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SUSTAINABLE DEVELOPMENT PERFORMANCE MEASURING WITH ENTROPHY- VIKOR AND ENTROPHY - MAUT INTEGRATED TECHNIQUES

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ABSTRACT

The principle of sustainable development is a set of politics which envisages the countries's developments by taking in to account the environment they live in and their social atmosphere. In this study, considering the sustainable development policy of the European Union, the main sustainable development indicators, which published by Eurostat (The European Union Official Data Center), has been studied. Sustainable development indicators have been weighted by entropy method first, and then a ranking for the member states of the European Union countries has been obtained via Maut and Vikor methods. In this way, countries have been listed in terms of sustainability.

KEYWORDS: Sustainable Development, Vikor Method, Maut Method, Entrophy Weighted Method, Rankings

INTRODUCTION

The name sustainability is derived from "sustinere" and it means "maintain", "support", or "endure"(Douglas, Dictionary). The concept *sustainable development*, that of the Brundtland Commission of the United Nations on March 20, 1987: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Sustainability can be defined as the practice of reserving resources for future generation without any harm to the nature and other components of it (Kahle and Atay 2014). According to European Union papers has been described in terms of three dimensions, domains or pillars. In the three-dimension model, these are seen as "economic, environmental and social" or "ecology, economy and equity

"this has been expanded by some authors to include a fourth pillar of culture, institutions or governance (Paul et. all, 2015).

There are two important views for the assessment of the sustainable development indicators. One of them is conventional economic view. In this view, the economy, environment and society interact with each other but not interdependent. They are drawn as of equal size alternatively

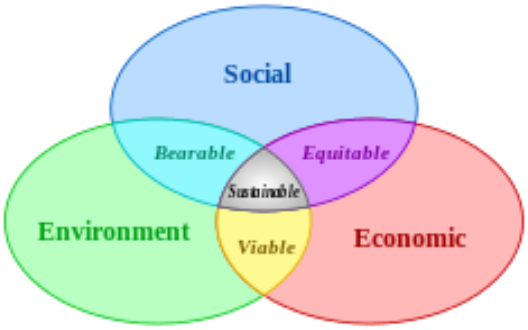

Figure 1: Conventional Economic View

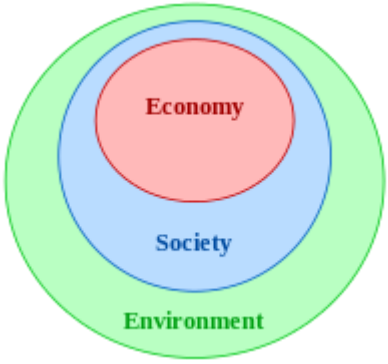

Figure 2: Green Economics View

According to green economics paradigms; economy works within social relationships and the All of the society is digged in within the natural world (Cato, 2009). In this article, It has been applied economic view for the assessment the sustainable development head indicators which have got equal importance.

Multi-Criteria Decision Analysis (MCDA) have a widespread applications area in the world and lately it can be seen at integrated form (Ahp- Topsis ; Ahp –Maut; Entrophy-Maut….etc). Boggia (2010) examines how Multi-criteria Decision Analysis (MCDA) can asses the level of sustainability. Türkoğlu and Uygun solved airport site selection problem in the Çukurova Region by using the Vikor and Maut Methods. It has been seen extensively to evaluate sustainability (Munda, 2005, Huangho et al., 2011, Akadiri and Olomolaiye, 2012, Rowley et al., 2012).

1. Research Methods:

In this study, the methods of Entrophy&Maut and Entrophy&Vikor integrated forms are used. These methods are acceptable for doing fair classification for the indicators sustainable development

1.1 Methodology:

In this section we give brief explanations about the methods used in this study.

