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Research Article

Comparison of the socio-economic sustainability performance of OECD countries

OECD ülkelerinin sosyo-ekonomik sürdürülebilirlik performansının karşılaştırılması

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Abstract

Socio-economic Sustainability (SES) enables an organisation or a country to pursue economic growth in the present without undermining the ability of future generations to meet their needs, especially in terms of curtailing the depletion or destruction of environmental resources. Ensuring SES in a country helps shape the conditions for long-term economic and social development while conserving the environment. This study compares the SES performance of 38 member countries of the Organisation for Economic Cooperation and Development (OECD) by applying a multi-criteria approach. This research aims to make inferences about SES in developed and developing countries and promote change in line with sustainable development goals. A technique known as Multi-Attributive Border Approximation area Comparison (MABAC), considered a valuable and reliable decision-making tool for rational management, was applied. In practice, socio-economic performance indicators obtained from the United Nations Development Programme (UNDP) were examined to evaluate the performance of the 38 OECD countries included based on nine criteria. The study found that, of those 38, the highest performings were Korea and Japan, and the lowest was Colombia and Mexico.

Keywords: Sustainability, Socio-Economic Sustainability, Multi-Attributive Border Approximation Area Comparison, Multi-Criteria Decision Making

Jel Codes: E60, C02, C63

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Öz

Sosyo-ekonomik sürdürülebilirlik (SES), bir kuruluşun veya bir ülkenin gelecek nesillerin ihtiyaçlarını karşılama yeteneklerini baltalamadan, çevresel kaynakların tükenmesini veya yok edilmesinin azaltılmasını ve ekonomik büyümenin sürdürülmesini sağlar. Bir ülkede SES'in sağlanması, çevreyi korurken uzun vadeli ekonomik ve sosyal kalkınmanın koşullarını şekillendirmeye yardımcı olur. Bu çalışma, çok kriterli bir yaklaşım uygulayarak Ekonomik İşbirliği ve Kalkınma Teşkilatı'na (OECD) üye 38 ülkenin SES performansına odaklanmakta ve bu performansları karşılaştırmaktadır. Bu araştırmanın amacı, gelişmiş ve gelişmekte olan ülkelerdeki SES hakkında çıkarımlarda bulunmak ve sürdürülebilir kalkınma hedefleri doğrultusunda değişimi teşvik etmektir. Rasyonel yönetim için yararlı ve güvenilir bir karar verme aracı olarak kabul edilen Multi-Attributive Border Approximation area Comparison (MABAC) tekniği uygulanmıştır. Uygulamada, dokuz kriter göz önünde bulundurularak 38 OECD ülkesinin performansını değerlendirmek için Birleşmiş Milletler Kalkınma Programı'ndan (UNDP) elde edilen sosyo-ekonomik performans göstergeleri incelenmiştir. Çalışmada, 38 ülke arasından en yüksek performans gösteren ülkelerin Kore ve Japonya, en düşük performans gösteren ülkelerin Kolombiya ve Meksika olduğunu tespit edilmiştir.

Anahtar Kelimeler: Sürdürülebilirlik, Sosyo-Ekonomik Sürdürülebilirlik, Multi-Attributive Border Approximation Area Comparison, Çok Kriterli Karar Verme

JEL Kodları: E60, C02, C63

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Introduction

Sustainability is the ability to meet present needs without compromising the ability to meet future needs by short-term depletion or destruction of available resources. Sustainability aims to preserve favourable environmental conditions and even improve them (Merlín-Uribe, González-Esquivel, Contreras-Hernández, Zambrano, Moreno-Casasola & Astier, 2013). The concept of socio-economic sustainability (SES), which includes two dimensions—social and economic—is the ability to achieve economic growth without undermining the future interests of society and to meet a society's needs without damaging the environment (Skvarciany, Jurevičienė & Volskytė, 2020). Especially in developing countries, many people suffer from socio-economic inequities, and the future of these countries depends on SES solutions. Therefore, SES is an essential agenda item for many countries, especially developing countries.

The Multi-Attributive Border Approximation area Comparison (MABAC) method is a multi-criteria decision-making (MCDM) technique whose basic principle is to calculate the distance of all alternative criterion functions from the created border approximation area (BAA). The method is a systematic procedure based on sound logic for human decision-making (Xue, You, Lai, & Liu, 2016). This technique can compare alternatives based on their strengths and weaknesses.

In the current study, the SES performance of selected Organisation for Economic Cooperation and Development (OECD) countries was compared using data from the United Nations Development Programme (UNDP). Each country's performance was evaluated using the MABAC technique. The SES performance of 38 countries was assessed based on nine criteria. The study found that, of the countries included, Korea and Japan reflected the highest performance, and Colombia and Mexico performed poorest.

