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Performance Analysis of Regional Development Agencies by LMAW-DNMA Methods

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Bölgesel Kalkınma Ajanslarının LMAW-DNMA Yöntemi ile Performans Analizi	**Performance Analysis of Regional Development Agencies by LMAW-DNMA Methods**
Öz Bu çalışmada, Türkiye'de faaliyet gösteren 26 adet Bölgesel Kalkınma Ajansının (BKA), kar amacı güden ve kar amacı gütmeyen kurumlara yönelik finansal destekleri açısından performansları incelenmiştir. Logarithm Methodology of Additive Weights (LMAW) yöntemi ile 9 adet kriterin ağırlıkları belirlenmiş olup Double Normalization-based Multiple Aggregation (DNMA) yöntemi ile Bölgesel Kalkınma Ajanslarının performans sıralamaları ortaya çıkarılmıştır. Kar amacı gütmeyen kurumlara yönelik mali destek programları açısından İstanbul Kalkınma Ajansı en başarılı Bölgesel Kalkınma Ajansı olarak belirlenmiştir. Bununla birlikte, kar amacı güden kurumlara yönelik mali destek programı açısından Çukurova Kalkınma Ajansı en başarılı performansı göstermiştir.	**Abstract** In this study, the performances of 26 Regional Development Agencies (RDAs) operating in Türkiy in terms of financial support for for-profit and non-profit organisations were examined. The weights of 9 criteria were determined with the Logarithm Methodology of Additive Weights (LMAW) method, and the performance order of the Regional Development Agencies was revealed with the Double Normalization-based Multiple Aggregation (DNMA) method. Istanbul Development Agency was determined as the most successful Regional Development Agency in terms of financial support programs for non-profit organisations. However, Çukurova Development Agency has shown the most successful performance in terms of the financial support programme for for-profit organisations.
Anahtar Kelimeler: Bölgesel Kalkınma Ajansı, Mali Destek Programı, Çok Kriterli Karar Verme, LMAW, DNMA	**Keywords:** Regional Development Agency, Financial Support Programme, Multi-Criteria Decision Making, LMAW, DNMA
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1. Introduction

Regional Development Agencies, the first applications of which were encountered in the United States of America (USA) in the 1930s, are among the most substantial regional and local development actors in many developed countries, especially in the European Union (EU) region. Even though the Development Agencies put forward different approaches individually, the aims of their entity can be generalized as guiding development policies and increasing the competitiveness of the region they are founded (*Avrupa Birliğinde Kalkınma Ajansları*, 2018; 1).

In order to provide information to development programs led by the central government and to supervise the implementation and monitoring of these plans, Regional Development Agencies were founded in the 1950s and 1960s. The importance of Regional Development Agencies has started to increase within the scope of ascending local competition with the understanding of public management and globalization that became widespread in the 1980s. These agencies were tasked with ensuring the active participation of the private sector and local shareholders in the regional development process. In the 1950s, Austria, Belgium, Ireland and France met with Regional Development Agencies. In the 1960s, Germany, Netherlands, England and Italy, and in the 1980s, Greece, Spain, Finland and Denmark started to adopt these institutions (Özen, 2005; 4).

The main mission of the Regional Development Agencies in Türkiye, which started to be established in the 2000s within the scope of Law No. 5449, can be listed as (Kalkınma Ajanslarının Kuruluşu, Koordinasyonu ve Görevleri Hakkında Kanun, 2006);

- to establish cooperation among the public sector, the private sector and civil society organisations,
- to expedite the regional development process in line with the principles and policies stated in the national development plan and programs by ensuring the appropriate and effective use of resources and actuating local potential,
- to ensure sustainability,
- to minimize inter-regional and intra-regional development disparities.

Çukurova and İzmir Development Agencies, which started their activities in 2006, are the first two Development Agencies in Türkiye and have been designed as a pilot scheme. Depending on the positive results obtained from these pilot schemes, 24 other Regional Development Agencies were additionally established in the following years.

The Nomenclature of Territorial Units for Statistics (NUTS) is one of the criteria that Türkiye is obliged to fulfil in the EU membership process. The aim of the application is defined as; the determination of regional policy framework, socio-economic analysis of the regions and generation of regional statistical data comparable at the European level. From this point of view, NUTS-II regions in Türkiye were associated with Regional Development Agencies and each Regional Development Agencies is responsible for one NUTS-II region as indicated in Table 1 and Figure 1.

