Temporal multicriteria evaluation of the categories proposed by the ‘Democracy Index’ of the countries: a perspective based on the DARIA-TOPSIS Method

Avaliação multicritério temporal das categorias propostas pelo ‘Índice de Democracia’ dos países: uma perspectiva baseada no Método DARIA-TOPSIS

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Abstract
This article analyzes the criteria of the ‘Democracy Index’ in countries, from 2017-2022, published by ‘The Economist’, aiming for an objective and comparative evaluation using the DARIA-TOPSIS method for temporal multicriteria assessment. The DARIA-TOPSIS method identified that among the top five ranked countries, the four most democratic ones are Nordic countries, with only New Zealand included in third place. Furthermore, the social and institutional trust, crucial for citizen participation observed in C_3 (Political Participation), reflects the high quality of democracy. These countries consistently exhibit high voter turnout

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rates and foster an active civil society culture in political decisions, as identified in C_1 (Electoral Process and Pluralism). Moreover, the variability of utility function values was better captured by the DARIA-TOPSIS method compared to a ranking based on average performance values (TOPSIS). However, the final order obtained by the methods generally coincides with or is very close.

**Keywords:** DARIA-TOPSIS. Temporal Multicriteria Evaluation. Democracy Index.

**Introduction**

Democracy plays a key role in the contemporary world and is widely regarded as a preferable political system compared to other forms of government (Lu & Chu, 2022). In this context, The Economist’s Democracy Index (EIU, 2023) is a measure commonly used to classify countries, based on a comprehensive and comparative assessment of the state of democracy in different nations (Jasiecki, 2021; Sobirovich, 2022). The criteria of this index allow countries to be measured and ranked according to their adherence to democratic principles and institutions, including political freedom, civic participation, respect for human rights, and the rule of law.
The analysis of global trends in the practice of democracy can be done using Multicriteria Decision Support (MDS) techniques that are present in a broader domain of Operations Research (OR), as it allows a quantitative analysis of the solution of complex problems in the organizational domain, national or social (Bączkiewicz, Kizielewicz, Shekhovtsov, Wątróbski, et al., 2021). Furthermore, decision-making is a systematic and formal process that involves four steps: (i) identification of the problem; (ii) derivation of preferences; (iii) evaluation of alternatives; and (iv) identification of the best alternatives (Thakkar, 2021).

Problems involving the evaluation of multiple criteria and alternatives are typically considered to be part of the MDS domain, which consists of three steps:

1. Identification of relevant criteria and alternatives from existing theory and practice.
2. Assigning numerical values to the criteria to indicate their relative importance and to quantify the impacts of the alternatives on these criteria.
3. Using a formal mathematical procedure to analyze numerical values to determine the rank (priorities) of the alternatives.

MDS techniques gain significant attention from managers, public or private organizations, to solve problems due to their potential to evaluate several conflicting alternatives (may be called choices, strategies, policies, scenarios, among other types of analytical categories) in the set of criteria. The process helps to observe, from the criteria, which alternatives are more suitable or stand out without compromising the subjective and intuitive insights for decision-making (Wątróbski et al., 2019).

In recent years there has been a significant increase in the number of studies and applications that record the successful integration of two or more MDS techniques (Junior, Moreira, & Santos, 2022). They have been successfully integrated to capture and analyze the complexity of a problem with greater rigor and detail. Furthermore, this type of successful integration of Multi Criteria Decision Making (MCDM) techniques with OR tools (some examples, AHP, ANP, TOPSIS, ELECTRE, PROMETHEE, VIKOR, DEMATEL, FUZZY, MOORA, LINMAP, COPRAS, ARM/ARAS, WASPAS, SWARA, GTA, ISM, SAPEVO-M, THOR/THOR-2, PrOPPAGA, CRITIC, GRA, WISP, MEREC, MAIRCA, CoCoSo, RAFSA, MABAC, BWM, AHP-TOPSIS-2N) significantly improves the discriminatory power of traditional OR-based decision-making. Frequently, these integrations are widely seen for decision-making in areas such as: engineering, project investment, social and applied sciences, business management issues, etc.
In this way, the MCDM approach accommodates often conflicting criteria and points of view within a solid and well-structured analysis framework. Recent trends in the scientific literature point to extensive use of these techniques so that decisions and strategies can be adequately implemented (Alinezhad & Khalili, 2019). However, there are limitations in existing multicriteria temporal assessment approaches. Considering this gap, the method called DARIA-TOPSIS (Data Variability Assessment Technique for Order of Preference by Similarity to Ideal Solution) was used in this study, which accurately reflects the variability in performance (Wątróbski et al., 2022).