The MABAC technique has been used in many studies in different application areas. For example, the MABAC method has been used in different areas such as the selection of transportation resources (Pamučar & Ćirović, 2015), material selection in different industries (Xue et al., 2016), determination of installation sites of wind farms (Gigović, Pamučar, Božanić & Ljubojević, 2017), evaluation of academic websites (Pamučar, Stević & Zavadskas, 2018), patient prioritization (Sun, Hu, Zhou & Chen, 2018), electric vehicle selection (Biswas & Das, 2019; Sonar & Kulkarni 2021), personnel selection (Luo & Xing, 2019), evaluation of logistics centre locations (Pamučar & Božanić, 2019), medical equipment supplier selection (Wei, Wei, Wu & Wang, 2019) and evaluation of health tourism strategies (Büyüközkan, Mukul & Kongar, 2021). However, no study has been found in the current literature comparing city, country or region performances using the MABAC. However, it is an important issue that needs to be studied on the concept of SES, which is a strategic issue for many countries, especially developing countries. Therefore, the current study aims to contribute to the relevant literature by comparing the SES performances of different countries through the MABAC technique.

The remaining parts of this study are organised as follows. In the second part, the concept of SES is explained, studies in relevant literature are reviewed, and the criteria used in the study are defined. In the third part, the MABAC method used in the study is introduced. The fourth part describes the steps adopted in the implementation process. Finally, the conclusion and discussion section present and interprets the study's results.

Literature review

Sustainability is meeting individuals' material and social needs without jeopardising socio-environmental conditions (Merlín-Uribe et al., 2013). According to another definition, it is the ability to maintain a population's standard of living without harming nature (Skvarciany et al., 2020).

The concept of SES includes two approaches—social and economic. Social sustainability is the improvement of living conditions for current and future generations (Boström, 2012). Economic sustainability is the equitable distribution of growth, productivity and wealth (Ivković, Ham & Mijoč, 2014). As a result, SES is the ability to achieve economic growth without harming the long-term interests of society and to meet needs without harming the environment (Skvarciany et al., 2020).

Ensuring SES is an essential agenda item for many countries, especially developing countries (Okoye, 2016). Despite recent economic progress in developing countries, SES solutions are needed. Many people suffer from socio-economic problems (Shan & Khan, 2016). Socio-economic problems can be solved by limiting income inequalities, providing equal opportunity, and increasing employment and access to education and health services (Smędzik-Ambroży, Guth, Stępień and Brelik, 2019). In several studies in the literature, the concept of SES and the effects of various sectors on the concept have been examined.

Merlín-Uribe et al. (2013) compared the environmental and SES of traditional wetland agricultural systems and greenhouses. Okoye (2016) examined the impact of the construction sector on socio-economic development with econometric techniques for the construction sector and total GDP data. Shan and Khan (2016) aimed to understand how reverse innovation spreads to market development strategies and present its implications for SES in emerging markets. Starik, Stubbs and Benn (2016) presented an integrated sustainability model in which environmental and SES models were synthesised.

Santos, Radicchi and Zagnoli (2019) aimed to determine cruise ports' impact on regions' SES through a qualitative case study. Smędzik-Ambroży et al. (2019) examined the effect of the standard agricultural policy on the SES of farms using panel regression. Bhattacharya (2020) examined the relationship between emissions and inequality in consumption expenditures and suggested strategies that would contribute to environmental and SES. Finally, Sawaengsak, Prasara and Gheewala (2021) aimed to evaluate the socio-economic effects of employment and income resulting from sugar cane production and to develop strategies for solving the problems that may arise during the transition to mechanised harvesting.

In the current study, the socio-economic performances of OECD countries were compared using the MABAC method, a new MCDM technique. During this process, data were taken from the UNDP (UNDP, 2022). The nine criteria used in the analysis and their definitions are presented in Table 1. Of these criteria, C_3 and C_5 are cost-based criteria, while the rest are benefit-based criteria.

Table 1: Criteria and Definitions Used in the Study

Criteria	Definition
Adjusted net savings (C_1)	Net national saving equals the value of fixed capital consumption minus gross national savings. Adjusted net savings are expressed as the ratio of net national savings to national income.
Average annual change in the income share of the bottom 40 per cent (C_2)	The compound annual rate of change of the income share of the poorest 40 per cent of the population
Concentration index (C_3)	It indicates the degree of product concentration in export from a country. A low value indicates that the country's exports are distributed homogeneously.
Gross capital formation (C_4)	It indicates the ratio of expenditures related to additions to the fixed assets of the economy and net changes in stocks to GDP.
Underdevelopment due to inequality (C_5)	The compound annual rate of change of total loss in human development index value due to inequality
Use of safe drinking water service (C_6)	The proportion of the population with access to an improved potable water source
Use of safe sanitation service (C_7)	The proportion of the population with advanced sanitation facilities not shared with other households; waste is safely disposed of on-site or treated off-site
Research and development (C_8)	Expenditure on creative work undertaken systematically to increase knowledge
Qualified workforce (C_9)	Percentage of workforce aged 15 and over with secondary or advanced education

The MABAC technique, a new MCDM approach, has a simple calculation process and is considered valuable. Furthermore, the method has been tested in many application areas recently, and reliable results have been obtained. Therefore, this part of the study includes research using the MABAC method.