Table 1. List of Regional Development Agencies in Türkiye

NUTS-II	Provinces	Regional Development Agency
TR31	İzmir	İzmir RDA
TR62	Adana-Mersin	Çukurova RDA
TR52	Karaman-Konya	Mevlana RDA
TR83	Amasya-Çorum-Samsun-Tokat	Middle Black Sea RDA
TRB2	Bitlis-Hakkâri-Muş-Van	Eastern Anatolia RDA
TRC1	Adıyaman-Gaziantep-Kilis	Silk Road RDA
TRC3	Batman-Mardin-Şırnak-Siirt	Tigris RDA
TR10	İstanbul	İstanbul RDA
TRC2	Diyarbakır-Şanlıurfa	Karacadağ RDA
TRA1	Bayburt-Erzincan-Erzurum	Northeast Anatolia RDA
TR21	Edirne-Kırklareli-Tekirdağ	Thrace RDA
TR22	Balıkesir-Çanakkale	Southern Marmara RDA
TR32	Aydın-Denizli-Muğla	Southern Aegean RDA
TR33	Afyonkarahisar-Kütahya-Manisa-Uşak	Zafer RDA
TR41	Bilecik-Bursa-Eskişehir	Bursa Eskişehir Bilecik RDA
TR42	Bolu-Düzce-Kocaeli-Sakarya-Yalova	Eastern Marmara RDA
TR51	Ankara	Ankara RDA
TR61	Antalya-Burdur-Isparta	West Mediterranean RDA
TR63	Hatay-Kahramanmaraş-Osmaniye	Eastern Mediterranean RDA
TR71	Aksaray-Kırıkkale-Kırşehir-Nevşehir-Niğde	Ahiler RDA
TR72	Kayseri-Sivas-Yozgat	Central Anatolia RDA
TR81	Bartın-Karabük-Zonguldak	Western Black Sea RDA
TR82	Çankırı-Kastamonu-Sinop	North Anatolian RDA
TR90	Artvin-Giresun-Gümüşhane-Ordu-Rize-Trabzon	Serhat RDA
TRA2	Ağrı-Ardahan-Iğdır-Kars	Serhat RDA
TRB1	Bingöl-Elazığ-Malatya-Tunceli	Euphrates RDA

Source: (Şimşek, 2013).

Figure 1. Map of NUTS-II Regions in Türkiye

Regional Development Agencies offer financial and technical support to regional shareholders in line with pre-determined criteria to accelerate the region's development process and implement activities of critical importance for the region. These supports are implemented under two topics, as Financial Support and Technical Support, as described below (*Kalkınma Ajansları Destek Yönetimi Kılavuzu*, 2021; 12-106).

Direct Financing Support, which is implemented within the scope of Financial Support, is a type of funding provided by the Regional Development Agencies to specific projects, mainly through the "call for project proposal" method and within the framework of certain rules. However, apart from the call for project proposals, the agency can also provide direct support in the form of "Feasibility Support" and "Guided Project Support".

Funding support is the type of aid served by Regional Development Agencies to cover the financing expenses paid for the loans taken from the relevant intermediary institutions for the projects. Interest-Free Credit Support, on the other hand, is a type of aid for interest-free loans provided by intermediary institutions to applicant companies.

The purpose of Technical Support is to prop up the efforts of local actors in the region for issues related to regional development, which face difficulties during the preparation and implementation phase stemming from a lack of institutional capacity. For this purpose, relevant support is served in subjects such as providing training, contributing to the preparation of programs and projects, assigning temporary expert personnel, receiving consultancy services, lobbying activities and establishing international relations.

Within the scope of this study, the performance of 26 Regional Development Agencies operating in Türkiye is evaluated in terms of Financial Support Programs (FSP) offered between the years 2006-2021 by Logarithm Methodology of Additive Weights (LMAW) and Double Normalization-Based Multiple Aggregation (DNMA) methods. Relevant data is officially requested from the Republic of Türkiye Ministry of Industry and Technology Development Agencies General Directorate. The data provided includes Financial Support Programs implemented for-profit and non-profit organizations, technical support programs and guided project supports applied by 26 Development Agencies. However, only the financial support of for-profit and non-profit organizations is taken into consideration for evaluation and calculated separately.

Regional Development Agencies, one of the most prominent institutions of our country, are legal entities operating in different regions under the coordination of the Ministry of Industry and Technology. The financial support programs they have been implementing since 2006 have triggered the investments of both public institutions and the private sector. However, there has not been any practice to measure the performance of the Regional Development Agencies in terms of these financial support programs implemented. Therefore, it is expected that this study will guide the Ministry of Industry and Technology in the performance measurement of institutions operating within their own structure.

This study, in which the performances of Regional Development Agencies are handled and evaluated as a decision-making problem, is expected to contribute to the literature. Furthermore, it is hoped that the results obtained will guide policymakers.

Within the scope of this research, a comprehensive literature review is presented in Section 2. The framework of the methodology introduced in Section 3 is explained in detail, and thereafter, the case study is examined in Section 4. Sensitivity analysis is illustrated in Section 5, and finally, the results are discussed in Section 6.

2. Literature Review

Decision-making is one of the substantial and fundamental processes for an organization's corporate goals. In this context, it is necessary to establish the targets correctly, determine possible solutions, evaluate them in terms of benefits and costs, and choose and implement the most suitable alternative (Alinezhad and Khalili, 2019; 14). In addition, Multi-Criteria Decision-Making (MCDM) is a set of approaches and techniques that allow ranking alternatives from most preferred to least preferred. The main purpose of the applied methods is not to make the final decision directly but to help with thinking and decision-making (Dodgson et. al., 2009: 46).

