Małgorzata ĆWIEK • Beata PATER • Paweł ULMAN

INEQUALITIES IN THE LEVEL OF SUSTAINABLE DEVELOPMENT IN THE EUROPEAN UNION COUNTRIES

Małgorzata **Ćwiek** (ORCID: 0000-0002-6375-098X) – *Krakow University of Economics*
Beata **Pater** (ORCID: 0000-0003-4209-241X) – *University of Agriculture in Krakow*
Paweł **Ulman** (ORCID: 0000-0002-1911-8821) – *Krakow University of Economics*

Correspondence address:
Mickiewicza Avenue 21, 31-120 Kraków, Poland
e-mail: beata.pater@urk.edu.pl

ABSTRACT: The aim of the research is to assess the degree of differentiation of sustainable development in the European Union countries in 2015-2019 and to group EU countries by the level of sustainability. In order to achieve the stated goal, a linear and non-linear ordering of selected variables included in the four orders that constitute sustainable development: social, economic, environmental, as well as institutional and political, was carried out. As a result of linear ordering, four groups of countries were distinguished. The linear ordering procedure was preceded by the construction of a synthetic variable. Ward's hierarchical method, based on Euclidean distance, was used as a non-linear ordering method. The data used in the analysis came from the Eurostat database. The research carried out shows significant inequalities in the level of sustainable development of EU countries. This applies to sustainable development in the integrated approach and to the assessment of individual orders. The rankings of countries in each order differ significantly from each other, and the overall assessment of sustainable development shows the greatest correlation between economic, institutional, and political order. Research results show that the leaders in sustainable development include Sweden, Finland, Denmark, Austria, and Estonia. At the other pole are Greece, Bulgaria, Cyprus and Romania.

KEYWORDS: sustainable development, inequality in sustainable development, European Union, sustainability measurement

Introduction

The concept of sustainable development arose from a critique of the dominant view of economic growth and welfare theory in economics, especially neoclassical economics (Estes, 1993; Górka et al., 2001; Poskrobko, 2013). This moral and philosophical order was created by recognising the weaknesses of past production and consumption trends and criticising sectoral and macroeconomic policies. Sustainable development was defined as development that meets the needs of the present without depriving future generations of such opportunities (Brundtland, 1989). This most widely cited definition of sustainable development was formulated by the World Commission on Environment and Development (sub-organization of the United Nations (UN)), established in 1992, and chaired by Gro Brundtland.

The concept of sustainable development has an impact on the formation of environmental policy, as its fundamental premise is to conduct policy and economic activity in the various sectors of the economy in such a way that environmental resources and values remain in a condition that ensures their sustainable use also for future generations (Żylicz, 2002; Ciszek, 2012, Chichilnisky, 1999). Thus, sustainability of growth determines not only short-term but also intergenerational equity.

To recognise or concretise sustainable development, the following orders were distinguished: social, economic, environmental, institutional and political, as well as integrated order. Sustainable development is, therefore, an interdisciplinary category – it is impossible to understand it solely through the lens of natural sciences or economics. Dissecting sustainable development as an interdisciplinary category, it is the integrated order, which is the sum of all orders, that can be treated as a state of developmental change or a landmark for developmental change in the process of implementing the assumptions of the concept of sustainable development. Its essence is the equal treatment of economic circumstances with ecological and social conditions (Górka et al., 2001). The indicators measuring its level make it possible to assess the state of implementation of the concept in various areas of life.

The implementation of sustainable development also means being concerned about access to education, health care, security, and ensuring adequate living conditions for people. Sustainable development and its assumptions about intergenerational justice are based on John Rawls' concept (Rawls, 1971), which was first used by Page (1991). According to this theory, representatives of different generations come together to decide on the distribution of wealth among them (Pater, 2019). However, they have no knowledge of which generation they belong to; no one is favoured a priori, and they operate behind a veil of ignorance. The only division that gives everyone equal opportunity is when no generation lives at the expense of the other. The concept of Rawls became more of a philosophical foundation for the concept of sustainable development. But over time, a viable alternative, now largely operationalised, grew out of the philosophical concept.

Concern about the state of the environment gave rise to the idea of sustainable development. The European Green Deal (European Commission, 2019) emphasises the importance and urgency of this problem. This document presents a sustainable growth strategy that intends to transform the European Union into a modern, competitive, resource-efficient economy with zero net emissions of greenhouse gases until 2050. What is more, in this vision, economic growth is decoupled from resource use. The implementation of the goals contained in the cited document requires constant monitoring of the progress of member states in implementing sustainable development policies.

Implementing the assumptions and objectives of sustainable development, applying ecological, social, and economic criteria to the limited, and evolving primarily under the influence of human activity of the whole environment are necessary to select the most relevant areas of development. The conceptualisation of the theory of sustainable development is carried out by identifying the characteristics of development (its sustainability), the principles of development, the definition of development objectives and integrated order.

The concretisation and operationalisation of the concept of sustainable development is indicator measurement, that is, to measure changes in sustainability of a benchmark nature. This applies to both orders and goals. The Sustainable Development Goals (SDG) are in force within the framework of the 2030 Agenda adopted by 193 countries (United Nations, 2015). 17 SDGs and 169 associated tasks have been defined, reflecting the three dimensions of sustainable development: economic, social, and environmental. Action to achieve the goals requires activity simultaneously within these

DOI: 10.34659/eis.2024.90.3.935

three dimensions and acting in an integrated manner. Development is to be based on transformational evolution in five areas: People, Planet, Prosperity, Peace, and Partnership (5Ps) (United Nations, 2015). In turn, the formation of integrated order is influenced by strategic goals of a social, economic, environmental (ecological), as well as institutional and political nature. The realisation of these goals in terms of the benchmark situation over a certain time horizon is shown by indicators of sustainable development (Eurostat, 2024).

The current set of the EU sustainable development indicators consists of ten thematic areas: socio-economic development, sustainable production and consumption, social inclusion, demographic change, public health, climate change and energy, sustainable transport, natural resources, global partnerships, and good governance (GUS, 2011). In turn, national indicators of sustainable development were grouped according to the four orders (Table 1).

Table 1. National indicators of sustainable development

Order			
Social (26 indicators)	**Economic (19 indicators)**	**Environmental (24 indicators)**	**Institutional and political (7 indicators)**
1. Demographic changes 2. Public health 3. Social integration 4. Education 5. Access to the labour market 6. Public safety 7. Sustainable consumption patterns	1. Economic development 2. Employment 3. Innovation 4. Transportation 5. Sustainable production patterns	1. Climate change 2. Energy 3. Air protection 4. Marine ecosystems 5. Fresh water resources 6. Land use 7. Biodiversity 8. Waste management	1. Global partnership 2. Cohesion and efficiency policy 3. Openness and participation 4. Active citizenship

Source: authors' work based on GUS (2011).

It should be emphasised that the mentioned classification of indicators is not the only valid one. The literature contains many classifications and typologies of indicators of sustainable development (Bell & Morse, 2003; Rasoolimanesh et al., 2023; Gebara et al., 2023).

