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## **A Novel Multi-Criteria Decision-Making Framework for Evaluating Airport Performance: Empirical Evidence from Türkiye**

**Abstract.** *Measuring airport performance is crucial for both local and global transportation systems, as it drives economic development, facilitates international trade, and enhances regional connectivity. This research aims to assess the performance of major airports in Türkiye by utilising a hybrid Multi-Criteria Decision-Making (MCDM) model. This model combines the LODECI-based ALPAS approach with the CORASO and RAWEC methods to assess airport performance. The data for this study are obtained from the 2024 Annual Activity Report published by DHMI. The LODECI method is employed to evaluate a range of criteria, while the ALPAS, CORASO, and RAWEC methods are employed to rank alternatives. Furthermore, the overall performance of Turkish airports is analysed using the Borda count method. Results from the LODECI indicate that international cargo and freight traffic, as well as the availability of check-in counters, are important factors influencing performance. The findings identify Istanbul Airport, Sabiha Gökçen Airport, and Antalya Airport as the most efficient and competitive airports in Türkiye. A sensitivity analysis is also performed to assess the robustness of the results. Together, this paper serves as a comprehensive guide for airport policymakers aiming to enhance long-term competitiveness.*

**Keywords:** *airport performance, Türkiye, LODECI, ALPAS, CORASO, RAWEC.*

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### **1. Introduction**

The airport industry, along with its numerous inputs and outputs, plays a significant role in shaping the global economy. It is essential to achieve an optimal balance among the interests of the general public, stakeholders, and airport operators. One of the key advantages of benchmarking is that it offers a straightforward approach to identify performance gaps and areas of excellence without requiring extensive and complicated process analysis. Benchmarking airports is crucial for providing all stakeholders with the necessary tools to manage these infrastructures effectively (Baltazar et al., 2018). Airports are constantly evolving to address changing global circumstances, enabling them to thrive in the aviation sector. Local governments are seeking methods to optimise operations as the number of airlines grows and air travel becomes increasingly accessible. Consequently, airport administrators are adopting innovative strategies to enhance customer service and

maintain a competitive edge. This emphasis on efficiency underscores the significant role that airports play in economic development, job creation, and international trade, prompting numerous countries to establish policies aimed at enhancing airport efficiency (Ersoy, 2021).

In recent years, airlines have encountered significant challenges in optimisation and decision-making, underscoring the necessity for a robust decision-making framework. The airline industry has concentrated on Multi-Criteria Decision-Making (MCDM) methods to tackle complex business issues characterised by conflicting objectives. MCDM approaches facilitate the evaluation and prioritisation of alternatives based on specific criteria, taking into account the interrelationships among various performance metrics. By employing integrated MCDM strategies, airlines can enhance their operational effectiveness and pinpoint opportunities for improvement (Kulaklı & Şahin, 2023). Accordingly, this paper employs a hybrid decision-making model that integrates LODECI-based ALPAS, CORASO, RAWEC, and Borda Count to assess the performance of the sixteen airports operating within Türkiye. The main objective of this study is to explore the following research questions:

*RQ1. What are the key factors affecting the performance of airports in Türkiye?*

*RQ2. How do Turkish airports compare in terms of their performance?*

*RQ3. Are there differences in airport performance among those operating in Türkiye based on the selected MCDM methods?*

The rationale for adopting this hybrid model can be summarised as follows: (i) The LODECI method represents an approach that combines the features of both the Entropy and MEREC methods. By incorporating a logarithmic function, this method effectively constrains the weight range to an appropriate scale, thereby reducing the risk of overestimating specific criteria that can occur in the Entropy and MEREC methods (Pala, 2024). (ii) The ALPAS method addresses several ranking-related challenges, such as low interpretability, the absence of dual evaluation metrics, and limited adaptability to data-driven contexts, thus representing a significant advancement in existing MCDM methods (Ulutaş et al., 2025). (iii) The CORASO method assesses alternatives by evaluating their proximity to the best and worst values for specific criteria. It determines the deviation of each alternative to create a conclusive ranking (Puška et al., 2024a). (iv) The RAWEC method combines two stages into a single, streamlined process. This approach emphasises the evaluation of outcomes by examining deviations from ideal values rather than merely ranking options based on their decision matrix values (Puška et al., 2024b). Finally, the Borda count method combines various rankings to reduce the impact or bias of any individual method or opinion, thus strengthening the overall reliability of the results (Ecer, 2021).

The novelties of this study can be summarised as follows:

- A novel hybrid decision-support model has been developed to comprehensively evaluate the performance of airports in Türkiye.

- To the best of the author's knowledge, this study represents the first instance of simultaneously employing the LODECI-based ALPAS, CORASO, RAWEC, and Borda count methods within the MCDM field.
- The proposed hybrid model is a functional tool for policymakers, private sector representatives, and other stakeholders aiming to assess, compare, and analyse airport performance across multiple indicators.
- The model's robustness and validity have been tested through sensitivity and comparative analysis, confirming its reliability for informed decision-making applications.

## 2. Literature review

Assessing the performance of any industry is crucial for determining efficiency; however, airports require additional considerations. As vital gateways for a nation, airports hold considerable economic and strategic significance. Many major airports are working to position themselves as international airline hubs, resulting in the development of new airports in metropolitan areas worldwide (Iyer & Jain, 2019). Consequently, the evaluation of airport efficiency and performance has gained increasing attention in the academic literature. A brief overview of the relevant studies is presented in Table 1.

