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SUSTAINABLE DEVELOPMENT AND ITS RELATIONSHIPS WITH OTHER DIRECTIONS OF THE DEVELOPMENT OF EUROPEAN UNION COUNTRIES

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Abstract: The main purpose of the paper is to present proposals for the study of relationships between the dimensions of sustainable development and other areas of the EU countries' development: innovation and competitiveness both from theoretical and practical perspective. The first part presents the assumptions adopted by the authors, and the second the 2-stage research procedure. In the first stage, the relative taxonomic measure of development was calculated, while in the next one the correlation coefficients between considered dimensions and areas were calculated. According to the authors, in the studies of relationships between sustainable development and other considered areas, one should take into account all of the particular dimensions and areas creating the research phenomena.

Keywords: sustainable development, innovation, competitiveness, relationships.

1. Introduction

Recently published scientific papers, as well as reports and business projects, indicate that the current stage of the evolution of the idea of sustainable development

is primarily its integration with other areas of research, including directions such as sustainable finance (Zioło, Filipiak, Bąk, Cheba, Tîrca, and Novo-Corti, 2019a), sustainable agriculture (Altieri, 2018), sustainable consumption (Young, Hwang, McDonald, and Oates, 2010), sustainable transport and sustainable logistics (Borys, 2008; Kiba-Janiak, 2015), sustainable finances (Fulliwer, 2015; Zioło et al., 2019a), and sustainable competitiveness (Aiginger, Bärenthaler-Sieber, and Vogel, 2013; Cheba, 2019) but also sustainable cities (Haughton and Hunter, 2004), sustainable innovations (Burget, Bardone, and Pedaste, 2017), sustainable transport infrastructure (Dembińska, 2018), sustainable strategies (Sassi, 2006), and many others. The multitude of the proposed definitions of their details and practical applications is immense. There are also different ways to incorporate the concept of sustainable development into the scope of other areas and research directions – ranging from merely combining sustainable development with other areas (Zioło, Filipiak, Bąk, and Cheba, 2019b), through more advanced proposals, to connections that take into account the network dimension of relations between connected areas (Cheba, 2019; Cheba and Bąk, 2020).

As part of a simplified way of integrating sustainable development into research in other fields of science and research areas, it is usually suggested to expand the existing definitions with elements that refer to sustainable development (e.g. Bartniczak, 2013; Kiba-Janiak, 2015). However, in more advanced proposals creating new economic categories, attention is primarily paid to the way of creating relations with sustainable development (e.g. Bąk, Cheba, and Łącka, 2020; Zioło et al., 2019b). The achieved level of sustainable development is treated therefore as the basis for assessing the ability to compete sustainably (Cheba, 2020) or as the overarching goal, as in the definitions of a green economy. According to authors, these more advanced proposals are more consistent with the assumptions of the idea of sustainable development in which the complex nature of these relations is underlined.

The starting point for more advanced analyses regarding the quantitative measurement of the implementation of the assumptions (development directions) adopted at the stage of creating new economic categories, is the presentation of the concept of sustainable development. The literature presents many different models describing in a graphic form the relationships between the various dimensions of sustainable development (e.g. Pelletier, Maas, Goralczyk, and Wolf, 2012; Wit, 2016). However, these concepts do not explain how these visualizations translate into a measurement, hence the most commonly used practice consisting in analysing individual indicators or determining the average level of sustainable development (Esty, Levy, Srebotnjak, and Sherbinin, 2005; Frenso, Espino, and Castro-Frenso, 2018); while the object considered to be sustainable should not only achieve the average level of sustainability. This may lead to a situation in which good results in terms of economic and social development will correspond to worse results in the environmental dimension (or vice versa), which, when averaged, may translate into even a relatively good overall result.

Therefore, the purpose of this work is to present proposals for the study of relationships between the individual dimensions of sustainable development and other areas essential for the further development of the EU countries. In the study the relationships between sustainable development and innovation and the competitiveness of the EU countries were considered. In addition to sustainable development, these are currently one of the most crucial development directions included in most strategic documents created at the level of a country, region, or a single enterprise.