Comparison of EU countries in terms of implementing sustainable development goals using multidimensional comparative analysis was the topic of the work of Kiselakova et al. (2020). This evaluation was based on data from 108 statistical indicators describing 17 sustainable development goals published by Eurostat. The synthetic variable was developed based on the zero unitisation method. The constructed synthetic measure allowed for the division of the EU countries into four groups with different levels of SDG implementation.

Resce and Schiltz (2021) evaluated 17 EU countries in terms of sustainable development goals using hierarchical stochastic multi-criteria acceptability analysis. The advantage of this method is that there is no need to choose one specific set of weights for a set of variables. Instead, the rankings are created based on Monte Carlo methods. This approach quantifies the probability of each country receiving a given ranking.

Guo et al. (2024) point out that different weight systems may lead to dissimilar results when analysing the performance of each country in relation to the SDG. They attempt to construct an aggregated index for OECD countries using a hierarchical data envelopment analysis model. For this purpose, UN Sustainable Development Reports for 2020–2022 were used.

The degree of implementation of the sustainable development goals of the Central and Eastern European countries was a subject of Huang (2023) research. The progress in this area was examined using an aggregate index based on the United Nations Sustainable Development Goals. To ensure the reliability of the results, the entropy weight method, equal weight method, and principal component analysis were used.

A comparison of the assessment of environmental sustainability in the EU-27 countries using distance measures, progress measures, and the SDG Index was the aim of the research paper by Tóthová and Heglasová (2022). In the analysis, both world and European indicators were used. The results showed that the country rankings obtained were very sensitive to the methodological approach and origin of the indicators used. The conducted analysis revealed numerous discrepancies and inconsistencies that may lead to negative consequences in political decision-making.

DOI: 10.34659/eis.2024.90.3.935

The level of EU countries was examined in the aspect of the main areas of Goal 9 of the 2030 Agenda, i.e. building stable infrastructure, promoting sustainable industrialisation and supporting innovation by Brodny and Tutak (2023). The assessment was based on a multi-criteria decision-making approach. The TOPSIS, EDAS and WASPAS methods were used to determine the sustainable development index. The analysis was carried out based on 14 indicators from the Eurostat database, which characterise the area of Goal 9 in the years 2015-2020.

In the literature, the assessment of progress in sustainable development, as shown above, is most often made in relation to the advancement in achieving sustainable development goals. Novelty of this research paper approach consists in assessing sustainable development based on separate orders – 1) social, 2) economical, 3) environmental, as well as 4) institutional and political. This division allows for a detailed analysis of the situation in individual aspects. At the same time, the joint analysis of separate orders gives a complex picture of sustainable development as a whole. Moreover, the indicated orders meet the criteria of separability and coherence.

Considering the aforementioned premises, a research problem was undertaken, which was formulated in the form of the following questions: 1) How to synthetically compare the degree of implementation of sustainable development in European Union countries? 2) What are the changes in inequalities between EU countries in sustainable development? 3) What is the ranking of the EU countries according to integrated and individual orders? 4) Is it possible to indicate homogeneous groups of EU countries based on the degree of implementation of sustainable development? This paper aims to assess the degree of differentiation of sustainable development in the European Union countries in 2015-2019. Furthermore, detailed objectives of the study were defined: 1) indication of a method of measuring the degree of implementation of sustainable development in European Union countries, including social, economic, environmental, institutional and political as well as integrated orders 2) measurement of the level and differentiation of sustainability of EU countries 3) ranking of EU countries based on integrated and individual orders as well as 4) separation of homogeneous clusters of EU countries by the level of sustainability. In order to achieve the stated goal, a linear and non-linear ordering of selected variables included in the various orders was carried out. The linear ordering procedure was preceded by the construction of a synthetic variable. To facilitate the analysis, the ranks of the studied countries were also assigned. Ward's hierarchical method, based on Euclidean distance, was used as a non-linear ordering method. The data used in the analysis came from the Eurostat database.

Research methods

The statistical analysis of inequality in sustainable development in the European Union countries was undertaken based on data obtained from the Eurostat database. For the main objective – to assess the degree of inequality in sustainable development of European Union countries, data from 2015 and 2019 were considered. Due to the fact that several countries had data gaps, calculations were made for most of European countries: Belgium, Bulgaria, the Czech Republic, Denmark, Germany, Estonia, Ireland, Greece, France, Spain, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, Malta, the Netherlands, Austria, Poland, Portugal, Romania, Slovenia, Slovakia, Finland and Sweden. Great Britain was excluded from the analysis because of missing data on too many diagnostic variables.

The study areas included the social, environmental and economic, as well as institutional and political orders. A description of the diagnostic variables assigned to each order describing the areas of sustainable development is provided in Table 2. The choice of variables was dictated by their availability. Preference was given to variables with a low number of data gaps. Several potentially available variables were omitted due to the very high level of correlation between them.

Linear and non-linear ordering methods can be used to analyse the differentiation in the implementation of sustainable development and sustainable development orders of selected EU countries described by diagnostic variables. Linear ordering makes it possible to indicate the position of a country due to the degree of implementation of individual sustainable development orders and sustainable development as a whole. Non-linear ordering, on the other hand, does not provide an indication of the order of countries but makes it possible to group them into homogeneous groups using the full set of diagnostic variables.

DOI: 10.34659/eis.2024.90.3.935

Table 2. Set of diagnostic variables by order describing areas of sustainable development

Social order	Economic order	Environmental order	Institutional and political order
• Total fertility rate • Poverty rate • Healthy life years at birth • Healthy life years at 65 – males • Healthy life years at 65 – females • Infant mortality rate • Death due to cancer • Road traffic deaths • Participation in early childhood education • Adult participation in learning (25-64 years) • Long-term unemployment (15-74 years) • Gender pay gap • Income distribution • Final energy consumption in households • Arrears • Passenger cars per 1,000 inhabitants	• Real GDP per capita • Employment rate • Resource productivity and domestic material consumption • Gross domestic expenditure on R&D (% GDP) • R&D personnel (% of total labour force and total employment) • Goods transported in intermodal transport units • Water use by supply category and economical sector • Area under organic farming (share of total utilised agricultural area) • Nominal labour productivity per person employed • Gross fixed capital formation (investments) • General government gross debt • Water productivity • Employment rate of older workers, age group 55-64	• Greenhouse gas emissions • Greenhouse gas emissions intensity of energy consumption • Share of renewable energy in gross final energy consumption • Area of wooded land • Fishing fleet • Recycling rate of packaging waste • Energy import dependency • Generation of municipal waste per capita • Average CO_2 emissions per km from new passenger cars • Population connected to at least secondary waste water treatment • Pollutant emissions from transport • Water exploitation index	• E-government activities of individuals via websites • Households level of internet access • Participation in formal or informal voluntary • Average rating of trust

Source: authors' work based on Eurostat (2024).