After conducting the TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution), which consists of choosing an alternative that is as close as possible to the positive ideal solution and as far as possible from the negative ideal solution (Hwang & Yoon, 1981), the weights were calculated using the CRITIC method (Criteria Importance Through Intercriteria Correlation) (Diakoulaki et al., 1995). The Gini Coefficient was used to calculate performance variability, which is suitable for analyzing political and democratic participation (Lai et al., 2020; Susánszky et al., 2023). Furthermore, in this methodological approach, the most recent period is considered the most relevant, and the utility function values obtained for this period are updated, considering the direction of variability about the scores obtained in all the collected periods.

Therefore, this article aims to analyze the criteria of the ‘Democracy Index’ in the countries from 2017-2022, published by ‘The Economist,’ seeking an objective and comparative evaluation through the DARIA-TOPSIS method for temporal multicriteria evaluation.

‘Democracy Index’ and its Categories (Criteria)

Analyzing the 'Democracy Index' criteria is extremely important for countries. Based on these criteria, it is possible to assess and monitor progress and challenges related to democracy, facilitating international comparison, and identifying best practices. In addition, the analysis promotes dialogue between governments, civil society, and the international community, stimulating debate on the quality of democracy and the need for reforms. The criteria also encourage countries to strengthen their democratic institutions by ensuring equal rights, promoting civic participation, and respecting the rule of law (Jasiecki, 2021; Karatas, 2021). The five categories are presented below (EIU, 2023; Walker et al., 2015).
2.1 The Electoral Process and Pluralism

The electoral process and pluralism are closely related to democracy in a country. Pluralism recognizes and values the diversity of opinions, interests, and groups in society, promoting the participation and representation of different perspectives, ensuring equal opportunities for the peaceful expression of ideas (Krisch, 2006). On the other hand, the electoral process allows citizens to choose their political representatives and influence government decisions. Elections provide a mechanism for the expression of different points of view and political competition (Sáez & Encalada, 2020). This category evaluates aspects such as political diversity, free electoral process, irregularities during voting, universal suffrage (all adults have the right to vote, and the exercise of this right is free), equal opportunities in electoral campaigns for all parties’ political parties, transparency in party funding, orderly transfer of power after elections, and opening up political offices to all without discrimination, promoting equal opportunities. This analysis seeks to strengthen democracy through inclusion, integrity, and equality (Cervantes, 2021; Deth, 2016). It should be noted that there are limitations and inconsistencies in electoral processes addressed in theories such as ‘Social Choice Theory’ and ‘Arrow’s Impossibility Theorem.’ However, these aspects will not be part of this article.

2.2 Government Functioning

The relationship between the functioning of government and democracy is crucial. The way government operates directly impacts the effectiveness and integrity of the democratic system. In a democracy, the government is made up of representatives elected by the people, whose responsibility is to make decisions and implement policies on behalf of the people. The proper functioning of government requires the observance of essential elements, such as: accountability of its actions and policies, which is a vital mechanism to avoid abuses of power and ensure that the government acts in the best interests of citizens (Krisch, 2006); submit to public scrutiny, allowing the population to criticize, question and monitor its performance; separation of powers (legislative, executive and judiciary) in order to avoid excessive concentration of power in a single body or individual, establishing a system of checks and balances, proposed by Charles-Louis de Secondat (1689-1755), but known for Montesquieu, who developed the ‘Theory of the Separation of Powers’ in the 18th century, based on studies of Ancient Greece; existence of a Government free from interference by the armed and
security forces (Army and Police), foreign organizations or economic, social or religious
groups within the country; whether or not corruption is considered a problem in the
functioning of the public machine; whether the government is acting within legal limits and
respecting the fundamental rights of citizens; and if the population trusts its rulers and political
parties (Cervantes, 2021; EIU, 2023).

2.3 Political Participation

Political participation refers to the active involvement of citizens in political issues in
society (Deth, 2016), functioning as a fundamental premise (Susánszky et al., 2023). Measurements for this category include the proportion of people who vote during elections, contributing to democratic legitimacy and building trust in government and democratic institutions; promoting diversity and inclusion in democracy (Krisch, 2006) - providing a space for marginalized groups, such as women, ethnic or religious minorities, youth and people with disabilities, to have an active voice in politics and decision-making. This inclusion strengthens representativeness and democratic legitimacy by enriching the diversity of perspectives and experiences in public policy. The population’s interest in politics can be observed through formal participation channels, such as public consultations and participatory decision-making processes, where citizens can express their opinions, contribute with ideas, and demands, and collaborate in defining policies that affect their lives. It promotes more inclusive governance and ensures that public policies reflect the needs and interests of the population. In addition to promoting civic education, strengthening democratic culture, and creating a solid foundation for the healthy functioning of democracy (EIU, 2023; Weiss, 2020).

