Classification of EU Countries in Terms of the Level of Sustainable Development

Stec Małgorzata
Grzebyk Mariola
University of Rzeszów, Poland
malgorzata.a.stec@gmail.com
mgrzebyk6@gmail.com

Abstract

This article has classified the EU countries in terms of the level of sustainable development. The study was based on main sustainability indicators developed by Eurostat. In empirical research, one of the methods used was Cluster Analysis - Ward's method. Grouping methods make it possible to distinguish countries with a similar level of sustainability which is particularly useful for monitoring the progress of individual EU countries in implementation of the Sustainable Development Strategy. For specific groups of countries, appropriate control instruments and strategies can be proposed. The research period is 2016. As a result of the research, 6 clusters of countries were obtained. For specific groups of countries, their characteristics were defined.

Key words: sustainable development, the indicators of sustainable development, level of development, European Union.
J.E.L. classification: C80, C82, O11

1. Introduction

Sustainable Development stands for meeting the needs of present generations without jeopardizing the ability of futures generations to meet their own needs – in other words, a better quality of life for everyone, now and for generations to come. It offers a vision of progress that integrates immediate and longer-term objectives, local and global action, and regards social, economic and environmental issues as inseparable and interdependent components of human progress [http://ec.europa.eu/environment/eussd/].

Sustainable development is one of the EU's most important goals and ways in which it is achieved are defined in the EU Sustainable Development Strategy (EU SDS). Progress towards the EU SDS objectives and targets is evaluated using a set of indicators (EU SDI set).

The aim of the article is to classify EU countries in terms of the level of sustainability. Leading indicators for sustainable development created by Eurostat constitute the basis of assessment. The research was carried out by means of cluster-method analysis.

The research period is 2016.

2. The indicators of sustainable development in EU countries

The term „sustainable development" is very widely used, hence publications in the subject area abound with varying approaches and concepts. This constitutes both cognitive and practical difficulties since sustainable development can be understood and interpreted in various ways. Discussions on this issue have been extensive and have yielded immense definitions of sustainable development. There, currently exists dozens of definitions and interpretations of sustainable development. Consequently, sustainable development has become a fluid and ambiguous category, saddled with degrees of subjectivity. Concepts of sustainable development are, to a large extent, relative to an authors point of view. The popularity of the term very often makes it difficult to

ascertain whether one is dealing with a real economic and ecological category or just a marketing ploy (Grzebyk, Stec, 2015; Jeżowski, 2009).

Specific objectives of sustainable development should include the following (Kośmicki, 2010):

- environmental objectives: protection of Earth's atmosphere, protection of wildlife, protection of resources, protection of human health, mobility within natural environments;
- economic objectives: full employment with acceptable quality of labour, adequate incomes and economic growth within natural environments, balance in international relations and progressive work, price stability, sustainable state budgets that is sufficiently furnished with collective (substantive) goods;
- socio-cultural objectives: social security, democracy and rule of law, internal and external security, social inclusion and equitable life opportunities, quality of life and quality of health.

Majority of definitions contain several common elements that can be defined as sustainable paradigms (Kistowski, 2003). Amongst them are the following assumptions (Stanny, Czarnecki, 2011):

- sustainable development is a type of socio-economic development (realized both for human and by human, pursuing environmental and socio-economic egalitarianism);
- sustainable development is a process integrating all human activities, commonly brought to three dimensions: economic, social and environmental, and less widespread by spatial or institutional (political) dimension.
- sustainable development means a desirable living environment and a responsible society pursuing the concept of internal and intergenerational governance.

In other words, sustainable development is a kind of compromise between the environmental, economic and social objectives of the present and future generations. The economic aspect of sustainable development means not only meeting today's needs, but also securing the resources needed to meet the needs of future generations (natural capital, material, man-made, intellectual and social). The ecological aspect means that the limits of the natural system for human activities are not established and not to be exceeded. On the other hand, the social aspect is identified with education and the ability to solve major social problems and participate in the development processes of the whole system (Ciegis *et al,* 2009; Stanny, Czarnecki, 2011).

