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Project performance analysis of Turkish universities by LOPCOW-CRADIS methods

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Abstract

The encouraging regulations put forward by the countries in the realm of science and technology make quite noteworthy contributions to the endeavours of the relevant stakeholders. The financial supports, which serve as a source of motivation for scientists and industrial organizations engaged in research and development activities, has evolved into a competitive issue and a performance indicator today. Given that the capability of scientists to execute projects is a significant metric, this study aimed to analyse the performance of 200 public and foundation universities operating in Türkiye for the first time Specifically, the study focused on their competence in submitting and carrying out projects coordinated by the Directorate of Research Support Programs (ARDEB). In order to assess the relative importance of the evaluation criteria, the LOgarithmic Percentage Change-driven Objective Weighting (LOPCOW) method was employed and the criterion "Number of Project Submissions" was determined as the prominent one. The performance order of the universities was determined by the Compromise Ranking of Alternatives from Distance to Ideal Solution (CRADIS) method where Middle East Technical University, Ege University, İstanbul Technical University, Hacettepe University, Ankara University, İstanbul University, Koç University, İhsan Doğramacı Bilkent University, İzmir Technology Institute and Erciyes University were determined in the first ten order. It has also been determined that especially the universities established in recent are far from a competitive position. In the final stage, the method's sensitivity to changes observed in the criterion weights was tested.

1. Introduction

The Scientific and Technological Research Council of Türkiye (TÜBİTAK), who aims to develop, challenge, regulate and coordinate research and development activities in positive science disciplines according to the priorities of the country's development; and to provide access to current scientific and technical information in Türkiye, is established with the Law No. 278, which was promulgated in the July 24, 1963 dated Official Journal with number of 11462 (Decree on the Amendment of Certain Articles of the Law on the Establishment of the Scientific and Technical Research Council of Türkiye, 1993).

Even though, several job descriptions of the Council are defined in the law of foundation of TÜBİTAK, the main duties can be described as (Law on Some Regulations Regarding the Scientific and Technological Research Council of Türkiye, 1963);

- To carry out basic and applied research in the field of positive science disciplines and to establish centres and institutes for this purpose,
- To guide the government for determination of Türkiye's science and technology policies,
- To determine the principles and methods that will be the basis of teaching in the field of positive sciences and to propose them to relevant institutions,

- To take measures to increase Türkiye's scientific and technological competitiveness at the international level,
- To develop methods for rapid transformation of scientific research into technological innovations,
- To make programs that will enable the private sector to participate in technological research and development effectively and predominantly,
- To develop programs that will enable Turkish Industry to cooperate with universities and research institutions and organizations, and to create physical environments where this cooperation can become tangible,
- To support the government in the course of preparation and negotiation of scientific and technological aid and cooperation agreements where Türkiye will act as a party of these programs,
- To realise all kinds of scientific and technical cooperation with local and foreign research institutions and researchers related to the activities within the scope of its duty. If necessary, to become a member of these institutions and to involve as a party to international scientific and technical agreements on behalf of Türkiye,
- To support, organize and participate in scientific meetings such as national and international congresses, seminars, colloquiums relevant with the subjects within the scope of its duty.

The Directorate of Research Support Programs (ARDEB), which operates within the framework of TÜBITAK, serves as a vital entity facilitating both internal and external collaboration in research and development endeavours. It effectively bridges the gap between research groups and various stakeholders such as universities, public institutions, organizations, as well as individual entities.

ARDEB carries out its activities by supporting and executing the scientific research projects through a process in which several scientific research groups are involved. These scientific groups mentioned are; "Chemistry and Biology Research Support Group" (KBAG), "Mathematics and Physics Research Support Group" (MFAG), "Health Sciences Research Support Group" (SBAG), "Electrical, Electronics and Informatics Research Support Group" (EEEAG), "Engineering Research Support Group" (MAG), "Environment, Atmosphere, Earth and Marine Sciences Research Support Group" (ÇAYDAG), "Agriculture, Forestry and Veterinary Research Support Group" (TOVAG), "Social and Humanities Research Support Group" (SOBAG), "Defence and Security Technologies Research Support Group" (SAVTAG) and "Public Research Support Group" (KAMAG) (TÜBİTAK, 2024).

The prominent national funding programs implemented by this unit can be summarized as; "1000 - Funding Program for improving R&D Potential of Universities", "1001 - The Scientific and Technological Research Projects Funding Program", "1002 - Short Term R&D Funding Program", "1003 - Primary Subjects R&D Funding Program", "1005 - National New Ideas And New Products Research Funding Program", "1007 - Public Institutions Research and Development Projects Support Program", "1505 - University – Industry Collaboration Support Program", "3001 - Starting R&D Projects Funding Program" and "3501 - Career Development Program" (TÜBİTAK, 2024).

The current success ranking of universities is calculated by University Ranking by Academic Performance (URAP) based on "article score, citation score, scientific document score, doctoral score, faculty and student score, international cooperation score, domestic cooperation score and TÜBİTAK project score" (URAP, 2023). However, despite the existence of numerous publications that assess various activities carried out by TÜBITAK, there is a lack of studies that assess the performance of universities specifically in terms of project applications. Additionally, a comprehensive performance evaluation using all the parameters suggested by TÜBİTAK has not been conducted thus far. Given these factors, this study aims to address the gap in the literature by undertaking a project performance evaluation of Turkish universities, treating it as a decision-making problem and employing the LOPCOW and CRADIS methods.

The research encompasses several key sections. Following the introduction, the second section delves into a comprehensive literature review. The third section provides a thorough examination of the methods employed throughout the study. In the fourth section, the study investigates the performance of universities in Türkiye with regards to their project capabilities as a case study. Finally, the research is concluded with a comprehensive analysis of the results, a thoughtful discussion of the findings, and a conclusion.

2. Literature Review

The previous studies reviewed within the scope of this research were carried out in two stages in terms of TÜBİTAK programs and LOPCOW and CRADIS methods employed.

Some of the published studies examining TÜBİTAK activities are as follows;

Konur and Yazıcı (2022) aimed to evaluate the effectiveness of the fairs organized within the scope of TÜBİTAK - 4006 Science Fairs Support Program and to determine the problems experienced by science teachers during preparatory and application stages of the fairs. The findings of the study demonstrate the favourable perceptions held by the majority of the teachers involved in the research. It is asserted that science fairs have a beneficial

impact on various skills, including creativity, active engagement, self-assurance, socialization, entrepreneurial understanding, and accountability among participating students.

Pilav and Orhan (2020) examined TÜBİTAK publications targeting the 6-12 age group in terms of 'values education' and aimed to reveal the contribution of these publications to the related subject. In the examination, it has been determined that the root values are transmitted to the reader directly or implicitly, the expressions and events are not interrupted, advice is not given directly, and the number of 'direct value transfers' is quite low.

Alabay et al. (2018) examined to what extent the children's magazine, published by TUBITAK, contains universal values, by means of qualitative research methods. This study was examined in terms of 12 universal values included in the "Living Values Education Program" defined by UNESCO. As a result of the research, it was seen that the magazine contains the values of "love, responsibility and cooperation" to a large extent. However, it has been determined that the values of "freedom, simplicity and unity" are seldomly included.

As it can be explicitly deducted from these publications, the number of which can be increased even more, it is possible to come across a large number of publications examining TÜBİTAK activities. However, there is no study to measure the success performance of institutions that submit to projects financed by TUBITAK.

On the other hand, some of the studies carried out using LOPCOW for criterion weighting and CRADIS for ranking alternatives are as follows:

Ecer and Pamucar (2022) conducted a study which aims to evaluate the sustainability capacities and to clarify the corporate sustainability levels of 9 different Turkish banks. In order to weight the 3 main criteria and 17 sub-criteria, they introduced the new objective weighting method LOPCOW, which eliminates the gap arising from size of the data, generates more comprehensible weights and takes both positive and negative values into consideration.

Biswas et al. (2022) conducted a study to investigate the performance of 30 companies in the fast-moving consumer goods and durable consumer goods industries after the Covid-19 pandemic. LOPCOW method was used to weight 5 criteria including "stock performance", "dividend pay-out capability", "sales and operational performance", "financial stability" and "economic sustainability".

Biswas et al. (2023) carried out a study to examine the energy efficiency performance of Brazil, Russia, India, China, South Africa, UK, USA, France, Canada, Germany, Italy and Japan, which are members of the BRICS and G7 countries. They proposed the modified LOPCOW method for weighting the 6 criteria used in this study.

On account of the fact that there are not sufficient number of studies in the literature regarding the sustainability of micro-mobility solutions, which are critical issues for primary urban transportation networks, Ecer et al. (2023) introduced a practical and robust decision-making mechanism for the sustainability of micro-mobility solutions and they implemented the LOPCOW method for criterion weighting of the study.