**Table 1. Airport performance evaluation**

Author(s)	Year	Methods	Topic
Janic & Reggiani	2002	AHP-SAW-TOPSIS	An application of the MCDM analysis to the selection of a new hub airport within the European Union.
Baltazar et al.	2014	MACBETH-DEA	Airports performance and efficiency predictive models using robust MCDM model
Lai et al.	2015	AHP-DEA	Evaluating the efficiency performance of airports with 24 major international airports
Pandey	2016	Fuzzy MCDM	Evaluating the service quality of airports in Thailand using fuzzy MCDM method
Eshtaiwi et al.	2018	AHP	Determination of key performance indicators for measuring airport success in Libya
Sennaroglu & Celebi	2018	AHP-PROMETHEE-VIKOR	Presents a location selection problem for a military airport using MCDM methods
Chakraborty et al.	2020	BWM-MABAC	An integrated performance evaluation approach for the Indian international airports
Ersoy	2021	DEA-TOPSIS-EDAS	Performance evaluation of airports during the COVID-19 pandemic
Kulakli & Şahin	2023	AHP-TOPSIS	Application of MCDM techniques to improve the ground operational performance of low-cost carriers airlines in Türkiye
Yılmaz et al.	2024	CRITIC-TOPSIS	Assessment of service quality in aviation within Central Airports in Asia
Mizrak & Şahin	2025	Fuzzy CRITIC-RATGOS	Presents a novel evaluation framework for prioritising investment strategies in sustainable airport energy systems
Ertuğrul & Özdarak	2025	MEREC-CoCoSo	Develop a comprehensive airline performance evaluation model utilising the Balanced Scorecard-based MCDM framework

*Source:* Author's own creation.

## 2.1 Research Gap

Assessing airport performance has become an increasingly pivotal concern in transportation management and operational analysis, primarily due to the sector's economic, environmental, and strategic importance. The existing literature indicates a growing trend toward utilising MCDM methods to evaluate airport efficiency, sustainability, safety, and service quality. Many researchers have employed hybrid MCDM frameworks to assess various performance dimensions. However, a significant gap exists in research examining the comparative reliability and consistency of these hybrid MCDM methods across different regional and temporal contexts. Numerous studies implement specific combinations of AHP, DEA, TOPSIS, or CRITIC without adequately assessing how methodological choices may influence outcomes or policy recommendations.

Additionally, current research is often heavily context-specific, focusing predominantly on regions such as Europe (Janic & Reggiani, 2002), Asia (Pandey, 2016; Yilmaz et al., 2024), or Africa (Eshtaiwi et al., 2018). As a result, the applicability of these models to other geopolitical or infrastructural contexts remains uncertain. Furthermore, the current applications of MCDM in airport assessments often rely on weighting methods based on expert judgment (such as AHP, BWM, and PIPRECIA), which can introduce subjectivity and bias. Recent advancements in objective weighting and hybrid fuzzy approaches, as highlighted by Yilmaz et al. (2024), Ertuğrul & Özdarak (2025), and Mizrak & Şahin (2025), suggest the potential for more robust, data-driven evaluations.

In summary, numerous studies have explored airport performance measurement through MCDM approaches. However, many of these investigations are constrained by a limited geographic focus, often targeting specific regions. Additionally, they frequently rely on traditional evaluation models, neglecting to integrate more novel methodologies. This study aims to address these limitations by proposing a comprehensive MCDM framework that systematically incorporates various performance dimensions. Unlike previous research, this study employs the novel MCDM framework to evaluate the performance of a diverse range of airports in Türkiye, offering a more detailed and comparative perspective.

## 3. Data and methodology

### 3.1 Data

This study employs a hybrid decision-making model to assess the performance of sixteen airports in Türkiye. In this study, we employed IATA codes for selected airports to ensure clarity, standardisation, and international comparability in our analysis. By using these codes, we established a concise and universally recognised method for identifying each airport. These airports have been chosen as key representatives of Türkiye's aviation network because they effectively illustrate the country's primary air traffic patterns, geographic diversity, and operational variety.

The list features major hubs such as Istanbul (IST) and Sabiha Gökçen (SAW), alongside essential regional centres like Ankara (ESB) and Izmir (ADB). It also includes significant tourism gateways, such as Antalya (AYT), Bodrum (BJV), Dalaman (DLM), and Gazipaşa (GZP). Additionally, the inclusion of mid-sized airports – such as Adana, Trabzon, Diyarbakır, Gaziantep, Kayseri, Erzurum, Malatya, and Samsun – ensures a diverse representation of regional markets and airport types, covering metropolitan, touristic, and regional service nodes. This comprehensive selection provides a robust framework for evaluating airport performance in terms of efficiency, capacity utilisation, service quality, and strategic significance within Türkiye’s air transport system.