In the case of linear ordering, the goal is to create a synthetic variable that combines information about the objects under study into a single indicator. However, it is also possible to construct such synthetic variables for individual areas of the problem under study and then aggregate them into a single measure. The most common way to do this is to calculate the arithmetic or weighted mean of the areas of the synthetic variables.

To aggregate dissimilar variables and variables of different natures, it is necessary to standardise their nature by means of converting destimulants into stimulants and normalising the variables. In the study, the variables were normalised using the method of zeroed unitisation according to the formula (Kukula, 1999):

For stimulant:

$$z_{ij} = \frac{x_{ij} - \min_i\{x_{ij}\}}{max_i\{x_{ij}\} - min_i\{x_{ij}\}}, \quad (1)$$

for destimulants:

$$z_{ij} = \frac{max_i\{x_{ij}\} - x_{ij}}{max_i\{x_{ij}\} - min_i\{x_{ij}\}}, \quad (2)$$

where:
x_{ij} – denotes the value of the j-th variable for the i-th object.

In multivariate studies, there is a problem of overly correlated diagnostic variables. This problem leads to the multiplication of the same information contained in subsequent diagnostic variables. In order to reduce or eliminate duplicative information, there are different methods: assigning lower weights to those variables that show high collinearity with other diagnostic variables, variable selection that eliminates those that are highly correlated with other variables, as well as sub-transform the original variables into so-called factors (uncorrelated) that contain most of the information of the original diagnostic variables. It was decided to use the first of the indicated methods. The weights used can be written as follows (Betti & Verma, 1999):

DOI: 10.34659/eis.2024.90.3.935

$$w_{hj} = w_{hj}^{a} \cdot w_{hj}^{b}, \quad h = 1, 2, ..., m; j = 1, 2, ..., k_h \tag{3}$$

$$w_{hj}^{a} = \left[\frac{1}{1+\sum_{j'=1}^{k_h}\left|r_{z_{hj,hj'}}\right| |r_{z_{hj,hj'}} < r_{z_{hj}}^{*}}\right]\left[\frac{1}{\sum_{j'=1}^{k_h}\left|r_{z_{hj,hj'}}\right| |r_{z_{hj,hj'}} \geq r_{z_{hj}}^{*}}\right], \tag{4}$$

$$j,j' = 1, 2, ..., k_h ; h = 1, 2, ..., m,$$

where:
w_{hj}^{b} – coefficient of variation,
$r_{z_{hj,hj'}}$ – correlation coefficient of sustainable development corresponding to the j-th and j-th variable in the h-th field,
$r_{z_{hj}}^{*}$ – the threshold value of the sustainability correlation coefficient due to the j-th variable in the h-th field, which can be calculated from the formula:

$$r_{z_{hj}}^{*} = \min_{j} \max_{j'} \left|r_{z_{hj,hj'}}\right| \; j,j' = 1, 2, ..., k_h ; j \neq j', \tag{5}$$

The synthetic variables in each area were calculated as a weighted average of the normalised variables. The overall synthetic variable is determined as an arithmetic mean calculated on the basis of area synthetic variables.

Country rankings were determined on the basis of synthetic variables and grouped according to the formula (Malina, 2004):

$$\begin{aligned} &1)\ G_1: s_i < \overline{s} - S(s) \\ &2)\ G_2: \overline{s} > s_i \geq s_i - S(s) \\ &3)\ G_3: \overline{s} + S(s) > s_i \geq \overline{s} \\ &4)\ G_4: s_i \geq \overline{s} + S(s), \end{aligned} \tag{6}$$

where:
$\overline{s}$ – arithmetic mean of the synthetic variable,
S(s) – standard deviation of the synthetic variable.

As a method of nonlinear ordering, Ward's hierarchical method based on Euclidean distance, widely described in the literature, was used (Panek & Zwierzchowski, 2013).

Results of the research

Using the described method of linear ordering, the EU countries were ordered in terms of the implementation of the various orders: social, economic, environmental, institutional and political, as well as the overall implementation of sustainable development policies in each country (integrated order). The value for the integrated assessment of sustainable development implementation for 2015 and 2019 was determined by calculating the arithmetic mean of values of synthetic variables for individual orders, as presented in Table 3.

Synthetic variables can take values in the range <0;1>, where a value of 0 indicates the lowest level of implementation of the individual orders: social, economic, environmental and political, as well as the implementation of sustainable development in general, while a value of 1 is the highest level among the countries studied in the years under review. Assessing the implementation of sustainable development principles, it can be seen that in both analysed periods, Bulgaria in terms of social, as well as institutional and political orders, Greece in terms of economic order, and Cyprus in terms of environmental order have the lowest values of synthetic variables. At the other extreme of individual orders was Sweden in terms of social, economic and environmental order, although in

DOI: 10.34659/eis.2024.90.3.935

2019, Finland obtained the highest value of the synthetic variable for environmental order. In contrast, the highest value of the synthetic variable for institutional and political order was obtained for Denmark. Thus, it can be seen that Bulgaria, Cyprus and Greece are characterised by low values of synthetic variables describing individual orders of sustainable development, which translates into a relatively low level of sustainable development in the overall assessment. On the other end of the spectrum are countries such as Sweden, Denmark, and Finland, which demonstrate a high level of implementation of most of the sustainability orders. To facilitate the analysis of the ordering results, country rankings were determined for each synthetic variable (Table 4).

Table 3. Values of synthetic variables for individual and integrated orders for the EU countries in 2015 and 2019