Pamučar and Ćirović (2015) proposed an approach using the MABAC method to contribute to the decision-making process regarding the purchase of transport resources in logistics hubs. Xue et al. (2016) proposed the MABAC-based model and tested the model's effectiveness for material selection in two industries. Gigovic et al. (2017) developed a reliable approach for determining the installation locations of wind farms with a MABAC-based model. Pamučar, Stević and Zavadskas (2018) presented a MABAC-based model to evaluate the quality levels of academic websites, which is a factor affecting the quality of academic institutions. Sun et al. (2018) developed an integrated model using the MABAC technique and hesitant fuzzy linguistic term sets. They tested the model's effectiveness in a case study of prioritizing patients in a hospital in China.

Biswas and Das (2019) developed an approach for battery electric vehicle group selection through the MABAC technique, considering technical and operational concepts. Luo and Xing (2019) developed an integrated model based on MABAC for the personnel selection process, which plays a strategic role in the sustainable development of an organization. Pamučar and Božanić (2019) used the MABAC technique to evaluate potential logistics centre locations and compared the results obtained with those obtained by different decision-making methods. Wei et al. (2019) tested the proposed MABAC-based method on supplier selection problems of medical consumables and compared the results obtained with the results of different techniques. Büyüközkan, Mukul and Kongar (2021) used the MABAC technique to determine the most effective strategy for successfully implementing health tourism in Istanbul, which is considered one of the appropriate centres in its region in terms of health tourism. Sonar and Kulkarni (2021) proposed a hybrid method for electric vehicle selection in which AHP and MABAC techniques are used together, thus aiming to contribute to the popularization of electric vehicles.

Methodology

The MABAC method is a new MCDM technique developed in a research centre at the University of Defence (Pamučar & Ćirović, 2015). The basic principle of this technique is to create a BAA and calculate the distances of the criterion functions of all alternatives from this area. Alternatives are ranked as a result of the evaluation of these distances. The method is a valuable and reliable decision-making tool (Pamučar & Ćirović, 2015). It has a simple calculation process and robust logic (Xue et al., 2016). It offers practice compared to other MCDM methods (Chakraborty, Dandge & Agarwal, 2020). MABAC enables evaluating alternatives' strengths and weaknesses from the objective criteria perspective.

The study focuses on the usefulness and applicability of the MABAC technique for research in which countries, cities or regions are evaluated in terms of various performances. In the current study, no criterion weighting method was used, and the weights of all criteria were considered equal. Alternatives were evaluated through the MABAC method, and the procedure adopted in the study is given below (Pamučar & Ćirović, 2015).

Step 1. A decision matrix (DM) is created in which m alternatives are evaluated according to the n criterion (Equation 1). The x_{ij} value in the DM represents the value of alternative i according to the j criterion. (i = 1, 2, …m; j = 1, 2, …n).

$$X=\begin{bmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2n} \\ \dots & \dots & \dots & \dots \\ x_{m1} & x_{m2} & \dots & x_{mn} \end{bmatrix} \quad (1)$$

Step 2. Benefit criteria are normalised using Equation (2) and cost criteria using Equation (3), thus creating a normalised DM. The value of n_{ij} Equations (2) and (3) indicate the normalised value of alternative i for criterion j. In addition, x_j^+ and x_j^- Values in Equations (4) and (5) express the most significant and most minor alternative values for the j criterion.

$$n_{ij} = \frac{x_{ij}-x_j^-}{x_j^+-x_j^-} \quad (2)$$

$$n_{ij} = \frac{x_{ij}-x_j^+}{x_j^- -x_j^+} \quad (3)$$

$$x_j^+ = \max_i(x_{ij}) \quad (4)$$

$$x_j^- = \min_i(x_{ij}) \quad (5)$$

Step 3. Using Equation (6), the weighted DM is obtained. Here, the expression w_j indicates the importance of the j criterion and $\sum_{j=1}^{n} w_j$=1 equality should be provided. In addition, the expression v_{ij} shows the weighted DM value of the alternative i in the j criterion.

$$v_{ij} = w_j(n_{ij}+1) \quad (6)$$

Step 4. A BAA matrix (G) is created (Equation (7)). For this, the BAA values (g_j) of all criteria are calculated via Equation (8).

$$G=[g_1 \quad g_2 \quad \cdots \quad g_n] \quad (7)$$

$$g_j=\left(\prod_{i=1}^{m} v_{ij}\right)^{1/m} \quad (8)$$

Step 5. The distances of the alternatives from the BAA are calculated. The boundary convergence area matrix is extracted from the weighted DM using Equation (9). Thus, the distance matrix (Q) is created from the BAA. The q_{ij} value, which is the element of this matrix, expresses the distance of the i alternative from the BAA for the j criterion.

$$Q = V - G = \begin{bmatrix} v_{11} & v_{12} & \dots & v_{1n} \\ v_{21} & v_{22} & \dots & v_{2n} \\ \dots & \dots & \vdots & \dots \\ v_{m1} & v_{m2} & \vdots & v_{mn} \end{bmatrix} - \begin{bmatrix} g_{11} & g_{12} & \dots & g_{1n} \\ g_{21} & g_{22} & \dots & g_{2n} \\ \dots & \dots & \vdots & \dots \\ g_{m1} & g_{m2} & \vdots & g_{mn} \end{bmatrix} = \begin{bmatrix} q_{11} & q_{12} & \dots & q_{1n} \\ q_{21} & q_{22} & \dots & q_{2n} \\ \dots & \dots & \vdots & \dots \\ q_{m1} & q_{m2} & \vdots & q_{mn} \end{bmatrix} \quad (9)$$