Puska et al. (2022) carried out a study for selection of incinerators for disposal of medical wastes generated in secondary health institutions of Bosnia and Herzegovina. Within the scope of this study conducted, they proposed the CRADIS method as the first time by taking the environmental, economic, social and technical data criteria into consideration. This method provides simplicity and flexibility compared to many applications used in multi-criteria decision-making processes and is applicable to all kinds problems in terms of the choice of alternatives.

Starcevic et al. (2022) conducted a study in Bosnia and Herzegovina and Serbia with the aim of providing a suitable functional model. This was achieved through an examination of the mutual influence of various macroeconomic parameters. In the study, the criteria such as "foreign direct investments", "gross domestic product", "imports", "exports", "inflation rate", "real exchange rate" and "employment rate" were taken into consideration. Finally, the years in which countries showed higher performance were determined by the CRADIS method.

Puska et al. (2023) conducted a study to evaluate the most preferred 20 electric vehicle models based on 13 criteria. In order to obtain more stable results compared to classical multi-criteria decision-making methods, the DNCRADIS method which recommends double normalization, has been preferred as an alternative to the CRADIS method.

By taking into account 9 different criteria, Dua (2023) used CRADIS and CURLI methods together for selection of milling, sawing and planer machines for the woodworking industry, which plays a pioneering role for development of the Vietnamese economy.

Some other studies where LOPCOW and CRADIS methods were implemented are summarized in the Table 1.

Table 1. Literature Review for LOPCOW and CRADIS Methods

LOPCOW Method	
Author	**Subject**
(Simic et al., 2023)	"prioritizing industry 4.0-based material handling technologies"
(Rong et al., 2023)	"a new FMEA model for risk prioritization"
(Lukić, 2023)	"research of the economic positioning of the Western Balkan countries"
(Nila & Roy, 2023)	"third-party logistics provider selection"
(Das et al., 2023)	"Selection of Appropriate Portfolio Optimization Strategy"
(Dhruva et al., 2024)	"selection of suitable cloud vendors for health centre"
(Setiawansyah & Sulistiyawati, 2024)	"recruitment of English teachers"
CRADIS Method	
Author	**Subject**
(Xu et al., 2023)	"assessment of mountain tourism"
(Puška et al., 2023)	"selection of electric vehicles"
(Krishankumar & Ecer, 2023)	"selection of IoT service provider"
(Wang et al., 2023)	"occupational risk evaluation in natural gas pipeline construction"
(Cheng et al., 2024)	"hydrogen fuel cell logistics path selection"
(Chowdhury et al., 2024)	"optimization of grinding processes"
(Krishankumar et al., 2024)	"Selection of a viable block chain service provider"

3. Methods

In order to assess and analyse the performance of 200 Turkish universities in terms of their capabilities in project submission and project execution, this study focused on the ARDEB supports by employing LOPCOW and CRADIS methods. The data utilized in the study were obtained from the Scientific and Technological Research Council of Türkiye (TÜBİTAK, 2023), which includes Number of Project Submissions, Number of Projects Decided to be Supported, Total Budget of the Projects Decided to be Supported, Number of Ongoing Projects, Total Budget of Ongoing Projects, and Budget Transferred to Ongoing Projects for 200 universities between the years 2017 and 2021. Therefore, the scope of the study was limited with the supports of The Directorate of Research Support Programs (ARDEB) unit which operates within TÜBİTAK.

In order to weight 6 criteria which are determined by TÜBİTAK, LOPCOW method was preferred since this approach eliminates the gap arising from size of the data, generates more reasonable weights and takes both positive and negative values into consideration in contrast to ENTROPY (Li et. al., 2011), MEREC (Keshavarz-Ghorabaee et. al., 2021), LMAW (Pamucar et.al., 2021) or CILOS (Zavadskas and Podvezko, 2016) methods, etc. Subsequently, CRADIS method (Puška et al., 2022) was opted for ordering of project submission and project execution capacities of 200 Turkish universities, since it provides simplicity and flexibility compared to many applications used in multi-criteria decision-making processes, and is applicable to all kinds problems in terms of the ordering the alternatives. This method also combines the best features of the ARAS (Zavadskas & Turskis, 2010), MARCOS (Stević et al., 2020) and TOPSIS (Hwang & Yoon, 1981) methods and thus offers a more superior approach. In the last stage, a sensitivity analysis was performed to determine the precision of the ranking method employed in the research against the change in the criteria weights.

Flowchart of the model covering the applied methods is given in Figure 1.

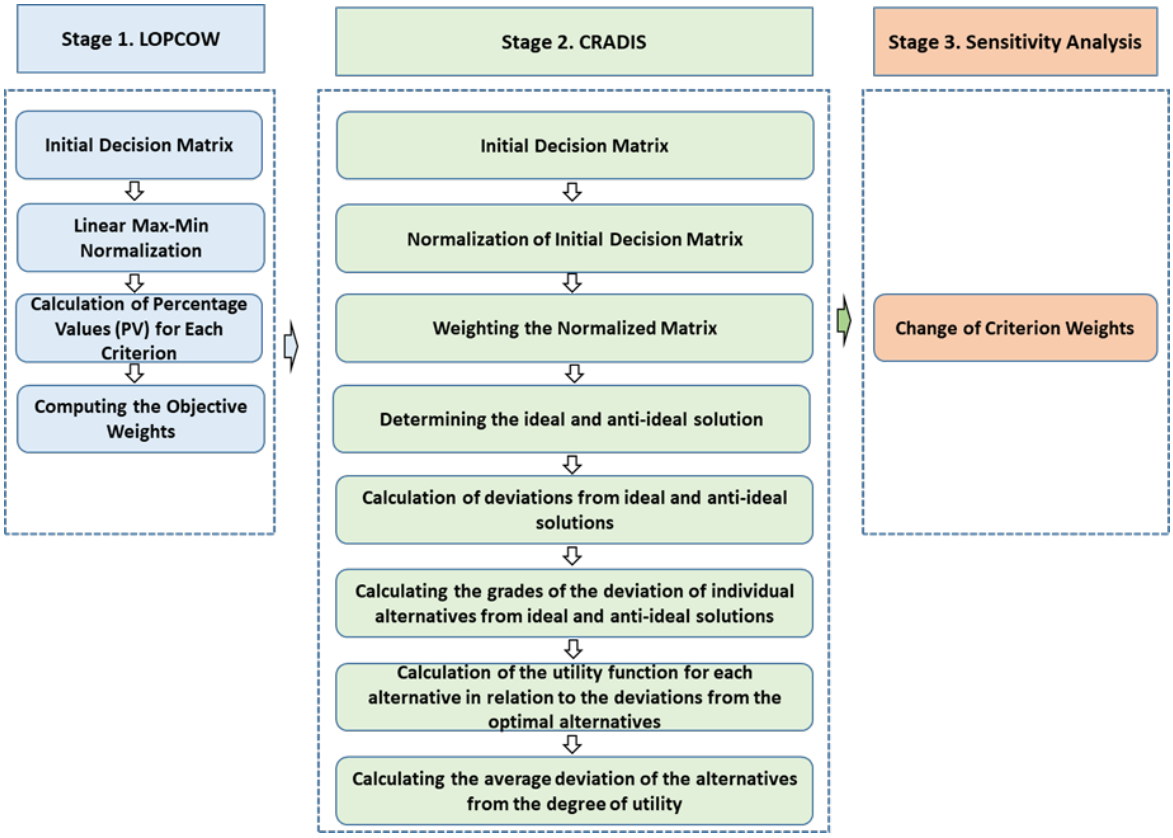

Figure 1. Flowchart of the study

3.1 LOPCOW Method

The application steps aiming to find the criterion weight coefficients with LOPCOW method is as follows (Ecer and Pamucar, 2022);

"Step 1: Construction of initial decision matrix

According to the data obtained, initial decision matrix is formed as;

$$DM = \begin{bmatrix} x_{11} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mn} \end{bmatrix} \qquad m; alternatives \quad n; criteria$$

Step 2: Linear max-min normalization

Normalization of initial decision matrix is realised by means of Equation (1) or Equation (2);

$$r_{ij} = \frac{x_{max} - x_{ij}}{x_{max} - x_{min}} \qquad ; for\ cost\ criterion \tag{1}$$

$$r_{ij} = \frac{x_{ij} - x_{min}}{x_{max} - x_{min}} \qquad ; for\ benefit\ criterion \tag{2}$$

Step 3: Calculation of Percentage Values (PV) for Individual Criteria

Calculation of Percentage Values (PV) for each criterion is realised by means of Equation (3) where б represents standard deviation;

$$PV_{ij} = \left| \ln \left(\frac{\sqrt{\frac{\sum_{i=1}^{m} r_{ij}^2}{m}}}{б} \right) * 100 \right| \quad (3)$$

Step 4: Computing the Objective Weights

The objective weights for each criterion is calculated by means of Equation (4);

$$w_j = \frac{PV_{ij}}{\sum_{i=1}^{n} PV_{ij}} \quad (4)$$

The sum of each weight calculated should be equal to 1."