There are so many manuscripts about the legal status, history and best practices of Regional Development Agencies, but there is no study realized aiming to measure the performance of these institutions. For this reason, financial support programs, which are one of the main performance indicators of Regional Development Agencies, are discussed within the scope of this study and it is examined which Regional Development Agency performs better in terms of this indicator.

Studies carried out in recent years to examine Regional Development Agencies in Türkiye from various perspectives are as follows;

A study was conducted by Özkan and Boylu (2022) in order to determine the impact and role of the Eastern Anatolia Development Agency (DAKA) in regional development in terms of tourism. As a result, it has been determined that the Eastern Anatolia Development Agency has not set any goals and objectives for tourism, has focused on promotional activities for the region since 2010, has been engaged in activities for archaeological and cultural heritage, and has organized scientific activities to find solutions to the problems of the region in terms of tourism. Within the scope of the project, it has been revealed that DAKA mainly works with public institutions and supports projects for alternative tourism types

In his study, Özışık (2021) determined some inconsistencies between the objectives expected to be realized according to the founding goals of the Regional Development Agencies and the implementation in practice. He also revealed that, even though the foundation of Regional Development Agencies in Türkiye was initially considered a requirement of the adaptation process with the European Union, they became a part of the national policy and centralized management approach over time.

Akbulut and Göküş (2017) aimed to examine the emergence process and effectiveness of Regional Development Agencies, which have become popular actors in the localization process brought about by the globalization phenomenon. Today, when the concepts of globalization and localization maintain their importance, they suggest that Regional Development Agencies should fulfil their institutionalization processes in order to develop participatory development.

Utilizing statistical data, Ultan and Saygın (2016) aimed to make an assessment of to what extent Regional Development Agencies affect Türkiye's regional development and to what extent Regional Development Agencies reach their founding goals. According to the results of their study, it is emphasized that in order to be considered "effective regional development tools" for Regional Development Agencies, the issue of reducing intra-regional disparities should be focused on rather than reducing the disparities between regions.

Although few fuzzy versions have been used in the literature, studies using the LMAW method have not been encountered more than once since it is an extremely new method. Similar to this situation, there are not many manuscripts published in the literature since the DNMA method is a recently introduced method as well.

In order to examine the potential of production systems of the heavy industry branches by means of cyber-physical systems, Görçün and Küçükönder (2022) utilized the LMAW method where the prominent criterion is determined as Overall Equipment Efficiency and the prominent branch of heavy industry is determined as Aerospace Industry.

By means of LMAW and DNMA methods together, Demir (2022) aimed to develop a multi-criteria model to measure and evaluate the performance of the deposit banking sector during the COVID-19 pandemic. The LMAW method was used for the weighting of the criteria, and the DNMA method was used to determine the performance order of the deposit banks.

Within the scope of this method, Pamucar et al. (2021) analysed the performance of six logistics service providers using the criteria of annual overhead expense, annual fuel consumption, cost of delay, innovativeness, average customer rating and turnover. According to the results of the analyse, the applied method resulted in consistent sorting of alternatives which is not affected by rank reversal implementation. By means of this study, the LMAW method is introduced to the literature.

Lai and Liao (2021) introduced a new approach for the evaluation of blockchain platforms by using linguistic D numbers (LDN), Double Normalization-Based Multiple Aggregation (DNMA) method and Criteria Importance through Inter-criteria Correlation (CRITIC) method together. During the implementation of the method, performance efficiency, interactivity, scalability, reliability, security, portability, maintainability, and cost criteria were taken into account for four different blockchain platforms. The CRITIC method is integrated into the LDN-based DNMA method to reveal correlations among criteria in the blockchain platform evaluation process.

The new Double Normalization-Based Multiple Aggregation method is proposed by Liao and Wu (2020) for green enterprise ranking problems and excavation scheme selection problems. This method is a multi-criteria decision-making method that includes benefit, cost and target criteria with quantitative and qualitative features. In this method, linguistic terms can be used. Linear normalization and vector normalization are used together while weight adjustment processes are performed to realize a trade-off between the criteria. The method also proposes a ranking method consisting of three sub-models based on three aggregation techniques.

By taking the DNMA method one step further to address Cloud Service Provider (CSP) selection problem, the Z-DNMA method is developed by Lai et. al. (2020). The weighting method based on the mean square used in the classical DNMA method was altered and the weighting method based on the Gini coefficient was applied. During the implementation of the method, cost, reliability, availability, response time and throughput criteria were taken into account for four different cloud service providers. After the normalization stage, they aimed to improve the applicability and isotonicity of the DNMA method by extending this approach to the Z-number environment level for the trade-off between criteria.