1.1.1 Entrophy:

There are lots of different weighting methods proposed by the researchers. In the literature ıt can be categorized into two groups (generally); subjective and objective based weight methods. Subjective based weights methods are determined only according to the preference decision makers. AHP method (Saaty,1980), weighted least squares method and Delphi method. One of the objective weighting measures which has been proposed by researchers is the Shannon entropy concept. One of them is Entropy, it has been defined firstly by Rudolph Clausius (1865) as a measure of uncertainty and irregularity in the system (Zhang, 2011). Firstly it can be thought as a second rule of thermodynamics. It is quite widely used today primarily in physics including mathematics and engineering sciences has been adapted to information theory by Shannon (1948).

Entropy Weight method in this context is used to measure the amount of useful information provided by the available data. (Wu, 2011) As long as the Entropy weight of evaluation index grows, the index of the useful information rate increases. Besides, entropy weight technique is an available measure which can be used to make an assessment at different decision-making processes. It is seen that Entropy Weight method is often used to determine the index weight in social sciences. In literature, the number of studies in which Entropy Weight method is used has increased in recent years. This method includes following steps;

Step 1: Structure the evaluation matrix (with the dimension mxn)

$$A_{ij} = \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2n} \\ . & & & . \\ . & & & . \\ . & & & . \\ x_{m1} & x_{m2} & \dots & x_{mn} \end{bmatrix}$$

Step 2: Standardization of Criteria's

Indexes are standardized by various techniques in order to eliminate the effects of different index sizes. According to utility index, criterias are normalized with the help of equations represented by following equality.

$$r_{ij} = \frac{x_{ij}}{mak_{ij}} \quad (i = 1,2,3 \ldots . m \, ; j = 1,2, \ldots \ldots \ldots n)$$

$$r_{ij} = \frac{min_{ij}}{x_{ij}} \quad (i = 1,2,3 \ldots . m \, ; j = 1,2, \ldots \ldots \ldots n)$$

Step 3: Calculation of all index values's entrophy

$$\boldsymbol{e_j = -\frac{\sum_{i=1}^{m} f_{ij} ln f_{ij}}{lnm}} \quad \boldsymbol{(i = 1,2 \ldots . m \, ; j = 1,2 \ldots \ldots n)}$$

$$\boldsymbol{f_{ij} = \frac{r_{ij}}{\sum_{i=1}^{m} r_{ij}} (i = 1,2 \ldots . m \, ; j = 1,2 \ldots \ldots n)}$$

Step 4 : Calculation of Entropy of weighted index

$$\boldsymbol{W_j = \frac{1 - e_j}{n - \sum_{i=1}^{m} e_j} \quad and \sum_{j=1}^{n} W_j = 1 \quad (j = 1,2 \ldots \ldots , n)}$$

The criteria, which has bigger Entropy weight, is more important in terms of the decision-making and evaluating for the Entropy weight demonstrates the degree of the useful information.

1.1.2 Vikor Method

The VIKOR (VIse Kriterijumska Optimizacija Kompromisno Resenje with the Serbian name, can be translated Multi-criteria Optimization and Compromise Solution) method is one of the multicriteria decision analysis method which was developed by Serafim Opricovic in 1980 . VIKOR ranks alternatives and determines the solution named compromise that is the closest to the ideal. The idea of compromise solution was introduced in MCDM by Po-Lung Yu in 1973, and by Milan Zeleny before Opricovic. Applications of this method were presented in 1998 (Oprikovic) and up to now.

L_p-metric used as an aggregating function in a compromise programming method (Tzeng, 2007) Development of the VIKOR method is started with the following form of L_p-metric:

$$L_{pi} = \left\{ \sum_{j=1}^{n} \left[(f_j^* - f_{ij}) / (f_j^* - f_j^-) \right]^p \right\}^{1/p} \quad 1 \le p \le \infty; i = 1,2,3,\ldots,m.$$

In the VIKOR method $L_{1,i}$ (as S_i)and $L_{\infty,i}$ (as R_i) are used to formulate ranking measure. The solution obtained by min S_i is with a maximum group utility ("majority" rule), and the solution obtained by min R_i is with a minimum individual regret of the "opponent".