3.2 CRADIS Method

The application steps for ordering the alternatives by CRADIS method is as follows (Puška et al., 2022);

"Step 1: Construction of initial decision matrix

According to the data obtained, initial decision matrix is formed as;

$$DM = \begin{bmatrix} x_{11} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mn} \end{bmatrix} \qquad m; alternatives \quad n; criteria$$

Step 2: Normalization of decision matrix

Normalization of initial decision matrix is realised by means of Equation (5) or Equation (6);

$$n_{ij} = \frac{x_{j(min)}}{x_{ij}} \qquad ; for\ cost\ criterion \quad (5)$$

$$n_{ij} = \frac{x_{ij}}{x_{j(max)}} \qquad ; for\ benefit\ criterion \quad (6)$$

Step 3: Weighting the Normalized Matrix

Normalized decision matrix is weighted by Equation (7);

$$v_{ij} = n_{ij} * w_j \quad (7)$$

Step 4: Determination of ideal solution and anti-ideal solution

The ideal and anti-ideal solutions are calculated by means of largest and smallest values of v_{ij} and by using Equation (8) and Equation (9);

$$t_i = max v_{ij} \quad (8)$$

$$t_{ai} = min v_{ij} \quad (9)$$

Step 5: Calculation of deviations from ideal solutions and anti-ideal solutions

Calculation of deviations from ideal and anti-ideal solutions are as performed with Equation (10) and Equation (11);

$$d^+ = t_i - v_{ij} \quad (10)$$

$$d^- = v_{ij} - t_{ai} \quad (11)$$

Step 6: Calculation of the grades of the deviation for each alternative from ideal solutions and anti-ideal solutions

The grades of the deviation for each alternative from ideal and anti-ideal solutions are calculated with Equation (12) and Equation (13);

$$S_i^+ = \sum_{j=1}^{n} d^+ \quad (12)$$

$$S_i^- = \sum_{j=1}^{n} d^- \quad (13)$$

Step 7: Calculation of the utility function of each alternative in relation to the deviations from the optimal alternatives

The utility function for individual alternative in relation to the deviations from the optimal alternatives are calculated with Equation (14) and Equation (15);

$$K_i^+ = \frac{S_0^+}{S_i^+} \quad (14)$$

$$K_i^- = \frac{S_i^-}{S_0^-} \quad (15)$$

$S_0^+;\ optimal\ alternative\ with\ the\ smallest\ distance\ from\ the\ ideal\ solution$

$S_0^-;\ optimal\ alternative\ with\ the\ largest\ distance\ from\ the\ ideal\ solution$

Step 8. Calculation of the average deviation of the alternatives from the degree of utility

Average deviation of the alternatives from the degree of utility is calculated by Equation (16);

$$Q_i = \frac{K_i^+ + K_i^-}{2} \quad (16)$$

Finally, the alternatives are ordered according to descending value of Q_i."

3.3 Sensitivity Analysis

To verify the consistency of multi-criteria decision making methods, some approaches such as the rank reversal method (Mukhametzyanov and Pamucar, 2018), cross-checking with different MCDM applications (Božanić et. al., 2022), changing the formula parameters (Pamucar et. al., 2021) or correlation test (Yazdani et.al., 2018) can be applied. In addition, there are also some applications in the form of a combination (Alakaş et al., 2024) of these methods.

Sensitivity analysis applied for this study is based on 50 different scenarios where the weight of the dominant criterion is decreased 1% in the first step and 2% sequentially. The remaining criterion weights are calculated by Equation (17) (Pamucar et. al., 2021);

$$w_n : (1 - w_D) = w_n^* : (1 - w_D^*) \quad (17)$$

where w_D indicates the original value of the dominant criterion, w_D^* indicates the corrected value of dominant criterion, w_n indicates the original value of nth criterion and w_n^* indicates the reduced value of nth criterion.

For each new criterion weight obtained, the alternatives are reordered according to the new Q_i values calculated by CRADIS method.

4. Determination of Project Performance Orders for Turkish Universities

4.1. Problem Description

In this study, it is aimed to determine the project performance of 200 Turkish universities through TÜBİTAK criteria and multi-criteria decision-making methods, based on the ARDEB projects implemented between the years 2017 and 2021.

The criteria determined by TÜBİTAK for evaluations of project is indicated in Table 2.

Table 2. List of criteria

Code	Criterion

C1	Number of Project Submissions Between the Years of 2017-2021
C2	Number of Projects Decided to be Supported Between the Years of 2017-2021
C3	Total Budget of Projects Decided to be Supported Between the Years of 2017-2021(M TL)
C4	Number of Ongoing Projects Between the Years of 2017-2021
C5	Total Budget of Ongoing Projects Between the Years of 2017-2021 (M TL)
C6	Total Budget Transferred to the Ongoing Projects Between the Years of 2017-2021 (M TL)

Therefore, evaluation of universities was conducted on the basis of six criteria indicated in Table 2.

In addition, the list of the Turkish universities used as alternatives for this study was alphabetically indicated in Table 3. In order to prevent any potential confusion, the Turkish equivalent titles of the universities were presented rather than their English titles.

Table 3. List of universities in Türkiye

Alternative	Alternative	Alternative	Alternative
"Abdullah Gül U.	Çukurova U.	İstanbul Rumeli U.	Muş Alparslan U.
Acıbadem Mehmet Ali Ayd. U.	Demiroğlu Bilim U.	İstanbul Sabahattin Zaim U.	Namık Kemal U.
Adana Alparslan Türkeş BT U	Dicle U.	İstanbul ST U.	Necmettin Erbakan U.
Adıyaman U.	Doğuş U.	İstanbul Şehir U.	Nevşehir Hacı Bektaş Veli
Afyon Kocatepe U.	Dokuz EylülU.	İstanbul Şişli MYO	Niğde Ömer Halisdemir U.
Afyonkarahisar Sağlık Bilimleri	Düzce U.	İstanbul Teknik U.	Nişantaşı U.
Ağrı İbrahim Çeçen U.	Ege U.	İstanbul Ticaret U.	Nuh Naci Yazgan U.
Akdeniz U.	Erciyes U.	İstanbul Topkapı U.	Ondokuz Mayıs U.
Aksaray U.	Erzincan Binali Yıldırım U.	İstanbul U.	Ordu U.
Alanya Alaaddin Keykubat U.	Erzurum Teknik U.	İstanbul Yeni Yüzyıl U.	Orta Doğu Teknik U.
Alanya Hamdullah Emin Paşa U.	Eskişehir Osmangazi U.	İstinye U.	Osmaniye Korkut Ata U.
Altınbaş U.	Eskişehir Teknik U.	İzmir Bakırçay U.	OSTİM Teknik U.
Amasya U.	Fatih Sultan Mehmet Vakıf U.	İzmir Demokrasi U.	Özyeğin U.
Anadolu U.	Fenerbahçe U.	İzmir Ekonomi U.	Pamukkale U.
Ankara Bilim U.	Fırat U.	İzmir Kâtip Çelebi U.	Piri Reis U.
Ankara Hacı Bayram Veli U.	Galatasaray U.	İzmir Tınaztepe U.	Recep Tayyip Erdoğan U.
Ankara Medipol U.	Gazi U.	İzmir YTE	Sabancı U.
Ankara Müzik Ve G. Sanatlar U.	Gaziantep İslam Bilim Ve Tek. U.	Kadir Has U.	Sağlık Bilimleri U.
Ankara Sosyal Bilimler U.	Gaziantep U.	Kafkas U.	Sakarya Uygulamalı Bil. U.
Ankara U.	Gebze Teknik U.	Kahramanmaraş İst.U.	Sakarya U.
Ankara Yıldırım Beyazıt U.	Gebze Yüksek Teknoloji Ens.	Kahramanmaraş S.İ.U.	Samsun U.
Antalya Bilim U.	Giresun U.	Kapadokya U.	SANKO U.
Ardahan U.	Gümüşhane U.	Karabük U.	Selçuk U.
Artvin Çoruh U.	Hacettepe U.	Karadeniz Teknik U.	Siirt U.
Atatürk U.	Hakkâri U.	Karamanoğlu Mehmetbey U.	Sinop U.
Atılım U.	Haliç U.	Kastamonu U.	Sivas Bilim ve Teknoloji U.
Avrasya U.	Harran U.	Kayseri U.	Sivas Cumhuriyet U.
Aydın Adnan Menderes U.	Hasan Kalyoncu U.	Kırıkkale U.	Süleyman Demirel U.
Bahçeşehir U.	Hatay Mustafa Kemal U.	Kırklareli U.	Şırnak U.
Balıkesir U.	Hitit U.	Kırşehir Ahi Evran U.	Tarsus U.
Bandırma Onyedi Eylül U.	Iğdır U.	Kilis 7 Aralık U.	TED U.
Bartın U.	Isparta Uygulamalı Bilimler U.	Kocaeli U.	Tekirdağ Namık Kemal U.
Başkent U.	Işık U.	Koç U.	TOBB Ekonomi ve Tek.U.
Batman U.	İbn Haldun U.	Konya Gıda ve Tarım U.	Tokat Gaziosmanpaşa U.
Bayburt U.	İhsan Doğramacı Bilkent U.	Konya Teknik U.	Toros U.
Beykent U.	İnönü U.	KTO Karatay U.	Trabzon U.
Bezmialem Vakıf U.	İskenderun Teknik U.	Kütahya Dumlupınar U.	Trakya U.
Bilecik Şeyh Edebali U.	İstanbul 29 Mayıs U.	Kütahya Sağlık Bilimleri U.	Türk Alman U.
Bingöl U.	İstanbul Arel U.	Lokman Hekim U.	Türk Hava Kurumu U.
Biruni U.	İstanbul Atlas U.	Malatya Turgut Özal U.	Ufuk U.
Bitlis Eren U.	İstanbul Aydın U.	Maltepe U.	Uşak U.
Boğaziçi U.	İstanbul Bilgi U.	Manisa Celal Bayar U.	Üsküdar U.
Bolu Abant İzzet Baysal U.	İstanbul Esenyurt U.	Mardin Artuklu U.	Van Yüzüncü Yıl U.
Burdur Mehmet Akif Ersoy U.	İstanbul Gedik U.	Marmara U.	Yalova U.
Bursa Teknik U.	İstanbul Gelişim U.	MEF U.	Yaşar U.
Bursa Uludağ U.	İstanbul Kent U.	Mersin U.	Yeditepe U.
Çağ U.	İstanbul Kültür U.	Milli Savunma U.	Yıldız Teknik U.
Çanakkale Onsekiz Mart U.	İstanbul Medeniyet U.	Mimar Sinan Güzel Sanatlar	Yozgat Bozok U.
Çankaya U.	İstanbul Medipol U.	Muğla Sıtkı Koçman U.	Yüksek İhtisas U.
Çankırı Karatekin U.	İstanbul Okan U.	Munzur U.	Zonguldak Bülent Ecevit U."