Wu and Liao (2019) conducted a study in order to compare the DNMA method and the TOPSIS, VIKOR and MULTIMOORA methods, which are among the other multi-criteria

decision-making methods based on utility value. Based on the results of this study, since TOPSIS, VIKOR and MULTIMOORA methods are calculated with only one normalization approach, they cause a certain amount of information loss. At the same time, the appropriate combination of normalization and aggregation approaches is not taken into account. The DNMA method, on the other hand, becomes a more advantageous application in terms of flexibility, reliability and simplicity, as it uses different normalization and aggregation approaches.

In order to determine the best methods for healthcare waste management, Saha et. al. (2022) used five alternative methods consisting of chemical disinfection, microwave disinfection, incineration, autoclaving (steam sterilization) and reverse polymerization following up weighting the criteria by means of FUCOM method. The results indicate that autoclaving (steam sterilization) would be the most efficient healthcare waste management method.

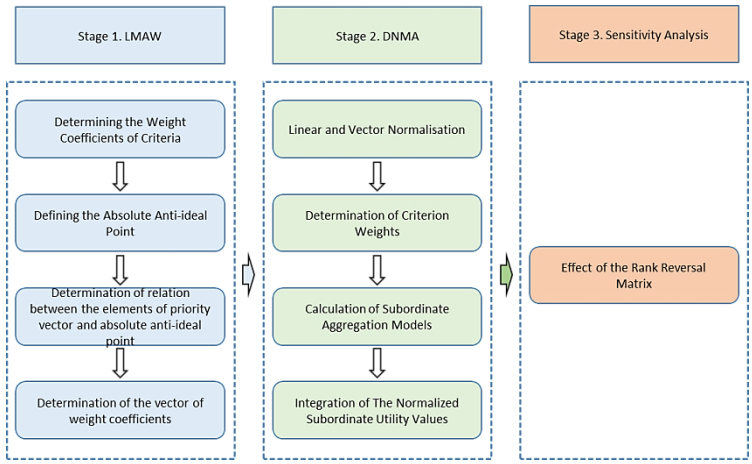
Hezam et. al. (2022) applied the MEREC and RS methods simultaneously in order to evaluate the objective and subjective criteria taken into consideration in the study, which included electric vehicles, hybrid vehicles and hydrogen-powered vehicles as alternatives. Evaluation results revealed that electric vehicles might serve as a prominent alternative to reduce carbon emissions and negative impacts on the environment.

Following up weighting fourteen criteria used to determine the performances of countries in terms of economic freedom with the MEREC method, Ecer and Zolfani (2022) realized the performance ranking of OPEC countries by means of the DNMA method. In the study, the most important indicator of economic freedom emerged as "investment freedom". Among the OPEC countries, the best-performing country in terms of economic freedom was determined to be the United Arab Emirates.

3. Methods

The aim of this study is to measure and evaluate the performance of Regional Development Agencies operating in Türkiye in terms of Financial Support Programs they implement for both non-profit and profit organizations. The data regarding the evaluation criteria used in performance measurement have been determined in line with the official letter sent from the Ministry of Industry and Technology of the Republic of Türkiye. The weights of the criteria were obtained by the LMAW approach, which is one of the new methods in which both qualitative and quantitative data can be used together, and the opinions of decision-makers can be included in the weighting process of the criteria. Afterwards, the financial support performance scores and orders of Regional Development Agencies were obtained by using the DNMA approach, which is a quite new MCDM method. The advantage of this model is that the opinions of experts are included in the analysis by the LMAW method, and on the other hand, the best alternative can be selected by means of the DNMA method using two normalized techniques and three aggregation approaches together. The study consists of three stages. LMAW method, DNMA method and sensitivity analysis were carried out, respectively. The Flowchart of the model covering the applied methods is given in Figure 2.

Figure 2. Flowchart of the Study



3.1 LMAW Method

The LMAW method was introduced to the literature by Pamucar et al. in 2021. Therefore, it is one of the up-to-date methods used for weighting criteria and ordering alternatives. LMAW method was preferred for such reasons that; it provides higher stability compared to similar methods such as TOPSIS, it is quite stable against rank reversal analysis, the mathematical framework of the method remains the same regardless of the number of alternatives and criteria, it is suitable for use in applications that consider different alternatives and criteria, and it allows to use qualitative and quantitative criteria together. The calculations aiming to find the criterion weight coefficients is explained here and the application steps of this method are as follows (Pamucar et. al., 2021).

By participation of k experts $E = \{E_1, E_2, \dots, E_k\}$, m alternatives $A = \{A_1, A_2, \dots, A_m\}$ are evaluated depending on n criteria $C = \{C_1, C_2, \dots, C_n\}$ and by means of a predefined linguistic scale.

Step 1: Determining the Weight Coefficients of the Criteria

Experts in the $E = \{E_1, E_2, \dots, E_k\}$ cluster prioritize the $C = \{C_1, C_2, \dots, C_n\}$ criteria over previously defined linguistic scale values. The prioritization process expressed here assigns a high value to the criterion of high importance and a low value to the criterion of low importance. At the end of the process, the priority vector $P^e = \left(\gamma_{C_1}^e, \gamma_{C_2}^e, \dots, \gamma_{C_n}^e\right)$ is obtained.