The recently published 2024 Annual Activity Report by DHMI aims to enhance transparency and accountability in the management of state airports and air navigation services nationwide. This report offers a comprehensive overview of performance in relation to strategic objectives and legal requirements. Key performance metrics include total and commercial aircraft movements, passenger traffic – categorised into domestic, international, direct, and transit routes – and cargo volumes. Additionally, it provides insights into capacity utilisation and the availability of runways, aprons, check-in counters, and other essential facilities (DHMI, 2024). The evaluation of airport performance was based on twelve criteria addressing both domestic and international aircraft traffic, passenger traffic (domestic and international), freight traffic (domestic and international), cargo traffic (domestic and international), proximity to the nearest city centre, availability of check-in counters, terminal building area, and communication systems. These criteria were determined through a comprehensive literature review (Ersoy, 2021; Kulakli & Şahin, 2023; Ekici et al., 2024) as well as insights from industry experts. The data utilised in this analysis were obtained from the 2024 Annual Activity Report published by DHMI (<https://dhmi.gov.tr/Sayfalar/FaaliyetRaporlari.aspx>).

In MCDM research, the orientation of criteria – whether they focus on benefits or costs – has a significant impact on the evaluation and ranking of alternatives. This orientation greatly determines how each criterion impacts the overall assessment. Benefit-oriented criteria indicate superior performance, while cost-oriented criteria are structured such that lower values are more favourable. In this analysis, 11 out of the 12 criteria are benefit-oriented, with only one criterion categorised as cost-oriented. Table 2 provides a summary of the criteria along with their brief descriptions. The decision matrix was also created using data gathered from the reports, as shown in Table 3.

**Table 2. Overview of criteria**

Criteria	Abbr.	Opt.	Unit	Description
Aircraft traffic (domestic)	$C_1$	Benefit	Number of movements	This indicator represents the overall number of aircraft movements within domestic routes, illustrating the airport's internal connectivity and operational activity.
Aircraft traffic (international)	$C_2$	Benefit	Number of movements	This indicator refers to the total number of aircraft movements on international routes, highlighting the airport's global connectivity and capacity for international services.

Criteria	Abbr.	Opt.	Unit	Description
Passenger traffic (domestic)	C <sub>3</sub>	Benefit	Number of passengers	This indicator indicates the total number of passengers transported on domestic flights, highlighting the airport's importance within the national transportation network.
Passenger traffic (international)	C <sub>4</sub>	Benefit	Number of passengers	This indicator measures the total number of international passengers, serving as an indicator of global demand and potential for tourism.
Freight traffic (domestic)	C <sub>5</sub>	Benefit	Tons of freight	This indicator denotes the volume of goods transported on domestic routes, reflecting the airport's contribution to internal economy.
Freight traffic (international)	C <sub>6</sub>	Benefit	Tons of freight	This indicator represents the amount of goods handled on international routes, highlighting the airport's role in global trade flows.
Cargo traffic (domestic)	C <sub>7</sub>	Benefit	Tons of cargo	This indicator refers the total movement of domestic cargo, illustrating the airport's role within the national air cargo network.
Cargo traffic (international)	C <sub>8</sub>	Benefit	Tons of cargo	This indicator indicates the total operations of international cargo, underscoring the airport's involvement in international freight transportation.
Proximity to the nearest city centre	C <sub>9</sub>	Cost	Kilometers	This indicator reflects the distance between the airport and the nearest urban centre, representing accessibility and convenience for passengers and logistics.
Availability of check-in counters	C <sub>10</sub>	Benefit	Number of units	This indicator measures the total number of check-in counters available at the terminal, indicating passenger handling capacity and service efficiency.
Terminal building area	C <sub>11</sub>	Benefit	m <sup>2</sup>	This indicator denotes the total usable area of passenger terminals, reflecting the infrastructural scale and capacity for processing passengers.
Communication systems	C <sub>12</sub>	Benefit	Number of units	This indicator indicates the quality and availability of communication and information systems installed, representing the technological infrastructure that supports operational efficiency.

Source: Author's own creation.

**Table 3. Decision matrix**

Airports	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>4</sub>	C <sub>5</sub>	C <sub>6</sub>	C <sub>7</sub>	C <sub>8</sub>	C <sub>9</sub>	C <sub>10</sub>	C <sub>11</sub>	C <sub>12</sub>
IST	17.393.810	63.036.930	114.526	389.596	219.374	3.258.663	50.808	1.987.960	40	698.662	591	2.013
SAW	19.503.828	21.945.216	107.727	129.652	145.073	306.919	5.878	52.697	35	115.858	160	751
ESB	9.719.730	3.194.023	62.487	22.322	77.525	48.122	8.613	1.882	28	88.566	136	500
ADB	6.692.978	4.814.318	38.930	31.950	84.567	77.404	31.200	1.770	18	87.550	134	907
AYT	6.372.634	31.760.639	38.225	184.460	60.155	408.467	5.796	5.313	13	59.500	186	866
GZP	467.125	560.529	3.346	3.554	4.114	7.025	3	1	5	2.926	19	73
DLM	1.865.929	3.771.138	11.460	22.624	15.874	53.569	98	1	6	53.242	155	537
BJV	2.392.787	1.930.950	14.259	12.832	20.276	25.866	205	0	35	46.239	94	439
ADA	1.483.075	445.569	9.192	3.397	12.278	6.819	3.305	652	40	32.515	34	84
TZX	2.845.342	810.237	17.757	6.154	23.672	13.460	778	10	7	11.325	41	270
ERZ	1.179.182	6.945	6.690	58	9.676	129	109	14	13	5.750	16	177
GZT	2.577.317	377.914	15.360	2.336	22.286	7.420	1.487	4	20	21.270	50	260
DIY	1.977.923	170.958	11.436	1.047	17.167	3.476	1.504	5	10	34.315	24	154
ASR	2.060.857	542.587	12.780	3.711	19.784	10.902	892	34	5	18.360	39	114
MLX	794.698	13.484	4.593	91	6.242	346	226	0	28	2.595	13	74
SZF	1.319.506	194.748	8.488	1.374	10.581	4.281	337	12	25	4.725	18	141

Source: DHMI (2024).