Country	Social order		Economic order		Environmental order		Institutional and political order		Integrated order	
	2015	2019	2015	2019	2015	2019	2015	2019	2015	2019
Belgium	0.6923	0.6309	0.4005	0.4599	0.7166	0.7231	0.5689	0.6198	0.5946	0.6084
Bulgaria	0.2500	0.3020	0.3044	0.3070	0.7044	0.7129	0.0455	0.0813	0.3261	0.3508
Czech Republic	0.7653	0.7730	0.5905	0.5699	0.6935	0.6232	0.3995	0.5234	0.6122	0.6224
Denmark	0.7385	0.7600	0.5586	0.6283	0.8259	0.8049	0.9342	0.9348	0.7643	0.7820
Germany	0.7150	0.7081	0.4934	0.5428	0.6858	0.7069	0.6806	0.7285	0.6437	0.6716
Estonia	0.7305	0.8727	0.6490	0.6643	0.7039	0.7101	0.8361	0.7511	0.7299	0.7496
Ireland	0.6608	0.7604	0.3856	0.4133	0.6512	0.6813	0.5954	0.6541	0.5732	0.6273
Greece	0.4020	0.4183	0.2231	0.2259	0.5461	0.4480	0.3457	0.3370	0.3792	0.3573
Spain	0.6795	0.7175	0.4070	0.3852	0.6163	0.5682	0.5099	0.6353	0.5532	0.5766
France	0.6986	0.6429	0.3999	0.4284	0.7138	0.7162	0.6535	0.7198	0.6165	0.6268
Italy	0.5495	0.5354	0.4556	0.4387	0.6543	0.6361	0.2949	0.2861	0.4886	0.4741
Cyprus	0.6318	0.7312	0.2457	0.2679	0.1799	0.1703	0.3072	0.5636	0.3412	0.4333
Latvia	0.6414	0.6848	0.5140	0.4707	0.7004	0.7741	0.4899	0.5799	0.5864	0.6274
Lithuania	0.5343	0.6108	0.4160	0.4058	0.6666	0.7154	0.3327	0.4209	0.4874	0.5382
Luxembourg	0.6367	0.6935	0.5474	0.5366	0.6587	0.6952	0.8831	0.7348	0.6815	0.6650
Hungary	0.6596	0.4783	0.2650	0.3375	0.6399	0.6522	0.4250	0.4954	0.4974	0.4908
Malta	0.6367	0.6697	0.2647	0.2855	0.4564	0.4996	0.4908	0.4766	0.4621	0.4829
Netherlands	0.4988	0.3152	0.4445	0.5106	0.6879	0.7009	0.9024	0.9313	0.6334	0.6145
Austria	0.7055	0.6499	0.7396	0.7397	0.7690	0.7664	0.6013	0.6886	0.7039	0.7112
Poland	0.6480	0.6991	0.3156	0.3140	0.6357	0.6345	0.3276	0.4359	0.4817	0.5208
Portugal	0.5579	0.5814	0.2856	0.3157	0.6097	0.6452	0.3525	0.3117	0.4515	0.4635
Romania	0.6097	0.6472	0.2529	0.2561	0.6828	0.6786	0.1184	0.1957	0.4160	0.4444
Slovenia	0.2597	0.3741	0.4304	0.4475	0.7716	0.7513	0.4708	0.5606	0.4831	0.5334
Slovakia	0.7642	0.7552	0.4487	0.4002	0.7121	0.7413	0.5229	0.4459	0.6120	0.5856
Finland	0.5726	0.5016	0.5505	0.5780	0.8147	0.8733	0.8495	0.8818	0.6968	0.7087
Sweden	0.9650	0.9170	0.7721	0.7585	0.8891	0.8679	0.8237	0.9190	0.8625	0.8656

DOI: 10.34659/eis.2024.90.3.935

Table 4. Rankings of EU countries based on values of synthetic variables in 2015 and 2019

Country	Social order		Economic order		Environmental order		Institutional and political order		Integrated order	
	2015	2019	2015	2019	2015	2019	2015	2019	2015	2019
Belgium	9	17	16	11	6	8	11	12	12	12
Bulgaria	26	26	20	22	9	11	26	26	26	26
Czech Republic	2	3	4	6	12	22	18	16	10	10
Denmark	4	5	5	4	2	3	1	1	2	2
Germany	6	9	9	7	14	13	7	7	7	7
Estonia	5	2	3	3	10	12	5	5	3	3
Ireland	11	4	18	15	19	16	10	10	14	14
Greece	24	23	26	26	24	25	20	22	24	24
Spain	10	8	15	18	22	23	13	11	15	15
France	8	16	17	14	7	9	8	8	9	9
Italy	21	20	10	13	18	20	24	24	17	17
Cyprus	17	7	25	24	26	26	23	14	25	25
Latvia	14	12	8	10	11	4	15	13	13	13
Lithuania	22	18	14	16	16	10	21	21	18	18
Luxembourg	15	11	7	8	17	15	3	6	6	6
Hungary	12	22	22	19	20	18	17	17	16	16
Malta	16	13	23	23	25	24	14	18	21	21
Netherlands	23	25	12	9	13	14	2	2	8	8
Austria	7	14	2	2	5	5	9	9	4	4
Poland	13	10	19	21	21	21	22	20	20	20
Portugal	20	19	21	20	23	19	19	23	22	22
Romania	18	15	24	25	15	17	25	25	23	23
Slovenia	25	24	13	12	4	6	16	15	19	19
Slovakia	3	6	11	17	8	7	12	19	11	11
Finland	19	21	6	5	3	1	4	4	5	5
Sweden	1	1	1	1	1	2	6	3	1	1

The top two positions in the implementation of the integrated order in both years under consideration were occupied by the countries of the so-called "old Union," namely Sweden and Denmark. Estonia was ranked next. Other countries from the former socialist camp received rather low ranking positions, as did old-EU Greece. Poland, for example achieved 20th position, Lithuania – 18th and Slovakia – 11th. Estonia's very good position (3rd) is due to its high ranking for the synthetic indicator describing social, economic, institutional and political order. For environmental order, the results of the synthetic indicator place Estonia in the middle of the ranking.

Analysing the rankings in terms of individual orders, it can be seen that the positions of individual countries in successive orders can differ significantly from one another. An example here is Belgium, which in 2019 was ranked 17th in the social order, 11th in economic order, 8th in environmental order and 12th in institutional and political order. An interesting situation can also be observed in the Netherlands. In 2019, this country was ranked in penultimate place in social order. In economic order, it was placed in 9th place; in environmental order – in 14th place, while in institutional and political order Netherlands achieved 2nd place. Overall, this diverse situation resulted in 8th place in the integrated order list. Therefore, the question should be asked whether a high degree of implementation of sustainable development in one order translates into high results in other orders. For examining which order is most correlated with the integrated assessment, the concordance of

DOI: 10.34659/eis.2024.90.3.935

rankings between each order was calculated using Spearman's rank correlation coefficient. The results for 2015 and 2019 are shown in Table 5.

As can be seen in Table 5, in 2015, the highest level of correlation between the assessment of sustainable development in integrated approach and individual orders was observed for political order (0.88) and economic order (0.87). However, with regard to the correlation between the individual orders, the highest concordance was observed between economic and environmental order (0.69) and the lowest between social and environmental order (0.35). The 2019 data confirms the highest influence of institutional and political order (0.86) and economic order (0.91) on the assessment of sustainable development. However, in terms of interdependence between the individual orders, the highest correlation was observed between institutional political and economic order (0.77). In both terms under consideration, the lowest correlation was observed between environmental and social orders. While in 2015, this correlation existed, although it was weak (0.35), based on the data from 2019, it should be concluded that these variables are completely independent from each other (0.007).

Table 5. Ranking concordance determined by Spearman's rank correlation coefficient in 2015 (above the main diagonal) and in 2019 (below the main diagonal)

Itemization		Social order	Economic order	Environmental order	Institutional and political order	Integrated order
		2015				
Social order	2019	1	0.5364	0.3532	0.4858	0.6773
Economic order		0.3477	1	0.6903	0.6280	0.8715
Environmental order		0.0072	0.6636	1	0.5022	0.6588
Institutional and political order		0.3860	0.7709	0.4831	1	0.8817
Integrated order		0.5309	0.9132	0.6581	0.8639	1

In the next step, the grouping of countries was carried out in accordance with formula 6. Countries for which the value of the synthetic variable was lower than the average value for all countries minus the value of the standard deviation were assigned to the first group. Assignment to subsequent groups is associated with achieving a higher value of the synthetic variable. In the case of the fourth group, this value is higher than the arithmetic mean plus the value of the standard deviation. The results of grouping countries for 2015 and 2019 are included in Tables 6 and 7.