European Union monitors advances in sustainable development through the application of sustainability indicators, divided into three levels:

1. Headline indicators,
2. Operational indicators, and
3. Explanatory indicators.

Headline indicators monitor the overall objectives related to the key challenges of the SDS. They are widely used indicators with a high communicative and educational value. They are robust and available for most EU Member States.

Table 1 presents a summary of theme groups and headline indicators for monitoring sustainable development in EU countries.

Table no. 1. Theme areas and headline indicators of sustainable development

Theme	Headline indicators*
1.Socio-economic development	X1-Growth rate of real GDP per capita (Percentage change on previous year, EUR per inhabitant) (S)
2.Sustainable consumption and production	X2-Resource productivity (2000=100) (S)
3.Social inclusion	X3-People at-risk-of-poverty or social exclusion (D)
4. Demographic changes	X4-Employment rate of older workers (S)
5.Public health	X5-Healthy life years and life expectancy at birth, females (S)
6.Climate change and energy	X6-Greenhouse gas emissions (1990=100) (D) X7-Primary energy consumption (D)
7.Sustainable transport	X8-Energy consumption of transport relative to GDP (2010=100) (D)
8. Natural resources	Common bird index Fish catches taken from stocks outside safe biological limits: Status

	of fish stocks managed by the EU in the North-East Atlantic
9.Global partnership	X9-Official development assistance as share of gross national income (S)
10.Good governance	No headline indicator

* Headline indicators applied in the study denoted with the symbols X1-X9. S-stimulating, D-non-stimulating. No indicator was considered for the area of "Natural resources" due to lack of data from EU countries.

Source: Own elaborations based on: Eurostat (http://ec.europa.eu/eurostat)

3. Empirical Results

The lead indicators in table 1, which were collected for the 28 EU countries in 2016, are the basis for grouping EU countries in terms of sustainability (Due to lack of data for 2016, for chosen countries data were included for 2015). Statistical data were standardized according to the formula:

$$z_{ij} = \frac{x_{ij} - \bar{x}_j}{S_j}$$

where:

z_{ij}- standardized value of *j-th* feature in *i-th* object,

x_{ij}, -value of *j-th* feature in *i-th* object,

$\bar{x}_j$ - mean value of *j-th* feature,

S_j -standard deviation of *j-th* feature.

Grouping of EU countries in terms of sustainability was conducted using the Ward method and STATISTICA program. Foundations of the Ward method can be found, among others in the works: (Lance, Williams, 1967; Ward 1963).

As a result of the Ward method, the EU dendrogram for the 2016 indicators for sustainability (Figure no.1) was obtained.