The paper is divided into two parts. The first one presents the theoretical basis for measuring the relationship between the indicated research areas, the second the results of measuring these relationships considered in relation to European Union countries based on Eurostat data. An essential part of the work is the conclusions and information about further research directions.

2. Relations between the dimensions of sustainable development as a basis for testing linkages with other research areas

According to the most popular in the literature definition of sustainable development, which is derived from the Gro Harlem Brundtland Report (WCED, 1987), it is defined as the development which "meets current needs without the risk that future generations will not be able to meet their needs". In this concept it was underlined that its foundations are created by separate dimensions: society, environment and the economy, and at their interface a common area describing sustainable development is created. In currently published scientific works one can find many different proposals for visualizing relationships that combine the basic dimensions of sustainable economic, social, and environmental development. These include, e.g. a) the model of three isolated pillars (Borys, 2011) and b) the model of an equilateral triangle (Pachocka, 2016), in which each of the distinguished dimensions is given the same rank (i.e. the same importance), c) the model of three independent but overlapping areas in which sustainable development is described by the common part created as a result of their combination (Marczak, 2015; Pelletier et al., 2012), d) the "Mickey Mouse" diagram with the predominance of the economy, characteristic for a narrow perception of the concept of sustainable development, e) the model with the predominance of the environmental dimension (Wit, 2016), f) the model of environmental foundations for pillars in the social and economic area (the UNEP model).

The method of visualizing the relationships between the fundamental dimensions of sustainable development should have an impact on both the selection of indicators and the choice of methods (e.g. mathematics and statistics) used to assess the level of development in specific dimensions. In practice, there are usually two approaches to this measurement. In strategic documents developed at various levels of management, the assessment of the level of development of the examined objects

(e.g. countries or regions) is made separately for each identified indicator. Thus, the distance between the examined objects in relation to the assumed goals (expressed quantitatively) is measured. Scientific literature focuses primarily on measuring the implementation of the concept of sustainable development in the classic approach as a mean value of these phenomena (e.g. Vachon and Mao, 2008). Regarding the distinguished dimensions, more advanced measurement methods are used, among which taxonomic methods predominate (see: Cheba, 2019; Malina, 2004; Sokołowski, 1998; Walesiak, 2016; Zeliaś, 2004). The achieved level of sustainable development is often identified therein as the average level determined based on indicators describing its various dimensions together or separately. According to the authors of this paper, this approach to measuring sustainable development does not correspond with the essential message of this idea, according to which one should strive to harmonize the level and (despite critical comments formulated for this purpose, by e.g. Vogt and Weber, 2019) maximize the results achieved in each of the dimensions.

At the same time, questions remain on how to connect (create relationships) sustainable development and other areas necessary for the further development of countries. The literature currently lacks straightforward solutions and universal acceptance for one definition of sustainable development. The definition most often cited in various types of studies, despite the accusation of being vague, is that from the Brundtland report (WCED, 1987). It emphasizes, in a general way, yet providing a chance for widespread acceptance, the essential elements of the idea of sustainable development: a process enabling development in a specific direction, not a state, and generational justice in an anthropocentric perspective (for present and future generations), as well as, importantly, the need to reconcile various socio-political interests of both present and future generations.

It is worth emphasizing at this point that while striving to achieve various goals, indicated as necessary under the concept of sustainable development, the most often considered (at least on the basis of an idea, a kind of a design) is the simultaneous maximization of individual goals, economic, social, and environmental, as well as the sustainability among them.

The pursuit of the maximization of all sustainable development goals is criticized in some publications, mainly due to the lack of reality in their determination and the pursuit of infinity (Pawłowski, 2008), in particular the model of 'isolated' pillars of sustainable development, which is treated as the realization of unrealistic maximization efforts. According to Vogt and Weber (2019), a network model in which the individual dimensions, however, have different ranks might be a solution. Nevertheless this raises doubts of the authors of this study. Giving different ranks to particular dimensions of sustainable development can lead to overemphasizing the importance of, e.g. economic factors at the expense of social and environmental dimensions. According to the authors, some aspects of this concept can be used to create a model of the relationships occurring between different dimensions of sustainable development and other areas integrated with this concept.