### 3.2 Methodology

#### 3.2.1 LODECI

Logarithmic DEcomposition of Criteria Importance (LODECI) method, proposed by Pala in 2024, provides a novel approach that combines features from both the Entropy and MEREC methods. The procedure for implementing this method is detailed below (Pala, 2024):

**Step 1.** The decision matrix is created.

**Step 2.** The decision matrix is normalised based on beneficial or non-beneficial criterion through Eqs. (1-2).

$$d_{ij} = \frac{\min(b_{ij})}{(b_{ij})} \text{ if } j \in NBAT \quad (1)$$

$$d_{ij} = \frac{(b_{ij})}{\max(b_{ij})} \text{ if } j \in BNA \quad (2)$$

**Step 3.** Decomposition Value ( $DV_{ij}$ ) for each criterion of the decision matrix is calculated by Eq. (3).

$$DV_{ij} = \max\{|d_{ij} - d_{rj}|\} \quad i \neq r \quad (3)$$

**Step 4.** Logarithmic Decomposition Values ( $LDV_j$ ) for or each criterion is computed using Eq. (4).

$$LDV_j = \ln\left(1 + \frac{DV_{ij}}{m}\right) \quad (4)$$

**Step 5.** The criteria importance level is determined as follows.

$$w_{jLDC} = \left(\frac{LDV_{ij}}{\sum_{j=1}^n LDV_{ij}}\right) \quad (5)$$

#### 3.2.2 ALPAS

ALternative Prioritisation and Assessment System (ALPAS) method, developed by Ulutaş et al. in 2025, presents a novel ranking approach within the field of MCDM. The procedure for this method is defined below (Ulutaş et al., 2025):

**Step 1.** The decision matrix is created

**Step 2.** The decision matrix is normalised using Eqs. (6-7).

$$b'_{ij} = \frac{b_{ij}}{\max(b_{ij})}, \text{ if } j \in BNA \quad (6)$$

$$b'_{ij} = \frac{\min(b_{ij})}{b_{ij}}, \text{ if } j \in NBAT \quad (7)$$

**Step 3.** The weighted normalised decision matrix is computed by Eq. (8).

$$y_{it} = w_{jINT} \times b'_{ij} \quad (8)$$

**Step 4.** According to Eqs. (9-10), the ideal and anti-ideal solutions for each attribute are determined.

$$I_j = \max(y_{ij}) \text{ if } j \in BNA \quad I_j = \min(y_{ij}) \text{ if } j \in NBAT \quad (9)$$

$$AI_j = \min(y_{ij}) \text{ if } j \in BNA \quad AI_j = \max(y_{ij}) \text{ if } j \in NBAT \tag{10}$$

**Step 5.** Each alternative's utility value ( $S_i$ ) is calculated with Eq. (11).

$$S_i = \sum_{j=1}^n \left( \frac{(y_{ij} + 1)}{(I_j + 1)} - \frac{(AI_j + 1)}{(y_{ij} + 1)} \right) \tag{11}$$

**Step 6.** The combined power ( $P_i$ ) of each alternative is determined using Eq. (12).

$$P_i = \alpha x \sum_{j=1}^n (y_{ij} + 1) + \beta x \left( \prod_{j=1}^n (y_{ij} + 1) \right)^{1/n} \tag{12}$$

In this Equation,  $\alpha$  and  $\beta$  values should be 0.5.

**Step 7.** Each alternative's final score ( $G_i$ ) is computed by Eq. (13).

$$G_i = \zeta x S_i + w x P_i \tag{13}$$

### 3.2.3 CORASO

COMpromise Ranking from Alternative Solutions (CORASO) method was proposed by Puška et al. in 2024a. The procedure for this method is outlined as follows (Puška et al., 2024a):

**Step 1.** The decision matrix is formed.

**Step 2.** The decision matrix is normalised based on beneficial or non-beneficial criterion through Eqs. (14-15).

$$t_{ij} = \frac{e_{ij}}{e_{jmax}} \tag{14}$$

$$t_{ij} = \frac{e_{jmin}}{e_{ij}} \tag{15}$$

**Step 3.** The weighted normalised decision matrix is calculated using Eq. (16).

$$v_j = w_j x t_{ij} \tag{16}$$

**Step 4.** The sum values for the weighted alternatives are determined by Eq. (17).

$$S_i = \sum_{j=1}^n v_j \tag{17}$$

**Step 5.** The deviations from alternative solutions are computed based on Eqs. (18-19).

$$R_i = \frac{S_i}{S_i maxAS} \tag{18}$$

$$R_i = \frac{S_i minAS}{S_i} \tag{19}$$

**Step 6.** Eq. (20) is applied to calculate the overall score ( $Q_i$ ) for each alternative.

$$Q_i = \frac{R_i - R'_i}{R_i + R'_i} \tag{20}$$

The alternative with the highest overall score is considered to be the most favourable option among all evaluated alternatives.