Table 6. Grouping of countries by individual orders and integrated order in 2015

Order	Group 1	Group 2	Group 3	Group 4
Social	Bulgaria, Slovenia, Greece	Netherlands, Lithuania, Italy, Portugal, Finland, Romania	Cyprus, Malta, Luxembourg, Latvia, Poland, Hungary, Ireland, Spain, Belgium, France, Austria, Germany, Estonia, Denmark, Slovakia, Czech Republic	Sweden
Economic	Greece, Cyprus, Romania, Malta, Hungary, Portugal	Bulgaria, Poland, Ireland, France, Belgium, Spain, Lithuania, Slovenia	Netherlands, Slovakia, Italy, Germany, Latvia, Luxembourg, Finland, Denmark	Czech Republic, Estonia, Austria, Sweden
Environmental	Cyprus, Malta	Greece, Portugal, Spain, Poland, Hungary, Ireland, Italy, Luxembourg, Lithuania	Romania, Germany, Netherlands, Czech Republic, Latvia, Estonia, Bulgaria, Slovakia, France, Belgium, Austria, Slovenia	Finland, Denmark, Sweden
Institutional and political	Bulgaria, Romania	Italy, Cyprus, Poland, Lithuania, Greece, Portugal, Czech Republic, Hungary, Slovenia, Latvia, Malta, Spain, Slovakia	Belgium, Ireland, Austria, France, Germany	Sweden, Estonia, Finland, Luxembourg, Netherlands, Denmark
Integrated	Bulgaria, Cyprus, Greece, Romania	Portugal, Malta, Poland, Slovenia, Lithuania, Italy, Hungary, Spain	Ireland, Latvia, Belgium, Slovakia, Czech Republic, France, Netherlands, Germany, Luxembourg	Finland, Austria, Estonia, Denmark, Sweden

DOI: 10.34659/eis.2024.90.3.935

Table 7. Grouping of countries by individual orders and integrated order in 2019

Order	Group 1	Group 2	Group 3	Group 4
Social	Bulgaria, Netherlands, Slovenia, Greece	Hungary, Finland, Italy, Portugal, Lithuania, Belgium	France, Romania, Austria, Malta, Latvia, Luxembourg, Poland, Germany, Spain, Cyprus, Slovakia, Denmark, Ireland, Czech Republic	Estonia, Sweden
Economic	Greece, Romania, Cyprus, Malta	Bulgaria, Poland, Portugal, Hungary, Spain, Slovakia, Lithuania, Ireland, France, Italy, Slovenia	Belgium, Latvia, Netherlands, Luxembourg, Germany, Czech Republic, Finland	Denmark, Estonia, Austria, Sweden
Environmental	Cyprus, Greece, Malta	Spain, Czech Republic, Poland, Italy, Portugal, Hungary	Romania, Ireland, Luxembourg, Netherlands, Germany, Estonia, Bulgaria, Lithuania, France, Belgium, Slovakia, Slovenia, Austria, Latvia, Denmark	Sweden, Finland
Institutional and political	Bulgaria, Romania, Italy, Portugal, Greece	Latvia, Poland, Slovakia, Malta, Hungary, Czech Republic, Slovenia, Cyprus	Lithuania, Belgium, Spain, Ireland, Austria, France, Germany, Luxembourg, Estonia	Finland, Sweden, Netherlands, Denmark
Integrated	Bulgaria, Greece, Cyprus, Romania	Portugal, Italy, Malta, Hungary, Poland, Slovenia, Lithuania, Spain	Slovakia, Belgium, Netherlands, Czech Republic, France, Ireland, Latvia, Luxembourg, Germany	Finland, Austria, Estonia, Denmark, Sweden

A comparison of the grouping of countries in the analysed periods shows that the division structure in 2015 and 2019 is very similar. Sustainability leaders in both periods studied in integrated approach, including Sweden, Finland, Denmark, Austria and Estonia. However, only Sweden was in the fourth group in each order under discussion in both periods. At the other extreme, both in 2015 and 2019, are Greece, Bulgaria, Cyprus and Romania. These are countries with unstable public finances and economic problems. The most numerous group of countries is the third one. Interestingly, Germany is considered a model example of a sustainable response to the global crisis, and it has been classified in this group. Poland, on the other hand, was classified in the third group in the context of social order and in the remaining orders, including integrated assessment in the second group. It is also worth noting the great similarity of the distinguished groups in the years studied.

The final element of the analysis was the creation of dendrograms presenting clusters of the studied countries by the level of sustainable development. They are shown in Figures 1 and 2. The results of the cluster analysis confirm the results of previous studies. Countries rated highly in terms of implementing sustainable development were included in one cluster, as were countries with low values of synthetic variables. On the tree presented for 2015, three groups of countries can be distinguished. The first cluster is formed by Belgium, Ireland, France, Germany, the Czech Republic, Spain, Slovakia, and Latvia. The second cluster is formed by Denmark, Finland, Estonia, Luxembourg, the Netherlands, Austria, and Sweden. The third cluster includes Bulgaria, Slovenia, Greece, Hungary, Poland, Portugal, Malta, Italy, Lithuania, Romania, and Cyprus.

In 2019, the first group includes Belgium, Latvia, France, Ireland, Spain, the Czech Republic, Lithuania, Slovakia, Malta, Poland, Hungary, Slovenia, and Cyprus. Bulgaria, Greece, Italy, Portugal, and Romania have been classified into the second group. The third group is formed by Denmark, Sweden, Germany, Luxembourg, Estonia, Austria, the Netherlands, and Finland. It should be remembered that in the case of non-linear ordering, which is the creation of clusters using Ward's method, the order of clusters does not indicate the level of the analysed phenomenon. Thus, for example, cluster two extracted from 2015 data almost entirely overlaps with cluster three extracted from 2019 data. However, it is noticeable that in the dendrogram for 2015 the internal structure of the first and second clusters differs significantly from the third cluster, which is reflected in the bond distance between them. This means that the degree of implementation of sustainable development in the countries at the end of the ranking delays significantly behind the countries occupying average positions. The situation looks different in the dendrogram for 2019. In this case, the first and second clusters, which contain countries with low and medium levels of sustainable development, are close to each other. Meanwhile, the third cluster is significantly distant from them.