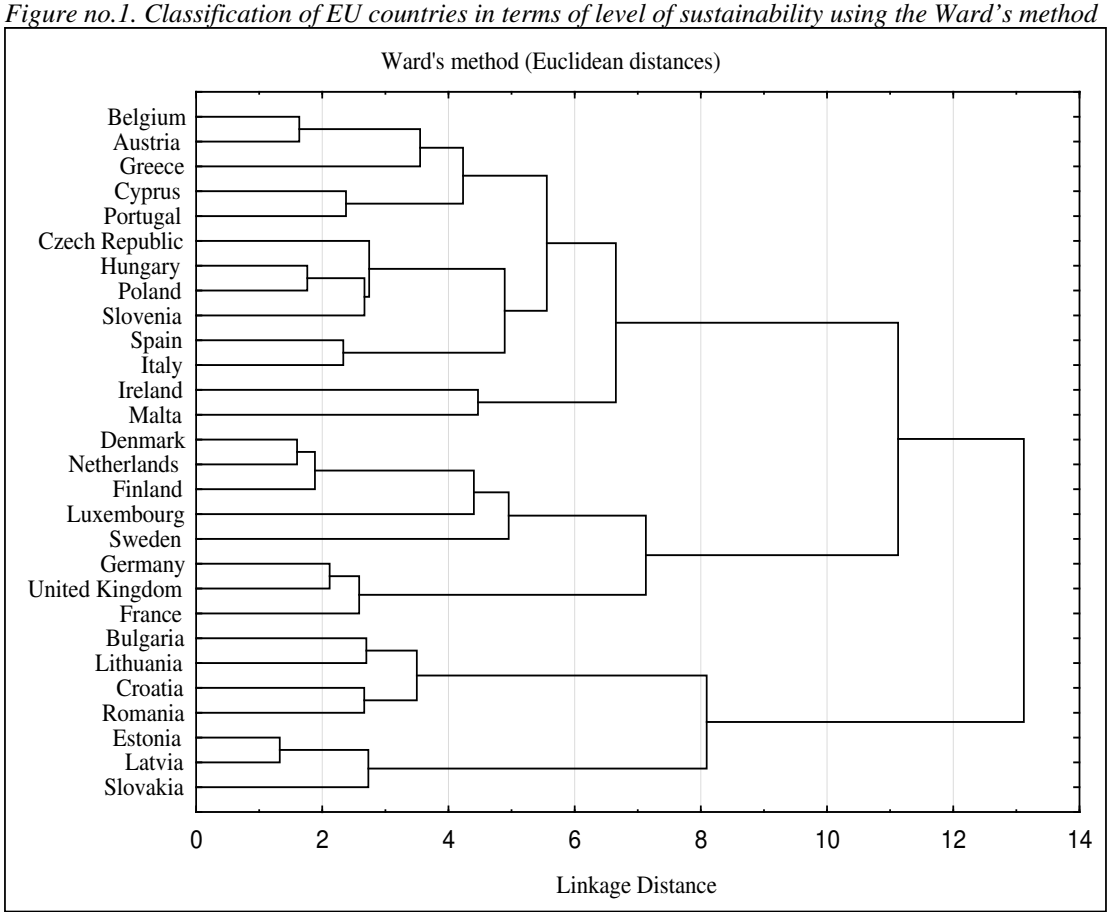
An important problem that arises after preparing dendrogram is the number of EU countries with a similar sustainability level.

In the literature on the subject, despite development of many indicators, the optimum rule for number of classes has not been established (see, for example, Filip, 2006; Halkidi, *et al,* 2001; Milligan, Cooper, 1985; Migdał-Najman, 2011; Stec, *et al,* 2014).

The commonly used criterion of objects division into groups is the analysis of agglomeration graph. Graph shows the distances between clusters when they were combined. The best cut off point is a clear flattening (longer vertical line), meaning distant focus (Stanisz, 2007).

