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Research Article

Ranking universities' graduate education performances through multi-criteria decision-making methods

Damla Yalçıner Çal*[a]

Department of Business Administration, Faculty of Economics and Administrative Sciences, Kafkas University, Kars, Türkiye

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Abstract

This study analyzes the performance of universities operating in Türkiye based on the number of graduate and specialty-level graduates by employing a multi-criteria decision-making (MCDM) approach. The dataset used in the research was obtained from the National Thesis Center's May 2026 database, and observations deemed unsuitable during the data preprocessing stage were excluded from the analysis. As a result, a final decision matrix consisting of 224 alternatives and 6 criteria (224×6) was constructed. Within the scope of the analysis, criterion weights were determined using the standard deviation method, an objective weighting technique that reflects the variability among criteria in the decision-making process. Subsequently, the MARCOS method was applied to calculate the performance scores of universities and establish their rankings. The findings revealed that Istanbul University, Gazi University, Marmara University, Hacettepe University, and Ankara University were the highest-performing universities. Their strong academic infrastructures, wide range of graduate programs, and high research capacities played a significant role in securing top positions in the ranking. In contrast, universities ranked at the lower end of the list were observed to possess more limited graduate education capacities. The results demonstrate that substantial differences exist among universities in Türkiye regarding graduate-level output. In conclusion, the integrated use of the standard deviation and MARCOS methods provided an objective and comparable framework for evaluating university performance. The study is expected to contribute to the development of higher education policies and support the strategic planning processes of universities.

1. Introduction

Today, higher education institutions play a significant role in the development processes of countries by contributing to knowledge production, the training of qualified human resources, and scientific advancement. The research capacity, academic productivity, and graduate education performance of universities are considered among the key factors determining the quality of higher education systems [1, 2]. For this reason, evaluating university performance through objective and comparable methods has become an important necessity for both policymakers and academic administrators. In particular, the number of graduate and specialty-level graduates is widely recognized as an important indicator reflecting the scientific production capacity and research-oriented structure of universities [3]. Decision-making processes are becoming increasingly complex due to the growing diversity of data and the need for multidimensional evaluations. In problems requiring the simultaneous consideration of multiple criteria, traditional decision-

*Corresponding author: damlayalciner@gmail.com
[a]orcid.org/0000-0002-9232-3063
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making approaches often remain insufficient, which has increased the importance of multi-criteria decision-making (MCDM) methods. MCDM methods provide decision-makers with an analytical and rational framework by enabling the systematic evaluation of alternatives under different criteria [4, 5]. These methods are widely used in many fields, including economics, engineering, healthcare, and education, and they produce effective results particularly in performance evaluation, ranking, and selection problems [6]. Recent studies conducted in the field of higher education also emphasize that MCDM methods provide reliable and effective outcomes in evaluating university performance [7].

One of the most critical stages in the MCDM process is the determination of criterion weights. Since criterion weights directly influence decision outcomes, it is essential that this process be carried out using objective methods as much as possible. In this context, the standard deviation (SD) method stands out as a statistically based objective weighting approach that assigns greater weights to criteria with higher variability by considering the distribution of criteria within the dataset [8]. The SD method is frequently preferred in the literature, especially in data-driven analyses, because it minimizes subjective evaluations. The use of objective weighting methods in university performance analyses contributes to a more accurate assessment of the differences among criteria [9]. Among the recently developed methods for ranking alternatives, the MARCOS (Measurement Alternatives and Ranking according to Compromise Solution) method has attracted considerable attention. The MARCOS method evaluates alternatives by comparing them with ideal and anti-ideal solutions, thereby enabling more consistent rankings [10]. The successful application of the method in different problem areas has contributed to its widespread adoption in the MCDM literature. In particular, it has been stated that the MARCOS method provides reliable results in performance evaluation and ranking problems and makes significant contributions to decision-making processes [11].

This study aims to evaluate the graduate and specialty-level performance of universities within the Turkish higher education system. For this purpose, graduate data obtained from the thesis database of the Council of Higher Education for January 2025 were used as the dataset. The criteria considered in the analysis consisted of six categories: Master's Degree, Doctorate, Medical Specialty, Proficiency in Arts, Dentistry Specialty, and Medical Subspecialty. Although the decision matrix initially included a broader dataset, several elimination procedures were carried out to ensure data integrity. Four universities with zero values across all criteria were excluded from the analysis. In addition, 35 universities that had a value in only one criterion while recording zero values in all remaining criteria were also excluded from the decision matrix. As a result of these procedures, the final decision matrix was constructed with dimensions of 224×6. Using the obtained dataset, criterion weights were objectively determined through the standard deviation method, and subsequently, university performance rankings were generated using the MARCOS method. In this respect, the study aims to contribute to the literature by evaluating the graduate and specialty-level output capacities of universities in Türkiye within a multi-criteria decision-making framework.

2. Literature Review

An examination of the multi-criteria decision-making (MCDM) literature reveals that standard deviation (SD)-based approaches occupy an important place among objective weighting methods used in the criterion weighting process. The SD method stands out as a statistical approach that assigns greater weights to criteria with higher variability by considering the distribution of data associated with each criterion. In this context, [8] compared the Entropy, CRITIC, and SD methods to examine how objective weighting approaches generate different results under varying data structures. Similarly, [12] proposed a new objective weighting method based on the impact of criterion removal and conducted comparative analyses with methods such as SD. [13] and [14] evaluated the effectiveness of several objective weighting methods, including SD, in determining criterion importance within the context of sustainable transportation problems. In addition, [15] analyzed the effects of objective and subjective weighting approaches on decision-making outcomes by considering both approaches together. More recent studies have further expanded the