DOI: 10.34659/eis.2024.90.3.935

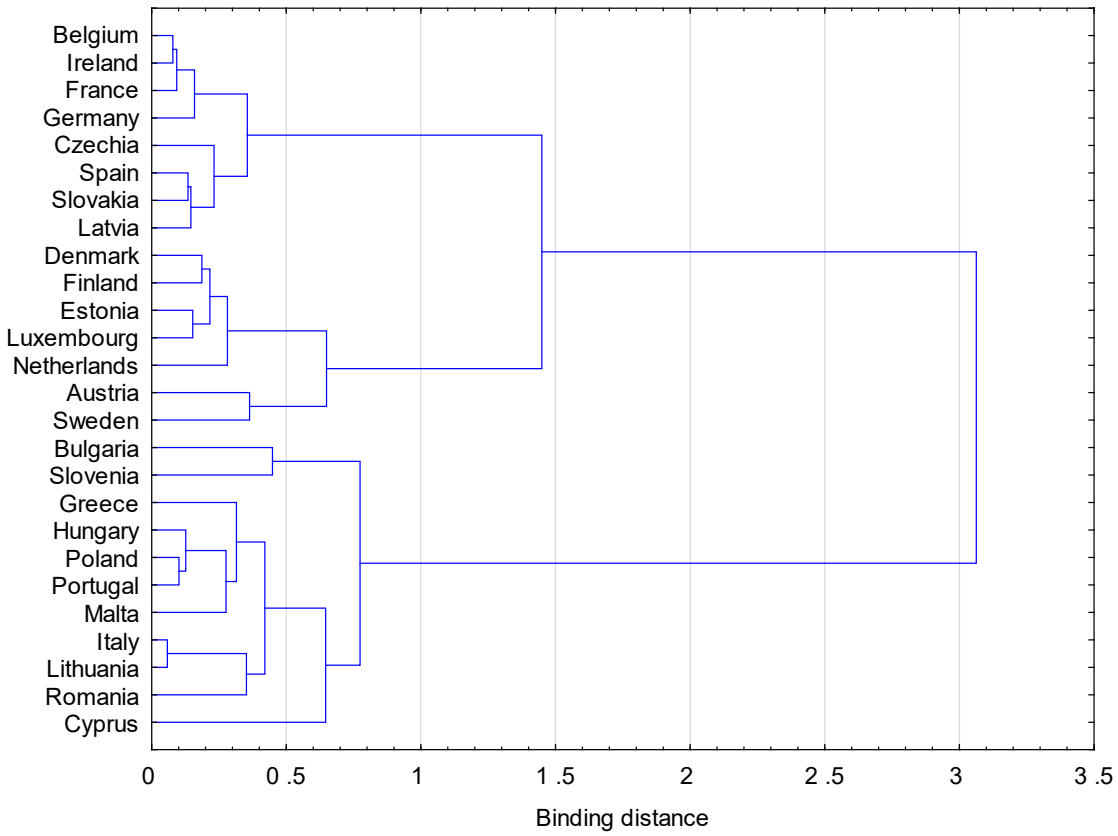

Figure 1. Grouping of countries by level of sustainable development in 2015

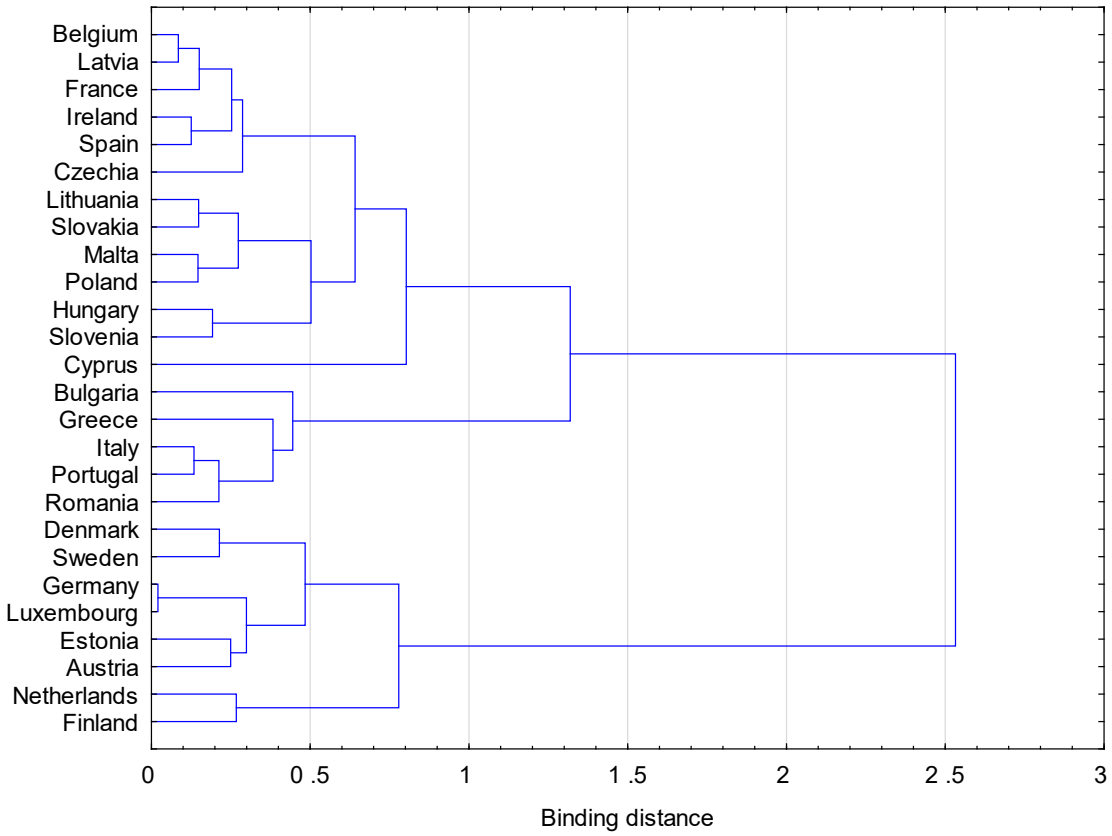

Figure 2. Grouping of countries by level of sustainable development in 2019

DOI: 10.34659/eis.2024.90.3.935

Taking into account the above observation and the data in Table 3, it can be concluded that countries with a low degree of sustainable development have made significant efforts in recent years towards reducing the gap to the leaders.

Discussion

The essence of the sustainable development concept is intergenerational justice in access to the environment, primarily the natural one, but also the social, economic or political-institutional one. Intergenerational justice is expressed in caring for the natural environment and its resources so that they can serve future generations. However, this should not exhaust the actions taken towards sustainability and maintaining intergenerational justice. Nevertheless, it should be borne in mind that although there is no controversy as to the general definition of sustainable development, moving on to its operationalisation, and especially the assessment of progress made in this area by individual businesses, territorial units or countries, it is extremely difficult. This results from the fact that sustainable development is a state that is universally desired but differently understood and extremely difficult to achieve (Grzebyk & Stec, 2015; Meadowcroft, 2007). In a sense, good practices are useful, but one must be aware of the different circumstances resulting from social and environmental conditions in individual countries (Munasinghe, 2009).