Source: TÜBİTAK (2023)

According to the alphabetically ordered list in Table 3, each university was coded from A001 to A200 in a sequential manner.

4.2. Determination of Criterion Weights by LOPCOW Method

Initial decision matrix was constructed according to the value obtained from TÜBİTAK as indicated in Table 4.

Table 4. Initial decision matrix

ALTT	C1	C2	C3	C4	C5	C6	ALT	C1	C2	C3	C4	C5	C6
A001	201	38	23.58	51	32.68	18.87	**A101**	19	1	0.59	1	0.59	0
A002	301	57	39.52	75	58.18	34.86	**A102**	95	6	2.74	10	4.05	2.72
A003	208	25	6.74	37	10.92	6.09	**A103**	4	2	0.42	2	0.42	0.25
A004	109	9	3.66	16	7.06	3.33	**A104**	74	4	2.38	14	6.06	1.84
A005	229	28	6.24	38	12.38	5.49	**A105**	5	0	0	0	0	0
A006	22	4	0.24	4	0.24	0.19	**A106**	1,428	297	200.1	515	393.7	189.2
A007	43	5	0.55	5	0.55	0.5	**A107**	28	2	1.6	4	2.64	1.3
A008	909	151	63.43	233	125.5	63.54	**A108**	2	0	0	0	0	0
A009	212	29	7.37	35	9.91	5.36	**A109**	1,815	249	121.4	351	177.5	99.15
A010	85	14	4.52	12	4.28	3.34	**A110**	41	3	0.15	5	0.27	0.19
A011	2	0	0	0	0	0	**A111**	136	19	5.52	19	5.64	3.38
A012	89	7	1.81	18	7.86	1.66	**A112**	36	6	1.56	6	1.56	1.12
A013	58	4	1.09	6	1.38	0.85	**A113**	44	7	2.74	7	2.74	1.74
A014	332	35	9.29	61	18.23	9.39	**A114**	129	30	11.41	42	17.83	9.82
A015	1	0	0	0	0	0	**A115**	291	43	18.77	70	30.76	16.27
A016	56	10	6.87	10	6.87	5.18	**A116**	5	2	3.72	2	3.72	2.9
A017	18	1	0.29	1	0.29	0.24	**A117**	626	173	102.5	252	179.5	98.51
A018	2	1	0.05	1	0.05	0.05	**A118**	295	51	23.73	58	27.7	15.8
A019	27	4	0.96	6	1.63	0.84	**A119**	82	11	2.75	15	5.47	2.01
A020	1,659	291	145.4	407	233.2	127	**A120**	3	0	0	0	17.72	0
A021	333	35	11.76	51	21.02	11.34	**A121**	265	33	6.17	51	0	6.2
A022	84	12	6.15	20	14.02	5.36	**A122**	3	1	0.14	1	0.14	0.12
A023	31	0	0	2	0.26	0.08	**A123**	222	25	5.9	28	10.26	5.3
A024	59	9	0.93	13	3.45	1.31	**A124**	1,098	158	53.86	245	95.55	47.21
A025	1,117	111	38.49	171	83.16	34.81	**A125**	254	34	11.06	46	19.52	10.16
A026	152	23	11.36	33	30.15	12.83	**A126**	139	11	4.23	19	7.47	3.73
A027	18	1	0.05	1	0.05	0.04	**A127**	38	5	0.81	5	0.81	0.47
A028	516	81	30.09	117	52.15	28.1	**A128**	147	16	3.68	29	9.43	3.74
A029	210	26	12.62	40	25.58	12.3	**A129**	51	10	1.62	14	3.36	1.61
A030	163	16	5.16	28	10.01	4.7	**A130**	148	15	5.8	21	7.53	4.41
A031	32	5	1.12	5	1.12	0.74	**A131**	54	5	0.79	9	2.2	1.03
A032	179	22	3.78	25	4.46	2.85	**A132**	425	67	26.59	116	52.27	27.42
A033	143	11	4.82	22	11.93	4.75	**A133**	816	250	175.9	347	267.3	142.7
A034	51	3	0.4	4	1.3	0.6	**A134**	108	15	7.05	17	8.07	5.41
A035	68	10	1.42	11	2.02	0.86	**A135**	196	33	14.23	34	15.67	11.56
A036	77	2	0.2	4	1.05	0.12	**A136**	65	5	1.31	6	2.01	1.21
A037	172	22	20.31	32	27.64	15.17	**A137**	144	14	4.92	22	9.95	4.69
A038	239	28	5.55	32	7.44	3.73	**A138**	50	7	0.95	7	0.95	0.65
A039	129	23	5.03	30	6.56	4.04	**A139**	29	3	2.29	3	2.29	1.8
A040	89	8	3.01	7	3.7	2.56	**A140**	49	6	1.1	6	1.1	0.65
A041	53	3	0.27	3	0.27	0.21	**A141**	65	4	1.53	8	3.94	2.16
A042	470	142	101.1	227	177.2	95.12	**A142**	314	37	11.48	57	21.89	10.98
A043	494	79	27.24	96	39.72	23.96	**A143**	26	0	0	0	0	0
A044	256	34	10.6	48	17.49	8.46	**A144**	818	130	57.34	174	87.53	46.33
A045	306	37	12.53	56	22.24	11.05	**A145**	36	10	4.39	12	4.83	3.95
A046	662	97	40.83	144	65.9	36.78	**A146**	354	48	18.42	76	31.83	17.65
A047	2	0	0	0	0	0	**A147**	38	6	2.51	7	2.89	1.95
A048	549	74	25.63	131	53.55	25.42	**A148**	39	8	2.42	16	7.48	2.93
A049	51	5	0.59	12	6.43	1.27	**A149**	580	74	24.47	92	35.69	22.33
A050	112	18	7.37	34	13.72	6.09	**A150**	85	6	3.85	13	8.91	3.11
A051	605	72	28.68	116	65.08	27.71	**A151**	81	0	0	0	0	0
A052	19	0	0	0	0	0	**A152**	2	0	0	0	0	0
A053	108	12	2.75	27	10.21	3.51	**A153**	273	33	12.8	44	19.97	12.83
A054	14	2	1.52	4	3.17	1.85	**A154**	105	8	1.62	11	2.33	1.55
A055	761	128	56.19	215	109.9	56.57	**A155**	286	45	19.51	72	35.1	17.09
A056	227	21	6.61	37	15.43	5.35	**A156**	30	4	1.8	5	1.98	0.77
A057	2,083	325	180	476	297.3	155	**A157**	45	1	0.05	1	0.05	0.05
A058	1,205	146	47.27	240	96.4	46.62	**A158**	832	97	25.62	153	53.71	24.7
A059	90	19	5.26	19	5.77	4.22	**A159**	129	12	3.74	25	8.22	3.54

