels (from global to local) is necessary for monitoring and measuring sustainability, yet this is frequently impossible. It is not simple to evaluate how successfully the agenda and goals are being implemented because it heavily depends on countries' positions as well as ranking systems and indicators (Avtar et al., 2019). Many authors have found interesting data in their studies on implementing goals and measuring sustainability. The SDGs must be attained in order to achieve the circular economy (CE), which is an overarching idea that demands a paradigm change (Naidoo et al., 2021). Some authors emphasize the connections that exist between the tools of new technologies 4.0 and the circular economy (Ahmed et al., 2022).

The SDGs can be achieved through reuse, reduce, renovate, recycle, repair, and remanufacture (Naidoo et al., 2021). A model is proposed that prepares the transition to resource efficiency (smart innovation; resource efficiency in industrial ecology, water reuse, cleaner manufacturing, and renewable energy). After 2012, the green economy saw its growth accelerate; however, after 2015, it saw its growth surge. To evaluate risk in the markets for green and conventional energy, Zhao et al. (2023) looked at the green economies of the Americas, Europe, and Asia. Three *green* indices – the Green Economy Index of the United States of America, the Green Economy European Index, and the Green Economy Asian Index – were compared by the aforementioned authors using NASDAQ data. The COVID-19 pandemic significantly impacted energy facilities, supply chains, and businesses, which hindered the rate of global green development, according to the study's findings. This detrimental outcome is especially evident in the areas of a sharp decline in investment in renewable energy projects, delays in the delivery of equipment for energy projects, and a fall in public demand for renewable energy (Ili et al., 2019; Ili, 2020; Prasad et al., 2022). The green economy is a crucial factor in determining how well the SDGs are implemented, especially in light of the fact that renewable energy sources are both economically advantageous and safer for ecosystems (Ospanova et al., 2022).

A true transition to a green economy, according to Zhironkin and Cehlár (2022), necessitates the saturation of production and consumption with green technologies as well as of all industries' sustainable growth. According to research by Chaaben et al. (2022) conducted a study to assess Saudi Arabia's environmental friendliness and its advancement toward sustainable development from 2015 to 2020. The authors previously stated employed the 42-indicator EEPSE GEI, which is based on the QHIM model. According to empirical findings, Saudi Arabia has made significant strides toward achieving the SDGs. Rybalkin (2022) used the same methodology and the 50-indicator, and produced results that support the efficacy of the EEPSE GEI and show how it contributes to the realization of the sustainable development goals in the member states of the European Union. *The percentage of people with at least basic digital skills*, and *infrastructure, business, and innovation* are significantly positively correlated with the EEPSE GEI, while *smoking prevalence* is significantly negatively correlated with this index, according to the findings of the aforementioned study. Two decision support models were proposed by Barcellos-Paula et al. (2021). The first proposes 20 QHIM indicators for the Sustainable Development Goals of Latin American countries, and the second uses a fuzzy logic algorithm to find forgotten impacts. According to the results, Chile ranked first, than Brazil second, folowed by Mexico, Peru and the least rank Colombia. The results of the study described above emphasize the importance of accurately determining causality by seeking systemic harmony. Quacoe et al. (2023) used the QHIM model to investigate how entrepreneurship and the green economy affect sustainable development in South Africa. According to the research of the aforementioned authors, resource productivity has a positive and statistically significant relationship with sustainable development, whereas natural capital and entrepreneurial attitudes have a significantly negative relationship with it. Entrepreneurial activity has a positive relationship with sustainable development, but has a very weak impact on it. Łącka (2020) notes that the QHIM model is hardly ever employed in Poland, mostly due to the numerous challenges that each component of this model confronts when being implemented. Autor attributes this to the dearth of interdisciplinary research that addresses these issues.

3. Methodology

3.1. Data and research sample

For the purposes of the research, data from several publications and official websites were used (Appendix). Since some of the data used in studies by Ribalkin et al. (2021), Rybalkin (2022), and Chaaben et al. (2022) are missing for certain emerging countries, other data were used, which are in line with the sustainable development indicators. When it comes from emerging countries, in this category of countries, the International Monetary Fund qualifies 20 countries, MSCI Emerging Markets Index, S&P and Dow Jones 25, and Russel 24. Due to the availability of data, 20 countries from these lists are included in this research (Argentina, Brazil, Chile, China, Columbia, Czech Republic, Egypt, Estonia, Greece, Hungary, India, Latvia, Poland, Malaysia, Mexico, Philippines, Slovak Republic, South Africa, Thailand and Turkey).