### 3.2.4 RAWEC

Ranking Alternatives with Weights of Criterion (RAWEC) method was introduced by Puška et al. in 2024b. The steps for implementing this method are detailed below (Puška et al., 2024b):

**Step 1.** The decision matrix is established.

**Step 2.** The decision matrix is normalised using a double normalisation approach through Eqs. (21-22).

$$n_{ij} = \frac{x_{ij}}{x_{j \max}}, \text{ and } n'_{ij} = \frac{x_{j \min}}{x_{ij}}, \text{ for benefit criteria, and} \quad (21)$$

$$n_{ij} = \frac{x_{j \min}}{x_{ij}}, \text{ and } n'_{ij} = \frac{x_{ij}}{x_{j \max}}, \text{ for cost criteria.} \quad (22)$$

**Step 3.** In this phase, the deviation from the criterion weight is computed by Eqs. (23-24). This process effectively integrates the weighting of the normalised decision matrix with an evaluation of the deviation from the established criteria weights.

$$v_{ij} = \sum_{i=1}^n w_j \cdot (1 - n_{ij}) \quad (23)$$

$$v'_{ij} = \sum_{i=1}^n w_j \cdot (1 - n'_{ij}) \quad (24)$$

**Step 4.** The final ranking of the alternatives is determined with Eq. (25).

$$Q_i = \frac{v'_{ij} - v_{ij}}{v'_{ij} + v_{ij}} \quad (25)$$

The RAWEC method generates a value between -1 and 1. The alternative that achieves the highest value is regarded as the optimal choice.

### 3.2.5 Borda Count

The Borda count method evaluates alternatives by ranking preferences, resulting in an ordered list from most preferred to least preferred. The alternative ranked lowest is assigned 0 points, while the next lowest receives 1 point. This point allocation continues incrementally, culminating in the highest-ranked alternative being awarded points equal to the sum of the points allocated to the other options. The points for each alternative are then summed across all submitted rankings, with the alternative that achieves the highest total Borda count recognised as the most favourable option (Reilly, 2002).

## 4. Results

### 4.1 The results obtained from the LODECI method

The criteria were initially normalised based on their benefits and cost optimisation, as demonstrated in Eqs. (1) and (2). Subsequently, the decomposition value ( $SD_{ij}$ ) for each criterion was calculated using Eq. (3). Following this, the logarithmic decomposition values ( $LSD_j$ ) for each criterion were derived according to Eq. (4). The importance level of the criterion was assessed using Eq. (5). The results obtained through the LODECI method are presented in Table 4.

**Table 4. The Results of the LODECI method**

Criterion	$C_1$	$C_2$	$C_3$	$C_4$	$C_5$	$C_6$	$C_7$	$C_8$	$C_9$	$C_{10}$	$C_{11}$	$C_{12}$
$LSD_j$	0.6187	0.6897	0.6522	0.6903	0.6573	0.7148	0.6944	0.7230	0.6001	0.6981	0.6641	0.6388
$w_j$	0.0769	0.08576	0.0811	0.08584	0.0817	0.0889	0.0863	0.0899	0.0746	0.0868	0.0826	0.0794
Rank	12	5	9	6	8	2	4	1	11	3	7	10

Source: Author’s own calculation.

The findings from the LODECI study suggest that international and infrastructure-related factors are crucial in assessing airport performance. Specifically,  $C_8$ ,  $C_6$ , and  $C_{10}$  received the highest weight values, emphasising that international cargo and freight traffic, as well as the availability of check-in counters, are critical factors influencing performance. Conversely,  $C_1$  (domestic aircraft traffic) and  $C_9$  (proximity to the nearest city centre) were identified as the least significant, suggesting that domestic operations and geographic accessibility have a minimal impact on overall performance.

### 4.2 The results obtained from the ALPAS method

Initially, the criteria were normalised based on their benefits and cost optimisation, as detailed in Eqs. (6) and (7). Later, the weighted normalised decision matrix was derived using Eq. (8). Following this, the ideal and anti-ideal solutions for each attribute were identified according to Eqs. (9) and (10). The utility value ( $S_i$ ), combined power ( $P_i$ ), and final score ( $G_i$ ) for each alternative were then calculated using the following equations: (11-13), respectively. The results obtained through the ALPAS method are illustrated in Table 5.

**Table 5. The Results of the ALPAS method**

Airports	$S_i$	$P_i$	$G_i$	Rank
IST	0.7638	6.5647	3.6643	1
SAW	-0.2638	6.2412	2.9887	2
ESB	-0.5667	6.1507	2.7920	5
ADB	-0.4897	6.1730	2.8416	4
AYT	-0.4211	6.1927	2.8858	3
GZP	-0.7738	6.0894	2.6578	9
DLM	-0.6657	6.1204	2.7274	6
BJV	-0.7925	6.0854	2.6464	10
ADA	-0.8594	6.0664	2.6035	14
TZX	-0.7363	6.1003	2.6820	8

Airports	$S_i$	$P_i$	$G_i$	Rank
ERZ	-0.8452	6.0698	2.6123	13
GZT	-0.8083	6.0806	2.6361	12
DIY	-0.7974	6.0832	2.6429	11
ASR	-0.7225	6.1040	2.6908	7
MLX	-0.8935	6.0566	2.5816	16
SZF	-0.8693	6.0634	2.5970	15

Source: Author's own calculation.