literature on SD-based methods. [16] introduced the ROCOSD method, which combines standard deviation and correlation-based weighting, thereby offering a new perspective to the literature. [17] examined the SD method within the framework of statistical weighting techniques, while [18] applied an improved criterion weighting approach based on standard deviation to MCDM problems. Collectively, these studies demonstrate that SD-based methods, both in their classical and enhanced forms, are widely employed in the literature. On the other hand, among the methods developed for ranking alternatives, the MARCOS method has emerged as one of the prominent approaches in recent MCDM studies. Developed by [19], this method is based on evaluating alternatives relative to ideal and anti-ideal solutions and was initially applied to sustainable supplier selection problems. Subsequent studies indicate that the method has been integrated with various approaches. For instance, [10] employed the integrated FUCOM-MARCOS model for evaluating human resources, while [20] addressed supplier selection problems using the Grey-MARCOS approach. Likewise, the D-MARCOS method proposed by [21] was applied to supplier selection in the iron and steel industry.

In the national literature, [22] jointly applied the MEREC and MARCOS methods to evaluate the social development levels of countries, whereas [23] analyzed the innovation performance of OECD and EU countries using the MEREC-MARCOS model. Furthermore, the type-2 neutrosophic MEREC-MARCOS model proposed by [24] extended the applicability of the method to decision-making problems involving uncertainty. In more recent studies, [25] utilized the MARCOS method in financial performance evaluation, while [26] incorporated the MARCOS method into a model involving machine learning and intuitionistic fuzzy MCDM approaches. Overall, the literature indicates that standard deviation-based weighting methods maintain a strong position due to their data-driven and objective structures, while the MARCOS method has been widely adopted across diverse application areas through integration with various MCDM techniques. This demonstrates that both approaches continue to preserve their relevance from both methodological and practical perspectives.

3. Methodology

3.1 Research Model

This section presents the methodology of the proposed model. In the proposed MCDM model, the criteria were weighted using the Standard Deviation method, and the weighted dataset was subsequently ranked through the MARCOS method. The methodological flowchart of the proposed model is presented in Figure 1.

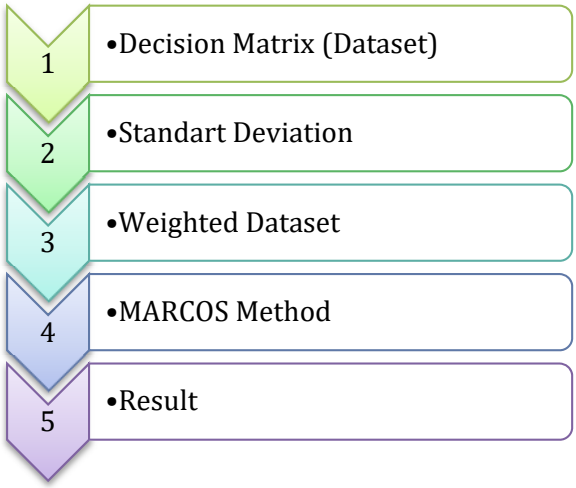

Figure 1. Flowchart of the Proposed Model

3.2. Dataset

The dataset used in this study includes the number of graduate and specialty-level graduates from universities operating in Türkiye and is based on the National Thesis Center's May 2026 data.

Within the scope of the analysis, six different criteria were taken into consideration. However, during the dataset preparation process, it was determined that the data structures of some universities were not suitable for the analysis. As a result of these elimination procedures, the final decision matrix constructed for the analysis consisted of 224 alternatives and 6 criteria (224×6). This structure ensured that the multi-criteria decision-making analysis was conducted on a balanced and suitable dataset. A portion of the dataset used in the application is presented in Table 1.

Table 1. Dataset

Code	University	Criterias					
		Master's Degree	Doctorate	Medical Specialty	Proficiency in Arts	Dentistry Specialty	Medical Subspecialty
A1	Abant İzzet Baysal University	1981	257	276	0	21	0
A2	Abdullah Gül University	175	65	0	0	0	0
A3	Acıbadem Mehmet Ali Aydınlar University	546	99	51	0	0	0
...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...
A221	Yüzüncü Yıl University	4002	706	714	0	12	9
A222	Zirve University	300	1	0	0	0	0
A223	Zonguldak Bülent Ecevit University	1536	212	315	0	126	0
A224	Zonguldak Karaelmas University	1040	103	245	0	0	0

Accordingly, Antalya Belek University, Gaziantep University of Science and Technology, National Intelligence Academy, Mudanya University, Semerkand Science and Civilization University, and Institute of Public Administration for Türkiye and the Middle East, which had zero values across all criteria, were excluded from the analysis. In addition, a total of 35 universities that had a value in only one criterion while recording zero values for all remaining criteria were also omitted from the decision matrix. These universities included Ministry of Justice, Adana Science and Technology University, Alanya Hamdullah Emin Paşa University, Alanya University, Ankara Science University, Antalya Bilim University, Beykoz University, Bursa Orhangazi University, Canik Başarı University, Naval Academy Command, Fenerbahçe University, Gaziantep Islamic Science and Technology University, Gedik University, Gediz University, Hakkari University, İpek University, Istanbul Atlas University, Istanbul Ayvansaray University, Istanbul Esenyurt University, Istanbul Kemerburgaz University, Istanbul Topkapı University, İzmir Tınaztepe University, Gendarmerie and Coast Guard Academy, Kahramanmaraş İstiklal University, Kapadokya University, Kocaeli Health and Technology University, Konya University, MEF University, Nuh Naci Yazgan University, OSTİM Technical University, Rize University, Süleyman Şah University, TED University, Yeni Yüzyıl University, and Yüksek İhtisas University.