3.2. Method

Based on the methodology used in the studies by Rybalkin et al. (2021), Rybalkin (2022), and Chaaben et al. (2022), the paper uses EEPSE GEI for a comparative analysis of the progress of the green economy and SDGs among emerging economies. Indeed, through a quantitative analysis of the content of numerous and divergent definitions of the concept of green economy, first Vertakova & Plotnikov (2017) and then Swart & Groot (2020) highlighted the multidisciplinary and multidimensional nature of this phenomenon and pointed out that the comprehensive index of the green economy should include education, economy, society and natural environment. Accordingly, Lavrinenko et al. (2019), as well as Rybalkin (2022) applied the Quintuple Helix Model in their studies, which includes 5 spirals: 1) the educational system (academic and higher education institutions), 2) the economic system (industry, banking and services), 3) the political system (authorities with their plans, laws and ideas), 4) the public sphere based on media and culture, and 5) the natural environment. Within this inter- and transdisciplinary model, these five spirals function according to the principle of *subsystems*, in which knowledge moves between subsystems in a circular fashion (Grundel & Dahlstroem, 2016; Rybalkin, 2022).

The construction of a complete EEPSE GEI, which encompasses education, the economics, politics, society, and the environment as subsystems of the green economy, was based on the Quintuple Helix Model (Rybalkin et al., 2021). Chaaben et al. (2022) suggest that the transition to a green economy and the achievement of sustainable development can be assessed based on this model. In light of this, the Quintuple Helix Innovation Model (QHIM), which has received support from global bodies like the UNESCO and United Nations (Millard, 2018; Chaaben et al., 2022), is a potent tool for making decisions. It offers a framework for research and policy, promoting inclusive and sustainable industrialization, and encouraging innovation.

In order to organize heterogeneous units into relatively homogeneous groupings, cluster analysis can be used to identify relationships between them. Choosing the right cluster approach is the first step in conducting a cluster analysis, and in this paper, agglomerative hierarchical cluster analysis will be used. The first step in doing a cluster analysis is choosing the best cluster process. In this research, agglomerative hierarchical cluster analysis will be used. Iteratively joining previously created groups of objects or creating a new group with another object is the essence of this technique, which applies a bottom-up approach. Each object originally represents a single cluster (Jafarzadegan et al., 2019).

The strength of the link between each subsystem and the EEPSE GEI, i.e. the importance of each subsystem in the EEPSE GEI, was analyzed using correlation analysis. The correlation coefficient (r) shows the degree of quantitative agreement (interdependence) of two random variables (x and y). This interdependence can be functional, i.e. very strong, and stochastic, i.e. very weak. It ranges from -1 to +1 and can be expressed mathematically by the following formula:

$$r = \frac{n\sum xy - \sum x \sum y}{\sqrt{n\sum x^2 - (\sum x)^2}\sqrt{n\sum y^2 - (\sum y)^2}} \quad (1)$$

The height of the correlation coefficient is interpreted based on the suggestions of Evans (1996), who suggests that the absolute value of the correlation coefficient (r) is in the interval of: 0.00 – 0.19 - very weak; 0.20 – 0.39 – weak; 0.40 – 0.59 – moderate; 0.60 – 0.79 - strong, and 0.80 – 1.00 - very strong.

3.3. Index configuration

A total of 41 indicators, including 8 indicators each for the subsystems *quality of education*, *economic aspects*, and *natural environment*, 10 indicators for *civil society*, and 7 indicators for the *political system*, were used to produce the composite indicator, or EEPSE GEI. Since it is a multidimensional process, Ribalkin et al. (2021) advise against using individual indicators and instead suggest using a composite index. The Z-score approach was used to standardize the data in the first phase so that it could be compared, and the T-score was produced in the second step to increase transparency (Chaaben et al., 2022; Rybalkin, 2022):

$$T = (Z * 10) + 50 \quad (2)$$

To calculate factors of the EEPSE Green Economy Index, the arithmetic mean of the corresponding indicators, i.e. 5 subsystems, which include education, economy, politics, society, and environment, was used. The EEPSE GEI is calculated as the arithmetic mean of the values of five subsystems (Lavrinenko et al., 2019; Chaaben et al., 2022; Rybalkin, 2022).