Assuming that each alternative is evaluated by each criterion function, the compromise ranking could be performed by comparing the measure of closeness to the ideal alternative. The various m alternatives are denoted as $A_1, A_2, A_3, \ldots, A_m$. For alternative A_i, the rating of the j th aspect is denoted by f_{ij}, i.e. f_{ij} is the value of j th criterion function for the alternative A_i; n is the number of criteria.The compromise ranking algorithm of the VIKOR method has the following steps (Tzeng, 2007)

(1) Determine the best f_j^* and the worst f_j^- values of all criterion functions $j = 1,2,\ldots,n$. If the jth function represents a benefit then:

$f_j^* = \max_i f_{ij}$, $f_j^- = \min_i f_{ij}$

(2) Computation of the values S_i and R_i; $i = 1,2,\ldots,m$, are below:

$$S_i = \sum_{j=1}^{n} w_j (f_j^* - f_{ij}) / (f_j^* - f_j^-),$$

$$R_i = \max_j w_j (f_j^* - f_{ij}) / (f_j^* - f_j^-),$$

Where w_j are the weights of criteria (in this article calculated with entrophy)

(3) Computation of the values $Q_i : i = 1,2,\ldots,m$,

$$Q_i = v(S_i - S^*)/(S^- - S^*) + (1-v)(R_i - R^*)/(R^- - R^*)$$

$$S^* = \min_i S_i, S^- = \max_i S_i,$$

$$R^* = \min_i R_i, R^- = \max_i R_i$$

v is explained as weight of the strategy of ‘‘the majority of criteria” (or ‘‘the maximum group utility”), here suppose that $v = 0.5$

(4) Rank the alternatives, sorting by the values S, R and Q in decreasing order. The results are three ranking lists.

(5) There are two admissible choice in this analysis. If the following two conditions (C1 and C2) are obtained.

Propose as a compromise solution the alternative A', which is ranked the best by the measure Q (Minimum)

C1. Acceptable advantage: $Q(A'') - Q(A') \geq DQ$, where A'' is the alternative with second position in the ranking list by Q;DQ=1/(m-1); m is the number of alternatives.

C2. Acceptable stability in decision making: Alternative A' must also be the best ranked

by S or/and R. This compromise solution is stable within a decision making process, which could be "voting by majority rule" (when $v > 0.5$ is needed), or "by consensus" $v \approx 0.5$, or "with veto" $(v < 0.5)$. Here, v is the weight of the decision making strategy "the majority of criteria" (or "the maximum group utility").

If one of the conditions is not obtained , then a set of compromise solutions is proposed, which includes of:

- Alternatives A' and A'' are compromise solutions if only condition C2 is not satisfied, or
- Alternatives $A', A'', \ldots, A^{(M)}$ are compromise solutions if condition C1 is not satisfied; $A^{(M)}$ is determined by the relation $Q(A^{(M)}) - Q(A') < DQ$ for maximum M (the positions of these alternatives are "in closeness").

The best alternative, ranked by Q, is the one with the minimum value of Q. The main ranking result is the compromise ranking list of alternatives, and the compromise solution with the "advantage rate". VIKOR is an effective tool in multi-criteria decision making, particularly in a situation where the decision maker is not able, or does not know how to express his/her preference at the beginning of system design. The obtained compromise solution could be accepted by the decision makers because it provides a maximum "group utility" (represented by min S) of the "majority", and a minimum of the "individual regret" (represented by min R) of the "opponent". The compromise solutions could be the basis for negotiations, involving the decision maker's preference by criteria weights.