3.3. Methods and Algorithms

3.3.1. Standard Deviation Method

The standard deviation method is a weighting approach based on the degree of variability exhibited by the values within a dataset [27]. In this method, criteria with similar values across alternatives are considered to have lower discriminating power; therefore, lower weights are assigned to such criteria. In this respect, the method follows a logic similar to the Entropy approach [14]. The implementation steps of the standard deviation method have been explained in detail in the literature and are summarized below [28, 29, 30]:

Step 1: The decision matrix is constructed using Equation (1).

$$IDM = \begin{bmatrix} x_{11} & \cdots & X_{1n} \\ \vdots & \ddots & \vdots \\ X_{m1} & \cdots & X_{mn} \end{bmatrix} \quad (1)$$

Step 2: After constructing the decision matrix, the normalization process is performed. Benefit-oriented criteria are normalized using Equation (2), whereas cost-oriented criteria are normalized using Equation (3).

$$X_{ij}^{*} = \frac{x_{ij} - x_j^{min}}{x_j^{max} - x_j^{min}} \quad (2)$$

$$X_{ij}^{*} = \frac{x_j^{max} - x_{ij}}{x_j^{max} - x_j^{min}} \quad (3)$$

i=1,2,...,m; j=1,2,...,n

Step 3: After calculating the standard deviation values of the criteria using Equation (4), the criterion weights are determined through Equation (5).

$$\sigma_j = \sqrt{\frac{\sum_{j=1}^{m}(x_{ij} - x_j)}{m}}\, j = 1 \qquad \text{j=1,...,n} \quad (4)$$

$$W_j = {\sigma_j}\Big/{\sum_{j=1}^{n} \sigma_j} \qquad \text{j=1,...,n} \quad (5)$$

3.3.2. MARCOS Method

The MARCOS method, introduced to the MCDM literature by Stević et al. in 2020, is one of the effective approaches used for the evaluation and ranking of alternatives. This method aims to determine performance rankings by considering the relationships between decision alternatives and ideal as well as anti-ideal reference points. The core principle of the method is based on analyzing the positions of alternatives relative to these two extreme reference points. Within the implementation process, utility functions are calculated for each alternative according to the defined relationships, and a compromise ranking is obtained through these functions. The preferences of the decision-maker are also reflected through these utility functions. The utility functions represent the position of an alternative relative to both the ideal and anti-ideal solutions. In this framework, the best alternative is identified as the option closest to the ideal solution and farthest from the anti-ideal solution [10, 22, 31, 32]:

Step 1: The decision matrix is constructed using Equation (1).

Step 2: The extended decision matrix is obtained by incorporating the ideal solution (AI) and anti-ideal solution (AAI) into the decision matrix and is calculated using Equation (6).

$$X = \begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ \vdots \\ A_m \\ AAI \\ AI \end{array} \begin{array}{c} \begin{array}{ccc} C_n & C1, C2 & .... \end{array} \\ \begin{bmatrix} x_{11} & x_{12} \ldots & x_{1n} \\ x_{21} & x_{22} \cdots & x_{2n} \\ \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots \\ x_{m1} & x_{m2} \cdots & x_{mn} \\ x_{aa1} & x_{aa2} \cdots & x_{aan} \\ x_{ai1} & x_{ai2} \cdots & x_{ain} \end{bmatrix} \end{array} \quad (6)$$

For benefit-oriented criteria, the calculation is performed using Equation (7), whereas for cost-oriented criteria, the calculation is carried out using Equation (8).

$$\begin{cases} AI = max_i x_{ij}, \text{benefit} - \text{oriented criteria } (j \in B) \\ AAI = min_i x_{ij}, \text{benefit} - \text{oriented criteria } (j \in B) \end{cases} \quad (7)$$

$$\begin{cases} AI = min_i x_{ij}, \text{cost} - \text{oriented criteria} (j \in C) \\ AAI = max_i x_{ij}, \text{cost} - \text{oriented criteria } (j \in C) \end{cases} \quad (8)$$

Step 3: The normalization of the extended decision matrix is calculated using Equation (9) for benefit-oriented criteria and Equation (10) for cost-oriented criteria.

$$n_{ij} = \frac{x_{ij}}{x_{ai}}, j \in B \quad (9)$$

$$n_{ij} = \frac{x_{aj}}{x_{ij}}, j \in C \quad (10)$$

The normalization of the generalized decision matrix is calculated using Equation (11).

$$N = \begin{bmatrix} n_{11} & n_{12} \dots & n_{1n} \\ n_{21} & n_{22} \cdots & n_{2n} \\ \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots \\ n_{m1} & n_{m2} \cdots & n_{mn} \\ n_{aa1} & n_{aa2} \cdots & n_{aan} \\ n_{ai1} & n_{ai2} \cdots & n_{ain} \end{bmatrix} \quad (11)$$

Step 4: The weighted matrix is calculated using Equation (12) and Equation (13).

$$v_{ij} = n_{ij}.w_j \quad (12)$$

$$V = \begin{bmatrix} v_{11} & v_{12} \dots & v_{1n} \\ v_{21} & v_{22} \cdots & v_{2n} \\ \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots \\ v_{m1} & v_{m2} \cdots & v_{mn} \\ v_{aa1} & v_{aa2} \cdots & v_{aan} \\ v_{ai1} & v_{ai2} \cdots & v_{ain} \end{bmatrix} \quad (13)$$

Step 5: In order to measure the utility degrees of the decision alternatives, the sum of the weighted matrix elements is calculated using Equation (14), the utility degree relative to the ideal solution is determined using Equation (15), and the utility degree relative to the anti-ideal solution is calculated using Equation (16).