The purpose of creating a new composite measure is to formulate an instrument, which will help researchers and policymakers of the researched group of countries, i.e. emerging economy, and can be used to assess the progress of the green economy and the goals of sustainable development (Table 1).

Table 1. EEPSE GEI and relevant goals of sustainable development (authors' presentation)

Subsystem	Sustainable Development Goals
Quality of education system	SDG4 and SDG9
Economic aspects	SDG7, SDG8, SDG9, SDG11, SDG13 and SDG17
Political system	SDG7, SDG9, SDG11, SDG12 and SDG13
Civil society	SDG1, SDG2, SDG3, SDG5, SDG9, SDG10, SDG16 and SDG17
Natural environment	SDG6, SDG12, SDG13, SDG14 and SDG15

4. Results and discussion

According to the research results (Figure 1), Estonia is the highest ranked country on the list of observed emerging countries, with EEPSE GEI equal to 59.02, while the lowest ranked country is Egypt, with EEPSE GEI equal to 44.50. Apart from Estonia, countries with EEPSE GEI scores above 50 include Latvia (55.81), Czech Republic (55.32), Greece (54.21), Slovakia 54.10), Chile (53.78), China (52.40), Hungary (51.94), Poland (51.67) and Brazil (50.07). The EEPSE GEI score of other emerging countries is less than 50.00.

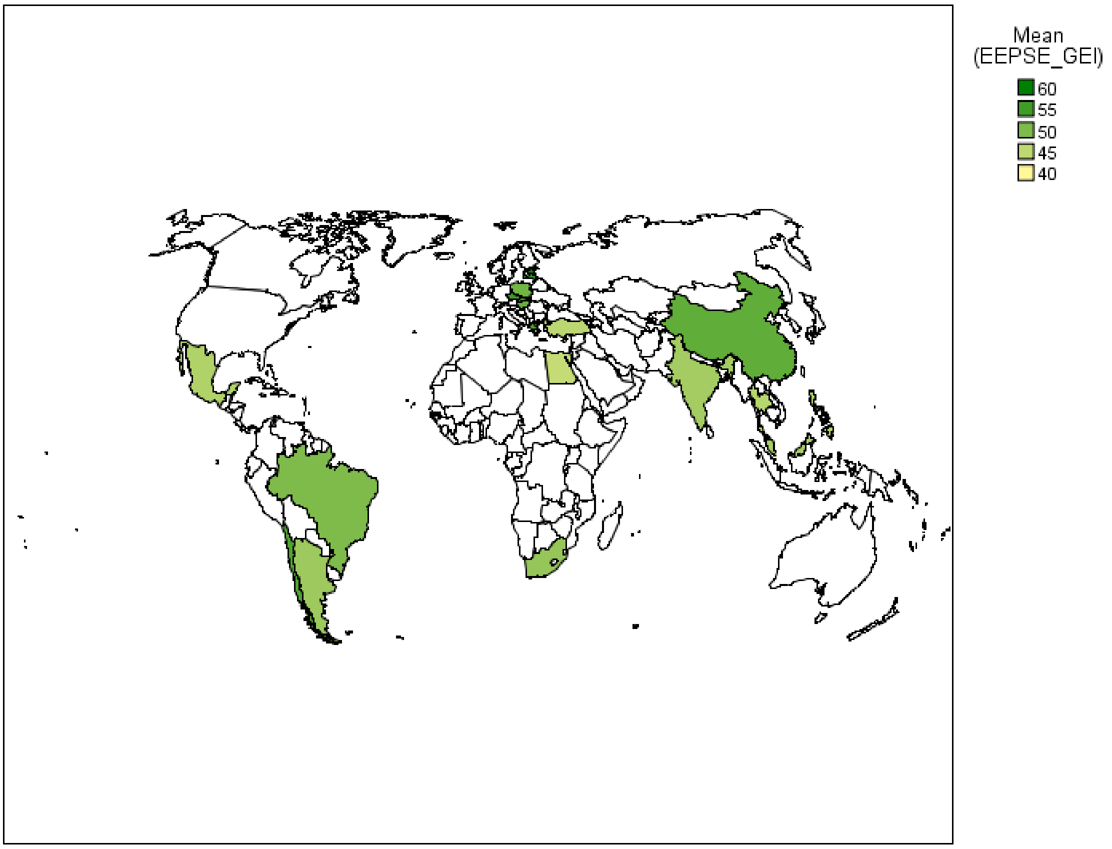

Figure 1. The emerging countries by EEPSE GEI in 2022 (authors' presentation)