3. Research model

Assuming that at the level of European Union countries, sustainable development is essential, covering three basic dimensions of sustainable development: economic (E), social (S) and environmental (EN), and additionally institutional and political (IP), which can be separated from the social dimension. In the case of the research on innovation level, however, four groups of indicators used by the European Commission and presented in the European Innovations Scoreboard report will be taken into account: framework conditions (EIS1), investments (EIS2), innovation activities (EIS3), impacts (EIS4). Then the network model of relationships between these dimensions and areas can be presented as follows (Figure 1).

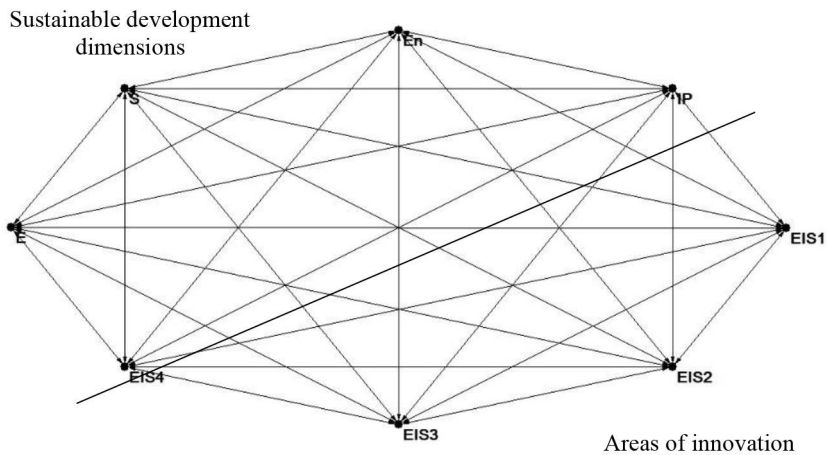

Fig. 1. A network model of relationships between dimensions of sustainable development and the areas of innovation

Source: own elaboration.

This model assumes that between all dimensions of sustainable development and the areas of innovation, there are links of varying intensity and the direction of dependence. Depending on the level of development, the acceptance of the idea of sustainable development, and the possibility of creating innovative solutions, these models may look differently. The relations between the dimensions and areas may be negative, which means that an improvement in one will cause a deterioration in the other. This type of relationship is observed in some countries between the economic and environmental dimensions of sustainable development. Along with economic development, an increase in negative pressure on the natural environment is observed. It is also possible that there will be no links or the strength between some dimensions and/or areas will be insignificant.

Similarly, the relations between sustainable development and competitiveness can be demonstrated, but in these proposals, sustainable development can also be treated as a kind of basis for assessing the ability to compete sustainably. As proposed in (Cheba, 2019), the key to a better understanding of how to integrate sustainable development into competitiveness research is the need to separate the ability to compete sustainably from a sustainable competitive position. Sustainable competitiveness on a national level is the result of "the ability of a given country to compete sustainably in the international arena, taking into account not only the economic dimension of this competition but also the social and environmental dimensions", whereas the sustainable position can be defined, as "the state and changes in the share of a given economy in the broadly understood international turnover" (cf. Misala, 2011) implemented with care for the environment and society (Cheba, 2019).

The presented examples do not exhaust the entire scope and the ways of including sustainable development in the newly developed definitions, however they outline a particular way of thinking. They are also important when developing proposals for measuring new research areas, which, like the proposed definitions, evolve from the approaches limited only to the selection of indicators describing a given research area, taking into account the basic dimensions of sustainable development (economic, social and environmental) through the approaches based on the inclusion of another dimension, and next to the already known dimensions of sustainable development or replacing one of them with a dimension dedicated to the new economic category being created, and finally to proposals focusing on examining the relationship between sustainable development and other areas important for further global development. The work focuses mainly on the latter approach.