2.4 Political Culture

Political culture influences citizens’ attitudes, values, and behavior toward politics and
the democratic system (Schmitt-Beck & Neumann, 2023). This criterion is measured in
different ways. One is through consensus and social cohesion, which reflect society’s ability
to find points of agreement and maintain internal cohesion. Another essential point measured
is the level of popular support for democracy, which indicates the degree of acceptance and
appreciation of the democratic system by the population. This indicator is crucial to assess the
stability and legitimacy of the democratic regime in a country.
Additionally, the belief that democracy benefits economic development is another relevant aspect. When citizens recognize the positive correlation between democracy and economic growth, they support and value the democratic system even more. On the other hand, some negative aspects are also measured, such as the proportion of the population that prefers a strong leader to the detriment of the parliamentary and electoral political model or those who prefer a military regime. In addition, the preference for a government composed of specialists or technocrats is also an object of analysis since it can impact the functioning and legitimacy of democracy (EIU, 2023).

### 2.5 Civil Liberties

Civil liberties constitute a fundamental element of a democratic system (Krisch, 2006). They protect citizens’ rights which include autonomy, freedom of expression and protest (for example, of political opinions, which would encourage debate on public issues and criticism of the government), freedom of association (to be able to represent specific interests and promote civic engagement), freedom of the press (which plays an essential role in disseminating information and controlling public authorities, keeping citizens well-informed to make informed political decisions), free thought, privacy, equality before the law, among others fundamental freedoms for the whole exercise of citizenship, allowing citizens to live their lives according to their individual choices. This criterion is measured by considering the media’s freedom to discuss public issues; the non-existence of restrictions on access to the Internet; the possibility for the population to form professional associations and unions; the existence of religious freedom and tolerance. Now measuring negative aspects, we have used the torture strategy by the State. Whether the government, in order to reduce civil liberties, invokes new risks or dangers to the population, the latter being a fundamental component of democracy, by allowing, among others, supervision by the public power and safeguarding plurality and diversity in society. Furthermore, civil liberties strengthen the independence of the judiciary, allowing citizens to seek the protection of their rights before the courts (EIU, 2023; Gastil, 1990).

**Presentation of Topsis-Critic-Daria Approaches**

This section presents the principles, fundamental assumptions, and mathematical formulas of the TOPSIS-CRITIC-DARIA approaches. The basic principle of the DARIA-
TOPSIS method is that, in addition to taking into account the unique performance efficiency, it provides a general aggregated evaluation of the alternatives $S$, for which the achieved efficiency values for each alternative in the vector $S^t$ received by the methods MDS for the most recent period $t$ are updated by the values of variability of efficiencies over all periods (for example, in this study in years) considered $p = 1, 2, ..., t$.

**Step 1:** Involves selecting the meaningful criteria needed to evaluate multi-criteria problems and a set of alternatives to evaluate from the database.

**Step 2:** Aims to build decision matrices containing performance tables for each investigated period. To start building the evaluation model of the set of alternatives with the TOPSIS method, a decision matrix with $m$ alternatives and $n$ criteria are represented in a table. Equation (1) represents the performance of the $E^p$ table, where the value of the $i$-th alternative $a_i$ ($i = 1, 2, ..., m$) is evaluated according to the $j$-th criterion $c_j$ ($j = 1, 2, ..., n$) is denoted by $e^p_{ij}$, where $p = 1, 2, ..., t$ means certain period.

$$E^p = \begin{bmatrix} c_1 & ... & c_j & ... & c_n \\ a_1 & e^p_{11} & ... & e^p_{1j} & ... & e^p_{1n} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ a_i & e^p_{i1} & ... & e^p_{ij} & ... & e^p_{in} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ a_m & e^p_{m1} & ... & e^p_{mj} & ... & e^p_{mn} \end{bmatrix}$$ (1)

**Step 3:** Criterion weights should be calculated using an objective weighting method. Several methods in the literature allow the calculation of weights (for example, CRITIC, DEMATEL, AHP, and SAPEVO, among others). In the case of this article, the method called Criteria Importance Through Intercriteria Correlation (the CRITIC method) is employed. The subsequent steps of the CRITIC method are provided according to seminal studies developed (Bączkiewicz, Kizielewicz, Shekhovtsov, Yelmikheiev, et al., 2021).

**Step 3.1:** Normalization of the decision matrix according to Equation (2).

$$x^*_{ij} = \frac{x_{ij} - \min(x_{ij})}{\max(x_{ij}) - \min(x_{ij})}$$ (2)

Where:
\( x_{ij} \) represents the normalized performance value of the i-th alternative considering the j-th criterion. It should be noted that the equation used is a minimum-maximum normalization and does not consider the division of criteria into cost and profit types.