1.1.3 MAUT (Multi Attribute Utility Theory):

Multi Attribute Utility Theory takes into consideration the decision maker's preferences in the form of the utility function which is defined over a set of attribute (Pohekar, Ramachandran, 2004). Utility function is a device which quantifies the preferences of a decision-maker by assigning a numerical index to varying levels of satisfaction of a criterion (Mustafa, Ryan, 1990). For a single criterion (X), the utility of satisfaction of a consequence x' is denoted by $u(x')$. The utility is generally calculated as the sum of the marginal utilities that each criteria assigns to the considered action (Figueira, Greco, Ehrgott, 2005). In this method both quantitative and qualitative criteria can be used. The most common method of multicriteria utility function is the additive model (Keeney, Raiffa, 1993).

There are two important MAUT categories discrete and continuous alternative problems. Discrete type alternative problems set of alternatives consist limited alternatives. Continuous alternative problems called multiple optimization problems feasible sets of

alternatives usually consist of a very large number of infinitely many alternatives (Wallenius, J. et. al., 2008)

The utility functions can be either additively separable or multiplicatively separable with respect to single attribute utility. Additively form;

$$U_i = \sum_{j=1}^{m} w_j \, U_{ij} \quad for\ all\ i$$

U_i = Utility value(overall) of alternative *i*
U_{ij} = Utility value for the alternative of *i* (criteria for the j)
n = Total number of criteria
m = Total number of alternatives

The multiplicative form of equation for then utility value is defined below(Keeney, Raiffa, 1976).

$$1 + ku(x_1, x_2, x_3 \ldots x_n) = \prod_{j=1}^{n} (1 + kk_j \, u_j(x_j))$$

j = attribute (alternative) index
k = scaling constant
u = overall utility function
u_j = utility function for each operator

In this studying, It has been used the additive type model. In the MAUT method, it can be used six important steps(Alp İ. et.al., 2015);

Step 1: Generate the criteria (C_1, C_2,…….C_n) and alternatives

Step 2: Determination of the weight values (with entrophy)

$$\sum_{i=1}^{m} w_j = 1$$

Step 3: Form the decision matrix

Step 4: Calculate the normalized utility values;

$u_i(x_i) = \frac{x - x_i^-}{x_i^+ - x_i^-}$ (for criteria to be maximized)

$u_i(x_i) = \frac{x_i^+ - x}{x_i^+ - x_i^-}$ (for the criteria to be minimized)

$x_i^+ = the\ best\ value\ of\ the\ alternatives$
$x_i^+ = the\ worst\ value\ of\ the\ alternatives$

Step 5: Calculate total utility

$$U_i = \sum_{j=1}^{m} w_j \, U_{ij} \quad for\ all\ i$$

Step 6: Rank the alternatives, Choose an alternative which gain the most utility.

2. FINDINGS:

In this article, it has been studied on sustainable development indicators for the member countries of European Union (Not all of the European Union Countries because of the lack of data) . The sustainable development indicators (SDI) are used to 8onitör the EU Sustainable Development Strategy in a report published by Eurostat every two years. They are presented in ten themes (headline indicators-because there are more than 130 indicators)

Table 1: Sustainable Development Indicators

Theme	Headline indicator
Socio-economic development	Real GDP per capita, growth rate and totals
Sustainable consumption and production	Resource productivity
Social inclusion	Persons at-risk-of-poverty or social exclusion
Demographic changes	Employment rate of older workers
Public health	Healthy life years and life expectancy at birth, by sex
Climate change and energy	Greenhouse gas emissions
	Primary energy consumption
Sustainable transport	Energy consumption of transport relative to GDP
Natural resources	Common bird index
Global partnership	Official development assistance as share of gross national income
Good governance	No headline indicator

This study has been compromised two important stages. Firstly, by using entrophy method, it has been achieved hierarchy in the matrix (a square matrix of size n×n). In the below table, firstly it can be thought which criteria must be minimum or maximum because different calculation has been made (C1, C2…..CN).