4. Research procedure

An illustration of the considerations presented in the first part of the work is an empirical example of the relationship between the results achieved by EU countries under individual dimensions of sustainable development (E-economic, S-social, EN-environmental and IP-institutional and political) and the areas of innovation considered as part of the European Innovation Scoreboard reports (EIS1-framework conditions, EIS2-investments, EIS3-innovation activities, EIS4-impacts) and four areas of competitiveness included in the reports of the Global Competitiveness Index published by the World Economic Forum (EES – enabling an environment subindex covering four pillars: F1 – institutions, F2 – infrastructure, F3 – ICT adoption, F4 – macroeconomic stability, HCS – human capital subindex covering two pillars: F5 – health, F6 – skills, MS - market subindex covering four pillars: F7 – product market, F8 – labour market, F9 – financial system, F10 – market size and IES – innovation ecosystem subindex covering two pillars: F11 – business dynamism and F12 – innovation capability). The basis for creating a database containing features

describing sustainable development in EU countries were the indicators used by the EU to monitor progress in implementing the latest Strategy for Sustainable Development. Agenda 2030. It is also worth noting that the work abandoned the use of statistical methods at the stage of selecting features for the study. The literature indicates that the use of this type of method may lead to an excessive reduction of the set of diagnostic features and thus to distorting the test results (e.g. Cheba, and Bąk, 2020; Sokołowski, and Sobolewski, 2019).

A two-stage research procedure was used to study the relationships between the dimensions and the analysed areas. In the first stage, taxonomic development measures were calculated for each dimension and area included in the study. For this purpose the relative taxonomy method was used, a detailed description of which can be found in the following works: Wydymus (2013), Cheba (2019), Lira (2019). The main advantage of this method is the possibility to simultaneously analyse changes in the assigned rankings not only due to the situation of individual EU countries, but also to the situation of all other ones. The measurement of relative synthetic feature variations is based on the construction of taxonomically relative measures of development and consists of the following three stages:

1. Relativization of the values of diagnostic features.

The indicators selected for the study are relativized for each object *i* and for *t*-year against the other analysed *l*-object. For this purpose the following formula is used (Wydymus, 2013):

$$d_{(l/i)jt} = x_{ljt} / x_{ijt},$$

where: d – relativized values of the indicators, i, $l = 1, \ldots, k$ – numbers of objects, $i \neq l, j = 1, \ldots, m$ – numbers of sub-indicators, $t = 1, \ldots, n$ – numbers of years.

If $d > 1$, then this implies the relative advantage of *l*-th country in terms of the analysed diagnostic X. Conversely, if $d < 1$, the interpretation is reversed. Based on the values d matrices $\mathbf{D}_{jt}$ is elaborated. These matrices provide the basis for the construction of taxonomically relative measures of development.

2. Classification of the objects.

Based on the matrices $\mathbf{D}_{jt}$, matrix $\mathbf{\Delta}_{it}$ for each spatial i object at t-year was constructed. Matrices $\mathbf{\Delta}_{jt}$ can be defined as k-1 observation vectors of j-feature objects. In the next step, based on the array of $\mathbf{D}_{jt}$ matrices, objects (in this case EU Member States) are classified, taking into account the whole set of diagnostic indicators X used for the analysis. This means defining the following matrices (Wydymus, 2013):

$$A = \begin{bmatrix} 0 & & \frac{1}{(k-1)} \\ & \ldots & \\ \frac{1}{((k-1)} & & 0 \end{bmatrix},$$

and products $\boldsymbol{D}_{jt}^{*} = \boldsymbol{A} \cdot \boldsymbol{D}_{jt}$. Elements on the main diagonal matrix $\boldsymbol{D}^{*}$ form a three--dimensional matrix W defined for all *j* indicators and periods *t* (Wydymus, 2013):

$$W = \begin{bmatrix} w_{11t} & w_{12t} & \cdots & w_{1mt} \\ w_{21t} & w_{22t} & \cdots & w_{2mt} \\ \cdots & \cdots & \cdots & \cdots \\ w_{k1t} & w_{k2t} & \ldots & w_{kmt} \end{bmatrix}.$$