**Step 3.2:** The correlation values between the pairs of criteria are calculated as shown in Equation (3).

\[
\rho_{jk} = \frac{\sum_{i=1}^{m}(r_{ij} - \bar{r}_k)(r_{ij} - \bar{r}_k)}{\sqrt{\sum_{i=1}^{m}(r_{ij} - \bar{r}_k)^2 \sum_{i=1}^{m}(r_{ij} - \bar{r}_k)^2}}
\]  

(3)

**Step 3.3:** Calculating the weight criteria according to Equations (4) and (5)

\[
c_j = \sigma_j \sum_{k=1}^{n} (1 - \rho_{jk})
\]  

(4)

\[
w_j = \frac{c_j}{\sum_{k=1}^{n} c_k}
\]  

(5)

Knowing that

\[
\sigma_j \left[ \sum_{k=1}^{n} 1 - \sum_{k=1}^{n} \rho_{jk} \right] = \sigma_j (n - \sum \rho_{jk})
\]

And that \( \sum_{k=1}^{n} \rho_{jk} \) is the sum of the j-th column of the correlation matrix.

Where:

\( i = 1, 2, ..., m; j, k = 1, 2, ..., n \). In the equations presented above, \( c_j \) represents the amount of information included in the j-th criterion, \( \sigma_j \) represents the standard deviation, and \( \rho_{jk} \) represents the correlation coefficient between the j-th and k-th criteria.

**Step 4:** Evaluate each decision matrix build in Step 2 with the TOPSIS method.

**Step 4.1:** The objective of the first step of the TOPSIS method is to normalize the decision matrix \( E^p \) denoted by Equation (1) for each \( p \) period (in the case of this study, in years) with the selected normalization technique. This study followed the orientation of previous studies using the normalization of the minimum-maximum method (Bączkiewicz & Wątróbski, 2022; Wątróbski et al., 2022). This method is demonstrated from two equations for profit (6) and for cost (7)
\[ r_{ij}^p = \frac{e_{ij}^p - \min_j(e_{ij}^p)}{\max_j(e_{ij}^p) - \min_j(e_{ij}^p)} \]  
\[ r_{ij}^p = \frac{\max_j(e_{ij}^p) - e_{ij}^p}{\max_j(e_{ij}^p) - \min_j(e_{ij}^p)} \]

Where:

\[ r_{ij} \] denotes normalized values for the decision matrix.

**Step 4.2:** In this step, the weight of the decision matrix is computed according to Equation (8)

\[ v_{ij}^p = w_j^p \times r_{ij}^p \]  

Where:

\[ w_j^p \] denotes weights of the criteria considered for the database of period \( p \) and \( v_{ij}^p \) represents the weight value in the normalized decision matrix. It should be noted that the vector including the weighting criterion can be received directly from the decision maker as well as calculated with different weighting objectives in the methods (Paradowski et al., 2021).

**Step 4.3:** The two reference solutions (best levels) are calculated involving Positive Ideal Solution (\( PIS^p \)) with Equation (9) and Negative Ideal Solution (\( NIS^p \)) using Equation (10). The \( PIS^p \) includes the maximum values of all alternatives for the investigated criteria for the \( p \)-period dataset, and the \( NIS^p \) contains the minimum values. At this step, splitting the criteria into profit and cost types is unnecessary because this was already done in Step 1 of the normalization procedure.

\[ v_j^{p+} = \{v_1^{p+}, v_2^{p+}, ..., v_n^{p+}\} = \{\max_i(v_{ij}^p)\} \]  
\[ v_j^{p-} = \{v_1^{p-}, v_2^{p-}, ..., v_n^{p-}\} = \{\min_i(v_{ij}^p)\} \]

**Step 4.4:** Determine the Euclidean distances between each alternative and its solution \( PIS^p \) (11) and \( NIS^p \) (12).
\[ D_i^{p+} = \sqrt{\sum_{j=1}^{n} (v_{ij}^p - v_{j}^{p+})^2} \]  \hspace{1cm} (11)

\[ D_i^{p-} = \sqrt{\sum_{j=1}^{n} (v_{ij}^p - v_{j}^{p-})^2} \]  \hspace{1cm} (12)

**Step 4.5:** Finally, calculate the value of the utility function, or the result of approximating the ideal solution, for each alternative for the period \( p \) as shown in Equation (13)

\[ S_i^p = \frac{D_i^{p-}}{D_i^{p+} + D_i^{p+}} \]  \hspace{1cm} (13)

The final ranking of the alternatives is determined by sorting the utility function values in descending order, as performed in the TOPSIS method. Quantitative efficiency \( (S^t) \) is then used to calculate the final ranking, and recommendations can be formulated.