Table 2: Matrix form of the Indicators

	Max C1	Max C2	Min C3	Min C4	Max C5	Min C6	Min C7	Min C8	Max C9
Belgium	33800	2,36	21,2	42,7	63,7	82,15	45	92,1	0,46
Bulgaria	5500	0,28	40,1	50	66,6	51,18	17,2	103,7	0,08
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Portugal	16300	1,14	27,5	47,8	62,2	109,67	20,7	94,3	0,19
Romania	6900	0,32	40,2	43,1	57,9	43,85	30,8	98,5	0,1
Slovenia	17600	1,34	20,4	35,4	59,5	98	6,5	101,1	0,13
Slovakia	13500	1,07	18,4	44,8	54,3	57,89	15,3	77,4	0,08
Finland	34100	1,1	17,3	59,1	57	90,11	33,4	98,4	0,6
Sweden	40300	1,75	16,9	74	66	79,3	46,2	93,6	1,1
Unit. Kingdom	30400	3,49	24,1	61	64,8	73,76	182,4	91,6	0,71
Max. values	78200	3,81	40,2	74	72,7	143,77	291,8	103,7	1,1
Min. Values	5500	0,28	14,8	34	54,2	41,81	0,9	77,4	0,08

In order to eliminate the effects of different index size (Criterias), it should be calculated normalized form (Table 3).

Table 3: Normalized Matrix of Criteria for the Entrophy

	Max C1	Max C2	Min C3	Min C4	Max C5	Min C6	Min C7	Min C8	Max C9
Belgium	0,05	0,05	0,03	0,03	0,04	0,04	0,03	0,04	0,05
Bulgaria	0,01	0,01	0,06	0,04	0,04	0,02	0,01	0,04	0,01
Czech. Rep.	0,02	0,02	0,02	0,04	0,04	0,03	0,03	0,04	0,01
Denmark	0,06	0,05	0,03	0,05	0,03	0,03	0,01	0,04	0,10
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…….	…….	…….	…….	…….	…….	…….	…….	…….	…….
Portugal	0,02	0,02	0,04	0,03	0,04	0,05	0,01	0,04	0,02
Romania	0,01	0,01	0,06	0,03	0,03	0,02	0,02	0,04	0,01
Slovenia	0,03	0,03	0,03	0,03	0,03	0,04	0,00	0,04	0,01
Slovakia	0,02	0,02	0,03	0,03	0,03	0,02	0,01	0,03	0,01
Finland	0,05	0,02	0,02	0,04	0,03	0,04	0,02	0,04	0,07
Sweden	0,06	0,04	0,02	0,05	0,04	0,03	0,03	0,04	0,12
Unit. Kingdom	0,04	0,08	0,03	0,04	0,04	0,03	0,12	0,04	0,08

Table 4: Entrophy Values

	C1	C2	C3	C4	C5	C6	C7	C8	C9
Belgium	-0,1	-0,2	-0,1	-0,1	-0,1	-0,1	-0,1	-0,1	-0,2
Bulgaria	0	0	-0,2	-0,1	-0,1	-0,1	-0,1	-0,1	0
Czech Rep.	-0,1	-0,1	-0,1	-0,1	-0,1	-0,1	-0,1	-0,1	-0,1
Denmark	-0,2	-0,1	-0,1	-0,1	-0,1	-0,1	0	-0,1	-0,2
Germany	-0,1	-0,1	-0,1	-0,1	-0,1	-0,1	-0,3	-0,1	-0,1
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Hungary	-0,1	-0,1	-0,1	-0,1	-0,1	-0,1	-0,1	-0,1	-0,1
Slovakia	-0,1	-0,1	-0,1	-0,1	-0,1	-0,1	0	-0,1	0
Finland	-0,1	-0,1	-0,1	-0,1	-0,1	-0,1	-0,1	-0,1	-0,2
Sweden	-0,2	-0,1	-0,1	-0,2	-0,1	-0,1	-0,1	-0,1	-0,3
United King.	-0,1	-0,2	-0,1	-0,1	-0,1	-0,1	-0,3	-0,1	-0,2
Total val.	-3,2	-3,2	-3,3	-3,3	-3,3	-3,3	-2,6	-3,3	-3
k value(neg.)	-0,5	-0,5	-0,5	-0,5	-0,5	-0,5	-0,5	-0,5	-0,5
eij values	1,42	1,42	1,48	1,49	1,5	1,48	1,19	1,5	1,33
total(1-eij)	-0,4	-0,4	-0,5	-0,5	-0,5	-0,5	-0,2	-0,5	-0,3
Entrophy values	**0,11**	**0,11**	**0,13**	**0,13**	**0,13**	**0,13**	**0,05**	**0,13**	**0,09**