3. The relative synthetic measure of development determined by the **W** matrix is based on the formula:

$$\mu_{it} = \left[\sum 1/w_{ijt}\right]/m.$$

This measure is close to 1 and can be interpreted as the relative position of the object relative to all other analysed objects. For objects with a similar level of development, the values generally hover around unity. The lower the value of the measure, the better the situation of the object is.

As part of the second stage of the study, based on the received taxonomic values of development measures and the positions taken by individual countries in the built rankings, the authors determined the correlation coefficients (respectively Pearson's *r* and Kendall's τ).

5. Study results and discussion

The results of the first stage of the study are presented in Table 1. They confirm the authors' previous observations (Cheba, 2019; Cheba, and Bąk, 2020), which show that among the EU countries, Scandinavian countries (i.e. Sweden, Denmark and Finland) are doing best principally in most of the dimensions and areas analysed. Similar observations can also be found in the works by Lidskog and Elander (2012), Strand, Freeman, and Hockerts (2015). These countries have managed to permanently separate economic growth from negative pressure on the environment. They have also achieve high ranking in the areas describing the innovation and competitiveness of EU countries. The last places in the rankings included countries located in Southern and Eastern Europe: Romania, Cyprus and Croatia. Their distance from the more developed countries of Northern and Western Europe is constantly increasing. When analysing the results of countries such as Romania, Croatia and Bulgaria, it is worth paying attention to their definitely higher results in terms of the environmental dimension of sustainable development. In this case it is clearly seen that these countries achieve much worse results, e.g. in the case of the economic and social dimensions of sustainable development and all areas of innovation and competitiveness, but at the same time have a much lower negative impact on the environment. The opposite situation can be observed for countries such as the United Kingdom and Germany. These countries achieved fairly good results in the areas

describing the competitiveness and innovation level, and definitely worse results in the environmental dimension of sustainable development.

The presented examples confirm the authors' considerations presented in the first part of this paper. Averaging the results for very different dimensions of sustainable development could lead to distorted interpretations regarding the assessment of the level of sustainable development of EU countries. A slightly smaller variation in the results was observed in the areas of competitiveness and innovation. This is also confirmed by the correlation coefficients: Pearson's r determined for the results of taxonomic measures of development and Kendall's τ for positions occupied by individual EU countries in the constructed rankings (Tables 2 and 3). The high correlation of the results, both in the case of taxonomic measures of development and the positions taken in the built rankings can be discussed, e.g. in relation to the economic dimension and most of the other dimensions (except environmental) and the analysed areas of innovation and competitiveness. It is also worth noting the negative correlations between the environmental dimension and other dimensions and areas. This means that development in these areas causes adverse changes in the environmental area.

In the literature (e.g. Li, Lin, and Chiu, 2020) it is noted that one of the main goals of sustainable development is the sustainability of the balance between the dimensions under consideration. Alipouri et al. (2020) indicated that sustainable development denotes the balanced status among various dimensions of development that aim to improve conditions of quality of human life, while Li et al. pointed out that research on the relationships between economic and environmental development focused only on a few aspects of this development. According to these authors, the complex research in this field requires including all of the possible associations.

The results of the research presented in this paper show how difficult this task is. Beckermann (1992) already in the 1990s indicated that the "sustainable growth concept is either morally indefensible or totally nonoperational". Opinions questioning the possibility of the practical implementation of the concept of sustainable development still appear in recently published works (e.g. Karahasanović, Tatić, and Avdić, 2012; Mitchell, 2006; Poczta-Wajda and Sapa, 2017). Despite many changes and the constant emphasis on the importance of environmental factors in the concept of sustainable development, one still observe a situation in which economic and social development is not carried out at the same pace as environmental development. Moreover, in the case of many EU countries, negative relationships between economic and environmental development are observed. Despite the growing awareness of the importance of environmental problems, the results achieved by countries such as Germany confirm that economic growth is still strongly associated with a negative environmental impact.