**Step 5:** After the MCDM evaluation by the TOPSIS method and the composition of the weights by the CRITIC method, the steps of the DARIA method begin, which appears as an aggregating approach with the proposal to create a ranking to be compared with the average of the \( t \) periods. Therefore, the matrix \( S = [S_{pi}]_{t \times m} \) including efficiency score values containing \( t \) periods in rows in scores for each alternative in columns are arranged in the matrix, presented by Equation (14)

\[
\begin{array}{cccc}
  a_1 & \ldots & a_l & \ldots & a_m \\
  s_{11} & \ldots & s_{1i} & \ldots & s_{1m} \\
  \vdots & \ldots & \vdots & \ldots & \vdots \\
  s_{p1} & \ldots & s_{pi} & \ldots & s_{pm} \\
  \vdots & \ldots & \vdots & \ldots & \vdots \\
  s_{t1} & \ldots & s_{ti} & \ldots & s_{tm} \\
\end{array}
\]  \hspace{1cm} (14)

**Step 6:** In this step, the variability of the scores of the alternatives obtained with the TOPSIS method is calculated for each evaluated period and the overall evaluation.

**Step 6.1:** Calculation of efficiencies variability values for certain periods \( (t) \) for the alternatives evaluated by the Gini coefficient (or Gini ratio) (Dorfman, 1979). Created by Conrado Gini in 1912, it is an instrument initially developed to measure the degree of income concentration of a particular group (poor or rich). Thus, Gini is a numerical measure
(statistics) derived from the Lorenz curve, which is a measure used to graph inequality in a population. However, this study understands and calculates it from unordered size data as the 'relative mean difference,' i.e., the mean difference between all possible pairs of individuals divided by the mean size. The Gini coefficient is a quantitative indicator used to measure variability and represents the differences in the analyzed data sets (Lai et al., 2020). In the equations presented below $i$ represents the index of the given alternative $i = 1, 2, \ldots, m$, $p$ means subsequent investigated periods $p = 1, 2, \ldots, t$ and $S_{pi}$ denotes the $i$-th efficiency alternative. $\bar{s}_i$ means the expected value for the efficiency scores of all periods considered for the $i$-th alternative, being computed as its average value. If $\bar{s}_i$ is not equal to 0, the Gini coefficient of the given criterion is calculated using Equation (15).

$$G_i = \sum_{p=1}^{t} \sum_{k=1}^{t} \frac{|s_{pi}-s_{ki}|}{2t^2 \bar{s}_i}$$

(15)

Step 6.2: Determine the direction of the efficiency variability. The threshold value given in Equation (16) using Equation (17) is applied to determine the direction of variability for each $i$-th alternative.

$$thresh_i = \sum_{p=2}^{t} s_p - s_{p-1}$$

(16)

$$dir_i = \begin{cases} 1 & se \ thresh_i > 0 \\ -1 & se \ thresh_i < 0 \\ 0 & se \ thresh_i = 0 \end{cases}$$

(17)

Step 6.3: Next, the efficiency obtained for the last period is selected, which is updated with the value of the variability of the efficiencies in the analyzed periods $t$ according to its direction by equation (18)

$$S_i = S_{i}^{t} + G_i \ dir_i$$

(18)

Where:

$S_i$ represents the efficiency of a given alternative $a_i$, updated by adding variability values, multiplied by the variability, $S_{i}^{t}$ denotes the efficiency of a given alternative $a_i$ received in the most recent period analyzed $t$, $G_i$ means variability values in the efficiencies of $a_i$ of alternatives over all investigated periods $p = 1, 2, \ldots, t$ calculated with the Gini coefficient, and $dir_i$ denotes directions of variability $G_i$, which can be equal to 1 for
increasing trend, -1 for decreasing trend or 0 for stability trend. The alternatives are represented by $a_i$ ($i = 1, 2, ..., m$).

**Step 6.4:** The last step aims to order the alternatives concerning the final values of efficiency $S$ according to the descending order, which is typical of the TOPSIS method.