Here, $\gamma_{C_n}^e$ represents the linguistic scale value assigned by expert e $(1 \le e \le k)$ to criterion C_t $(1 \le t \le n)$.

Step 1.1: Defining the absolute anti-ideal point (γ_{AIP})

The absolute ideal point (Υ_{AIP}) defined by the minimum values of the priority vector and must be less than the minimum value of the priority vector. The relevant value is calculated by the equation;

$$\Upsilon_{AIP} = \frac{\Upsilon_{min}^e}{s}$$

where Υ_{min}^{e} is the minimum value of the priority vector. The value of s should be greater than the base of the logarithmic function. Thus, if the logarithmic function is considered as Ln function, the s value may be preferred as 3.

Step 1.2: Determination of the relation between the elements of the priority vector and absolute anti-ideal point

By means of Equation (1) below, the relation between the elements of the priority vector and the absolute anti-ideal point is calculated.

$$\eta_{Cn}^{e} = \frac{\Upsilon_{Cn}^{e}}{\Upsilon_{AIP}} \tag{1}$$

Thus and so, the relation vector $R^{e} = (\eta_{C1}^{e}, \eta_{C2}^{e}, \ldots\ldots, \eta_{Cn}^{e})$ is acquired where η_{Cn}^{e} represents the value from the relation vector derived from Equation (1) and R^{e} represents the relation vector of e $(1 \leq e \leq k)$.

Step 1.3: Determination of the vector of weight coefficients $w_j = (w_1, w_2, \ldots\ldots, w_n)^T$

By implementing Equation (2), the values of weight coefficients of the criteria are calculated for expert e $(1 \leq e \leq k)$.

$$w_j^{e} = \frac{\log_A(\eta_{Cn}^{e})}{\log_A\left(\prod_{J=1}^{n} \eta_{Cn}^{e}\right)}, A > 1 \tag{2}$$

η_{Cn}^{e} expression in the equation represents the elements of relation vector R and w_j^{e} indicates the weight coefficients obtained based on the evaluations of the e[th] expert. All the weight coefficients determined should meet the condition of $\sum_{j=1}^{n} w_j^{e} = 1$.

Thereafter, aggregated vector of weight coefficients $w_j = (w_1, w_2, \ldots\ldots, w_n)^T$ is obtained by applying the Bonferroni aggregator as indicated in Equation (3).

$$w_j = \left(\frac{1}{k.(k-1)} . \sum_{x=1}^{k} \left(w_j^{(x)}\right)^{p} . \sum_{\substack{y=1 \\ y \neq x}}^{k} \left(w_{ij}^{(y)}\right)^{q} \right)^{\frac{1}{p+q}} \tag{3}$$

p and q values in the equation are the stabilization parameters of the Bonferonni aggregator where p and $q \geq 0$.

3.2 DNMA Method

The DNMA method, which is one of the up-to-date methods aiming to order alternatives, was introduced to the literature by Liao and Wu (2020). The method takes two different normalizations (linear and vector) techniques and three different aggregations (Complete Compensatory Model-CCM, Un-compensatory Model-UCM, Incomplete Compensatory Model-ICM) functions into account. The advantage of this model is that, the best alternative can be selected by means of two normalized techniques and three aggregation approaches together. This method can deal with quantitative and qualitative criteria simultaneously. Besides, benefit, cost and target-based criteria can be evaluated synchronously. Three aggregation models with different functions also improve the reliability of the method. This method also enables the decision-makers to feel more flexible. That's why this application

renders the decision-making process a robust method compared with other methods. The application steps of this method are as follows (Liao and Wu, 2020):

Step 1: Linear and Vector Normalisation

The decision matrix is normalized by both linear normalization ($\tilde{x}_{ij}^{1N}$) and vector normalization $\left(\tilde{x}_{ij}^{2N}\right)$ by means of Equation (4) and Equation (5), respectively.

$$\tilde{x}_{ij}^{1N} = 1 - \frac{\left|x^{ij} - r_j\right|}{max\left\{\max_i x^{ij}, r_j\right\} - min\left\{\min_i x^{ij}, r_j\right\}} \tag{4}$$

$$\tilde{x}_{ij}^{2N} = 1 - \frac{\left|x^{ij} - r_j\right|}{\sqrt{\sum_{i=1}^{m}(x^{ij})^2 + \left(r_j\right)^2}} \tag{5}$$

The r_j value is the target value for the c_j criterion and will be taken into account as $\max_i x^{ij}$ for benefit-oriented criteria and $\min_i x^{ij}$ for cost-oriented criteria.

Step 2: Determination of Criterion Weights

Determination of criterion weights step is applied in 3 phases.