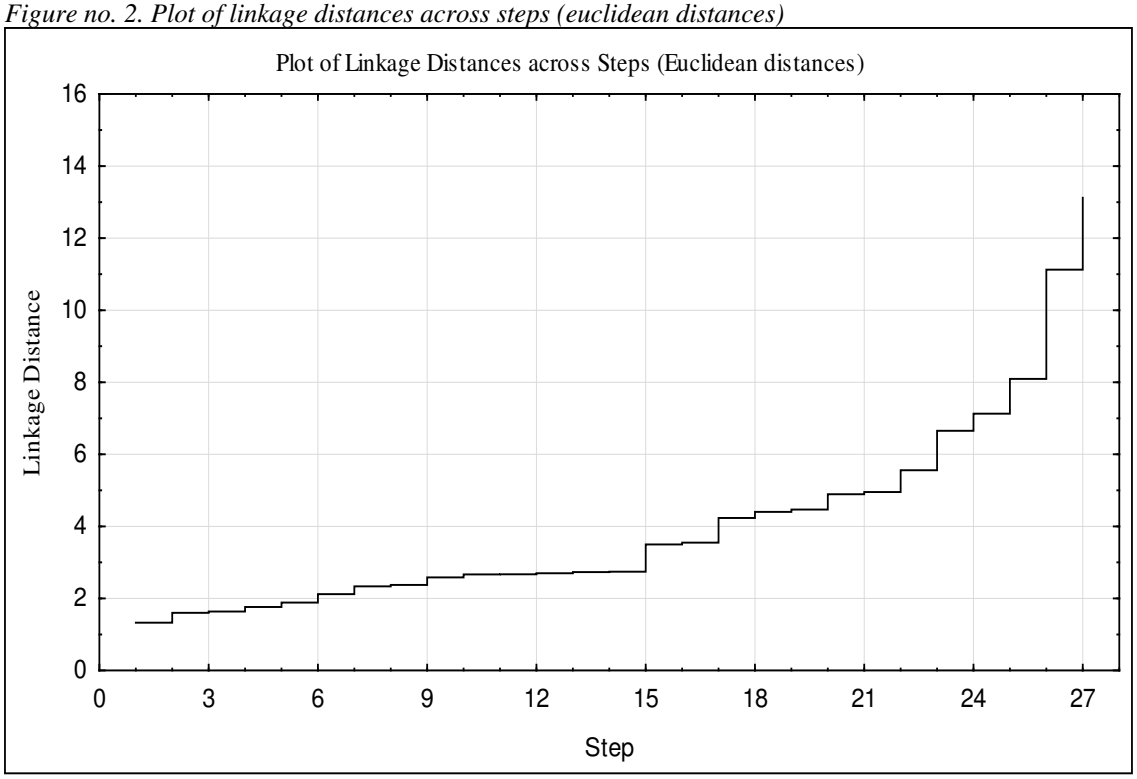
The course of agglomeration for 28 EU countries in terms of sustainable development level is presented in Figure 2.

Figure no.1. Classification of EU countries in terms of level of sustainability using the Ward's method



Source: Own calculations

Figure no. 2. Plot of linkage distances across steps (euclidean distances)



Source: Own elaboration

By analyzing the pattern of agglomeration shown in Figure no. 2, it can be observed that dividing EU countries into 6 groups of similar countries would be the most sensible (distance 6). The composition and characteristics of individual clusters are shown in Table 2 by the most favorable arithmetic means of the leading indices computed for the countries categorized in each cluster of countries.

Table no. 2. Groups of EU countries with similar levels of sustainable development

Groups	Country	The most favorable values of leading indicators
I	Belgium, Greece, Austria, Czech Republic, Cyprus, Portugal, Hungary, Poland, Slovenia, Spain, Italy	Lack of data
II	Ireland, Malta	X1, X2, X5, X7, X8
III	Denmark, Netherlands, Finland, Luxembourg, Sweden	X3, X4, X9
IV	Germany, United Kingdom, France	Lack of data
V	Bulgaria, Lithuania, Croatia, Romania	Lack of data
VI	Estonia, Latvia, Slovakia	X6

Source: Own elaboration.

Ireland and Malta as countries from Group II have the best situation in terms of sustainable development. Of all the studied countries groups, these countries have obtained the most favorable average values of five leading indicators: X1 - Percentage change on previous year, EUR per inhabitant, X2 - Resource productivity (2000=100), X5 - Healthy life years and life expectancy at birth, females, X7 - Primary energy consumption and X8 - Energy consumption of transport relative to GDP.

Countries in group number III (Denmark, Netherlands, Finland, Luxembourg, Sweden) also have a good situation in this subject area. Their characteristic is the favorable situation in terms of three leading indicators: X3 - People at-risk-of-poverty or social exclusion, X4 - Employment rate of older workers and X9 - Official development assistance as share of gross national income.

Favorable values of one of the leading indicators (X6 - Greenhouse gas emissions) have Estonia, Latvia, Slovakia, forming conglomeration VI.

In contrast, groups of countries numbered I, IV and V do not stand out among the other clusters in terms of the value of any leading level of sustainable development indicator.

4. Conclusion

The main findings of the paper can be summarized as follows:

1. Sustainable development is a priority of the European Union. In measuring the progress of EU countries in implementing this development concept, EU uses indicators of varying detail levels.