**Step 7:** This is a final stage of comparing the results using ranking rank correlation coefficient (Bączkiewicz et al., 2022). In the study of the authors who proposed the construction of the method (Bączkiewicz & Wątróbski, 2022; Wątróbski et al., 2022) observed that an essential step in the analysis of the multicriteria decision is the benchmarking of the results obtained. Comparative analysis can involve comparing ratings from different methodological approaches, models, and periods. The objective measures used to determine rank convergence are correlation coefficients, including the Spearman rank correlation coefficient $r_s$ and the weighted Spearman rank correlation coefficient $r_w$ (Faizi et al., 2021). The correlation coefficient $r_w$ is calculated to compare two rankings $x$ and $y$, according to equation (19). $N$ denotes a number of rank values $x_i$ and $y_i$ (Sałabun et al., 2020).

$$r_w = 1 - \frac{6 \sum_{i=1}^{N} (x_i - y_i)^2 ((N-x_i+1)+(N-y_i+1))}{N^4+N^3-N^2-N}$$

(19)

The Spearman Rank Correlation Coefficient is calculated to compare two ranks $x$ and $y$ as shown in Equation (20).

$$r_s = 1 - \frac{6 \sum_{i=1}^{N} (x_i - y_i)^2 }{N (N^2-1)}$$

(20)

Where:

$N$ represents the size of the $x$ and $y$ vectors (Kumar & Abirami, 2018).

Evaluation of the Democracy Index of Countries Based on the Progress of the Criteria with Daria-TOPSIS

This article presents the convergence and usefulness of three methods, TOPSIS-CRITIC-DARIA, for temporal evaluations of the 30 best-ranked countries in 2022, the latest research in the ‘Index of Democracy.’ This index consists of a public database provided by Economist Intelligence (EIU, 2023) this report provides an overview of democracy worldwide.
in 165 independent states and two territories. It covers virtually the entire world population. The ‘Democracy Index’ is based on five categories (criteria to be analyzed in the MCDM method): (i) electoral process and pluralism, (ii) government functioning, (iii) political participation, (iv) political culture, and (v) civil liberties. The score for each criterion corresponds to the attribution of 0 to 10 points (measurement unit). Only the 30 best-ranked countries in 2022, the latest available survey, were selected for this study. The methods used in this research consider the dynamics of changes in country performance over the six years spanning 2017-2022.

The evaluation criteria are provided in Table 1 with their names, unit, and objectives which can be profit ↑ or cost ↓. In this research, all the criteria objectives were ‘profit,’ thus seeking to maximize the score for a better placement in the classification. The 2022 sample of countries is shown in Table 2. The complete database is provided by the ‘Democracy Index’ annual reports.

<table>
<thead>
<tr>
<th>Criteria $C_j$</th>
<th>Name</th>
<th>Unit</th>
<th>Goal</th>
<th>Authors</th>
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<tbody>
<tr>
<td>$C_1$</td>
<td>Electoral Process and Pluralism</td>
<td>Relevance weight based on the methodology itself (values up to 10)</td>
<td>↑</td>
<td>Sáez and Encalada (2020); Cervantes (2021); Deth (2016)</td>
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<td>$C_2$</td>
<td>Government Functioning</td>
<td></td>
<td>↑</td>
<td>Krisch (2006); Cervantes (2021)</td>
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<td>$C_3$</td>
<td>Political Participation</td>
<td></td>
<td>↑</td>
<td>Deth (2016); Susánszky et al. (2023); Krisch (2006); Weiss (2020)</td>
</tr>
<tr>
<td>$C_4$</td>
<td>Political Culture</td>
<td></td>
<td>↑</td>
<td>Schmitt-Beck and Neumann (2023)</td>
</tr>
<tr>
<td>$C_5$</td>
<td>Civil Liberties</td>
<td></td>
<td>↑</td>
<td>Krisch (2006); Gastil (1990)</td>
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Table 1: Evaluation of the criteria considered in the ‘Democracy Index’ Ranking
Source: Authors creation
Perspective based on the DARIA Temporal multicriteria evaluation of the categories proposed by the ‘Democracy Index’ of the countries: a perspective based on the DARIA-TOPSIS Method

Table 3 shows the utility function and classification values received for each year assessed using the TOPSIS method. When analyzing the average performance of countries each year (see Table 3), it is possible to observe that the best-evaluated countries, from highest to lowest, are Norway $A_1$, Iceland $A_3$, New Zealand $A_2$, Finland $A_5$, and Denmark $A_6$. This variability relates to both progress and worsening outcomes.

### Results

This section presents the results of the ‘Democracy Index’ in the temporal evaluation of countries from 2017-2022, applying the methods presented above. The results that makeup Table 3 show the utility function and classification values received for each year assessed using the TOPSIS method. When analyzing the average performance of countries each year (see Table 3), it is possible to observe that the best-evaluated countries, from highest to lowest, are Norway $A_1$, Iceland $A_3$, New Zealand $A_2$, Finland $A_5$, and Denmark $A_6$. This variability relates to both progress and worsening outcomes.