Step 2.1: Standard deviation (σ_j) of the criterion c_j is determined by Equation (6) where m indicates the number of alternatives.

$$\sigma_j = \sqrt{\frac{\sum_{i=1}^{m}\left(\frac{x^{ij}}{\max_i x^{ij}} - \frac{1}{m}\sum_{i=1}^{m}\left(\frac{x^{ij}}{\max_i x^{ij}}\right)\right)^2}{m}} \tag{6}$$

Step 2.2: Normalization of the standard deviation values calculated for the criteria by Equation (7).

$$w_j^{\sigma} = \frac{\sigma_j}{\sum_{i=1}^{n}\sigma_j} \tag{7}$$

Step 2.3: Adjust the criterion weights by Equation (8).

$$\widetilde{w}_j = \frac{\sqrt{w_j^{\sigma}.w_j}}{\sum_{i=1}^{n}\sqrt{w_j^{\sigma}.w_j}} \tag{8}$$

Step 3: Calculation of Subordinate Aggregation Models

CCM (complete compensatory model), UCM (uncompensatory model) and ICM (incomplete compensatory model) aggregation models are calculated individually for each alternative based on the two normalization methods applied.

CCM, UCM and ICM are calculated by Equation (9), Equation (10) and Equation (11), respectively.

$$u_1(a_i) = \sum_{j=1}^{n}\frac{\widetilde{w}_j.\tilde{x}_{ij}^{1N}}{\max_i \tilde{x}_{ij}^{1N}} \tag{9}$$

$$u_2(a_i) = \max_j \tilde{w}_j \left(\frac{1 - \tilde{x}_{ij}^{1N}}{\max_i \tilde{x}_{ij}^{1N}} \right) \quad (10)$$

$$u_3(a_i) = \prod_{j=1}^{n} \left(\frac{\tilde{x}_{ij}^{2N}}{\max_i \tilde{x}_{ij}^{2N}} \right)^{\tilde{w}_j} \quad (11)$$

Step 4: Integration of The Normalized Subordinate Utility Values

Three types of subordinate utility values of each alternative are integrated by the weighted Euclidean distance formula as indicated in Equation (12).

$$DN_i = w_1 \sqrt{\varphi \left(\frac{u_1(a_i)}{\max_i u_1(a_i)} \right)^2 + (1-\varphi) \left(\frac{m - r_1(a_i) + 1}{m} \right)^2} - w_2 \sqrt{\varphi \left(\frac{u_2(a_i)}{\max_i u_2(a_i)} \right)^2 + (1-\varphi) \left(\frac{r_2(a_i)}{m} \right)^2} + w_3 \sqrt{\varphi \left(\frac{u_3(a_i)}{\max_i u_3(a_i)} \right)^2 + (1-\varphi) \left(\frac{m - r_3(a_i) + 1}{m} \right)^2} \quad (12)$$

$r_1(a_i)$ and $r_3(a_i)$ used in the above formula represent the sequence number for the alternative a_i which is sorted according to the CCM and ICM functions in descending order (the highest value first). On the other hand, $r_2(a_i)$ indicates the sequence number in the order obtained for the UCM utility function in ascending order (smallest value first). The φ coefficient is the relative importance of the subordinate utility values and takes a value in the range of [0,1]. Those who developed the method recommend that it could be assumed as $\varphi = 0.5$. The coefficients w_1, w_2, w_3 are the importance weights of CCM, UCM and ICM utility functions, respectively. It is determined by the decision makers as the sum of the weights is $w_1 + w_2 + w_3 = 1$. When determining the weights, if the decision maker gives importance to the wide-ranging performance of the alternatives, he can assign the greatest weight to w_1. In case the decision maker is not willing to take risks, i.e., the chosen alternative should not perform poorly according to some criteria, he can assign the greatest weight to w_2. However, the decision-maker can assign the greatest weight to w_3 if he considers both the overall performance and the risks. Finally, the DN values are sorted in descending order, where the alternative with the highest value will be evaluated as the best.

4. Performances Evaluation of Regional Development Agencies

4.1. Problem Description

This study it is aimed to determine the performance orders of Regional Development Agencies operating in Türkiye through the criteria and multi-criteria decision-making methods based on the Financial Support Programs they announced between the years 2006-2021. The evaluation is carried out through the Financial Support Programs implemented by the Regional Development Agencies for both profit and non-profit organizations, and the relevant data were obtained from the Ministry of Industry and Technology of the Republic of Türkiye by official letter. Therefore, the criteria used in the study were created in accordance with the

parameters requested by the Ministry of Industry and Technology from the Regional Development Agencies for their annual reports.

All Regional Development Agencies, criteria used in the study and relevant codes are listed in Table 2.