In the cluster analysis, emerging countries are divided into two homogeneous clusters, of 10 countries each, according to their EEPSE GEI (Figure 2). The first cluster includes countries with lower EEPSE Green Economy Index scores, namely: Columbia, South Africa, Argentina, India, Malaysia, Mexico, Philippines, Thailand, Turkiye and Egypt, while the second cluster includes countries with higher EEPSE Green Economy Index scores, namely: Estonia, Latvia, Greece, Slovakia, Chile, China, Czech Republic, Hungary, Poland and Brazil.
From the tabular presentation (Table 2), it can be seen that in the group of countries from Cluster 1, India has the best results for the subsystem *quality of education* (52.67), Colombia for *economic aspects* (55.31) and for *natural environment* (51.87), India for *political system* (55.87), while Argentina has the best results for the subsystem *civil society* (53.51). In this group of countries, Columbia (48.46) has the best score on the overall index EEPSE GEI, while Egypt (44.50) has the least.

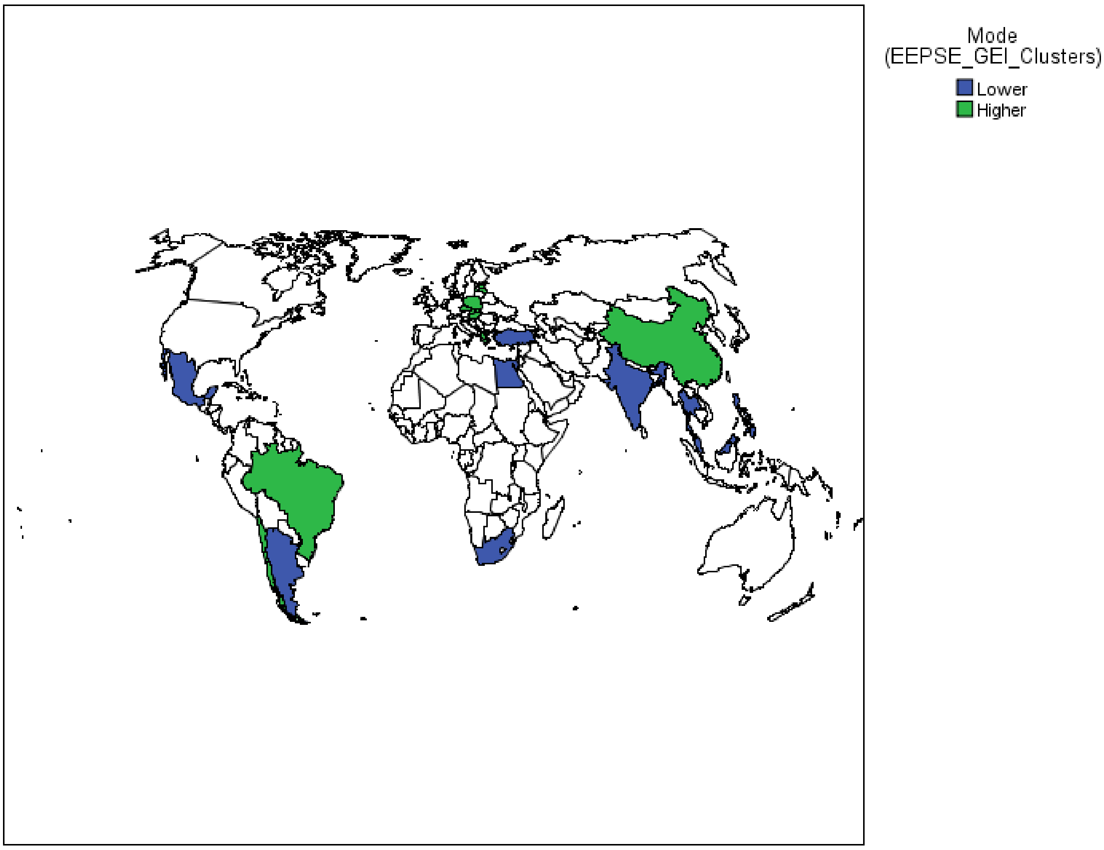

Figure 2. The emerging countries clusters by EEPSE GEI in 2022 (authors' presentation)