### Table 2: Decision Matrix with the performance of annual data evaluated by countries (2022)

Source: Authors creation

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<td>1</td>
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<td>0.783</td>
<td>0.837</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>4</td>
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<td>6</td>
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<td>0.4554</td>
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<tr>
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<td>0.7241</td>
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This variability relates to both progress and worsening outcomes.
Temporal multicriteria evaluation of the categories proposed by the ‘Democracy Index’ of the countries: a perspective based on the DARIA-TOPSIS Method

Revista Gestão e Secretariado (GeSec), São Paulo, SP, v. 14, n. 9, 2023, p. 16146-16167.

<table>
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<tr>
<th>Country</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
<th>Year 6</th>
<th>Year 7</th>
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<tr>
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<td>0.359</td>
<td>0.359</td>
<td>0.359</td>
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</tr>
</tbody>
</table>

Table 3: Annual results by the TOPSIS model with all criteria from 2017-2022
Source: Authors creation

Figure 1: Stacked columns of evidence utility functions for the six periods
Source: Authors creation
Stacked Column Figure 1 displays the relative size of the sum of the efficiency utility function pooled values for the six analyzed periods. It is possible to observe the evolution of each country about the others, noting that only \( A_1 \) and \( A_3 \) maintained better consistency in each period.

However, the vast majority of countries had, in both methods, very similar rankings, with slight variation or even maintaining the position. Because the DARIA-TOPSIS method measures the variability of utility function values, the results reflect progress or deterioration more accurately than ranking analysis alone. Therefore, the variability of utility function values was better reflected by the DARIA-TOPSIS method than a ranking based on average performance values. Consequently, the final order obtained by the DARIA-TOPSIS method will, in most cases, coincide or be very close to the order obtained by the TOPSIS sorting averages for all periods.

In the sense of aggravation, the most worrisome variabilities were observed in the last positions of the classification presented in Table 4. When comparing the ranked results of both methods and analyzing the DARIA-TOPSIS outputs, it is observed that, for example, \( A_{30} \) (United States of America) and \( A_{21} \) (Mauritius) had, respectively, the worst scores (0.3343 and 0.2962). Furthermore, in addition to \( A_{30} \) (United States of America) and \( A_{21} \) (Mauritius), other countries such as \( A_4 \) (Sweden), \( A_{15} \) (Australia), \( A_{15} \) (United Kingdom), \( A_{21} \) (Mauritius) and \( A_{23} \) (Spain), among others, had the worst declines in their rankings. On the Other hand, \( A_{10} \) (Taiwan) which rose ten positions, and \( A_{26} \) (Greece) rose thirteen positions, are countries that had a worse classification in the TOPSIS method and had considerable gains by the DARIA-TOPSIS method. The country with the best score in the DARIA-TOPSIS ranking was \( A_1 \) (Norway) in both methods. The second, third, fourth, and fifth place, respectively, were occupied by \( A_2 \) (New Zealand), \( A_3 \) (Iceland), \( A_6 \) (Denmark) and \( A_5 \) (Finland) and had inversion in order by methods but with approximate score values.

<table>
<thead>
<tr>
<th>( A_i ) Countries</th>
<th>( G_i )</th>
<th>( \text{thresh}_i )</th>
<th>\text{Direction}</th>
<th>\text{Score Rank}</th>
<th>\text{Score Rank}</th>
</tr>
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<tbody>
<tr>
<td>( A_1 ) Norway</td>
<td>0.002</td>
<td>9</td>
<td>↓ 0.0216</td>
<td>1, 0.950</td>
<td>1, 0.9662</td>
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<tr>
<td>( A_2 ) New Zealand</td>
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<td>5</td>
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<tr>
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<td>↓ 0.0511</td>
<td>3, 0.824</td>
<td>3, 0.8492</td>
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<tr>
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<td>↓ 0.0994</td>
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<td>4, 0.7375</td>
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<tr>
<td>( A_5 ) Finland</td>
<td>0.009</td>
<td>3</td>
<td>↓ 0.0022</td>
<td>5, 0.742</td>
<td>5, 0.7855</td>
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</table>
### Temporal multicriteria evaluation of the categories proposed by the ‘Democracy Index’ of the countries: a perspective based on the DARIA-TOPSIS Method

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<th>Criteria 3</th>
<th>Criteria 4</th>
<th>Criteria 5</th>
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Table 4: Comparison of the results of the DARIA-TOPSIS method involving all criteria
Source: Authors creation

During the execution of the TOPSIS method for each period, the CRITIC method was used to calculate the weights \( w_j \) of the five criteria used for the analysis. The weight values of the criteria are shown in Table 5. Furthermore, analyzing the period 2017-2022, criteria \( C_3 \) (Political Participation) and \( C_1 \) (Electoral process and pluralism) had the highest weight. Of
these, from 2017 to 2022, $C_3$ and $C_1$ were the ones that gained greater prominence in the evaluation of the ‘Democracy Index’ (by the weight of their evaluation presented). $C_2$ (Functioning of the Government) and $C_5$ (Civil Liberties) had the lowest weights among the criteria.