Table 2. Regional Development Agencies, Criteria and Codes

ALTERNATIVES		CRITERIA	
Code	**Regional Development Agency**	**Code**	**Criteria**
ALT1	Ahiler Development Agency	**CA1**	Number of Calls for Financial Support Program for Non-Profit Organizations
ALT2	Ankara Development Agency	**CA2**	Total Call Budgets for Non-Profit Organizations (₺)
ALT3	West Mediterranean Development Agency	**CA3**	Total Number of Applications of Non-Profit Organizations
ALT4	Western Black Sea Development Agency	**CA4**	Number of Successful Projects for Non-Profit Organizations
ALT5	Bursa Eskişehir Bilecik Development Agency	**CA5**	Number of Contracted Projects for Non-Profit Organizations
ALT6	Çukurova Development Agency	**CA6**	Number of Successfully Completed Projects for Non-Profit Organizations
ALT7	Tigris Development Agency	**CA7**	Number of Terminated Projects for Non-Profit Organizations
ALT8	Eastern Mediterranean Development Agency	**CA8**	Contribution Amount of Development Agency for Non-Profit Organizations (₺)
ALT9	Eastern Anatolia Development Agency	**CA9**	Co-financing Amount for Non-Profit Organizations (₺)
ALT10	Eastern Black Sea Development Agency		
ALT11	Eastern Marmara Development Agency	**CB1**	Number of Calls for Financial Support Program for Profit Organizations
ALT12	Euphrates Development Agency	**CB2**	Total Call Budgets for Profit Organizations (₺)
ALT13	Southern Aegean Development Agency	**CB3**	Total Number of Applications of Profit Organizations
ALT14	Southern Marmara Development Agency	**CB4**	Number of Successful Projects for Profit Organizations
ALT15	Silk Road Development Agency	**CB5**	Number of Contracted Projects for Profit Organizations
ALT16	İstanbul Development Agency	**CB6**	Number of Successfully Completed Projects for Profit Organizations
ALT17	İzmir Development Agency	**CB7**	Number of Terminated Projects for Profit Organizations
ALT18	Karacadağ Development Agency	**CB8**	Contribution Amount of Development Agency for Profit Organizations (₺)
ALT19	North Anatolian Development Agency	**CB9**	Co-financing Amount for Profit Organizations
ALT20	Northeast Development Agency		
ALT21	Mevlana Development Agency		
ALT22	Central Anatolia Development Agency		
ALT23	Middle Black Sea Development Agency		
ALT24	Serhat Development Agency		
ALT25	Thrace Development Agency		
ALT26	Zafer Development Agency		

The data in the first two columns as alternatives represent 26 Regional Development Agencies operating in Türkiye and the codes assigned for each. The distinction between the criteria CA and CB in the last two columns is due to the separate evaluation of calls for Financial Support Programs applied to non-profit and profit organizations by Regional Development Agencies.

4.2. Explanation of the Data

Data on the Financial Support Programs implemented by the Regional Development Agencies for non-profit organizations are given in Table 3, while the Financial Support Programs implemented by for-profit organizations are summarized in Table 4.

Table 3. Financial Support Programs for Non-Profit Organizations

	CA1	CA2	CA3	CA4	CA5	CA6	CA7	CA8	CA9
ALT1	12	100,991,247	1,162	277	161	140	20	54,767,804	83,432,796
ALT2	18	171,500,000	1,450	512	249	243	6	67,265,520	81,647,551
ALT3	13	134,176,445	1,633	651	182	167	26	62,290,432	88,816,627
ALT4	10	75,500,000	600	262	175	134	3	60,115,378	83,744,211
ALT5	19	171,000,000	1,463	407	237	206	8	102,745,389	136,060,407
ALT6	22	161,500,000	1,914	517	321	299	14	102,165,678	149,844,996
ALT7	11	90,585,539	333	166	116	109	23	78,348,749	117,113,970
ALT8	12	108,500,000	660	258	195	177	10	88,947,035	136,615,281
ALT9	9	76,908,658	807	180	48	43	14	45,538,614	69,721,349
ALT10	10	75,175,000	639	282	187	157	10	71,280,383	105,968,750
ALT11	10	54,779,265	505	185	127	114	10	60,573,252	81,011,703
ALT12	8	72,500,000	412	142	75	55	7	51,056,824	72,080,602
ALT13	14	114,600,000	927	403	175	131	12	88,654,421	137,058,419
ALT14	15	117,091,128	1,423	471	265	262	5	79,075,184	105,018,706
ALT15	15	123,105,218	821	430	234	231	33	71,808,018	110,809,207
ALT16	33	948,500,000	4,635	862	801	643	16	687,771,319	836,597,300
ALT17	17	209,441,489	1,509	576	314	308	17	125,429,849	175,189,226
ALT18	21	133,350,000	1,477	744	207	181	25	65,542,823	104,346,483
ALT19	5	48,000,000	254	77	38	32	9	43,019,273	69,442,141
ALT20	15	97,567,500	901	301	203	139	12	99,654,405	146,362,209
ALT21	13	166,000,000	1,767	746	279	226	24	73,932,856	116,340,153
ALT22	14	97,697,000	1,066	366	176	149	37	68,812,098	108,265,225
ALT23	11	145,862,500	972	353	241	228	23	95,646,363	185,660,598
ALT24	10	82,850,000	671	253	167	135	12	77,195,557	126,622,895
ALT25	18	70,404,802	1,384	423	295	285	21	66,732,726	92,471,446
ALT26	13	159,200,000	1,291	466	275	222	20	127,698,559	229,658,595