A060	142	18	7.92	22	10.6	6.11	**A160**	1,194	378	298.3	555	511.2	264.7
A061	607	74	47.06	98	57.95	34.8	**A161**	111	7	0.77	12	2.65	1.05
A062	259	53	30.3	62	37.42	23.07	**A162**	13	1	0.17	1	0.17	0.13
A063	49	2	0.88	3	1.54	0.57	**A163**	205	50	34.08	82	64.9	34.34
A064	15	1	0.34	1	0.34	0.3	**A164**	332	48	17.06	71	28.63	15.25
A065	860	98	25.1	126	59.8	21.86	**A165**	28	3	0.36	5	1.4	1.04
A066	28	6	1.81	13	4.97	2.39	**A166**	364	54	17.73	75	31.17	17.71
A067	827	96	51.99	200	109.1	51.94	**A167**	436	135	106	213	191.2	91.51
A068	11	2	0.5	2	0.5	0.17	**A168**	330	19	8.66	24	11.78	5.86
A069	370	42	13.9	65	24.15	12.67	**A169**	75	10	2.92	10	2.92	1.9
A070	707	148	89.44	159	99.57	69.33	**A170**	579	67	22.1	104	36.64	20.24
A071	9	7	3.53	74	43.14	9.54	**A171**	23	4	0.92	4	0.92	0.81
A072	98	8	2.66	17	4.38	2.21	**A172**	15	0	0	1	0.18	0.03
A073	107	6	1.65	14	5.99	1.9	**A173**	633	64	21.76	113	45.87	20.11
A074	1,561	323	159	471	273.1	145.8	**A174**	87	8	2.32	13	4.47	2.3
A075	25	0	0.48	0	0.48	0.37	**A175**	55	7	1.82	11	3.4	1.66
A076	31	1	0.82	1	0.82	0.64	**A176**	16	6	3.06	5	2.59	1.67
A077	228	24	4.63	35	11.11	4.32	**A177**	322	34	10.17	49	29.07	12.95
A078	138	12	2.65	15	3.55	1.92	**A178**	674	63	20.58	138	61.65	21.72
A079	224	27	4.58	42	18.76	4.91	**A179**	20	6	1.51	7	2.54	1.17
A080	67	7	1.34	14	4.26	1.58	**A180**	34	7	3.53	8	4.69	2.82
A081	81	8	1.44	10	2.78	1.45	**A181**	77	22	11.31	28	15	9.76
A082	297	50	11.53	56	16.5	10.94	**A182**	299	38	7.87	57	18.96	8.16
A083	60	9	2.4	11	3.33	2.13	**A183**	197	55	31.68	93	65	31
A084	17	2	1.06	3	1.31	0.8	**A184**	167	16	3.91	34	15.72	5.14
A085	423	158	109.1	276	262.1	113.7	**A185**	6	0	0	0	0	0
A086	295	40	13.2	82	30.86	13.53	**A186**	72	13	3.14	15	4.4	2.72
A087	157	12	6.2	13	5.67	3.88	**A187**	244	21	6.74	34	14.79	7.64
A088	15	0	0	1	0.35	0.06	**A188**	47	3	0.89	3	0.89	0.62
A089	43	2	2.29	6	3.59	2.09	**A189**	19	1	0.9	1	0.9	0.52
A090	6	0	0	0	0	0	**A190**	16	1	0.84	2	1.62	0.63
A091	151	7	1.4	8	2.37	1.55	**A191**	159	14	3	21	5.81	2.66
A092	75	12	5.73	26	11.15	4.87	**A192**	121	4	1.49	8	2.61	1.35
A093	3	0	0	0	0	0	**A193**	285	34	9.11	62	22.81	9.79
A094	26	0	0	4	6.48	2.4	**A194**	97	17	5.41	22	10.38	5.79
A095	47	2	0.55	2	0.55	0.45	**A195**	84	12	4.67	17	6.68	4.38
A096	10	2	0.18	2	0.18	0.18	**A196**	292	55	34.32	89	59.36	27.86
A097	80	10	2.33	16	5.19	2.36	**A197**	1,019	119	68.17	186	112.2	61.54
A098	242	36	13.5	47	19.4	11.2	**A198**	138	13	3.01	20	6.2	2.53
A099	380	81	50.32	112	82.73	44.66	**A199**	14	1	0.47	1	4.71	1.7
A100	81	9	1.92	16	4.94	1.55	**A200**	162	17	3.92	27	8.3	4.04

The normalization of the initial decision matrix was accomplished using Equation (2) due to the fact that all criteria were benefit oriented. Given the large number of alternatives, the tables presenting the calculation results were provided in the form of a condensed list. The normalized values of the initial decision matrix are presented in Table 5.

Table 5. Normalized decision matrix

	C1	**C2**	**C3**	**C4**	**C5**	
A001	0.09606	0.10053	0.07904	0.09189	0.06393	0.07129
A002	0.14409	0.15079	0.13247	0.13514	0.11382	0.13170
A003	0.09942	0.06614	0.02259	0.06667	0.02136	0.02301
⋮	⋮	⋮	⋮	⋮	⋮	⋮
A198	0.06580	0.03439	0.01009	0.03604	0.01213	0.00956
A199	0.00624	0.00265	0.00158	0.00180	0.00921	0.00642
A200	0.07733	0.04497	0.01314	0.04865	0.01624	0.01526

Percentage Value (PV) for each criterion was calculated by means of Equation (3) and the objective weight for each criterion was calculated by means of Equation (4). The calculated PV values and criteria weights are emerged as follows indicated in Table 6.

Table 6. PV values and criterion weights

	C1	**C2**	**C3**	**C4**	**C5**	**C6**
PV	19.4441	14.4070	9.2297	14.4367	9.5137	9.3818
w	0.2545	0.1885	0.1208	0.1889	0.1245	0.1228

4.3. Ordering the Turkish Universities by CRADIS Method

Since all the criteria are benefit oriented, the normalized decision matrix in Table 7 was created by applying Equation (6) based on the values in Table 4.

Table 7. Normalized decision matrix

	C1	C2	C3	C4	C5	C6
A001	0.09650	0.10053	0.07904	0.09189	0.06393	0.07129
A002	0.14450	0.15079	0.13247	0.13514	0.11382	0.13170
A003	0.09986	0.06614	0.02259	0.06667	0.02136	0.02301
⋮	⋮	⋮	⋮	⋮	⋮	⋮
A198	0.06580	0.03439	0.01009	0.03604	0.01213	0.00956
A199	0.00624	0.00265	0.00158	0.00180	0.00921	0.00642
A200	0.07733	0.04497	0.01314	0.04865	0.01624	0.01526

By means of Equation (7), normalized decision matrix was weighted and this weighted matrix was emerged as indicated in Table 8.

Table 8. Weighted normalized decision matrix

	C1	C2	C3	C4	C5	C6
A001	0.02455	0.01895	0.00955	0.01736	0.00796	0.00875
A002	0.03677	0.02843	0.01600	0.02553	0.01417	0.01617
A003	0.02541	0.01247	0.00273	0.01260	0.00266	0.00282
⋮	⋮	⋮	⋮	⋮	⋮	⋮
A198	0.01686	0.00648	0.00122	0.00681	0.00151	0.00117
A199	0.00171	0.00050	0.00019	0.00034	0.00115	0.00079
A200	0.01979	0.00848	0.00159	0.00919	0.00202	0.00187

The ideal and anti-ideal solutions calculated by using Equation (8) and Equation (9) wa indicated in Table 9. Here, t_i represents the maximum and t_{ai} represents the minimum value of each criterion.

Table 9. Ideal (t_i) and anti-ideal (t_{ai}) solutions of criteria

	C1	C2	C3	C4	C5	C6
t_i	0.25446	0.18854	0.12079	0.18893	0.12450	0.12278
t_{ai}	0.00012	0.00000	0.00000	0.00000	0.00000	0.00000

Deviations from ideal solutions (d^+) and deviations from anti-ideal solutions (d^-) were calculated with Equation (10) and Equation (11) subsequently. The results obtained are summarized in Table 10 and Table 11.

Table 10. Deviations from ideal solutions (d^+)

	C1	C2	C3	C4	C5	C6
A001	0.22991	0.16959	0.11124	0.17157	0.11654	0.11402
A002	0.21769	0.16011	0.10479	0.16340	0.11033	0.10661
A003	0.22905	0.17607	0.11806	0.17633	0.12184	0.11995
⋮	⋮	⋮	⋮	⋮	⋮	⋮
A198	0.23760	0.18206	0.11957	0.18212	0.12299	0.12160
A199	0.25275	0.18804	0.12060	0.18859	0.12336	0.12199
A200	0.23467	0.18006	0.11920	0.17974	0.12248	0.12090

Table 11. Deviations from anti-ideal solutions (d^-)

	C1	C2	C3	C4	C5	C6

A001	0.02443	0.01895	0.00955	0.01736	0.00796	0.00875
A002	0.03665	0.02843	0.01600	0.02553	0.01417	0.01617
A003	0.02529	0.01247	0.00273	0.01260	0.00266	0.00282
⋮	⋮	⋮	⋮	⋮	⋮	⋮
A198	0.01674	0.00648	0.00122	0.00681	0.00151	0.00117
A199	0.00159	0.00050	0.00019	0.00034	0.00115	0.00079
A200	0.01967	0.00848	0.00159	0.00919	0.00202	0.00187

The grade of the deviation from ideal solution (S_i^+) and the grade of the deviation from ant-ideal solution (S_i^-) for each alternative were calculated with Equation (12) and Equation (13) successively. Afterwards, Equation (14) and Equation (15) were implemented in order to calculate the utility function ($K_i^+ \; and \; K_i^-$) for each alternative. Ultimately, average deviation of the alternatives (Q_i) from the degree of utility was deducted by Equation (16) and the alternatives are ordered according to descending value. The values of integrated results are as summarized in Table 12.