<table>
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<th>Year</th>
<th>$C_1$</th>
<th>$C_2$</th>
<th>$C_3$</th>
<th>$C_4$</th>
<th>$C_5$</th>
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</tr>
<tr>
<td>2022</td>
<td>0.2323</td>
<td>0.1777</td>
<td>0.2470</td>
<td>0.1903</td>
<td>0.1527</td>
</tr>
</tbody>
</table>

Table 5: Criteria weights ($w_j$) determined by the CRITIC method
Source: Authors creation

In the final part of the research, the values of the correlation coefficients $r_w$ and $r_s$ between the DARIA-TOPSIS rankings and the annual rankings based on average performance were calculated. This research sought to determine which results of the DARIA-TOPSIS method achieved greater convergence. The results in Table 5 show that the convergence of the DARIA-TOPSIS ranking is more significant for more recent years. These findings are consistent with the assumptions of the DARIA-TOPSIS method that these data are relevant for decision-makers. The correlation coefficients $r_w$ and $r_s$ obtained by two comparison methods, independently of each other, indicate the ‘closeness’ between the two ranking methods. Therefore, the closer the methods, the more the value $r_w$ or $r_s$ approaches 1. In the case of this study, the correlations from 2017 to 2020 were considered strong, and from 2021 and 2022 very strong, from 2022 very close to 1 for being the original classification of study selection (see Table 6).

<table>
<thead>
<tr>
<th>Correlation coefficients</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>$r_w$</td>
<td>0.7969</td>
<td>0.7937</td>
<td>0.8037</td>
<td>0.8980</td>
<td>0.9489</td>
<td>0.9930</td>
<td>0.9201</td>
</tr>
<tr>
<td>$r_s$</td>
<td>0.7451</td>
<td>0.7250</td>
<td>0.7517</td>
<td>0.8687</td>
<td>0.9181</td>
<td>0.9942</td>
<td>0.9008</td>
</tr>
</tbody>
</table>

Table 6: Correlations of DARIA-TOPSIS rankings with TOPSIS annual average rankings
Source: Authors creation

Conclusions

This article aimed to analyze the criteria of the ‘Democracy Index’ in the countries of 2017-2022, published by ‘The Economist,’ seeking an objective and comparative evaluation through the DARIA-TOPSIS method for temporal multicriteria evaluation. It is fundamental
to consider the changing dynamics of world democracy and the evaluation of the evaluation criteria in the results in individual investigated periods to monitor the progress in the achievement of the goals established by the countries.

The DARIA-TOPSIS method allowed identification that of the five best-ranked countries, the four most democratic are Nordic, with only the inclusion of New Zealand in third place. Given the results, these countries have a high quality of democracy. Probably, due to the historical public policies developed in these countries that emphasize social well-being and providing high-quality public services, such as education, health, and social assistance. These practices collaborate to reduce inequality and create a more egalitarian society. Furthermore, social and institutional trust is fundamental for citizen participation observed in $C_3$ (Political Participation) (Deth, 2016; Krisch, 2006; Susánszky et al., 2023; Weiss, 2020). These countries are encouraged and engaged with consistently high voter turnout rates, and an active civil society culture has developed in political decisions, identified by $C_1$ (Electoral process and Pluralism) (Cervantes, 2021; Dordella, 2014; Deth, 2016; Sáez & Encalada, 2020). Transparency, accountability, and effective accountability mechanisms are crucial elements in the fight against corruption. In addition, the Nordic countries stand out as leaders in promoting gender equality, extending it to different spheres of society.

Finally, it is essential to highlight that this research covered only 30 of the 165 independent states and two territories. Furthermore, even if each country presents its particularities and approaches to democracy, the criteria help countries compare their performance against the best-ranked countries. However, it should be noted that no political system is perfect, and the countries that ranked first also face challenges and democratic issues that are constantly evolving. The results encourage further research in the MCDM field to understand changes in the dynamics of results over time. Therefore, the DARIA-TOPSIS method (Bączkiewicz & Wątróbski, 2022; Wątróbski et al., 2022), despite being little used in research carried out so far, brings a promising perspective to direct future work to replicate or adapt the method with other approximation measures.

Referências


Temporal multicriteria evaluation of the categories proposed by the ‘Democracy Index’ of the countries: a perspective based on the DARIA-TOPSIS Method


Method with Gini-Coefficient-Based Weight Determination. *Sustainability, 12*(8), Article 8.


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