Table 2. Mean values of subsystems and EEPSE GEI for Cluster 1 in 2022, (authors' own calculation)

Country	Quality of education system	Economic aspects	Political system	Civil society	Natural environment	EEPSE GEI
Columbia	**46.19**	**53.31**	43.55	47.39	**51.87**	**48.86**
South Africa	49.59	43.80	50.59	51.12	45.88	48.20
Argentina	48.23	**43.02**	43.06	**53.51**	50.51	47.67
India	**52.67**	50.09	**55.87**	40.33	**36.63**	47.12
Malaysia	46.26	43.43	47.75	51.14	44.99	46.71
Mexico	46.92	43.56	48.59	43.62	48.22	46.18
Philippines	46.97	51.68	49.11	41.61	40.80	46.03
Thailand	46.68	46.72	43.20	46.79	44.10	45.50
Turkiye	48.98	49.43	**39.21**	45.45	43.02	45.22
Egypt	47.24	46.95	45.86	**39.52**	42.94	**44.50**

In the group of countries with higher mean scores of EEPSE GEI (Cluster 2), China shows the best results for the subsystem *quality of the education system* (81.20), Latvia for *economic aspects* (57.47) and Estonia for the subsystems: *political system* (61.60), *civil society* (61.13) and *natural environment* (62.75). In this group of countries, Estonia has the best result of the overall index EEPSE GEI (59.02), while Brazil (50.07) has the worst result. Table 3 shows more detailed results. Based on the data in Table 2 and Table 3, it can be observed that the mean values of all subsystems are higher in the emerging countries grouped in Cluster 2, which includes emerging countries with higher values of the observed index. It can be noted that the greatest differences between emerging countries are observed in the area of education, then in the area of the natural environment, political system and the civil society, and the least in the area of the economy. The tabular representations generally suggest that each of the observed countries has weaker outcomes in certain subsystems, with the exception of Estonia, which attained high results in each of the five subsystems. The mean values of each subsystem, in the observed emerging countries, is shown in Figure 3.

Table 3. Mean values of subsystems and EEPSE GEI for Cluster 2 in 2022 (authors' own calculation)

Country	Quality of education system	Economic aspects	Political system	Civil society	Natural environment	EEPSE GEI
Estonia	52.33	57.30	**61.60**	**61.13**	**62.75**	**59.02**
Latvia	**46.18**	**57.47**	57.38	57.33	60.67	55.81
Czech Republic	51.63	53.67	55.10	57.26	58.93	55.32
Greece	52.32	49.91	54.56	56.37	57.91	54.21
Slovakia	48.49	51.93	54.91	56.65	58.51	54.10
Chile	49.05	52.01	58.06	56.72	53.03	53.78
China	**81.20**	51.79	49.69	**40.55**	**38.80**	52.40
Hungary	51.03	53.94	50.68	50.99	53.07	51.94
Poland	51.65	**48.09**	**45.54**	54.61	55.49	51.67
Brazil	51.79	49.90	45.87	49.91	52.89	**50.07**