The relationship between sustainable development and innovation as well as competitiveness is similar. The highest scores for correlation coefficients relate to the dimensions of economic and social sustainable development and individual

Table 1. The results of the adopted procedure – stage 1

Country	Sustainable development dimensions								Innovations area								Competitiveness pillars							
	E		S		EN		IP		EIS1		EIS2		EIS3		EIS4		EES		HCS		MS		IES	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Austria	0.76	6	0.81	8	0.84	11	0.96	22	0.58	9	0.44	4	0.38	1	0.89	17	0.93	9	0.94	8	0.93	11	0.86	10
Belgium	0.80	7	0.89	14	1.10	19	0.56	5	0.51	7	0.43	3	0.45	7	0.86	14	0.95	11	0.94	7	0.92	9	0.82	7
Bulgaria	1.41	25	1.56	27	0.81	7	0.87	16	1.57	24	1.14	23	1.26	22	1.20	25	1.12	26	1.15	27	1.11	20	1.24	26
Croatia	1.11	22	1.13	21	0.82	8	1.50	26	1.61	25	0.70	14	1.20	21	1.43	27	1.20	27	1.11	25	1.14	25	1.36	28
Cyprus	1.17	24	1.03	18	1.24	22	3.65	27	1.10	21	1.61	25	1.88	26	6.89	28	1.09	23	0.99	15	1.20	28	1.14	20
Czechia	0.80	8	0.72	1	0.84	12	1.07	23	0.80	16	0.48	5	0.75	14	0.73	7	0.99	14	1.02	20	0.99	14	0.98	15
Denmark	0.62	2	0.74	4	0.66	1	0.56	4	0.37	1	0.59	10	0.45	6	0.82	12	0.88	3	0.92	5	0.89	5	0.80	6
Estonia	0.96	14	1.16	22	0.71	3	0.94	18	0.71	14	0.67	12	0.80	16	0.89	18	0.94	10	1.01	19	1.07	18	1.02	17
Finland	0.75	5	0.75	5	0.80	6	0.53	2	0.45	4	0.53	8	0.41	3	0.82	11	0.89	4	0.89	1	0.91	8	0.79	5
France	0.83	10	0.81	9	1.53	26	0.71	9	0.62	12	0.54	9	0.56	8	0.68	4	0.93	8	0.97	10	0.90	6	0.85	8
Germany	0.71	4	0.84	12	1.95	28	0.60	6	0.75	15	0.33	2	0.41	2	0.64	3	0.91	6	0.91	4	0.81	2	0.73	1
Greece	1.13	23	1.56	26	0.94	17	1.20	24	1.48	23	0.81	18	0.96	19	1.17	24	1.21	28	0.99	16	1.18	27	1.19	23
Hungary	0.99	17	1.09	19	0.84	13	>200	28	0.99	18	0.75	17	1.27	23	0.73	6	1.10	25	1.11	26	1.11	22	1.20	24
Ireland	0.92	12	0.79	6	0.88	16	0.71	8	0.52	8	0.69	13	0.87	18	0.53	1	0.96	12	0.94	6	0.91	7	0.85	9
Italy	0.99	18	1.17	23	1.33	24	0.75	10	0.95	17	0.74	16	0.67	12	0.84	13	1.09	22	0.98	14	0.99	16	0.93	11
Latvia	1.10	21	1.49	25	0.73	4	0.87	13	1.09	20	1.91	26	1.42	24	1.06	21	1.03	18	1.09	24	1.16	26	1.22	25
Lithuania	1.01	19	1.36	24	0.70	2	0.87	14	1.17	22	0.88	21	0.76	15	1.35	26	1.00	15	1.09	23	1.11	21	1.15	22