$$S_i = \sum_{i=1}^{n} v_{ij} \quad (14)$$

$$K_1^+ = \frac{S_i}{S_{ai}} \quad (15)$$

$$K_1^- = \frac{S_i}{S_{aai}} \quad (16)$$

Step 6: The utility function of the decision alternatives relative to the ideal solution is calculated using Equation (17), whereas the utility function relative to the anti-ideal solution is determined using Equation (18).

$$f(K_i^+) = \frac{K_i^-}{K_i^+ + K_i^-} \quad (17)$$

$$f(K_i^-) = \frac{K_i^+}{K_i^+ + K_i^-} \quad (18)$$

Step 7: The utility functions of the alternatives are calculated using Equation (19).

$$f(K_i) = \frac{K_i^+ + K_i^-}{1 + \frac{1 - f(K_i^+)}{f(K_i^+)} + \frac{1 - f(K_i^-)}{f(K_i)}} \quad (19)$$

4. Findings

The study consists of two stages. In the first stage, the Standard Deviation method was employed to evaluate the performance criteria, while the MARCOS method was used to assess the universities. The criteria utilized in the study are presented in Table 2.

Tablo 2. Criterias

Sıra	Code	Description	Optimization
1	K1	Master's Degree	max
2	K2	Doctorate	max
3	K3	Medical Specialty	max
4	K4	Proficiency in Arts	max
5	K5	Dentistry Specialty	max
6	K6	Medicel Specialty	max

The alternatives used in the study are presented in Table 3.

Table 3. Alternatives

Code	University	Code	University
A1	Abant İzzet Baysal University	A113	Istanbul Health and Technology University
A2	Abdullah Gül University	A114	Istanbul Şehir University
A3	Acıbadem Mehmet Ali Aydınlar University	A115	Istanbul Technical University
A4	Acıbadem University	A116	Istanbul Commerce University
A5	Adana Alparslan Türkeş Science and Technology University	A117	Istanbul University
A6	Adıyaman University	A118	Istanbul University-Cerrahpaşa
A7	Adnan Menderes University	A119	Istanbul Yeni Yüzyıl University
A8	Afyon Kocatepe University	A120	Istanbul 29 Mayıs University
A9	Afyonkarahisar Health Sciences University	A121	İstinye University
A10	Ağrı İbrahim Çeçen University	A122	İzmir Bakırçay University
A11	Ahi Evran University	A123	İzmir Democracy University
A12	Akdeniz University	A124	İzmir University of Economics
A13	Aksaray University	A125	İzmir Katip Çelebi University
A14	Alanya Alaaddin Keykubat University	A126	İzmir University
A15	Altınbaş University	A127	İzmir Institute of Technology
A16	Amasya University	A128	Kadir Has University
A17	Anadolu University	A129	Kafkas University
A18	Ankara Hacı Bayram Veli University	A130	Kahramanmaraş Sütçü İmam University
A19	Ankara Medipol University	A131	Military Academy Command
A20	Ankara Music and Fine Arts University	A132	Karabük University
A21	Ankara Social Sciences University	A133	Karadeniz Technical University
A22	Ankara University	A134	Karamanoğlu Mehmetbey University
A23	Ankara Yıldırım Beyazıt University	A135	Kastamonu University
A24	Ardahan University	A136	Kayseri University
A25	Artvin Çoruh University	A137	Kyrgyzstan-Türkiye Manas University
A26	Atatürk University	A138	Kırıkkale University
A27	Atılım University	A139	Kırklareli University
A28	Avrasya University	A140	Kırşehir Ahi Evran University
A29	Aydın Adnan Menderes University	A141	Kilis 7 Aralık University
A30	Bahçeşehir University	A142	Kocaeli University
A31	Balıkesir University	A143	Koç University
A32	Bandırma Onyedi Eylül University	A144	Konya Food and Agriculture University
A33	Bartın University	A145	Konya Technical University
A34	Başkent University	A146	KTO Karatay University
A35	Batman University	A147	Kütahya Dumlupınar University
A36	Bayburt University	A148	Kütahya Health Sciences University
A37	Beykent University	A149	Lokman Hekim University
A38	Bezm-i Alem Vakıf University	A150	Malatya Turgut Özal University