2. Lead indicators for sustainable development cover the most important areas of this development and can be an effective tool for a preliminary assessment of the progress of individual EU countries in implementing this development concept.

3. The empirical studies used the leading indicators for sustainable development for 28 EU countries in 2016. The Warda method was used to classify EU countries into groups with a similar level of sustainability.

4. Using the criterion of division of groups based on the agglomeration graph, 6 groups of countries were separated and their characteristics were determined. Good results in the implementation of the concept of sustainable development reached the countries included in Group II (Ireland, Malta) and III (Denmark, Netherlands, Finland, Luxembourg, Sweden). On the other hand, in terms of Greenhouse gas emissions - group VI stands out (Estonia, Latvia, Slovakia).

5. The importance of the sustainable development concept in EU countries indicates the need for further in-depth research.

5. References

- Ciegis, R., Ramanauskiene, J., Martinkus, B., 2009. The concept of sustainable development and its use for sustainability scenarios. *Engineering Economics*, 2, pp. 28-37.
- Filip, P., 2006. Instruments for financing development of enterprises with national and EU means, *Geopolitical Studies,* 14, Warsaw: National Academy of Sciences Geographical Institute for Spatial Management, pp. 345-355.
- Halkidi, M., Batistakis, Y., Vazirgiannis, M., 2001. On Clustering Validation Techniques. *Journal of Intelligent Information Systems,* 17(2), pp. 107-145.
- Grzebyk, M., Stec, M., 2015. Sustainable development in EU countries: concept and rating of levels of development. *Sustainable Development*, 23(2), pp. 110-123; DOI: 10.1002/sd.1577.
- http://ec.europa.eu/environment/eussd/
- http://ec.europa.eu/eurostat
- Jeżowski, P., 2009. Kapitał naturalny i rozwój zrównoważony a sprawiedliwość. In: B. Fiedor & R. Jończy, eds., *Rozwój zrównoważony. Teoria i praktyka ze szczególnym uwzględnieniem obszarów wiejskich*, Wrocław: UE Publishing in Wrocław, pp.73.
- Kistowski, M., 2003. Model zrównoważonego rozwoju i ochrony środowiska Polski a strategie rozwoju województw, Gdańsk-Poznań: Wyd. Naukowe Uniwersytetu Gdańskiego, pp.15.
- Kośmicki, E., 2010. Zrównoważony rozwój w warunkach globalizacji gospodarki, Białystok-Poznań: Wyd. Ekonomia i Środowisko, pp. 154-155
- Lance, G.M., Williams, W.T., 1967. A General Theory of Classificatory Sorting Strategies I. Hierarchical System. *Computer Journal,* 9, pp. 373-380.
- Migdał-Najman, K., 2011. Ocena jakości wyników grupowania-przegląd bibliografii, *Przegląd Statystyczny,* 3-4, pp. 281-299.
- Milligan, G. W., Cooper, M.C., 1985. An Examination of Procedures for Determining the Number of Clusters in a Data Set. *Psychometrika*, 50(2), pp. 159-179.
- Stanisz, A.*,* 2007, *Przystępny kurs statystyki z zastosowaniem STATISTICA PL na przykładach z medycyny, Tom 3. Analizy wielowymiarowe,* StatSoft, Kraków, pp. 141-142.
- Stec, M., Filip, P., Grzebyk, M., Pierścieniak, A., 2014. Socio-economic development in EU member states – concept and classification, *Engineering Economics*, 25(5), pp. 504-512; DOI:10.5755/j01.ee.25.5.6413.
- Stanny, M., Czarnecki, A., 2011. Zrównoważony rozwój obszarów wiejskich Zielonych Płuc Polski. Próba analizy empirycznej, wyd. IRWiR, PAN, Warszawa, pp. 16-17.
- Ward, J.H., 1963. Hierarchical Grouping to Optimise an objective Functions. *Journal of the American Statistical Association*, 58, pp. 236-244.