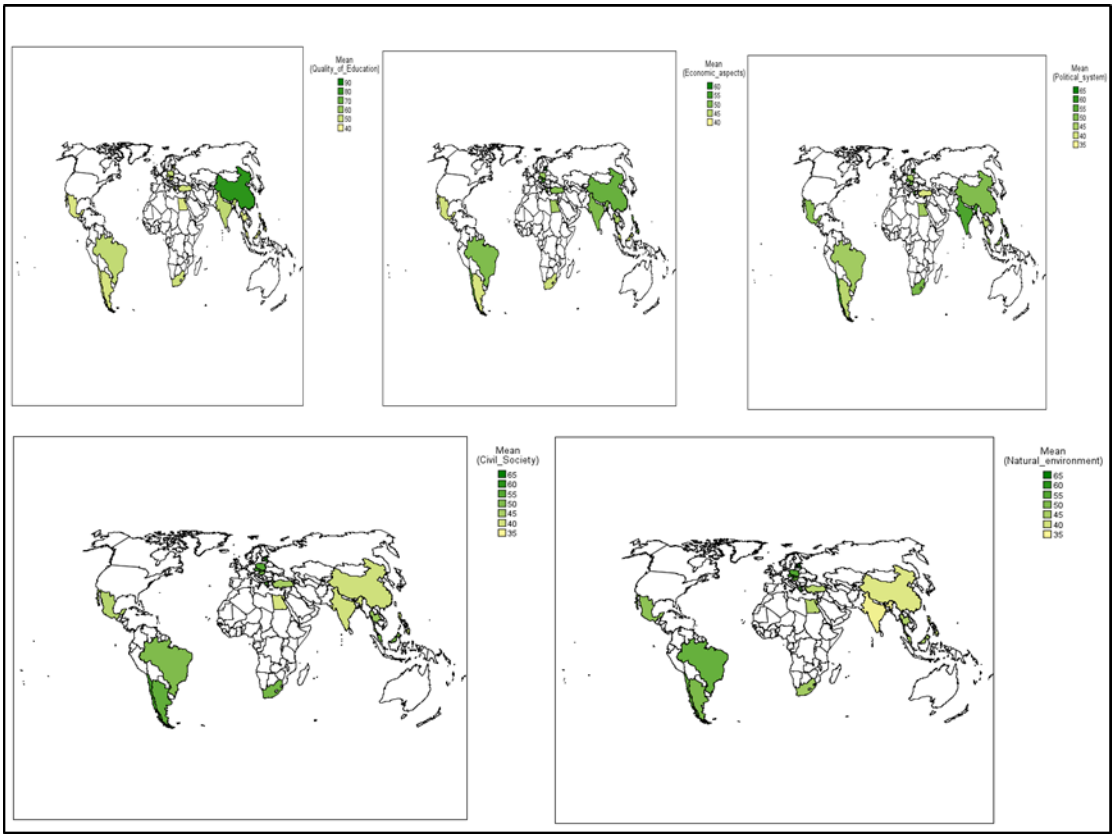

Figure 3. EEPSE GEI subsystem's mean value in emerging country (authors' presentation)

The application of EEPSE GEI has shown that Estonia achieves the best result among the countries observed. Previous research (Rybalkin et al., 2021; Rybalkin, 2022) also shows that Estonia is one of the countries with higher levels of EEPSE GEI. However, unlike the results of earlier studies, which classify Hungary, Slovakia, Czech Republic, Greece, Poland and Latvia (Rybalkin et al., 2021; Rybalkin, 2022) in the group of countries with a low level of the index, according to the results of the current study, these countries are classified in a cluster with higher levels of the EEPSE GEI. These differences can be attributed to the different groups of countries that were examined.

The degree of connection of each of the 5 subsystems with the EEPSE GEI was analyzed using correlation analysis. Since China is one of the most developed countries at the global level in the subsystem *quality of the education system*, Table 4 shows the results of the correlation analysis with and without indicators for this country. When China is included in the analysis, the results show that *quality of education system* is positively, but not statistically significantly correlated with EEPSE GEI, while there is a very strong, statistically significant and positive correlation between *natural environment* (0.874) with EEPSE GEI and a strong, statistically significant and positive correlation between *civil society* (0.779), *political system* (0.771) and *economic aspects* (0.701) with EEPSE GEI. However, when China is excluded from the analysis, *natural environment* (0.906) and *civil society* (0.880) are very strongly positively correlated at statistically significant levels with EEPSE GEI. Apart from that, *political system* (0.779) and *economic aspects* (0.698) are in a strong positive and statistically significant correlation with EEPSE GEI, while there is a moderate, positive and statistically significant correlation between the *quality of education system* (0.463) and EEPSE GEI.