A39	Bilecik Şeyh Edebali University	A151	Maltepe University
A40	Bingöl University	A152	Manisa Celal Bayar University
A41	Biruni University	A153	Mardin Artuklu University
A42	Bitlis Eren University	A154	Marmara University
A43	Boğaziçi University	A155	Mehmet Akif Ersoy University
A44	Bolu Abant İzzet Baysal University	A156	Melikşah University
A45	Bozok University	A157	Mersin University
A46	Burdur Mehmet Akif Ersoy University	A158	Mevlana University
A47	Bursa Technical University	A159	National Defense University
A48	Bursa Uludağ University	A160	Mimar Sinan Fine Arts University
A49	Bülent Ecevit University	A161	Muğla Sıtkı Koçman University
A50	Celal Bayar University	A162	Muğla University
A51	Cumhuriyet University	A163	Munzur University
A52	Çağ University	A164	Mustafa Kemal University
A53	Çanakkale Onsekiz Mart University	A165	Muş Alparslan University
A54	Çankaya University	A166	Namık Kemal University
A55	Çankırı Karatekin University	A167	Necmettin Erbakan University
A56	Çukurova University	A168	Nevşehir Hacı Bektaş Veli University
A57	Demiroğlu Science University	A169	Nevşehir University
A58	Dicle University	A170	Niğde Ömer Halisdemir University
A59	Doğuş University	A171	Niğde University
A60	Dokuz Eylül University	A172	Nişantaşı University
A61	Dumlupınar University	A173	Okan University
A62	Düzce University	A174	Ondokuz Mayıs University
A63	Ege University	A175	Ordu University
A64	Erciyes University	A176	Middle East Technical University
A65	Erzincan Binali Yıldırım University	A177	Osmaniye Korkut Ata University
A66	Erzincan University	A178	Özyeğin University
A67	Erzurum Technical University	A179	Pamukkale University
A68	Eskişehir Osmangazi University	A180	Piri Reis University
A69	Eskişehir Technical University	A181	Police Academy
A70	Fatih Sultan Mehmet Vakıf University	A182	Recep Tayyip Erdoğan University
A71	Fatih University	A183	Sabancı University
A72	Fırat University	A184	Ministry of Health
A73	Galatasaray University	A185	Health Sciences University
A74	Gulhane Military Medical Academy (GATA)	A186	Sakarya University of Applied Sciences
A75	Gazi University	A187	Sakarya University
A76	Gaziantep University	A188	Samsun University
A77	Gaziosmanpaşa University	A189	Sanko University
A78	Gebze Technical University	A190	Selçuk University
A79	Gebze Institute of Technology	A191	Siirt University
A80	Giresun University	A192	Sinop University
A81	Gümüşhane University	A193	Sivas Science and Technology University
A82	Hacettepe University	A194	Sivas Cumhuriyet University
A83	Haliç University	A195	Süleyman Demirel University
A84	War Academies Command	A196	Şırnak University
A85	Harran University	A197	Şifa University
A86	Hasan Kalyoncu University	A198	Tarsus University
A87	Hatay Mustafa Kemal University	A199	Tekirdağ Namık Kemal University
A88	Air Force Academy Command	A200	TOBB University of Economics and Technology
A89	Hitit University	A201	Tokat Gaziosmanpaşa University
A90	Khoja Akhmet Yassawi International Turkish-Kazakh University	A202	Toros University
A91	Iğdır University	A203	Trabzon University
A92	Isparta University of Applied Sciences	A204	Trakya University
A93	Işık University	A205	Tunceli University
A94	Ibn Haldun University	A206	Turgut Özal University
A95	İhsan Doğramacı Bilkent University	A207	Turkish Aeronautical Association University
A96	İnönü University	A208	Turkish-German University
A97	İskenderun Technical University	A209	Ufuk University
A98	Istanbul Arel University	A210	Uludağ University
A99	Istanbul Aydın University	A211	Uşak University
A100	Istanbul Beykent University	A212	Üsküdar University
A101	Istanbul Bilgi University	A213	Van Yüzüncü Yıl University
A102	Istanbul Bilim University	A214	Yalova University

A103	Istanbul Gedik University	A215	Yaşar University
A104	Istanbul Gelişim University	A216	Yeditepe University
A105	Istanbul Kent University	A217	Yıldırım Beyazıt University
A106	Istanbul Kültür University	A218	Yıldız Technical University
A107	Istanbul Medeniyet University	A219	Yozgat Bozok University
A108	Istanbul Medipol University	A220	Foreign Universities
A109	Istanbul Nişantaşı University	A221	Yüzüncü Yıl University
A110	Istanbul Okan University	A222	Zirve University
A111	Istanbul Rumeli University	A223	Zonguldak Bülent Ecevit University
A112	Istanbul Sabahattin Zaim University	A224	Zonguldak Karaelmas University

In MCDM methods, the first step is the construction of the decision matrix. In this context, the decision matrix, where the alternatives are represented in the rows and the criteria are represented in the columns, is presented in Table 4.

Table 4. Decision Matrix

Code	Master's Degree	Doctorate	Medical Specialty	Proficiency in Arts	Dentistry Specialty	Medicel Specialty
A1	1981	257	276	0	21	0
A2	175	65	0	0	0	0
A3	546	99	51	0	0	0
...	...	...	...	...	...	...
...	...	...	...	...	...	...
A221	4002	706	714	0	12	9
A222	300	1	0	0	0	0
A223	1536	212	315	0	126	0
A224	1040	103	245	0	0	0

4.1. Standard Deviation Analysis Results

As the first step in determining the importance levels of the criteria, all criteria were identified as benefit-oriented and normalized using Equation (2). The normalized decision matrix is presented in Table 5.

Table 5. Normalized Decision Matrix

Code	Master's Degree	Doctorate	Medical Specialty	Proficiency in Arts	Dentistry Specialty	Medicel Specialty
A1	0,0637	0,0196	0,0167	0,0000	0,0814	0,0000
A2	0,0056	0,0050	0,0000	0,0000	0,0000	0,0000
A3	0,0175	0,0075	0,0031	0,0000	0,0000	0,0000
...	...	...	...	...	...	...
...	...	...	...	...	...	...
A221	0,1287	0,0538	0,0432	0,0000	0,0465	0,0726
A222	0,0096	0,0001	0,0000	0,0000	0,0000	0,0000
A223	0,0494	0,0161	0,0191	0,0000	0,4884	0,0000
A224	0,0334	0,0078	0,0148	0,0000	0,0000	0,0000

After calculating the standard deviation of each column in the decision matrix using Equation (4), the weight of each criterion was determined through Equation (5), and the results are presented in Table 6.

Table 6. Criterion Weights

Criteria	Master's Degree	Doctorate	Medical Specialty	Proficiency in Arts	Dentistry Specialty	Medicel Specialty
Sd Wj	0,191646	0,172456	0,107591	0,131311	0,255378	0,141619

4.2. Results of the MARCOS Method

Within the scope of the MARCOS method, the decision matrix was first established using Equation (1). The relevant decision matrix was previously presented in Table 4. In the second step of the MARCOS method, the extended decision matrix was constructed using Equation (6) and Equation (7). The extended decision matrix is presented in Table 7.