After getting the entrophy weights , rankings has been obtained by using two techniques . Firstly Maut and then Vikor. It can be seen Maut steps in Table 5. Marginal Utility Scores, which is the identification of best and worst values in the MAUT method, is given as follows.

Table 5: Max and Min Values for the Maut

	Max C1	Max C2	Min C3	Min C4	Max C5	Min C6	Min C7	Min C8	Max C9
Belgium	33800	2,36	21,2	42,7	63,7	82,15	45	92,1	0,46
Bulgaria	5500	0,28	40,1	50	66,6	51,18	17,2	103,7	0,08
Czech. Rep.	15200	1	14,8	54	64,2	66,02	38,6	97,5	0,11
Denmark	43700	2,18	17,9	63,2	59,1	80,39	16,7	93	0,85
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Portugal	16300	1,14	27,5	47,8	62,2	109,67	20,7	94,3	0,19
Romania	6900	0,32	40,2	43,1	57,9	43,85	30,8	98,5	0,1
Slovenia	17600	1,34	20,4	35,4	59,5	98	6,5	101,1	0,13
Slovakia	13500	1,07	18,4	44,8	54,3	57,89	15,3	77,4	0,08

Finland	34100	1,1	17,3	59,1	57	90,11	33,4	98,4	0,6
Sweden	40300	1,75	16,9	74	66	79,3	46,2	93,6	1,1
Unit. Kingdom	30400	3,49	24,1	61	64,8	73,76	182,4	91,6	0,71
Max. Values	78200	3,81	40,2	74	72,7	143,77	291,8	103,7	1,1
Min. Values	5500	0,28	14,8	34	54,2	41,81	0,9	77,4	0,08

Total utility values have been calculated for each country after normalized values are obtained by multiplying with Entrophy coefficients.

Table 6: Total Utility For the Maut

	C1	C2	C3	C4	C5	C6	C7	C8	C9	Total utility
Belgium	0,04	0,06	0,09	0,09	0,07	0,07	0,03	0,06	0,03	0,55
Bulgaria	0,00	0,00	0,00	0,07	0,09	0,11	0,04	0,00	0,00	0,31
Czech Republic	0,01	0,02	0,12	0,06	0,07	0,09	0,03	0,03	0,00	0,44
Denmark	0,06	0,05	0,11	0,03	0,03	0,07	0,04	0,05	0,06	0,51
Germany	0,04	0,05	0,09	0,03	0,02	0,08	0,00	0,03	0,03	0,36
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Slovenia	0,02	0,03	0,09	0,12	0,04	0,05	0,04	0,01	0,00	0,40
Slovakia	0,01	0,02	0,10	0,09	0,00	0,10	0,04	0,13	0,00	0,49
Finland	0,04	0,02	0,11	0,04	0,02	0,06	0,04	0,03	0,04	0,40
Sweden	0,05	0,04	0,11	0,00	0,08	0,08	0,03	0,05	0,08	0,53
United King.	0,04	0,09	0,08	0,04	0,07	0,08	0,02	0,06	0,05	0,52

In the vikor method, firstly, decision matrix has been structured and then the best and worst values (f^+ ,f^-) calculated. After getting S and R values fort the all alternatives (countries), obtained Q values(by using S and R values) At the end of vikor methods , rankings has been made for all of the S, Q and R values. In the model, v value was considered 0.5 (the maximum group utility). From the Table 7, it can be seen that United Kingdom is the best ranked alternative according to the VIKOR ranking. Slovakia is the last ranked alternative. Moreover, both of them have good advantage and also good stability as they both satisfy *"condition C*1" and*"condition C*2*"*.According to Maut rankings; Luxemburg is the best ranked alternative and Belgium is the second one and last alternative is the Romania.