Table 4. The Correlation Coefficients of 5 subsystems and EEPSE GEI (authors' own calculation)

		EEPSE GEI	Quality of education system	Economic aspects	Political system	Civil society	Natural environment
EEPSE GEI with Kina	Pearson Correlation	1	.260*	.701***	.771***	.779***	.801***
EEPSE GEI without Kina	Pearson Correlation	1	.463**	.698***	.779***	.880***	.906***

Note: N = 19; * - Correlation is not ignificant; **- Correlation is significant at the 0.05 level; ***- Correlation is significant at the 0.01 level

Unlike Ribalkin et al. (2021), as well as Chaaben et al. (2022) who highlight the *political system* and *quality of education system* as the most important determinants of EEPSE GEI, when it comes to emerging countries, the situation is different. The obtained results show that the *natural environment* is the most important factor of the EEPSE GEI, followed by the *civil society, political system, economic aspects* and, in the last place, *quality of education*. These results are unexpected. However, given that all of the countries under observation have good scores for *quality of education,* ranging from 46.18 (for Latvia) to 81.20 (for China), indicating that they are moving in the right direction to meet SDG4 (quality of education) and SDG9 (industry, innovation and infrastructure), it is clear that they still have work to do and need to make investments in a variety of areas that are related to other SDGs. The study's findings indicate the weaker performance of emerging countries (primarily within Cluster 1) in the *economic aspect* and the *political system*. Within the *economic aspects* subsystem, the lowest score was recorded by Argentina (43.02), while in the *political system*, the lowest performance was recorded by Turkey (39.21). An extensive spectrum of players, including businesses, citizens, and civic sector organizations, must be involved in the more intensive utilization of renewable energy sources. The leading players in the use of renewable energy sustainably are state governments, which must see to the creation of an effective institutional and organizational framework as well as the bolstering of administrative capacities. By reducing greenhouse gas emissions, enhancing health through a reduction in pollutant emissions, and producing financial savings, energy-efficient technology could help emerging economies realize SDG3 (good health and well-being), SDG7 (affordable and clean energy), SDG8 (decent work and economic growth), SDG9, SDG11 (sustainable cities and communities) and SDG13 (climate action). The attainment of the above goals and SDG12 (responsible consumption and production), as well as SDG17, can be greatly aided by the implementation of incentive programs for renewable energy producers and consumers, as well as the allocation of funding for pertinent R&D initiatives in this field, by investment in green technologies, improving cooperation between universities and industry, the creation and implementation of more environmental regulations, and increasing consumer awareness of environmental protection. The societal acceptance of projects' green economy and the general improvement of environmentally friendly consumer behavior can both be influenced by the public understanding of renewable energy sources. Lower performances were also recorded in the *civil society* subsystem. The lowest performance of this subsystem was recorded in Egypt (39.52), India (40.33), China (40.55), the Philippines (41.61), and Mexico (43.62). Emerging countries have different potentials for improving this subsystem, primarily by establishing national social development strategies, in order to secure financial resources, solve the problem of unequal access to health services, promote gender equality, and improve access to internet services, which are in line with SDG1 (no poverty), SDG2 (zero hunger), SDG3 (good health and well-being), SDG5 (gender equality), SDG10 (reduced inequalities) SDG16 (peace, justice and strong institutions) and SDG17 (partnerships for the goals). Emerging countries, also, show weaker performance in the *natural environment* subsystem, particularly India with a score of 36.63 and China with a score of 38.80. In this sense, further financial investments and efforts are needed to promote and protect the sustainable management and use of all types of forests and waters, reduced waste production, ensuring access to safe drinking water, preservation of biodiversity and habitat, as well as compliance with measures related to climate change, which is in line with SDG6 (clear water and sanitation), SDG12 and SDG13, SDG 14 (life below water) and SDG15 (life on land).

Conclusion

The study aimed to apply the EEPSE Green Economy Index in determining progress in achieving SDGs and examine the interdependence between each of the 5 subsystems with this index. According to the findings, among the studied emerging economies, Estonia came out on top, while Egypt came in last. Ten countries (Estonia, Latvia, Greece, Slovakia, Chile, China, Czech Republic, Hungary, Poland and Brazil) are categorized into nations with a higher level of EEPSE GEI in accordance with the findings of the cluster analysis., while 10 countries are grouped into nations with a lower level of the observed index. (Columbia, South Africa, Argentina, India, Malaysia, Mexico, Philippines, Thailand, Turkiye and Egypt).

When China was taken into account in the correlation analysis, the findings revealed a positive link between each of the five subsystems and the EEPSE GEI. The findings demonstrated that the economic aspects come in last, with the political system, civil society and natural environment playing the next-largest important roles in the observed index. When China is included in the analysis, the influence of educational quality is not statistically significant. The findings of the correlation analysis, without Kina, revealed that the quality of the natural environment is the most important determinant of EEPSE GEI, followed by the civil society, political system, economic aspects and educational system.