The region above the boundary convergence area is designated as the upper approximation area (UAA) and the region below it as the lower approximation area (LAA). It is assumed that UAA includes ideal alternatives and LAA includes non-ideal alternatives. Equation (10) determines whether an alternative is in the UAA or the LAA. If the q_{ij} value of an alternative is greater than 0, and the alternative is equal to or close to the ideal alternative. If the q_{ij} value of an alternative is less than 0; the alternative is equal to or close to the non-ideal alternative. Thus, the strengths and weaknesses of the alternatives can be determined according to the criteria.

$$A_i \in \begin{cases} UAA & if \;\; q_{ij} > 0 \\ Border & if \;\; q_{ij} = 0 \\ LAA & if \;\; q_{ij} < 0 \end{cases} \quad (10)$$

Step 6. Finally, the criterion function values (S_i) of the alternatives are calculated. For this, q_{ij} values of all alternatives are summed using Equation (11). The alternative with the highest S_i value is determined as the most successful alternative and the alternative with the lowest S_i value is determined as the most unsuccessful alternative.

$$S_i = \sum_{j=1}^{n} q_{ij} \quad (11)$$

Application

In this study, the SES performances of OECD countries were compared using the MABAC method. The data used to apply these criteria were taken from the UNDP. The UNDP maintains 12 data relating to countries' SES. However, data on the 'ratio of education and health expenditure to military expenditure' and 'total debt service' were not included in the study because they are unavailable for many OECD countries. In addition, the value for 'rural population with access to electricity (%)', also SES data, was excluded from the study because it was 100% in 37 countries and 99.7% in the other (Colombia). While the C_3 and C_5 criteria used in practice are cost-based, and other criteria are benefit-based. This study compared the SES performance of 38 countries based on nine criteria. In practice, 38 countries whose performances are compared are listed as Austria (A_1), Australia (A_2), Belgium (A_3), Canada (A_4), Chile (A_5), Colombia (A_6), Costa Rica (A_7), Czechia (A_8), Denmark (A_9), Estonia (A_{10}), Finland (A_{11}), France (A_{12}), Germany (A_{13}), Greece (A_{14}), Hungary (A_{15}), Iceland (A_{16}), Ireland (A_{17}), Israel (A_{18}), Italy (A_{19}), Japan (A_{20}), Korea (A_{21}), Latvia (A_{22}), Lithuania (A_{23}), Luxembourg (A_{24}), Mexico (A_{25}), Netherlands (A_{26}), New Zealand (A_{27}), Norway (A_{28}), Poland (A_{29}), Portugal (A_{30}), Slovak Republic (A_{31}), Slovenia (A_{32}), Spain (A_{33}), Sweden (A_{34}), Switzerland (A_{35}), Turkey (A_{36}), United Kingdom (A_{37}) and the United States (A_{38}). The steps adopted in the study are given below.

Step 1. The initial DM is created, which is presented in Table 2 for the 38 countries evaluated in this study.

Table 2: Initial DM

-	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9
A_1	14.3	-0.3	0.068	25.4	0.922	99	97	3.2	87.6
A_2	4.4	-0.2	0.291	23.3	0.944	96	76	1.9	78.9
A_3	11.1	0.2	0.096	25.3	0.931	100	97	2.8	85.6
A_4	6	-0.2	0.147	22.7	0.929	99	82	1.6	92
A_5	0.5	1.9	0.324	22.8	0.851	99	77	0.4	71.3
A_6	-2	0.7	0.341	22.3	0.767	73	17	0.2	59.9
A_7	16.9	-0.1	0.262	17.9	0.81	94	87	0.4	44
A_8	10.2	0.4	0.127	26.3	0.9	98	94	1.9	95.4
A_9	19.4	-0.6	0.1	22.7	0.94	97	95	3.1	79.7
A_{10}	16.7	0.3	0.099	28.1	0.892	93	97	1.4	91.2
A_{11}	10.8	0	0.143	24	0.938	100	99	2.8	90.5
A_{12}	8.9	-0.3	0.089	24.2	0.901	98	88	2.2	85.7
A_{13}	14.4	-0.1	0.093	21.6	0.947	100	97	3.1	87.3
A_{14}	-1.7	0	0.291	12.5	0.888	100	90	1.2	81.3
A_{15}	14.5	0.6	0.108	28.6	0.854	90	96	1.6	88.8
A_{16}	11	0.4	0.46	20.1	0.949	100	82	2	76.2
A_{17}	16.1	0.2	0.269	43.8	0.955	97	82	1.1	85
A_{18}	15.6	0.5	0.223	21.8	0.919	99	94	5	90.3
A_{19}	6.4	-0.5	0.053	18	0.892	95	96	1.4	70
A_{20}	7.3	2.1	0.139	24.3	0.919	98	99	3.3	99.9
A_{21}	19.2	0.1	0.198	31.2	0.916	98	100	4.8	86
A_{22}	4.7	0.6	0.083	22.1	0.866	95	86	0.6	92.5
A_{23}	11.2	-0.5	0.115	16.7	0.882	92	91	0.9	96.4
A_{24}	13.1	-1.2	0.106	17.4	0.916	100	97	1.2	79.6
A_{25}	6.6	1.5	0.137	21.4	0.779	43	50	0.3	41.6
A_{26}	19.2	0.1	0.083	21.2	0.944	100	97	2.2	78.6
A_{27}	10.1	0.2	0.176	24	0.931	100	89	1.4	82.2
A_{28}	18.2	0.3	0.357	29	0.957	98	76	2.1	84.3
A_{29}	10.5	1.3	0.063	19.6	0.88	99	93	1.2	95.1
A_{30}	4.6	0.8	0.08	18.9	0.864	95	85	1.4	56.6
A_{31}	4.3	0.5	0.216	23.3	0.86	100	83	0.8	95.6
A_{32}	11.8	0.1	0.177	20.7	0.917	98	83	1.9	92.1
A_{33}	10.2	-0.6	0.097	20.8	0.904	98	97	1.2	67.7
A_{34}	17.8	-0.3	0.097	25.2	0.945	100	93	3.3	87.1
A_{35}	16.9	-0.1	0.246	22.3	0.955	95	100	3.4	87.3
A_{36}	12.1	0.3	0.076	25.1	0.82	96	65	1	46.3
A_{37}	3	0	0.111	17.4	0.932	100	98	1.7	84.4
A_{38}	5.6	-0.3	0.1	21	0.926	99	90	2.8	96.5