Table 7. Extended Decision Matrix

Criteria	Master's Degree	Doctorate	Medical Specialty	Proficiency in Arts	Dentistry Specialty	Medicel Specialty
A1	1981	257	276	0	21	0
A2	175	65	0	0	0	0
A3	546	99	51	0	0	0
...	...	...	...	...	...	...
...	...	...	...	...	...	...
A221	4002	706	714	0	12	9
A222	300	1	0	0	0	0
A223	1536	212	315	0	126	0
A224	1040	103	245	0	0	0
MIN	2	0	0	0	0	0
MAX	31086	13127	16527	560	258	124

In the third step of the method, the values of the extended decision matrix were normalized using Equation (9) and Equation (11). The normalized values of the extended decision matrix are presented in Table 8.

Table 8. Normalized Extended Decision Matrix Values

Criteria	Master's Degree	Doctorate	Medical Specialty	Proficiency in Arts	Dentistry Specialty	Medicel Specialty
A1	0,0637	0,0196	0,0167	0,0000	0,0814	0,0000
A2	0,0056	0,0050	0,0000	0,0000	0,0000	0,0000
A3	0,0176	0,0075	0,0031	0,0000	0,0000	0,0000
...	...	...	...	...	...	...
...	...	...	...	...	...	...
A221	0,1287	0,0538	0,0432	0,0000	0,0465	0,0726
A222	0,0097	0,0001	0,0000	0,0000	0,0000	0,0000
A223	0,0494	0,0162	0,0191	0,0000	0,4884	0,0000
A224	0,0335	0,0078	0,0148	0,0000	0,0000	0,0000
MIN	0,0001	0,0000	0,0000	0,0000	0,0000	0,0000
MAX	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000

In the fourth step of the method, the weighted decision matrix values were calculated using Equation (12) and Equation (13). The weighted decision matrix is presented in Table 9.

Table 9. Weighted Decision Matrix

Criteria	Master's Degree	Doctorate	Medical Specialty	Proficiency in Arts	Dentistry Specialty	Medicel Specialty
A1	0,0122	0,0034	0,0018	0,0000	0,0208	0,0000
A2	0,0011	0,0009	0,0000	0,0000	0,0000	0,0000
A3	0,0034	0,0013	0,0003	0,0000	0,0000	0,0000
...	...	...	...	...	...	...
...	...	...	...	...	...	...
A221	0,0247	0,0093	0,0046	0,0000	0,0119	0,0103
A222	0,0018	0,0000	0,0000	0,0000	0,0000	0,0000
A223	0,0095	0,0028	0,0021	0,0000	0,1247	0,0000
A224	0,0064	0,0014	0,0016	0,0000	0,0000	0,0000
MIN	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
MAX	0,1916	0,1725	0,1076	0,1313	0,2554	0,1416

In the fifth step of the method, the utility degrees of the decision alternatives were calculated. First, the sum of the elements of the weighted matrix (S_i) was determined using Equation (14). Subsequently, the utility degrees relative to the ideal solution (K_i^+) were calculated using Equation (15), while the utility degrees relative to the anti-ideal solution (K_i^-) were determined using Equation (16). In this context, the utility degrees of the decision alternatives are presented in Table 10.

Table 10. Utility Degrees of Decision Alternatives

Code	S_i	K_i^+	K_i^-
A1	0,0122	0,0366	990,5000
A2	0,0011	0,0032	87,5000
A3	0,0034	0,0101	273,0000
...	...	...	...
...	...	...	...
A221	0,0350	0,1049	2834,6342
A222	0,0018	0,0055	150,0000
A223	0,0095	0,0284	768,0000
A224	0,0064	0,0192	520,0000

In the sixth step of the method, the utility function values of the decision alternatives relative to the ideal solution were measured using Equation (17), denoted as $f(K_i^+)$, while the utility function values relative to the anti-ideal solution were determined using Equation (18), denoted as $f(K_i^-)$. In the final step, the performance values of the universities—namely, the utility function values of the decision alternatives, $f(K_i)$—were calculated using Equation (19), and the rankings of these performance values were obtained. The calculated values are presented in Table 11.

Table 11. $f(K_i^+)$, $f(K_i^-)$, and $f(K_i)$ values

Code	$f(K_i^+)$	$f(K_i^-)$	$f(K_i)$
A1	0,99996	0,00004	0,03665
A2	0,99996	0,00004	0,00324
A3	0,99996	0,00004	0,01010
...	...	...	...
...	...	...	...
A221	0,99996	0,00004	0,10488
A222	0,99996	0,00004	0,00555
A223	0,99996	0,00004	0,02841
A224	0,99996	0,00004	0,01924

The ranking of the calculated values is presented in Table 12.

Table 12. $f(K_i)$ Ranking Values

Code	University	Rank	Code	University	Rank
A117	Istanbul University	1	A140	Kırşehir Ahi Evran University	113
A75	Gazi University	2	A128	Kadir Has University	114
A154	Marmara University	3	A52	Çağ University	115
A82	Hacettepe University	4	A200	TOBB University of Economics and Technology	116
A22	Ankara University	5	A87	Hatay Mustafa Kemal University	117
A60	Dokuz Eylül University	6	A70	Fatih Sultan Mehmet Vakıf University	118
A115	Istanbul Technical University	7	A65	Erzincan Binali Yıldırım University	119
A63	Ege University	8	A69	Eskişehir Technical University	120
A176	Middle East Technical University	9	A214	Yalova University	121
A184	Ministry of Health	10	A153	Mardin Artuklu University	122
A56	Çukurova University	11	A81	Gümüşhane University	123
A190	Selçuk University	12	A209	Ufuk University	124
A26	Atatürk University	13	A39	Bilecik Şeyh Edebali University	125
A12	Akdeniz University	14	A191	Siirt University	126
A218	Yıldız Technical University	15	A35	Batman University	127
A64	Erciyes University	16	A215	Yaşar University	128
A187	Sakarya University	17	A166	Namık Kemal University	129
A43	Boğaziçi University	18	A219	Yozgat Bozok University	130
A210	Uludağ University	19	A145	Konya Technical University	131
A195	Süleyman Demirel University	20	A162	Muğla University	132
A72	Fırat University	21	A47	Bursa Technical University	133
A142	Kocaeli University	22	A224	Zonguldak Karaelmas University	134