Luxembourg	2.14	27	0.82	10	1.02	18	0.68	7	0.47	5	1.17	24	0.60	11	0.77	9	0.91	7	0.97	11	0.93	10	0.93	12
Malta	2.84	28	0.80	7	1.75	27	1.38	25	>200	28	>200	28	>200	28	1.05	20	1.01	16	0.98	13	1.12	24	1.13	18
Netherlands	0.68	3	0.73	2	1.30	23	0.55	3	0.42	3	0.91	22	0.43	4	0.69	5	0.87	1	0.90	3	0.82	3	0.78	4
Poland	1.07	20	0.97	16	1.15	20	0.87	15	1.91	26	0.81	19	1.42	25	1.01	19	1.08	21	1.04	21	0.98	13	1.14	19
Portugal	0.98	16	1.13	20	0.87	15	0.94	19	0.60	10	0.61	11	0.73	13	1.07	22	1.03	19	1.01	18	0.99	15	1.01	16
Romania	1.52	26	1.67	28	0.82	9	0.95	20	2.36	27	2.21	27	3.21	27	1.13	23	1.10	24	1.18	28	1.11	23	1.34	27
Slovakia	0.98	15	0.96	15	0.82	10	0.96	21	1.07	19	0.85	20	1.20	20	0.81	10	1.04	20	1.08	22	1.07	17	1.14	21
Slovenia	0.84	11	0.82	11	0.85	14	0.88	17	0.64	13	0.48	6	0.57	9	0.87	15	1.02	17	1.00	17	1.10	19	0.98	14
Spain	0.94	13	1.00	17	1.22	21	0.79	12	0.61	11	0.72	15	0.83	17	0.88	16	0.97	13	0.98	12	0.94	12	0.94	13
Sweden	0.61	1	0.74	3	0.74	5	0.44	1	0.39	2	0.33	1	0.44	5	0.75	8	0.87	2	0.90	2	0.86	4	0.76	2
United Kingdom	0.82	9	0.86	13	1.34	25	0.75	11	0.50	6	0.52	7	0.60	10	0.57	2	0.89	5	0.94	9	0.80	1	0.77	3

Source: own calculations, where: 1 – value of taxonomic measure of development, 2 – positions in the ranking.

Table 2. Pearson's *r* correlation coefficients between dimensions of sustainable development and areas of innovation and competitiveness – stage 2

	E	S	EN	IP	EIS1	EIS2	EIS3	EIS4	EES	HCS	MS	IES
E	1.00	0.20	0.25	–0.02	0.75	0.75	0.75	0.11	0.28	0.29	0.42	0.46
S	0.20	1.00	–0.30	0.05	–0.14	–0.14	–0.14	0.14	0.70	0.76	0.67	0.75
EN	0.25	–0.30	1.00	–0.10	0.43	0.43	0.43	0.07	–0.16	–0.38	–0.33	–0.31
IP	–0.02	0.05	–0.10	1.00	–0.03	–0.03	–0.03	–0.05	0.21	0.28	0.19	0.21
EIS1	0.75	–0.14	0.43	–0.03	1.00	1.00	1.00	–0.01	0.02	–0.05	0.20	0.15
EIS2	0.75	–0.14	0.43	–0.03	1.00	1.00	1.00	–0.01	0.02	–0.05	0.20	0.15
EIS3	0.75	–0.14	0.43	–0.03	1.00	1.00	1.00	0.00	0.02	–0.05	0.20	0.15
EIS4	0.11	0.14	0.07	–0.05	–0.01	–0.01	0.00	1.00	0.31	0.09	0.45	0.29
EES	0.28	0.70	–0.16	0.21	0.02	0.02	0.02	0.31	1.00	0.73	0.81	0.86
HCS	0.29	0.76	–0.38	0.28	–0.05	–0.05	–0.05	0.09	0.73	1.00	0.73	0.91
MS	0.42	0.67	–0.33	0.19	0.20	0.20	0.20	0.45	0.81	0.73	1.00	0.90
IES	0.46	0.75	–0.31	0.21	0.15	0.15	0.15	0.29	0.86	0.91	0.90	1.00

Source: own calculations.