Step 2. Because C_3 and C_5 are cost criteria while the rest are benefit criteria, values of the benefit criteria are normalised using Equation (2), and those of the cost criteria are normalised using Equation (3). The resulting normalised DMs are presented in Table 3.

Table 3: Normalized DM

-	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9
A_1	0.762	0.273	0.963	0.412	0.184	0.982	0.964	0.625	0.789
A_2	0.299	0.303	0.415	0.345	0.068	0.93	0.711	0.354	0.64
A_3	0.612	0.424	0.894	0.409	0.137	1	0.964	0.542	0.755
A_4	0.374	0.303	0.769	0.326	0.147	0.982	0.783	0.292	0.864
A_5	0.117	0.939	0.334	0.329	0.558	0.982	0.723	0.042	0.509
A_6	0	0.576	0.292	0.313	1	0.526	0	0	0.314
A_7	0.883	0.333	0.486	0.173	0.774	0.895	0.843	0.042	0.041
A_8	0.57	0.485	0.818	0.441	0.3	0.965	0.928	0.354	0.923
A_9	1	0.182	0.885	0.326	0.089	0.947	0.94	0.604	0.654
A_{10}	0.874	0.455	0.887	0.498	0.342	0.877	0.964	0.25	0.851
A_{11}	0.598	0.364	0.779	0.367	0.1	1	0.988	0.542	0.839
A_{12}	0.509	0.273	0.912	0.374	0.295	0.965	0.855	0.417	0.756
A_{13}	0.766	0.333	0.902	0.291	0.053	1	0.964	0.604	0.784
A_{14}	0.014	0.364	0.415	0	0.363	1	0.88	0.208	0.681
A_{15}	0.771	0.545	0.865	0.514	0.542	0.825	0.952	0.292	0.81
A_{16}	0.607	0.485	0	0.243	0.042	1	0.783	0.375	0.593
A_{17}	0.846	0.424	0.469	1	0.011	0.947	0.783	0.188	0.744
A_{18}	0.822	0.515	0.582	0.297	0.2	0.982	0.928	1	0.835
A_{19}	0.393	0.212	1	0.176	0.342	0.912	0.952	0.25	0.487
A_{20}	0.435	1	0.789	0.377	0.2	0.965	0.988	0.646	1
A_{21}	0.991	0.394	0.644	0.597	0.216	0.965	1	0.958	0.762
A_{22}	0.313	0.545	0.926	0.307	0.479	0.912	0.831	0.083	0.873
A_{23}	0.617	0.212	0.848	0.134	0.395	0.860	0.892	0.146	0.94
A_{24}	0.706	0	0.87	0.157	0.216	1	0.964	0.208	0.652
A_{25}	0.402	0.818	0.794	0.284	0.937	0	0.398	0.021	0
A_{26}	0.991	0.394	0.926	0.278	0.068	1	0.964	0.417	0.635
A_{27}	0.565	0.424	0.698	0.367	0.137	1	0.867	0.25	0.696
A_{28}	0.944	0.455	0.253	0.527	0	0.965	0.711	0.396	0.732
A_{29}	0.584	0.758	0.975	0.227	0.405	0.982	0.916	0.208	0.918
A_{30}	0.308	0.606	0.934	0.204	0.489	0.912	0.819	0.25	0.257
A_{31}	0.294	0.515	0.6	0.345	0.511	1	0.795	0.125	0.926
A_{32}	0.645	0.394	0.695	0.262	0.211	0.965	0.795	0.354	0.866
A_{33}	0.57	0.182	0.892	0.265	0.279	0.965	0.964	0.208	0.448
A_{34}	0.925	0.273	0.892	0.406	0.063	1	0.916	0.646	0.78
A_{35}	0.883	0.333	0.526	0.313	0.011	0.912	1	0.667	0.784
A_{36}	0.659	0.455	0.943	0.403	0.721	0.930	0.578	0.167	0.081
A_{37}	0.234	0.364	0.857	0.157	0.132	1	0.976	0.313	0.734
A_{38}	0.355	0.273	0.885	0.272	0.163	0.982	0.88	0.542	0.942

Step 3. It is assumed that the nine criteria used in the present study have the same level of importance. Since the sum of the criteria weights should be 1, the w_j value of all criteria is evaluated as 0.111. Then, the weighted DM is created using Equation (6) (Table 4).