A174	Ondokuz Mayıs University	23	A107	Istanbul Medeniyet University	135
A68	Eskişehir Osmangazi University	24	A16	Amasya University	136
A76	Gaziantep University	25	A173	Okan University	137
A34	Başkent University	26	A124	İzmir University of Economics	138
A167	Necmettin Erbakan University	27	A146	KTO Karatay University	139
A30	Bahçeşehir University	28	A91	Iğdır University	140
A17	Anadolu University	29	A92	Isparta University of Applied Sciences	141
A133	Karadeniz Technical University	30	A139	Kırklareli University	142
A204	Trakya University	31	A10	Ağrı İbrahim Çeçen University	143
A220	Foreign Universities	32	A186	Sakarya University of Applied Sciences	144
A53	Çanakkale Onsekiz Mart University	33	A103	Istanbul Gedik University	145
A74	Gulhane Military Medical Academy (GATA)	34	A203	Trabzon University	146
A96	İnönü University	35	A177	Osmaniye Korkut Ata University	147
A157	Mersin University	36	A93	Işık University	148
A179	Pamukkale University	37	A137	Kyrgyzstan-Türkiye Manas University	149
A95	İhsan Doğramacı Bilkent University	38	A178	Özyeğin University	150
A130	Kahramanmaraş Sütçü İmam University	39	A6	Adıyaman University	151
A221	Yüzüncü Yıl University	40	A109	Istanbul Nişantaşı University	152
A99	Istanbul Aydın University	41	A119	Istanbul Yeni Yüzyıl University	153
A8	Afyon Kocatepe University	42	A207	Turkish Aeronautical Association University	154
A216	Yeditepe University	43	A36	Bayburt University	155
A132	Karabük University	44	A94	Ibn Haldun University	156
A58	Dicle University	45	A42	Bitlis Eren University	157
A48	Bursa Uludağ University	46	A32	Bandırma Onyedi Eylül University	158
A212	Üsküdar University	47	A192	Sinop University	159
A185	Health Sciences University	48	A141	Kilis 7 Aralık University	160
A138	Kırıkkale University	49	A165	Muş Alparslan University	161
A51	Cumhuriyet University	50	A159	National Defense University	162
A7	Adnan Menderes University	51	A49	Bülent Ecevit University	163
A85	Harran University	52	A97	İskenderun Technical University	164
A160	Mimar Sinan Fine Arts University	53	A21	Ankara Social Sciences University	165
A213	Van Yüzüncü Yıl University	54	A67	Erzurum Technical University	166
A125	İzmir Katip Çelebi University	55	A25	Artvin Çoruh University	167
A61	Dumlupınar University	56	A3	Acıbadem Mehmet Ali Aydınlar University	168
A50	Celal Bayar University	57	A181	Police Academy	169
A31	Balıkesir University	58	A172	Nişantaşı University	170
A37	Beykent University	59	A41	Biruni University	171
A161	Muğla Sıtkı Koçman University	60	A217	Yıldırım Beyazıt University	172
A55	Çankırı Karatekin University	61	A163	Munzur University	173
A83	Haliç University	62	A120	Istanbul 29 Mayıs University	174
A18	Ankara Hacı Bayram Veli University	63	A131	Military Academy Command	175
A194	Sivas Cumhuriyet University	64	A202	Toros University	176
A101	Istanbul Bilgi University	65	A100	Istanbul Beykent University	177
A23	Ankara Yıldırım Beyazıt University	66	A105	Istanbul Kent University	178
A29	Aydın Adnan Menderes University	67	A102	Istanbul Bilim University	179
A104	Istanbul Gelişim University	68	A123	İzmir Democracy University	180
A127	İzmir Institute of Technology	69	A14	Alanya Alaaddin Keykubat University	181
A151	Maltepe University	70	A121	İstinye University	182
A135	Kastamonu University	71	A38	Bezm-i Alem Vakıf University	183
A116	Istanbul Commerce University	72	A66	Erzincan University	184
A118	Istanbul University-Cerrahpaşa	73	A196	Şırnak University	185
A62	Düzce University	74	A155	Mehmet Akif Ersoy University	186
A112	Istanbul Sabahattin Zaim University	75	A11	Ahi Evran University	187
A201	Tokat Gaziosmanpaşa University	76	A24	Ardahan University	188
A129	Kafkas University	77	A5	Adana Alparslan Türkeş Science and Technology University	189
A152	Manisa Celal Bayar University	78	A28	Avrasya University	190
A183	Sabancı University	79	A45	Bozok University	191