By filling the identified gaps, the study improves the frontier of knowledge while contributing to the analysis of green economy and sustainable development through the proposed EEPSE GEI. Compared with other studies, this study empirically proposes a new indicator system technique that can quantify the achievement of SDGs in the context of emerging economies. Research results of this study are useful input for government, society, academia and business, providing a means of assessing a country's performance, identifying its shortcomings and advancing a systemic vision for achieving the Sustainable Development Goals. As such, this study is original and useful to various stakeholders. The study, also, opens new avenues for future research on the potential use of EEPSE GEI on global sustainable development issues.

In conclusion, it should be noted that facilitating the transition to a green economy is critical to maximizing economic, social and environmental potential and creating a sustainable future. However, cooperation among the five subsystems of the QHIM – education, political institutions, economy, nature, and society – is becoming necessary for all economies to facilitate this transformation.

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Appendix

Table 4. Quality of education system indicators

Variable	Source
Documents	Scientifc Journal Rankings
Citable documents	Scientifc Journal Rankings
Citations	Scientifc Journal Rankings
Self citations	Scientifc Journal Rankings
Citations per document	Scientifc Journal Rankings
H index	Scientifc Journal Rankings
Gross expenditure on R&D, % GDP	Global Innovation Index
Patents by origin/bn PPP$ GDP	Global Innovation Index

Table 5. Economic aspects

Variable	Source
Resource Efficience Index	The global sustainable competitiveness index
GDP per unit of energy use	Global Innovation Index
ISO 14001 environmental certificates per bn PPP$ GDP	Global Innovation Index
Greenhouse gas emissions score	Climate Change Performance Index
Global sustainable competitiveness index	Global Sustainability Rankings
Renewable energy consumption (% of total final energy consumption)	https://data.worldbank.org/indicator/EG.FEC.RNEW.ZS
University-industry collaboration in Research & Development	Global Innovation Index
Labor productivity	Global Innovation Index

Table 6. Political system

Variable	Source
Climate Policy	Climate Change Performance Index
Climate Change Performance Index	https://ccpi.org/
Environmental Performance Index	https://epi.yale.edu/epi-results/2022/component/epi
Environment related treaties in force count	Global Competitiveness Report
Intellectual property protection	Global Competitiveness Report
Renewable energy regulation	Global Competitiveness Report
Government effectiveness	Global Innovation Index

Table 7. Civil society

Variable	Source
World Press Freedom Index	https://www.jagranjosh.com/general-knowledge/world-press-freedom-index-2022-norway-tops-the-index-india-ranked-at-150th-position-1651663899-1
Democracy index	Economist Intelligence Unit
Political Civil Liberties	https://ourworldindata.org/grapher/political-civil-liberties?country=ARG~AUS~BWA~CHN~OWID_WRL
Social Capital Index	https://solability.com/the-global-sustainable-competitiveness-index/the-index/social-capital
Corruption Perception Index	https://www.transparency.org/en/cpi/2022
Individuals Using the Internet (% of population)	https://data.worldbank.org/indicator/IT.NET.USER.ZS
ICT access	Global Innovation Index
Human Development Index	https://hdr.undp.org/data-center/human-development-index#/indicies/HDI
Poverty Rate	https://worldpopulationreview.com/country-rankings/poverty-rate-by-country
Unemployment, female (% of female labor force) (modeled ILO estimate)	https://data.worldbank.org/indicator/SL.UEM.TOTL.FE.ZS

Table 8. Natural environment

Variable	Source
Water Resources	https://epi.yale.edu/epi-results/2022/component/wrs
Air quality	https://epi.yale.edu/epi-results/2022/component/wrs
Agriculture	https://epi.yale.edu/epi-results/2022/component/wrs
Biodiversity and habitat	https://epi.yale.edu/epi-results/2022/component/wrs
Waste management	https://epi.yale.edu/epi-results/2022/component/wrs
Environmental Health	https://epi.yale.edu/epi-results/2022/component/wrs
Protected Areas Representativeness Index	https://epi.yale.edu/epi-results/2022/component/wrs
Climate Change Mitigation	https://epi.yale.edu/epi-results/2022/component/wrs