Table 4: Weighted Normalized DM

-	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9
A_1	0.196	0.141	0.218	0.157	0.132	0.22	0.218	0.181	0.199
A_2	0.144	0.145	0.157	0.149	0.119	0.214	0.19	0.15	0.182
A_3	0.179	0.158	0.21	0.157	0.126	0.222	0.218	0.171	0.195
A_4	0.153	0.145	0.197	0.147	0.127	0.22	0.198	0.144	0.207
A_5	0.124	0.215	0.148	0.148	0.173	0.22	0.191	0.116	0.168
A_6	0.111	0.175	0.144	0.146	0.222	0.17	0.111	0.111	0.146
A_7	0.209	0.148	0.165	0.13	0.197	0.211	0.205	0.116	0.116
A_8	0.174	0.165	0.202	0.16	0.144	0.218	0.214	0.15	0.214
A_9	0.222	0.131	0.209	0.147	0.121	0.216	0.216	0.178	0.184
A_{10}	0.208	0.162	0.21	0.166	0.149	0.209	0.218	0.139	0.206
A_{11}	0.178	0.152	0.198	0.152	0.122	0.222	0.221	0.171	0.204
A_{12}	0.168	0.141	0.212	0.153	0.144	0.218	0.206	0.157	0.195
A_{13}	0.196	0.148	0.211	0.143	0.117	0.222	0.218	0.178	0.198
A_{14}	0.113	0.152	0.157	0.111	0.151	0.222	0.209	0.134	0.187
A_{15}	0.197	0.172	0.207	0.168	0.171	0.203	0.217	0.144	0.201
A_{16}	0.179	0.165	0.111	0.138	0.116	0.222	0.198	0.153	0.177
A_{17}	0.205	0.158	0.163	0.222	0.112	0.216	0.198	0.132	0.194
A_{18}	0.202	0.168	0.176	0.144	0.133	0.22	0.214	0.222	0.204
A_{19}	0.155	0.135	0.222	0.131	0.149	0.212	0.217	0.139	0.165
A_{20}	0.159	0.222	0.199	0.153	0.133	0.218	0.221	0.183	0.222
A_{21}	0.221	0.155	0.183	0.177	0.135	0.218	0.222	0.218	0.196
A_{22}	0.146	0.172	0.214	0.145	0.164	0.212	0.203	0.12	0.208
A_{23}	0.18	0.135	0.205	0.126	0.155	0.207	0.21	0.127	0.216
A_{24}	0.19	0.111	0.208	0.129	0.135	0.222	0.218	0.134	0.184
A_{25}	0.156	0.202	0.199	0.143	0.215	0.111	0.155	0.113	0.111
A_{26}	0.221	0.155	0.214	0.142	0.119	0.222	0.218	0.157	0.182
A_{27}	0.174	0.158	0.189	0.152	0.126	0.222	0.207	0.139	0.188
A_{28}	0.216	0.162	0.139	0.17	0.111	0.218	0.19	0.155	0.192
A_{29}	0.176	0.195	0.219	0.136	0.156	0.22	0.213	0.134	0.213
A_{30}	0.145	0.178	0.215	0.134	0.165	0.212	0.202	0.139	0.14
A_{31}	0.144	0.168	0.178	0.149	0.168	0.222	0.199	0.125	0.214
A_{32}	0.183	0.155	0.188	0.140	0.135	0.218	0.199	0.1	0.207
A_{33}	0.174	0.131	0.21	0.141	0.142	0.218	0.218	0.134	0.161
A_{34}	0.214	0.141	0.21	0.156	0.118	0.222	0.213	0.183	0.198
A_{35}	0.209	0.148	0.17	0.146	0.112	0.212	0.222	0.185	0.198
A_{36}	0.184	0.162	0.216	0.156	0.191	0.214	0.175	0.13	0.12
A_{37}	0.137	0.152	0.206	0.129	0.126	0.222	0.22	0.146	0.193
A_{38}	0.151	0.141	0.209	0.141	0.129	0.22	0.209	0.171	0.216

Step 4. The g_j values of the nine criteria used for evaluation are obtained using Equation (8), and the BAA matrix is created (Table 5).

Table 5: BAA matrix

-	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9
g_j	0.173	0.157	0.190	0.147	0.141	0.212	0.204	0.149	0.184

Step 5. As a result of subtracting the BAA matrix from the weighted normalized DM, the distance matrix from the BAA is created using Equation (9). Then, the distance matrix from the boundary convergence area is given in Table 6, and the values in this matrix are evaluated using Equation (10). Thus, the performance of the alternatives in the criteria perspective and the criterion status in the alternative perspective is obtained.