A143	Koç University	80	A114	Istanbul Şehir University	192
A110	Istanbul Okan University	81	A206	Turgut Özal University	193
A98	Istanbul Arel University	82	A59	Doğuş University	194
A15	Altınbaş University	83	A111	Istanbul Rumeli University	195
A44	Bolu Abant İzzet Baysal University	84	A222	Zirve University	196
A170	Niğde Ömer Halisdemir University	85	A122	İzmir Bakırçay University	197
A78	Gebze Technical University	86	A198	Tarsus University	198
A79	Gebze Institute of Technology	87	A208	Turkish-German University	199
A108	Istanbul Medipol University	88	A84	War Academies Command	200
A175	Ordu University	89	A189	Sanko University	201
A71	Fatih University	90	A136	Kayseri University	202
A77	Gaziosmanpaşa University	91	A149	Lokman Hekim University	203
A147	Kütahya Dumlupınar University	92	A150	Malatya Turgut Özal University	204
A27	Atılım University	93	A2	Abdullah Gül University	205
A1	Abant İzzet Baysal University	94	A169	Nevşehir University	206
A199	Tekirdağ Namık Kemal University	95	A144	Konya Food and Agriculture University	207
A80	Giresun University	96	A188	Samsun University	208
A171	Niğde University	97	A20	Ankara Music and Fine Arts University	209
A13	Aksaray University	98	A148	Kütahya Health Sciences University	210
A46	Burdur Mehmet Akif Ersoy University	99	A88	Air Force Academy Command	211
A134	Karamanoğlu Mehmetbey University	100	A193	Sivas Science and Technology University	212
A168	Nevşehir Hacı Bektaş Veli University	101	A205	Tunceli University	213
A106	Istanbul Kültür University	102	A9	Afyonkarahisar Health Sciences University	214
A54	Çankaya University	103	A19	Ankara Medipol University	215
A86	Hasan Kalyoncu University	104	A158	Mevlana University	216
A182	Recep Tayyip Erdoğan University	105	A4	Acıbadem University	217
A73	Galatasaray University	106	A57	Demiroğlu Science University	218
A211	Uşak University	107	A156	Melikşah University	219
A223	Zonguldak Bülent Ecevit University	108	A180	Piri Reis University	220
A164	Mustafa Kemal University	109	A126	İzmir University	221
A89	Hitit University	110	A197	Şifa University	222
A40	Bingöl University	111	A113	Istanbul Health and Technology University	223
A33	Bartın University	112	A90	Khoja Akhmet Yassawi International Turkish-Kazakh University	224

When Table 12 is examined, the universities with the highest performance values based on graduation indicators are identified as Istanbul University, Gazi University, Marmara University, Hacettepe University, and Ankara University.

5. Conclusion

Higher education institutions play a critical role in the development processes of countries by contributing to knowledge production, the training of qualified human resources, and scientific advancement. For this reason, evaluating university performance through objective and comparable methods has become an important necessity for both policymakers and academic administrators. In particular, the number of graduate and specialty-level graduates is considered one of the key indicators reflecting the research capacity and academic productivity of universities. The literature also emphasizes that multi-criteria decision-making (MCDM) methods provide effective and reliable outcomes in performance evaluation processes [33, 34]. Accordingly, this study analyzed the performance of universities operating in Türkiye based on graduate and specialty-level graduate numbers within the framework of a multi-criteria decision-making approach. The dataset, constructed using the National Thesis Center's May 2026 data, was transformed into a final decision matrix consisting of 224 alternatives and 6 criteria (224×6) after the necessary elimination procedures were completed. Previous studies have highlighted that university performance evaluations should incorporate multidimensional criteria and that MCDM methods offer effective solutions in this regard [7]. During the analysis process, criterion weights

were objectively determined using the standard deviation method, and subsequently, university performance rankings were obtained through the MARCOS method. It has been stated in the literature that objective weighting methods produce more consistent and reliable results by considering the variability among criteria [9]. Furthermore, the widespread use of MCDM methods across various fields demonstrates that these approaches provide reliable support for decision-making processes [35]. From a methodological perspective, the integrated use of standard deviation-based weighting and the MARCOS method enabled the achievement of more objective and data-driven results by considering the variability among criteria. This demonstrates that the applied methodology provides distinctive and reliable outcomes in measuring university performance. In this respect, Stević et al. [19] stated that the MARCOS method provides strong outcomes in evaluating alternatives relative to ideal and anti-ideal solutions, while Zavadskas and Turskis [34] emphasized that MCDM methods are widely preferred in solving economic and managerial problems. According to the findings, the top five universities with the highest performance values were respectively Istanbul University, Gazi University, Marmara University, Hacettepe University, and Ankara University. The diversity of graduate programs, strong academic staff, and advanced research infrastructures of these universities are considered the primary factors supporting their top positions in the ranking. In addition, well-established universities such as Dokuz Eylül University, Istanbul Technical University, Ege University, and Middle East Technical University were also found to be concentrated among the upper ranks. This situation can be associated with the strong graduate program diversity, qualified academic staff, and advanced research infrastructures of these universities. Similarly, previous studies have emphasized that research-oriented universities tend to demonstrate higher performance in academic productivity indicators [36]. On the other hand, universities positioned at the lower levels of the ranking were generally observed to be newly established institutions or universities with limited graduate education capacity. This finding indicates that there are substantial differences among universities in Türkiye in terms of graduate-level output. Furthermore, it was observed that the majority of universities performing above the average performance value consisted of long-established and research-oriented institutions. A review of the literature indicates that studies ranking university performance through MCDM methods based specifically on graduate-level graduate data remain limited. Therefore, the present study contributes to the literature both in terms of the dataset employed and the methodology applied. Furthermore, the study demonstrates that university performance can be evaluated not only through publication and citation indicators but also through graduate education outputs. In conclusion, the findings reveal that universities in Türkiye exhibit significant differences in terms of graduate education and research capacity. Within this scope, it is recommended that universities with relatively low performance improve their graduate programs, strengthen their research infrastructures, and enhance academic incentive mechanisms. Future studies may compare ranking results using different MCDM methods and incorporate additional academic indicators such as publications, citations, project budgets, and international collaborations in order to provide a more comprehensive evaluation of university performance.

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