Table 12. Integrated results

	S_i^+	S_i^-	K_i^+	K_i^-	Q_i	Order
A001	0.91287	0.08701	0.11897	0.09762	0.10829	54
⋮	⋮	⋮	⋮	⋮	⋮	⋮
A020	0.33908	0.66080	0.32028	0.74140	0.5308	5
⋮	⋮	⋮	⋮	⋮	⋮	⋮
A057	0.20420	0.79568	0.53184	0.89274	0.71229	2
A058	0.63403	0.36585	0.17129	0.41047	0.29088	10
⋮	⋮	⋮	⋮	⋮	⋮	⋮
A074	0.28932	0.71056	0.37537	0.79724	0.58631	4
⋮	⋮	⋮	⋮	⋮	⋮	⋮
A085	0.61480	0.38508	0.17664	0.43205	0.30435	8
⋮	⋮	⋮	⋮	⋮	⋮	⋮
A106	0.23745	0.76243	0.45737	0.85544	0.65640	3
⋮	⋮	⋮	⋮	⋮	⋮	⋮
A109	0.39623	0.60365	0.27409	0.67729	0.47569	6
⋮	⋮	⋮	⋮	⋮	⋮	⋮
A117	0.62056	0.37932	0.17500	0.42559	0.30030	9
⋮	⋮	⋮	⋮	⋮	⋮	⋮
A133	0.45500	0.54488	0.23868	0.61135	0.42502	7
⋮	⋮	⋮	⋮	⋮	⋮	⋮
A160	0.10860	0.89128	1.00000	1.00000	1.00000	1
⋮	⋮	⋮	⋮	⋮	⋮	⋮
A200	0.95706	0.04282	0.11347	0.04804	0.08076	83

4.4. Sensitivity Analysis

Following up the study carried out with the CRADIS method to determine the success order of 200 universities, 50 different weight values were calculated for each criterion by using Equation 17. The gradual change of weights for these criteria is illustrated in Figure 2.

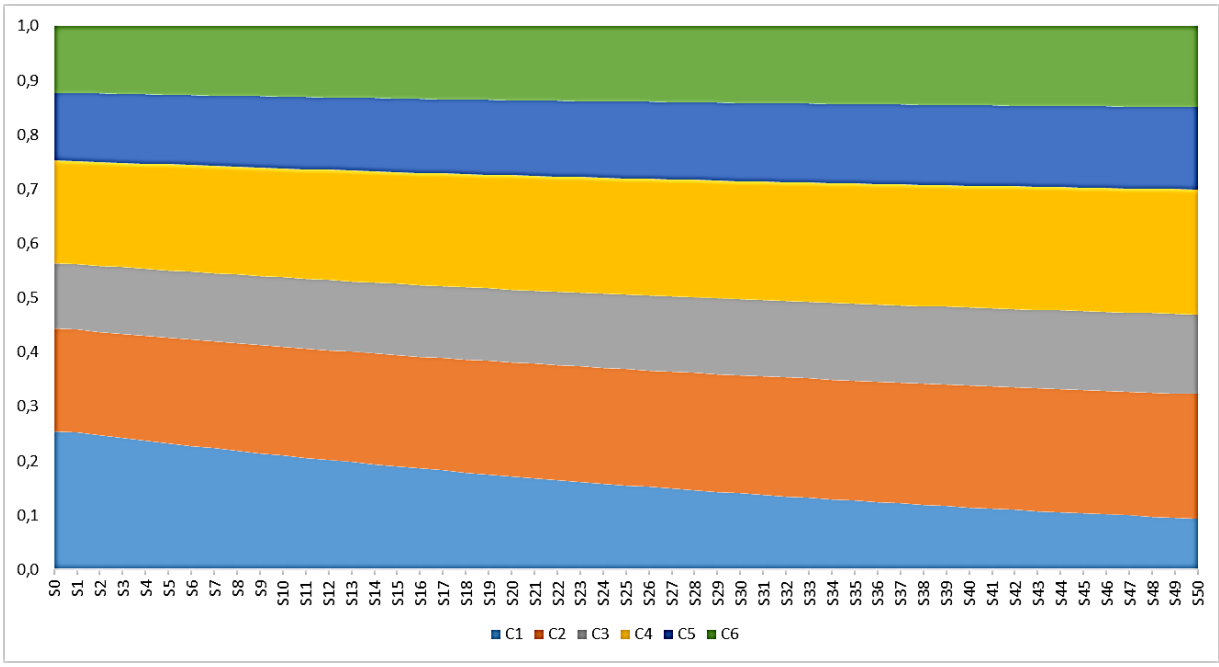

Figure 2. Change of criterion weights

According to the change of criterion in Figure 2, the value of the C1, which has the highest value and is indicated in dark grey, has been reduced by 1% at the first step and by 2% in the following steps. Meanwhile, total value of the weights was maintained as 1. In response to the decrease in the weight of the C1 criterion, increases in the weights of remaining criteria are explicitly visible. According to the changes of these criteria, different order results of universities emerged as indicated in Figure 3. Due to the large number of alternatives, only the orders of the top ten universities are illustrated.

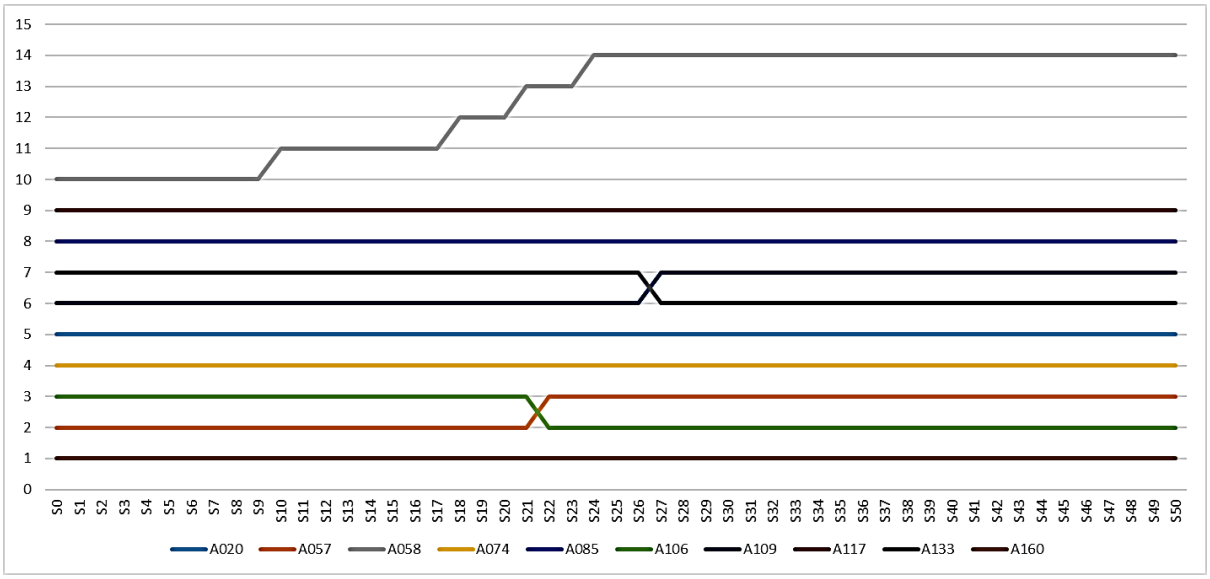

Figure 3. Sensitivity analysis

5. Results

Since the success ranking of universities is calculated according to article score, citation score, scientific document score, doctorate score, academic staff and student score, international cooperation score, domestic cooperation

score and TÜBITAK project score, performance analyses of 200 universities operating in Türkiye was handled in this study in terms of ARDEB funds for the years between 2017 and 2021.

Within the scope of the research, LOPCOW method was used in order to weight 6 benefit oriented criteria, and the CRADIS method was applied for performance evaluation of 200 Turkish universities by using the data obtained from TÜBİTAK.