Table 6: Distance Matrix from BAA

-	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9
A_1	0.022	-0.016	0.028	0.010	-0.010	0.008	0.014	0.032	0.014
A_2	-0.029	-0.012	-0.032	0.002	-0.023	0.002	-0.014	0.002	-0.002
A_3	0.006	0.001	0.021	0.009	-0.015	0.01	0.014	0.023	0.011
A_4	-0.021	-0.012	0.007	0	-0.014	0.008	-0.006	-0.005	0.023
A_5	-0.049	0.059	-0.041	0	0.032	0.008	-0.012	-0.033	-0.017
A_6	-0.062	0.018	-0.046	-0.001	0.081	-0.043	-0.093	-0.038	-0.038
A_7	0.036	-0.009	-0.025	-0.017	0.056	-0.002	0.001	-0.033	-0.069
A_8	0.001	0.008	0.012	0.013	0.003	0.006	0.01	0.002	0.029
A_9	0.049	-0.026	0.020	0	-0.020	0.004	0.012	0.03	-0.001
A_{10}	0.035	0.005	0.020	0.019	0.008	-0.004	0.014	-0.01	0.021
A_{11}	0.004	-0.005	0.008	0.005	-0.019	0.01	0.017	0.023	0.02
A_{12}	-0.006	-0.016	0.023	0.005	0.002	0.006	0.002	0.009	0.011
A_{13}	0.023	-0.009	0.022	-0.004	-0.024	0.01	0.014	0.03	0.014
A_{14}	-0.061	-0.005	-0.032	-0.036	0.010	0.01	0.005	-0.014	0.002
A_{15}	0.023	0.015	0.017	0.021	0.030	-0.01	0.013	-0.005	0.017
A_{16}	0.005	0.008	-0.079	-0.009	-0.026	0.01	-0.006	0.004	-0.007
A_{17}	0.032	0.001	-0.026	0.075	-0.029	0.004	-0.006	-0.017	0.009
A_{18}	0.029	0.011	-0.014	-0.003	-0.008	0.008	0.01	0.074	0.02
A_{19}	-0.019	-0.022	0.032	-0.017	0.008	0	0.013	-0.01	-0.019
A_{20}	-0.014	0.065	0.009	0.006	-0.008	0.006	0.017	0.034	0.038
A_{21}	0.048	-0.002	-0.007	0.03	-0.006	0.006	0.018	0.069	0.011
A_{22}	-0.027	0.015	0.024	-0.002	0.023	0	0	-0.028	0.024
A_{23}	0.006	-0.022	0.016	-0.021	0.014	-0.006	0.006	-0.021	0.031
A_{24}	0.016	-0.046	0.018	-0.019	-0.006	0.01	0.014	-0.014	-0.001
A_{25}	-0.018	0.045	0.010	-0.005	0.074	-0.101	-0.049	-0.035	-0.073
A_{26}	0.048	-0.002	0.024	-0.005	-0.023	0.01	0.014	0.009	-0.003
A_{27}	0.001	0.001	-0.001	0.005	-0.015	0.01	0.004	-0.01	0.004
A_{28}	0.043	0.005	-0.051	0.022	-0.030	0.006	-0.014	0.006	0.008
A_{29}	0.003	0.038	0.03	-0.011	0.015	0.008	0.009	-0.014	0.029
A_{30}	-0.028	0.021	0.025	-0.013	0.024	0	-0.002	-0.01	-0.045
A_{31}	-0.030	0.011	-0.012	0.002	0.026	0.01	-0.004	-0.024	0.03
A_{32}	0.009	-0.002	-0.001	-0.007	-0.007	0.006	-0.004	0.002	0.023
A_{33}	0.001	-0.026	0.02	-0.007	0.001	0.006	0.014	-0.014	-0.024
A_{34}	0.041	-0.016	0.02	0.009	-0.023	0.01	0.009	0.034	0.013
A_{35}	0.036	-0.009	-0.02	-0.001	-0.029	0	0.018	0.037	0.014
A_{36}	0.011	0.005	0.026	0.009	0.050	0.002	-0.028	-0.019	-0.064
A_{37}	-0.036	-0.005	0.017	-0.019	-0.016	0.01	0.016	-0.003	0.008
A_{38}	-0.023	-0.016	0.02	-0.006	-0.012	0.008	0.005	0.023	0.031

Step 6: S_i values of all alternatives are calculated using Equation (11). S_i values and ranking results of 38 countries are presented in Table 7. Accordingly, the most prosperous countries in terms of SES are Korea (A_{21}) and Japan (A_{20}). The least prosperous countries in terms of SES are Colombia (A_6) and Mexico (A_{25}). The criteria for these four countries in UAA and LAA are given in Table 8.