The authors of the study attempted to assess inequalities in the level of sustainable development in the EU countries, both in 2015 and 2019, using statistical analysis, i. e., linear and non-linear ordering. To compare the degree of implementation of sustainable development in European countries, synthetic variables for the social, economic, environmental, institutional and political orders, as well as integrated order, were constructed. The conducted research indicates significant inequalities in the level of sustainable development of European countries in both periods under consideration. This applies to both sustainable development in the integrated approach and the assessment for individual orders. The rankings of countries in individual orders differ significantly from each other, and the overall assessment of sustainable development shows the greatest correlation between economic, institutional, and political order.

In light of the conducted research, including linear and non-linear ordering, the leaders of sustainable development include Sweden, Finland, Denmark, Austria, and Estonia. Similar results were obtained by Kiselakova et al. (2020). In OECD countries, Denmark, Finland and Sweden, alongside Norway and New Zealand, were identified as leaders and role models for sustainable development (Guo et al., 2024). In these countries, pro-ecological innovation activities have been supported for many years by huge investments in research and development (Brodny et al., 2023; Börje et al., 2015). At the other end of the spectrum are Greece, Bulgaria, Cyprus and Romania. Greece is a country torn by constant economic crises, which translates into difficulties in reaching the level of European leaders. In turn, Bulgaria and Romania, among the new EU countries, are in the process of continuous transformation of their economies and must meet the challenges related to industrialisation and digitalisation of the economy (Hess, 2020).

Significant differentiation in terms of the implementation of the 9th SDG of the 2030 Agenda in the analysed period has been proven by Brodny and Tutak (2023). According to this research, Denmark, Germany, Luxembourg, the Netherlands, Finland, and Sweden were considered the most advanced countries in this respect. On the other hand, Bulgaria, Greece, Portugal, and Lithuania were indicated as countries where significant problems are observed (Brodny & Tutak, 2023). The low degree of sustainable development of Bulgaria and Romania was also confirmed in the study by Resce and Schiltz (2021).

In turn, research conducted by Huang (2023) shows that in the Balkan countries, i.e. Bosnia and Herzegovina, Serbia, Montenegro, North Macedonia and Albania, there is a lower level of sustainable development than in other countries of Central and Eastern Europe. On the other hand, these countries have a higher score in the progress index, which indicates their high potential in the field of sustainable development. In the context of the Balkan countries, Slovenia can be considered a positive example, as it is exceptionally favourably located geographically and has a rich infrastructure and transport network, which translates into a significantly higher assessment of sustainable development. But when it comes to the assessment of the degree of sustainable development in Bulgaria and

DOI: 10.34659/eis.2024.90.3.935

Romania, which in this study obtained one of the last positions, Huang (2023) indicates that it is at a much higher level compared to the Western Balkans, which is associated with the membership of the above-mentioned countries in the European Union. This shows how important the reference point is in conducting comparative research in the context of implementing sustainable development.

The research that was conducted allowed to formulate practical implications. Research results discussed in the article can be useful for policymakers, both at national and international levels. Among the examined orders, economic, institutional, and political orders received the lowest scores. Therefore, in order to achieve sustainable development in all areas of socio-economic life, the economic, institutional, and political aspects require the greatest attention of decision-makers.

Limitations and future research

There are many methods for measuring sustainable development, and all of them provide potentially useful, although not necessarily identical, conclusions for decision-makers, scientists and the general public. In each case, the research conducted is limited by the availability and quality of statistical data. The next aspect to consider is how to calculate the value of integrated order. In this study, it was calculated as the arithmetic mean of the assessments of individual orders. However, weights could be introduced for synthetic variables, taking into account their information scope or expert opinions. The last limitation of the proposed methodology for measuring sustainable development, including the division into four orders, is the inability to be directly translated to countries outside Europe due to the lack of complete data, especially in the field of institutional and political order.

It should also be remembered that the path to achieving high positions in the implementation of sustainable development goals is not the same for all countries, which results from different geographical, environmental and social conditions. The research conducted so far indicates the important role of the European Union in shaping sustainable economies. The subject of future research should be the assessment of the effectiveness of implemented policies in achieving the adopted sustainable development goals. Future research should also take into account the social and economic consequences of the green transformation. Moreover, due to the time frame of the study, it is necessary to conduct further research to determine the impact of the COVID–19 pandemic on the level of sustainable development in European countries. This would allow to chart a long-term sustainable development trajectory in the EU countries in order to develop more tailored development policies for the future.

Acknowledgements

The publication was financed from the subsidy granted to the Krakow University of Economics within the Support for Publishing Activities 2024 (Wsparcie Aktywności Publikacyjnej 2024) programme.

The contribution of the authors

Conceptualisation, M.Ć., B.P. and P.U.; literature review, M.Ć., B.P. and P.U.; methodology, M.Ć., B.P. and P.U.; formal analysis, M.Ć., B.P. and P.U.; writing, M.Ć., B.P. and P.U.; conclusions and discussion, M.Ć., B.P. and P.U.

The authors have read and agreed to the published version of the manuscript.

References

Bell, S., & Morse, S. (2003). *Measuring Sustainability*. *Learning from Doing*. London: Earthscan.

Betti, G., & Verma, V. (1999). Measuring the degree of poverty in a dynamic and comparative context: A multidimensional approach using fuzzy set theory. Proceedings ICCS, 6(11), 289-301.

Börje, J., Hans, L., & Maxim, S. (2015). European R&D efficiency. Economics of Innovation and New Technology, 24(1-2), 140-158. http://dx.doi.org/10.1080/10438599.2014.897857

Brodny, J., & Tutak, M. (2023). The level of implementing sustainable development goal "Industry, innovation and infrastructure" of Agenda 2030 in the European Union countries: Application of MCDM methods. Oeconomia Copernicana, 14(1), 47-102. https://doi.org/10.24136/oc.2023.002

Brodny, J., Tutak, M., Grebski, W., & Bindzár, P. (2023). Assessing the level of innovativeness of EU-27 countries and its relationship to economic, environmental, energy and social parameters. Journal of Open Innovation: Technology, Market, and Complexity, 9(2), 100073. https://doi.org/10.1016/j.joitmc.2023.100073

Brundtland, G. H. (1989). Global change and our common future. Environment: Science and Policy for Sustainable Development, 31(5), 16-43.

Chichilnisky, G. (1999). What is sustainable development? In O. Hohmeyer & K. Rennings (Eds.), *Man-Made Climate Change: Economic Aspects and Policy Options* (pp. 42-82). Heidelberg: Physica-Verlag HD.

Ciszek, M. (2012). Bezpieczeństwo ekologiczne i zrównoważony rozwój w aspekcie Strategii Bezpieczeństwa Narodowego Rzeczypospolitej Polskiej. Studia Ecologiae et Bioethicae, 10(1), 29-41. http://dx.doi.org/10.21697/seb.2012.10.1.02 (in Polish).

Estes, R. (1993). Toward sustainable development: from theory to praxis. Social Development Issues, 15(3), 1-29.