The ALPAS results reveal that Istanbul Airport (IST) reflects outstanding performance across operational, infrastructural, and international service dimensions. Following IST, Sabiha Gökçen Airport (SAW) and Antalya Airport (AYT) rank as the second and third-best-performing airports, respectively, demonstrating robust operational activity. In contrast, smaller and regional airports such as Malatya (MLX), Samsun (SZF), and Adana (ADA) exhibit lower performance due to their limited capacity.

#### 4.3 The results obtained from the CORASO method

The criteria were initially normalised based on their benefits and cost optimisation, as outlined in Eqs. (14) and (15). Following this, the weighted normalised decision matrix was derived using Eq. (16). The total values for the weighted alternatives were then calculated by Eq. (17). The deviations from alternative solutions were assessed using Eqs. (18-19). Finally, the overall score ( $Q_i$ ) for each alternative was determined based on Eq. (20). The results derived from the CORASO method are summarised in Table 6.

**Table 6. The Results of the CORASO method**

Airports	$S_i$	$R_i$	$R'_i$	$Q_i$	Rank
IST	0.9264	0.8918	0.0269	0.9415	2
SAW	0.3635	1.0000	0.0240	0.9532	1
ESB	0.1998	0.4983	0.0481	0.8241	3
ADB	0.2404	0.3432	0.0698	0.6620	4
AYT	0.2760	0.3267	0.0733	0.6335	5
GZP	0.0880	0.0240	1.0000	-0.9532	16
DLM	0.1448	0.0957	0.2503	-0.4470	11
BJV	0.0805	0.1227	0.1952	-0.2282	8
ADA	0.0456	0.0760	0.3150	-0.6111	12
TZX	0.1079	0.1459	0.1642	-0.0590	6
ERZ	0.0518	0.0605	0.3961	-0.7352	14
GZT	0.0717	0.1321	0.1812	-0.1567	7
DIY	0.0764	0.1014	0.2362	-0.3992	10
ASR	0.1148	0.1057	0.2267	-0.3641	9
MLX	0.0275	0.0407	0.5878	-0.8703	15
SZF	0.0400	0.0677	0.3540	-0.6791	13

Source: Author's own calculation.

The results of the CORASO analysis indicate that Sabiha Gökçen Airport (SAW) ranks first, signifying that its performance is closest to the ideal solution among the evaluated criteria. Istanbul Airport (IST) follows in second place, showcasing strong performance, though it is slightly less efficient than SAW.

Esenboğa (ESB), Adnan Menderes (ADB), and Antalya (AYT) occupy the 3<sup>rd</sup> to 5<sup>th</sup> positions, reflecting a consistent level of operational and infrastructure performance. In contrast, regional airports such as Gazipaşa (GZP), Malatya (MLX), and Samsun (SZF) are located at the lower end of the rankings.

**4.4 The results obtained from the RAWEC method**

The decision matrix (Table 2) outlines the maximum and minimum values for each alternative as assessed against specific criteria. This preliminary step is crucial, as it establishes the groundwork for the normalisation process. Following this, the decision matrix experienced a double normalisation, as described in Eqs. (21-22). Criteria weights were assigned, and deviations from the maximum normalisation values were evaluated using Eqs. (23) and (24). The final ranking of the alternatives was determined through Eq. (25), as demonstrated in Table 7.

**Table 7. The Results of the RAWEC method**

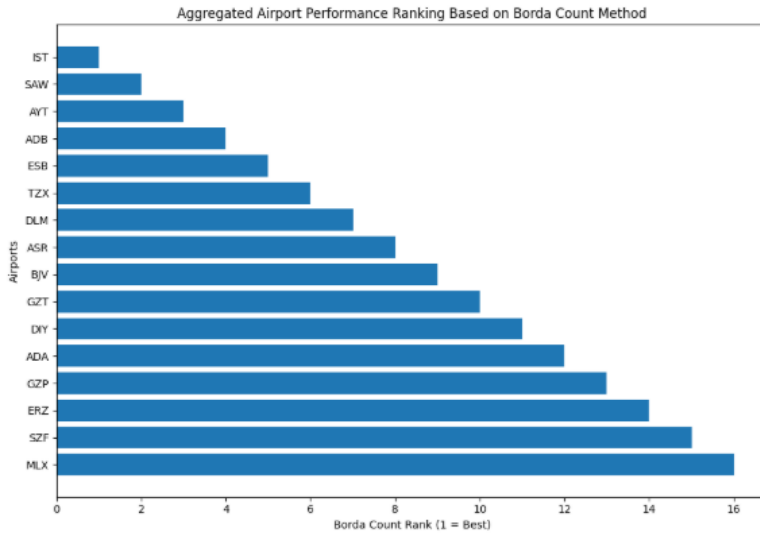
Airports	$v_{ij}$	$v'_{ij}$	$Q_i$	Rank
IST	0.0736	0.9144	0.8510	1
SAW	0.6365	0.9115	0.1777	2
ESB	0.8002	0.9127	0.0657	5
ADB	0.7596	0.9327	0.1023	4
AYT	0.7240	0.9411	0.1303	3
GZP	0.9120	0.4475	-0.3417	15
DLM	0.8552	0.8999	0.0255	6
BJV	0.9195	0.8524	-0.0379	9
ADA	0.9544	0.7321	-0.1318	12
TZX	0.8921	0.8746	-0.0099	7
ERZ	0.9482	0.4684	-0.3387	14
GZT	0.9283	0.8562	-0.0404	10
DIY	0.9236	0.8192	-0.0599	11
ASR	0.8852	0.8406	-0.0259	8
MLX	0.9725	0.4087	-0.4081	16
SZF	0.9600	0.7039	-0.1539	13

Source: Author’s own calculation.