Table 7: S_i Values and Ranking Results of Alternatives

-	S_i	Rank
A_1	0.104	7
A_2	-0.106	35
A_3	0.079	10
A_4	-0.020	26
A_5	-0.054	32
A_6	-0.222	38
A_7	-0.061	33
A_8	0.085	9
A_9	0.067	13
A_{10}	0.108	5
A_{11}	0.062	14
A_{12}	0.037	17
A_{13}	0.075	11
A_{14}	-0.122	36
A_{15}	0.122	4
A_{16}	-0.099	34
A_{17}	0.043	16
A_{18}	0.127	3
A_{19}	-0.033	21
A_{20}	0.153	2
A_{21}	0.167	1
A_{22}	0.028	19
A_{23}	0.002	22
A_{24}	-0.028	29
A_{25}	-0.152	37
A_{26}	0.072	12
A_{27}	-0.002	23
A_{28}	-0.004	24
A_{29}	0.106	6
A_{30}	-0.027	27
A_{31}	0.010	21
A_{32}	0.018	20
A_{33}	-0.028	28
A_{34}	0.098	8
A_{35}	0.045	15
A_{36}	-0.010	25
A_{37}	-0.028	30
A_{38}	0.030	18

Table 8: Status of Criteria in Alternative Perspective

-	UAA	LAA
A_6	C_2, C_5	$C_1, C_3, C_4, C_6, C_7, C_8, C_9$
A_{20}	$C_2, C_3, C_4, C_6, C_7, C_8, C_9$	C_1, C_5
A_{21}	$C_1, C_4, C_6, C_7, C_8, C_9$	C_2, C_3, C_5
A_{25}	C_2, C_3, C_5	$C_1, C_4, C_6, C_7, C_8, C_9$

Conclusion and discussion

In the current study, the SES of 38 OECD countries was compared using the MABAC method, which is accepted as a valuable and reliable MCDM technique for rational decision-making. Alternative countries were compared based on nine criteria; comparison data were derived from UNDP. Since the MABAC technique provides a method for assessing the strengths and weaknesses of alternatives based on criteria, it facilitates an interpretation of countries with high and low performance.

As a result of the application, the country with the highest SES performance is Korea (0.167). Korea's six criteria are also found in the UAA. OnlyC_2, C_3 and C_5 are in the LAA. In other words, many criteria have a value equal to or close to the ideal alternative. Korea is notable for its high adjusted net savings rate and gross capital formation rate. In addition, the development index's decline rate due to inequality is low. Compared to other countries, the rate of access to safe drinking water and sanitation services for its citizens is high. A highly-skilled workforce ratio and high research and development expenditures are other remarkable features. However, the low change in the income share of the poor and the high export concentration index are negative features of the country.

Japan was the second-highest performing country (0.153). All criteria for the country except C_1 are in the UAA. In this country, the income share change rate of those in the lower-income group is high, and exports are homogeneously distributed. In addition, the gross capital formation rate is high, and the loss due to inequality is low. Research and development expenditures and the rate of the qualified workforce are high. In addition, its citizens have high access rates to safe drinking water and sanitation. However, the country's adjusted net savings rate is close to the non-ideal alternative.

Colombia had the lowest performance in terms of SES (–0.222). Colombia has only the C_2 and C_5 criteria in the UAA. It is observed that the adjusted net savings rate and gross capital formation rate are low in the country, and exports are concentrated in certain products. In addition, its citizens' access to safe drinking water and sanitation services is low compared to other countries. Research and development expenditures and the ratio of the qualified workforce are other weak points of the country. However, the high rate of change in the income share of the poor and the low loss due to inequality is a promising findings in terms of limiting income inequalities and ensuring equal opportunity in the country. Data from Mexico, which had the second-lowest performance (–0.152), were similar to Colombia's criteria. In contrast, only Mexico's C_3 criterion is in the UAA. This shows that Mexico's exports are not concentrated among certain products and that exports are distributed homogeneously.

When the case studies and results are examined, it is seen that the potential of performance benchmarking studies to increase the efficiency of environmental actions and their contribution to local administrators are emphasized. Carli, Dotoli and Pellegrino (2018) examined the level of sustainability of energy, water and environmental systems of Bari, Bitonto, Mola and Molfetta in Italy. As a result of the application, it has been determined that the Mola region is the most prosperous. The potential of the results of the study to increase the effectiveness of actions that can improve specific dimensions of the regions was emphasized. Chen and Zhang (2020) compared fourteen cities in Liaoning province, considering economic, social and environmental criteria. As a result of the application, it was determined that only five cities were classified at a reasonable level, and no city was at a perfect level. The study emphasised the dramatic decrease in the sustainable development levels of cities.

The significance of this study is evidenced by the fact that no study was found in the literature review that compared the SES performance of various country groups. In addition, the MABAC technique was applied, which provides safe and consistent solutions and detailed results based on criteria and alternatives. However, it is possible to carry the research further in future studies. The current study aims to test the effectiveness and applicability of the MABAC method in studies where the performances of various alternative groups are evaluated. For this reason, the weight of all the criteria in which the alternatives are evaluated has been accepted as equal, and no criterion weighting technique has been used. In future studies, objective weighting methods such as ENTROPY and MEREC or subjective weighting methods such as AHP, DEMATEL and SWARA can be used. Comparing the results of an integrated method in which these methods are included with the current study results is a research topic that will contribute to the literature. In addition, longitudinal studies could assess changes in the SES performance of countries over time. The study's next step is to compare countries' human development performances such as education, health, and environmental sustainability.

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