Table 7 : Vikor and Maut Rankings

COUNTRIES		VİKOR						MAUT	
Countries	Codes	SJ değeri		RJ		Qj değeri		Total Utility	
Belgium	A1	0,434	A28	0,095	A22	0,019	A28	0,728	A16
Bulgaria	A2	0,449	A27	0,096	A7	0,108	A7	0,546	A1
Czech Rep.	A3	0,506	A12	0,097	A28	0,134	A12	0,527	A27
Denmark	A4	0,514	A18	0,098	A13	0,146	A13	0,525	A28
Germany	A5	0,515	A5	0,101	A12	0,163	A22	0,521	A19
Estonia	A6	0,522	A10	0,108	A9	0,223	A9	0,509	A4
Ireland	A7	0,525	A7	0,113	A1	0,343	A16	0,507	A7
Greece	A8	0,527	A9	0,116	A21	0,354	A10	0,495	A25
Spain	A9	0,536	A16	0,117	A17	0,360	A27	0,487	A10
France	A10	0,538	A2	0,118	A20	0,361	A1	0,473	A18
Croatia	A11	0,539	A13	0,119	A16	0,376	A5	0,450	A20
Italy	A12	0,540	A19	0,122	A10	0,422	A4	0,446	A21
Cyprus	A13	0,554	A4	0,124	A6	0,430	A20	0,445	A3
Latvia	A14	0,567	A8	0,125	A5	0,432	A2	0,438	A9
Lithuania	A15	0,582	A22	0,125	A4	0,434	A18	0,414	A17
Luxembourg	A16	0,601	A1	0,128	A2	0,481	A19	0,407	A12
Hungary	A17	0,604	A26	0,129	A26	0,509	A26	0,405	A24
Malta	A18	0,625	A20	0,131	A27	0,515	A17	0,405	A26
Netherlands	A19	0,656	A11	0,131	A18	0,530	A21	0,397	A8
Austria	A20	0,665	A23	0,133	A19	0,614	A6	0,390	A13
Poland	A21	0,666	A3	0,137	A11	0,624	A8	0,388	A15
Portugal	A22	0,668	A24	0,138	A23	0,646	A11	0,386	A14
Romania	A23	0,669	A15	0,140	A24	0,669	A23	0,381	A6
Slovenia	A24	0,710	A17	0,141	A15	0,687	A24	0,379	A11
Slovakia	A25	0,729	A21	0,143	A3	0,700	A15	0,368	A22
Finland	A26	0,737	A6	0,145	A8	0,712	A3	0,364	A5
Sweden	A27	0,804	A14	0,147	A25	0,908	A14	0,306	A2
United King.	A28	0,887	A25	0,147	A14	1,000	A25	0,303	A23

Results

The subject of Sustainable Development Indicators's ranking in the European Countries, which has been discussed as multi-criteria decision making problems, has been handled in our study. As methodology, Entrophy- Maut ve Entrophy- Vikor integrated methods has been used. Quite different results has been occured by both analyzes. Not the which of them is better doing analysis, but it is possible that; which one revealed a more harmonious result with European Union reports. In this respect, it is possible that; the ranking conducted by Maut provides more meaningful results compared the findings obtained by Vikor method. In my opinion, it would be important to create a ranking for countries since there is no any index that created by considering sustainable development indicators. For forward-term studies, a ranking will be obtained by realizing the Multi-Criteria Decision Making techniques for all countries which possess the data.

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