The results of the RAWEC analysis reveal that Istanbul Airport (IST) ranks first, demonstrating the highest level of overall efficiency. Sabiha Gökçen Airport (SAW) closely follows in second place, showcasing a strong performance attributed to its well-balanced infrastructure and operational capacity. Antalya Airport (AYT), Izmir Airport (ADB), and Ankara Airport (ESB) secure the third to fifth positions, respectively. In contrast, smaller regional airports such as Malatya (MLX), Gazipaşa (GZP), and Erzurum (ERZ) are placed at the lower of the ranking.

**4.5 The results obtained from the Borda Count method**

Following a comprehensive analysis of the airport performance in Türkiye, the Borda count method was employed to assess the overall performance of airports. The results derived from the Borda count method are presented in Figure 1.



**Figure 1. Borda Count result**

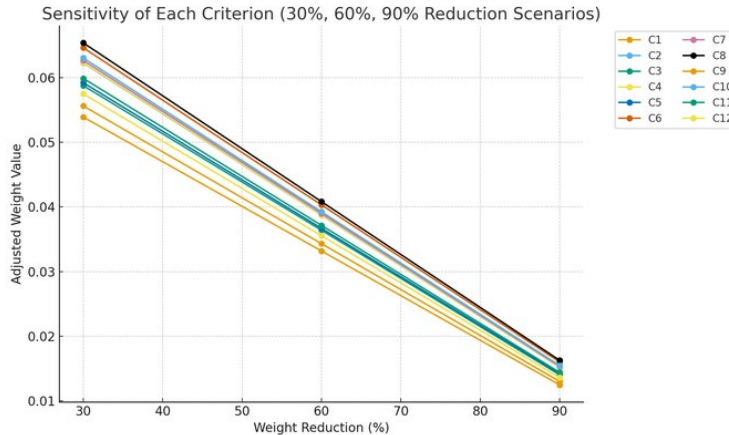
*Source:* Author's own creation.

The aggregated ranking results from the ALPAS, CORASO, and RAWEC methods, combined using the Borda count technique, provide a robust evaluation of airport performance. Istanbul Airport (IST) claims the top position with the highest cumulative Borda score of 44, closely followed by Sabiha Gökçen (SAW) at 43 points, underscoring their exceptional operational capabilities and infrastructural quality. Antalya (AYT), Izmir (ADB), and Ankara (ESB) occupy the next three spots (3rd–5th), reflecting strong performances that are slightly less comprehensive based on the evaluated criteria. Conversely, regional airports such as Gazipaşa (GZP), Adana (ADA), and Erzurum (ERZ) rank lower due to their limited infrastructure and lower traffic levels. Malatya (MLX) receives the lowest overall score, indicating minimal operational capacity within the assessed parameters.

#### **4.6 Sensitivity Analysis**

After validating the results generated by the hybrid model, a sensitivity analysis was conducted. The purpose of this analysis is to assess whether the rankings of the alternatives are affected by variations in the weights assigned to the criteria. This can be accomplished using several methods, including modifying the weight of an individual criterion or adjusting multiple criteria simultaneously (Puška et al., 2024a). This study primarily investigates the effect of systematically adjusting one criterion at a time to assess how reductions in that criterion's weight impact airport rankings. The sensitivity analysis will involve decreasing the weight of each criterion by 30%, 60%, and 90%, while proportionately redistributing the weights among the remaining criteria. This approach will create three scenarios for each criterion,

resulting in a total of thirty-six scenarios for the sensitivity analysis, considering there are twelve criteria in total. Figure 2 illustrates the results of the sensitivity analysis.



**Figure 2. Sensitivity analysis**  
*Source: Author's own creation.*

The figure illustrates the fluctuations in weights for twelve criteria across three sensitivity scenarios, where each criterion's weight is reduced by 30%, 60%, and 90%, while maintaining a total normalised weight of one. Each line on the graph represents a specific criterion, with the slope indicating the degree of influence reduction as the weight decreases. The gradual decline of all curves suggests a degree of stability in the LODECI method, revealing no significant shifts in dominance among the criteria. Criteria with higher initial weights, such as  $C_8$ ,  $C_6$ , and  $C_{10}$ , exhibit steeper declines that considerably affect the overall weighting. In contrast, those with lower initial weights, like  $C_9$  and  $C_1$ , demonstrate more gradual declines, underscoring their limited influence. Overall, the results indicate that the model remains robust and predictable, even in the face of moderate changes in individual criterion weights.