Table 3. Kendall's τ correlation coefficients between dimensions of sustainable development and areas of innovation and competitiveness – stage 2

	E	S	EN	IP	EIS1	EIS2	EIS3	EIS4	EES	HCS	MS	IES
E	1.00	0.54	0.05	0.45	0.65	0.67	0.65	0.45	0.61	0.54	0.60	0.63
S	0.54	1.00	–0.12	0.31	0.52	0.35	0.41	0.46	0.57	0.58	0.50	0.56
EN	0.05	–0.12	1.00	–0.02	0.00	0.02	–0.05	–0.24	–0.05	–0.26	–0.19	–0.26
IP	0.45	0.31	–0.02	1.00	0.54	0.24	0.52	0.39	0.59	0.53	0.57	0.58
EIS1	0.65	0.52	0.00	0.54	1.00	0.44	0.62	0.42	0.65	0.60	0.60	0.65
EIS2	0.67	0.35	0.02	0.24	0.44	1.00	0.60	0.32	0.35	0.41	0.46	0.49
EIS3	0.65	0.41	–0.05	0.52	0.62	0.60	1.00	0.37	0.54	0.59	0.58	0.64
EIS4	0.45	0.46	–0.24	0.39	0.42	0.32	0.37	1.00	0.47	0.42	0.62	0.56
EES	0.61	0.57	–0.05	0.59	0.65	0.35	0.54	0.47	1.00	0.63	0.67	0.70
HCS	0.54	0.58	–0.26	0.53	0.60	0.41	0.59	0.42	0.63	1.00	0.58	0.79
MS	0.60	0.50	–0.19	0.57	0.60	0.46	0.58	0.62	0.67	0.58	1.00	0.75
IES	0.63	0.56	–0.26	0.58	0.65	0.49	0.64	0.56	0.70	0.79	0.75	1.00

Source: own calculations.

areas analysed within the area of innovation and competitiveness. However, in the case of other dimensions and areas, these relations are definitely weaker.

Similar regularities were also noticed by Fonseca et al. (2020), who highlighted the relationships between the individual goals of the 2030 Agenda. The results of their research confirm that Poverty elimination (SDG1) and Good health and well--being (SDG3) have synergetic relationships with most of the other goals. SDG7 (Affordable and clean energy) has significant relationships with other SDGs (e.g. SDG1 (No poverty), SDG2 (Zero hunger), SDG3 (Good health and well-being), SDG8 (Decent work and economic growth), SDG13 (Climate action)). However, some SDGs show no significant correlation with other SDGs (e.g. SDG13 (Climate action) and SDG17 (Partnerships for the goals), which highlights the need for future research. This kind of research is also planned by the authors of this article.

6. Conclusion

The studied phenomena, also confirmed by other authors (Borys, 2011; Ciegis, Ramanauskiene, and Martinkus, 2009), are characterized by a high degree of complexity. From the measurement side, this complexity is attempted to be explained using advanced statistical methods, which, by averaging the final result, do not fully reflect all aspects of the studied phenomenon. According to the authors, the solution may be to look for relationships first between the dimensions (areas) considered for their feedback. Then, between them and other areas with this phenomenon, they should at least in theory form strong relationships.

As the research results presented in the paper show, the authors' expectations have not been fully met. The relations between the various dimensions of sustainable development are not so strong. This is particularly evident in the relationship between the environmental dimension and other dimensions of sustainable development. The situation is similar in the case of relations between this dimension and other areas analysed at work. The existence of strong links between the environmental dimension and other dimensions and areas is key for implementing the concept of sustainable development. Unfortunately, only a few Scandinavian countries have such strong connections. The research results presented in the work are part of a larger project carried out by the authors. The aim of subsequent research in this field will be a detailed review of measurement proposals in the aspect of integrating sustainable development into other fields of science and research areas.

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Słowa kluczowe: zrównoważony rozwój, innowacyjność, konkurencyjność, relacje.