European Commission. (2019). Communication from the Commission, The European Green Deal, Pub. L. No. 52019DC0640. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2019%3A640%3AFIN

Eurostat. (2024). *Sustainable development in the European Union Monitoring report on progress towards the SDGs in an EU context*. https://ec.europa.eu/eurostat/web/products-flagship-publications/w/ks-05-24-071

Gebara, C. H., Thammaraksa, C., Hauschild, M., & Laurent, A. (2023). Selecting indicators for measuring progress towards sustainable development goals at the global, national and corporate levels. Sustainable Production and Consumption, 44, 151-165. https://doi.org/10.1016/j.spc.2023.12.004

Górka, K., Poskrobko, B., & Radecki, W. (2001). *Ochrona środowiska. Problemy społeczne, ekonomiczne i prawne.* Warszawa: PWE. (in Polish).

Grzebyk, M., & Stec, M. (2015). Sustainable development in EU countries: concept and rating of levels of development. Sustainable Development, 23(2), 110-123. https://doi.org/10.1002/sd.1577

Guo, Y., Yu, M. M., & See, K. F. (2024). Developing a sustainable development goals index for OECD countries: An effectiveness-based hierarchical data envelopment analysis. Environmental Science & Policy, 160, 103836. https://doi.org/10.1016/j.envsci.2024.103836

GUS. (2011). *Wskaźniki zrównoważonego rozwoju Polski.* https://katowice.stat.gov.pl/publikacje-i-foldery/inne-opracowania/wskazniki-zrownowazonego-rozwoju-polski,11,1.html (in Polish).

Hess, J. (2020). Entrepreneurial ecosystems in Bulgaria and Romania: A comparative analysis. Thunderbird International Business Review, 62(5), 489-501. https://doi.org/10.1002/tie.22154

Huang, R. (2023). SDG-oriented sustainability assessment for Central and Eastern European countries. Environmental and Sustainability Indicators, 19, 100268. https://doi.org/10.1016/j.indic.2023.100268

Kiselakova, D., Stec, M., Grzebyk, M., & Sofrankova, B. (2020). A multidimensional evaluation of the sustainable development of European Union countries—An empirical study. Journal of Competitiveness, 12(4), 56-73. http://dx.doi.org/10.7441/joc.2020.04.04

Kukuła, K. (1999). Metoda unitaryzacji zerowanej na tle wybranych metod normowania cech diagnostycznych. Acta Scientifica Academiae Ostroviensis, 4, 5-31. (in Polish).

Malina, A. (2004). *Wielowymiarowa analiza przestrzennego zróżnicowania struktury gospodarki Polski według województw*. Zeszyty Naukowe/Akademia Ekonomiczna w Krakowie. Seria Specjalna, Monografie, 162. (in Polish).

Meadowcroft, J. (2007). National sustainable development strategies: features, challenges and reflexivity. European Environment, 17(3), 152-167. http://dx.doi.org/10.1002/eet.450

Munasinghe, M. (2009). *Sustainable development in practice*. New York: Cambridge.

Page, T. (1991). Sustainablility and the problem of valuation. In R. Constanza (Ed.), *Ecological economics: The Science and Management of Sustainability* (pp. 58-74). New York: Columbia University Press.

Panek, T., & Zwierzchowski, J. K. (2013). *Statystyczne metody wielowymiarowej analizy porównawczej: teoria i zastosowania*. Oficyna Wydawnicza, Szkoła Główna Handlowa.

Pater, B. (2019). Implementation of the intergenerational justice postulate in the context of statutory tasks and functions of national parks. Economics and Environment, 69(2), 179-189. https://ekonomiaisrodowisko.pl/journal/article/view/94

Poskrobko, B. (2013). Paradygmat zrównoważonego rozwoju jako wiodący kanon w badaniu nowych obszarów ekonomii. Ekonomia i Środowisko, 46(3), 10-24. https://ekonomiaisrodowisko.pl/journal/issue/view/9 (in Polish).

Rasoolimanesh, S. M., Ramakrishna, S., Hall, C. M., Esfandiar, K., & Seyfi, S. (2023). A systematic scoping review of sustainable tourism indicators in relation to the sustainable development goals. Journal of Sustainable Tourism, 31(7), 1497-1517. https://doi.org/10.1080/09669582.2020.1775621

Rawls, J. (1971). *A theory of justice*. Cambridge: Harvard University Press.

Resce, G., & Schiltz, F. (2021). Sustainable development in Europe: A multicriteria decision analysis. Review of Income and Wealth, 67(2), 509-529. https://doi.org/10.1111/roiw.12475

Tóthová, D., & Heglasová, M. (2022). Measuring the environmental sustainability of 2030 Agenda implementation in EU countries: How do different assessment methods affect results? Journal of environmental management, 322, 116152. https://doi.org/10.1016/j.jenvman.2022.116152

United Nations. (2015). *Transforming our world: the 2030 Agenda for Sustainable Development.* https://sdgs.un.org/2030agenda

Żylicz, T. (2002). Rola nauki w polityce trwałego rozwoju. Ekonomia i Środowisko, 22(2), 57-71. (in Polish).

Małgorzata ĆWIEK • Beata PATER • Paweł ULMAN

NIERÓWNOŚCI W POZIOMIE ZRÓWNOWAŻONEGO ROZWOJU W KRAJACH UNII EUROPEJSKIEJ

STRESZCZENIE: Celem badań jest ocena stopnia zróżnicowania rozwoju zrównoważonego w krajach Unii Europejskiej w latach 2015-2019 a także grupowanie państw unijnych ze względu na poziom zrównoważenia rozwoju. Aby zrealizować założony cel dokonano porządkowania liniowego i nieliniowego wybranych zmiennych w ramach czterech ładów składających się na zrównoważony rozwój: społecznego, gospodarczego, środowiskowego i instytucjonalno-politycznego. W wyniku porządkowania liniowego wyodrębniono cztery grupy państw. Procedura porządkowania liniowego została poprzedzona konstrukcją zmiennych syntetycznych. Jako metodę porządkowania nieliniowego wykorzystano hierarchiczną metodę Warda na bazie odległości euklidesowej. Dane wykorzystane w analizie pochodzą z bazy Eurostat. Przeprowadzone badania wskazują na znaczne nierówności w poziomie zrównoważonego rozwoju krajów UE. Dotyczy to zarówno zrównoważonego rozwoju w podejściu zintegrowanym, jak i oceny dla poszczególnych ładów. Rankingi krajów w poszczególnych ładach różnią się znacząco od siebie a ogólna ocena zrównoważonego rozwoju wykazuje największą korelację z ładem gospodarczym i instytucjonalno-politycznym. W świetle przeprowadzonych badań własnych, do liderów zrównoważonego rozwoju należą Szwecja, Finlandia, Dania, Austria i Estonia. Na drugim biegunie znajduje się Grecja, Bułgaria, Cypr i Rumunia.

SŁOWA KLUCZOWE: zrównoważony rozwój, nierówności w zrównoważonym rozwoju, Unia Europejska, pomiar zrównoważonego rozwoju

DOI: 10.34659/eis.2024.90.3.935