## 5. Discussion and Conclusions

This research examines the performance of Türkiye's major airports using a hybrid MCDM framework, providing a comprehensive, data-driven evaluation of the national airport system. The selected airports serve as the country's key hubs, characterised by high air traffic density, varied geographical distribution, and a range of operational capabilities that enhance both regional connectivity and international presence. In the initial phase of the analysis, the LODECI method was employed to determine the relative significance of various assessment criteria. The results from the LODECI method revealed that factors related to international operations and infrastructure – such as international passenger and cargo volumes, as well as check-in services – have the most substantial impact on overall airport performance. In

contrast, indicators associated with domestic operations and proximity to urban areas were deemed less critical, suggesting that accessibility and internal connectivity are of lower importance in determining performance rankings. This trend underscores the strategic evolution of Türkiye's aviation sector toward greater global integration and competitiveness, primarily driven by capacity. Airports that experience higher levels of international traffic and possess enhanced infrastructure tend to outperform their regional counterparts. Overall, the findings suggest that the efficiency and global competitiveness of airports are primarily determined by their ability to manage international operations and maintain a robust service infrastructure, rather than by local geographical conditions or levels of domestic traffic.

After establishing the criterion weights, a comprehensive evaluation of Türkiye's major airports was performed using a combination of multi-MCDM methods, specifically the ALPAS, CORASO, and RAWEC techniques. Each method was employed to ensure methodological robustness and to validate the consistency of the ranking results. The findings from the ALPAS assessment reveal that Istanbul Airport (IST) excels in almost all operational and infrastructure metrics, solidifying its status as the premier aviation hub in the country. Sabiha Gökçen Airport (SAW) and Antalya Airport (AYT) follow as the second and third-highest-performing airports, respectively, underscoring their substantial passenger traffic and crucial roles in both domestic and international travel. The findings from CORASO identify Sabiha Gökçen Airport (SAW) as the top-performing airport, with Istanbul Airport (IST) closely in second place, followed by Esenboğa Airport (ESB) in third. This result reflects an impressive balance of efficiency, accessibility, and service capacity. Similarly, the RAWEC assessment confirms these findings by ranking Istanbul Airport (IST) as the leader, with Sabiha Gökçen (SAW) and Antalya Airport (AYT) following. This alignment among the methodologies underscores a strong consensus on identifying high-performing airports. Furthermore, the Borda count method was utilised as an aggregation technique to consolidate the various evaluations into a single ranking. This synthesis indicated that Istanbul Airport (IST) emerges as the most efficient and competitive airport in Türkiye, followed in second place by Sabiha Gökçen (SAW) and third by Antalya (AYT). The consistency of these findings across different MCDM methods supports the reliability of the hybrid framework. Moreover, it underscores that airports with strong international connectivity, modern infrastructure, and a diverse range of operations are more likely to excel within the Turkish aviation sector. The prominent airports in Türkiye, including İstanbul, Ankara, and Antalya, are critical aviation hubs, marked by significant passenger volumes and extensive route networks. İstanbul Airport (IST) and Sabiha Gökçen Airport (SAW) serve as the primary international gateways, boasting expansive terminals, modern infrastructure, and integration into global air traffic. Ankara Esenboğa Airport (ESB) plays a crucial role in government operations and domestic connectivity. At the same time, Antalya Airport (AYT) distinguishes itself as the principal tourism hub, efficiently handling a substantial inflow of seasonal international travellers.

The findings of this research indicate that the proposed MCDM framework offers a reliable and comprehensive assessment of the analysed indicators. These results align with previous studies in the field, which underscore the importance of multidimensional evaluation methods in complex decision-making scenarios. For example, earlier research (Durmuşçelebi & Kiracı, 2022; Akın, 2025; Yüksel & Tekin, 2026; Öksüzıkaya, 2026) revealed that Istanbul Airport (IST) achieved the highest performance, whereas Gazipaşa (GZP) and Samsun (SZF) ranked the lowest. In contrast, Ünlü and Yeşilkaya (2025) identified Cargo Traffic as the least important criterion; however, this study emphasises its significance as a crucial factor. As a result, this research's findings contribute to the growing body of literature supporting systematic evaluation frameworks, providing policymakers and practitioners with more reliable insights.

Sensitivity analysis is crucial in MCDM, as it assesses the stability of ranking results. This study evaluated the robustness of the hybrid LODECI–ALPAS–CORASO–RAWEC framework by systematically reducing the weight of each criterion by 30%, 60%, and 90%, while reallocating the remaining weights to ensure normalisation. The results indicated that the rankings remained stable across all scenarios, demonstrating that variations in the importance of criteria did not significantly affect the rank of airport performance. This finding validates the robustness of the hybrid approach, establishing it as a reliable decision-support tool for evaluating airport performance. Furthermore, the study contributes to the existing literature by integrating advanced weighting and ranking techniques, making it a valuable resource for airport managers and policymakers in strategic planning and enhancing operational efficiency. The findings highlight several key managerial implications for airport administrators and policymakers. Firstly, it is essential to enhance engagement in international markets, which can be achieved through diversifying route offerings and establishing airline partnerships to boost overall performance and competitiveness. Furthermore, investing in infrastructure – especially to enhance service efficiency – is crucial for meeting the growing demands of both passengers and cargo. Lastly, the declining significance of domestic operations and proximity to city centres indicates a need to shift the strategic focus from geographic accessibility towards prioritising operational excellence and service quality. Collectively, these insights offer a practical roadmap for airport authorities seeking to enhance their long-term competitiveness.

It is important to recognise several limitations inherent to this research. The study focused on twelve criteria, primarily emphasising operational aspects, which may not encompass all dimensions of performance evaluation. Future research could be significantly enhanced by integrating additional criteria that consider environmental and social factors. Additionally, a longer duration of performance evaluations could provide a more comprehensive understanding of the topic.

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