According to the results derived from LOPCOW method, "Number of Project Submissions Between the Years of 2017-2021" (C1) emerged as the prominent criteria. "Number of Ongoing Projects Between the Years of 2017-2021" (C4), "Number of Projects Decided to be Supported Between the Years of 2017-2021" (C2), "Total Budget of Ongoing Projects Between the Years of 2017-2021" (C5), "Total Budget Transferred to the Ongoing Projects Between the Years of 2017-2021" (C6) followed the most important criterion. Consequently, "Total Budget of Projects Decided to be Supported Between the Years of 2017-2021"(C3) was determined as the least important criterion among the others. Consequently, the importance level for each criterion can be ordered as; C1>C4>C2>C5>C6>C3. The sum of final weights of each criterion in Table 6 equals to 1.000 and therefore, meets the required condition.

The final results derived by CRADIS method reveal that Middle East Technical University (A160) demonstrates a superior performance among 200 universities in terms of project submission and project execution capacities. Middle East Technical University was followed by Ege University (A057), İstanbul Technical University (A106), Hacettepe University (A074), Ankara University (A020), İstanbul University (A109), Koç University (A133), İhsan Doğramacı Bilkent University (A085), İzmir Institute of Technology (A117) and Erciyes University (A058) in the top ten order respectively. Universities among the last ten institutions in the order are Ankara Music and Fine Arts University, İstanbul Atlas University, Toros University, İstanbul Şişli Vocational School, İstanbul Esenyurt University, Alanya Hamdullah Emin Paşa University, Çağ University, İstanbul Topkapı University, Namık Kemal University and Ankara Science University.

According to the sensitivity analysis illustrated in Figure 3, Middle East Technical University (A160) maintains its order as well as Hacettepe University (A074), Ankara University (A020), İhsan Doğramacı Bilkent University (A085) and izmir Institute of Technology (A117) in all cases of scenarios. Furthermore, the order of Ege University (A057) and İstanbul Technical University (A106) is altered only after 21st scenario while the order of İstanbul University (A109) and Koç University (A133) is interchanged only after 26th scenario. Erciyes University (A058) maintains its order till the 10th scenario but releases its consistency beginning from that stage. In conclusion, the method implemented to order 200 universities reveals a quite stable performance under variable criterion weights.

6. Discussion

TÜBİTAK is a leading informatory and participatory institution in the field of science and technology who aims to increase the life quality of the society and to ensure sustainable development in Türkiye. In addition to fostering academic and industrial R&D studies, it also operates several R&D institutes itself. The domestic and international academic activities of scientists are supported and encouraged with plenty of scholarships and awards. By the way, it is aimed to increase the competitiveness of Türkiye by funding the projects of Turkish universities, public institutions and industry. Generating qualified knowledge and enhancing qualified human resources while supporting the national science, technology and innovation ecosystem are among its main objectives.

The Directorate of Research Support Programs (ARDEB) carries out activities on supporting, conducting and completing scientific research projects with the contribution of ten different scientific research groups and by implementation of several funding programs. One of the target groups of the ARDEB unit is universities. Thanks to numerous funding programs, it makes significant contributions to the research and development activities of our universities.

Project execution skills are an important parameter in determining the success levels of universities. On the other hand, each project framework involves its own set of key criteria that determine the level of success for its own beneficiaries. When analysing the criteria established by TÜBİTAK, it becomes evident that the quantity of project submissions significantly impacts the ranking of universities in terms of performance. It is worth emphasizing that maintaining a high level of compliance with this influential criterion will also yield positive and cumulative effects on other evaluation criteria. Specifically, in the event of an increase in the number of project submissions, the probability of project admission and, consequently, the allocated budgets will naturally exhibit an upward trend.

Taking into account the establishment dates of the top ten universities, it is evident that the history of state universities, as listed, can be traced back to the years ranging from 1933 to 1978. This data suggests that state universities with a significant historical background exhibit a commendable level of academic excellence due to their rich intellectual heritage. However, emerging institutions such as Koç University and İhsan Doğramacı

Bilkent University, established relatively later, have demonstrated noteworthy achievements by prioritizing research and development endeavours.

Although the last ten institutions in the university list were established after 2006, the majority of these universities did not commence their activities until after 2013. The ranking of these universities suggests that newly established institutions require significant effort and a considerable amount of time to establish robust research and development infrastructure. This suggestion is further supported by the fact that the total number of project submissions from the universities in the bottom ten is a mere 30, in contrast to the 1194 submissions made by the Middle East Technical University alone.

In addition, one of the crucial findings of this study is the significance of prioritizing the quality of universities alongside their quantity. While the establishment of new universities through diverse funding sources may seem like a convenient solution, the key concern lies in elevating the academic proficiency of universities to attain national and international competitiveness.

7. Conclusion

Given the significance of project activities in the present-day context, the objective of this study was to assess the performance of 200 universities in terms of their capabilities in project submission and implementation within the framework of ARDEB funds. To achieve this, the LOPCOW and CRADIS methods were employed. Consequently, the scope of this investigation is limited to the supports provided by the Directorate of Research Support Programs (ARDEB), a department operating under TÜBİTAK. It is worth noting that the methods utilized in this research can also be employed to evaluate the performance of beneficiaries who submit projects to the Directorate of Support Programs for Scientists (BİDEB) and to the Directorate of Technology and Innovation Support Programs (TEYDEB) at TÜBİTAK, and Scientific Research Grants provided by The Council of Higher Education (YÖK). Moreover, these methods can serve as a project evaluation tool for institutions such as the Small and Medium Enterprises Development Organization (KOSGEB), the Agriculture and Rural Development Support Institution (TKDK), and Regional Development Agencies, all of which play a significant role in project financing in Türkiye.

Conflicts of Interest

The author declares that there is no conflict of interest.

References

Alabay, E., Can, B. H., Kandemir, A. B. & Güney, K. (2018). An Analysis of the Curious Little Child Magazine Published by TÜBİTAK in Terms of Values, *Journal of Values Education*, 16(35): 7-26. https://ded.dem.org.tr/tr/makale/tubitak-tarafindan-yayinlanan-merakli-minik-cocuk-dergisinin-degerler-acisindan-incelenmesi.

Alakaş, H. M., Yazıcı, E., Ebiri, U., Kızılay, B. A., & Oruç, O. (2024). Havya setlerin seçimi için karşılaştırmalı çok kriterli karar verme yaklaşımı. Journal of Turkish Operations Management, 8(1), 140–156. https://doi.org/10.56554/jtom.1260377.

Biswas, S., Bandyopadhyay, G. & Mukhopadhyaya, J. N. (2022). A Multi-Criteria Based Analytic Framework for Exploring the Impact of Covid-19 on Firm Performance in Emerging Market, *Decision Analytics Journal*, 5: 100143. https://doi.org/10.1016/j.dajour.2022.100143.

Biswas, S., Datta, D. & Kar, S. (2023). Energy Efficiency and Environmental Sustainability: A Multi-Criteria Based Comparison of BRICS and G7 Countries*, Emerging Technology and Management Trends in Environment and Sustainability*: 107. https://doi.org/10.4324/9781003356233.

Božanić, D., Pamucar, D., Badi, I. & Tešić, D. (2022). A Decision Support Tool for Oil Spill Response Strategy Selection: Application of LBWA and Z MABAC Methods, *OPSEARCH*, 60. https://doi.org/10.1007/s12597-022-00605-0.

Cheng, R., Fan, J., Wu, M., & Seiti, H. (2024). A large-scale multi-attribute group decision-making method with R-numbers and its application to hydrogen fuel cell logistics path selection. *Complex & Intelligent Systems*, *10*(4), 5213–5260. https://doi.org/10.1007/s40747-024-01437-9.

Chowdhury, S. R., Chatterjee, S., & Chakraborty, S. (2024). Optimization of grinding processes using multi-criteria decision making methods in intuitionistic fuzzy environment. *OPSEARCH*, *61*(2), 709–740. https://doi.org/10.1007/s12597-024-00741-9.

Das, A., Chaudhuri, T., Sinha, S., Biswas, S., & Guha, B. (2023). Selection of Appropriate Portfolio Optimization Strategy. *Theoretical and Applied Computational Intelligence*, *1*, 58–81. https://doi.org/10.31181/taci1120237.

Dhruva, S., Krishankumar, R., Zavadskas, E. K., Ravichandran, K. S., & Gandomi, A. H. (2024). Selection of Suitable Cloud Vendors for Health Centre: A Personalized Decision Framework with Fermatean Fuzzy Set, LOPCOW, and CoCoSo. *Informatica*, *35*(1), 65–98. https://doi.org/10.15388/23-INFOR537.

Dua, T. V. (2023). Combination of Symmetry Point of Criterion, Compromise Ranking of Alternatives from Distance to Ideal Solution and Collaborative Unbiased Rank List Integration Methods for Woodworking Machinery Selection for Small Business in Vietnam, *EUREKA: Physics and Engineering*, 2: 83-96. https://doi.org/doi.10.21303/2461-4262.2023.002763.

Ecer, F., Küçükönder, H., Kayapınar Kaya, S. & Faruk Görçün, Ö. (2023). Sustainability Performance Analysis of Micro-Mobility Solutions in Urban Transportation with a Novel IVFNN-Delphi-LOPCOW-Cocoso Framework, *Transportation Research Part A: Policy and Practice*, 172: 103667. https://doi.org/10.1016/j.tra.2023.103667.

Ecer, F. & Pamucar, D. (2022). A novel LOPCOW-DOBI Multi-Criteria Sustainability Performance Assessment Methodology: An Application in Developing Country Banking Sector, *Omega*, 112: 102690. https://doi.org/10.1016/j.omega.2022.102690.

Hwang, C.-L., & Yoon, K. (1981). *Multiple attribute decision making: Methods and applications: A state-of-the-art survey*. Springer-Verlag. https://link.springer.com/book/10.1007/978-3-642-48318-9.

Keshavarz-Ghorabaee, M., Amiri, M., Zavadskas, E. K., Turskis, Z. & Antucheviciene, J. (2021). Determination of Objective Weights Using a New Method Based on the Removal Effects of Criteria (MEREC), *Symmetry*, 13(4): 1-20. https://doi.org/10.3390/sym13040525.

Konur, K. B. & Yazıcı, A. (2022). Evaluation of 4006 TUBITAK Science Fairs in Terms of Science Teachers, *Education Quarterly Reviews*, 5(3): 180-194. https://doi.org/DOI: 10.31014/aior.1993.05.03.537.

Krishankumar, R., Dhruva, S., Ravichandran, K. S., & Kar, S. (2024). Selection of a viable blockchain service provider for data management within the internet of medical things: An MCDM approach to Indian healthcare. *Information Sciences*, *657*, 119890. https://doi.org/10.1016/j.ins.2023.119890.

Krishankumar, R., & Ecer, F. (2023). Selection of IoT service provider for sustainable transport using q-rung orthopair fuzzy CRADIS and unknown weights. *Applied Soft Computing*, *132*, 109870. https://doi.org/10.1016/j.asoc.2022.109870.

Li, X., Wang, K., Liu, L., Xin, J., Yang, H. & Gao, C. (2011). Application of the Entropy Weight and TOPSIS Method in Safety Evaluation of Coal Mines, *ISMSSE2011*, 26: 2085-2091. https://doi.org/10.1016/j.proeng.2011.11.2410.

Lukić, R. (2023). Research of the economic positioning of the Western Balkan countries using the LOPCOW and EDAS methods. *Journal of Engineering Management and Competitiveness*, *13*, 106–116. https://doi.org/10.5937/JEMC2302106L.

Mukhametzyanov, I. & Pamucar, D. (2018). A Sensitivity Analysis in MCDM Problems: A Statistical Approach, *Decision Making: Applications in Management and Engineering*, 2: 1-20. https://doi.org/10.31181/dmame1802050m.

Nila, B., & Roy, J. (2023). A new hybrid MCDM framework for third-party logistics provider selection under sustainability perspectives. *Expert Systems with Applications*, *234*, 121009. https://doi.org/10.1016/j.eswa.2023.121009.

Pamucar, D., Zizovic, M., Biswas, S. & Božanić, D. (2021). A New Logarithm Methodology of Additive Weights (LMAW) For Multi-Criteria Decision-Making: Application in Logistics, *Facta Universitatis Series Mechanical Engineering*, 19(3): 361-380. https://doi.org/10.22190/FUME210214031P.

Pilav, S. & Orhan, S. (2020). Examination of TÜBİTAK Children's Books for the Ages 6 - 12 in Terms of Values Education, *Manisa Celal Bayar University Journal of Social Sciences*, 18(33): 434-453. https://doi.org/10.18026/cbayarsos.759891.

Puška, A., Štilić, A., Božanić, D., Đurić, A., & Marinkovic, D. (2023). Selection of EVs as Tourist and Logistic Means of Transportation in Bosnia and Herzegovina's Nature Protected Areas Using Z-Number and Rough Set Modeling. *Discrete Dynamics in Nature and Society*, *2023*(1), 5977551. https://doi.org/10.1155/2023/5977551.

Puška, A., Božanić, D., Mastilo, Z. & Pamučar, D. (2023). Extension of MEREC-CRADIS Methods with Double Normalization-Case Study Selection of Electric Cars, *Soft Computing*. https://doi.org/10.1007/s00500-023-08054-7.

Puška, A., Stević, Ž. & Pamučar, D. (2022). Evaluation and Selection of Healthcare Waste Incinerators Using Extended Sustainability Criteria and Multi-Criteria Analysis Methods, *Environment, Development and Sustainability*, 24(9): 11195-11225. https://doi.org/10.1007/s10668-021-01902-2.

Rong, Y., Yu, L., Liu, Y., Simic, V., & Garg, H. (2023). The FMEA model based on LOPCOW-ARAS methods with interval-valued Fermatean fuzzy information for risk assessment of R&D projects in industrial robot offline programming systems. *Computational and Applied Mathematics*, *43*(1), 25. https://doi.org/10.1007/s40314-023-02532-2.

Setiawansyah, S., & Sulistiyawati, A. (2024). Penerapan Metode Logarithmic Percentage Change-Driven Objective Weighting dan Multi-Attribute Utility Theory dalam Penerimaan Guru Bahasa Inggris. *Journal of Artificial Intelligence and Technology Information*, *2*(2), 62–75. https://doi.org/10.58602/jaiti.v2i2.119.

Simic, V., Dabic-Miletic, S., Tirkolaee, E. B., Stević, Ž., Ala, A., & Amirteimoori, A. (2023). Neutrosophic LOPCOW-ARAS model for prioritizing industry 4.0-based material handling technologies in smart and sustainable warehouse management systems. *Applied Soft Computing*, *143*, 110400. https://doi.org/10.1016/j.asoc.2023.110400.

Starčević, V., Petrović, V., Mirović, I., Tanasić, L. Ž., Stević, Ž. & Đurović Todorović, J. (2022). A Novel Integrated PCA-DEA-IMF SWARA-CRADIS Model for Evaluating the Impact of FDI on the Sustainability of the Economic System, *Sustainability*, 14(20). https://doi.org/10.3390/su142013587.

Stević, Ž., Pamučar, D., Puška, A., & Chatterjee, P. (2020). Sustainable supplier selection in healthcare industries using a new MCDM method: Measurement of alternatives and ranking according to COmpromise solution (MARCOS). *Computers & Industrial Engineering*, *140*, 106231. https://doi.org/10.1016/j.cie.2019.106231.

TÜBİTAK (2023). Retrieved from https://www.tubitak.gov.tr/tr/destekler/akademik/ulusal-destek-programlari/icerik-akademik-destek-istatistikleri, (Access: 03.05.2023).

TÜBİTAK (2024). Retrieved from https://tubitak.gov.tr/sites/default/files/ardeb_kitapcigi.pdf, (Access: 29.08.2024).

Decree on the Amendment of Certain Articles of the Law on the Establishment of the Scientific and Technical Research Council of Turkey, 1993, Substance 1. https://www.resmigazete.gov.tr/arsiv/21693.pdf.

Law on Some Regulations Regarding the Scientific and Technological Research Council of Turkey, 1963, Substance 1. https://www.mevzuat.gov.tr/MevzuatMetin/1.5.278.pdf.

URAP (2023). Retrieved from https://newtr.urapcenter.org, (Access: 03.05.2023).

Wang, W., Wang, Y., Fan, S., Han, X., Wu, Q., & Pamucar, D. (2023). A complex spherical fuzzy CRADIS method based Fine-Kinney framework for occupational risk evaluation in natural gas pipeline construction. *Journal of Petroleum Science and Engineering*, *220*, 111246. https://doi.org/10.1016/j.petrol.2022.111246.

Xu, M., Bai, C., Shi, L., Puška, A., Štilić, A., & Stević, Ž. (2023). Assessment of Mountain Tourism Sustainability Using Integrated Fuzzy MCDM Model. *Sustainability*, *15*(19). https://doi.org/10.3390/su151914358.

Yazdani, M., Zaraté, P., Zavadskas, E. K. & Turskis, Z. (2018). A Combined Compromise Solution (CoCoSo) Method for Multi-Criteria Decision-Making Problems, *Management Decision*, 57(9): Article 3. https://doi.org/10.1108/MD-05-2017-0458.

Zavadskas, E. K. & Podvezko, V. (2016). Integrated Determination of Objective Criteria Weights in MCDM, *International Journal of Information Technology & Decision Making*, 15(2): 267-283. https://doi.org/10.1142/S0219622016500036.

Zavadskas, E. K., & Turskis, Z. (2010). A New Additive Ratio Assessment (ARAS) Method in Multicriteria Decision-Making. *Technological and Economic Development of Economy*, *16*(2), Article 2. https://doi.org/10.3846/tede.2010.10.