Table 4. Financial Support Programs for Profit Organizations

	CB1	CB2	CB3	CB4	CB5	CB6	CB7	CB8	CB9
ALT1	7	74,418,753	840	246	173	173	18	57,705,832	122,524,766
ALT2	14	158,500,000	1,038	400	222	201	15	51,881,617	138,293,278
ALT3	11	96,923,882	1,497	580	171	169	32	42,814,039	93,550,678
ALT4	5	47,500,000	587	247	144	137	10	37,575,523	78,398,037
ALT5	11	90,000,000	858	277	137	133	16	39,782,858	84,239,831
ALT6	14	186,000,000	2,398	852	424	422	58	143,580,856	325,277,096
ALT7	7	59,951,461	468	234	121	119	37	27,620,395	59,488,708
ALT8	17	141,500,000	1,321	504	292	268	72	70,270,435	167,621,102
ALT9	8	83,177,635	1,502	431	203	203	39	48,138,740	99,641,155
ALT10	5	48,000,000	683	306	222	209	24	40,388,682	81,538,419
ALT11	15	82,850,000	1,124	405	240	240	21	57,594,951	123,749,105
ALT12	10	76,700,000	1,213	397	246	243	29	65,580,224	137,756,429
ALT13	10	92,600,000	1,011	364	167	150	8	54,452,778	118,620,856
ALT14	8	81,908,872	858	219	124	123	6	34,048,325	70,707,401
ALT15	11	101,800,000	863	393	160	160	38	31,555,280	67,045,285
ALT16	11	213,500,000	1,504	160	110	105	2	34,668,240	73,057,106
ALT17	11	141,130,293	1,590	569	225	22	12	66,688,891	141,646,026
ALT18	13	135,750,000	1,032	423	319	309	30	67,992,492	159,899,422
ALT19	6	61,500,000	583	300	190	190	30	45,418,780	93,853,118
ALT20	13	87,205,000	1,076	379	250	193	36	43,612,882	136,032,072
ALT21	9	149,000,000	1,591	905	274	270	58	77,943,185	161,035,788
ALT22	12	99,717,278	1,445	488	218	218	50	55,451,644	116,930,301
ALT23	6	54,500,000	1,167	323	201	200	18	41,927,881	87,437,396
ALT24	14	68,346,560	817	332	204	190	21	48,463,101	99,554,890
ALT25	7	45,000,000	606	140	90	90	6	20,094,341	43,021,217
ALT26	7	113,200,000	1,141	345	201	201	32	61,722,403	130,135,780

4.3. LMAW Method Application

Since the final beneficiaries of the Financial Support Programs are the representatives of industrial organizations and managers of public institutions, evaluation is made by using the linguistic scale with the participation of four Decision Makers (DM) doing business in these fields. The importance levels of the criteria were determined by the final beneficiaries of the financial support programs and no significant contradictions were found between the assessments of these four decision-makers. For this reason, it is foreseen that it would not be meaningful to involve more decision-makers in the process.

To calculate the weight coefficient values for each criterion, these four experts stated their own comments based on the scale indicated in Table 5.

Table 5. Prioritization Scale

Linguistic Variables	Prioritization Score
Absolutely Low (AL)	1
Very Low (VL)	1.5
Low (L)	2
Medium (M)	2.5
Equal (E)	3
Medium High (MH)	3.5
High (H)	4
Very High (VH)	4.5
Absolutely High (AH)	5

Source: (Pamucar et. al., 2021)

Priority vectors obtained with the opinions of four experts for the criteria relevant to calls for non-profit organizations are given in Table 6, and the implementation steps are explained.

Table 6. Priority Vector of Criteria for Calls towards Non-profit Organizations

	CA1	CA2	CA3	CA4	CA5	CA6	CA7	CA8	CA9
DM1	4	5	5	4.5	4.5	5	3	4.5	4
DM2	4.5	4	4.5	4.5	5	4.5	2.5	4.5	4.5
DM3	5	4.5	4.5	5	5	4.5	3.5	5	5
DM4	4.5	5	4.5	4.5	4.5	5	2	5	5

The absolute anti-ideal point (Υ_{AIP}) *is* arbitrarily defined as $\Upsilon_{AIP} = 0.5$. The relationship between the elements of the priority vector and the absolute anti-ideal point (Υ_{AIP}) is determined by means of Equation (1) based on the data obtained from the expert priority vectors and $\Upsilon_{AIP} = 0.5$. The relationships between the elements of the priority vector and the absolute anti-ideal point are presented in the following section.

The elements of the vector R^1 are obtained by applying Equation (1) as follows.

$$\eta^1_{CA_1} = \frac{4}{0{,}5} = 8, \eta^1_{CA_2} = \frac{5}{0{,}5} = 10, \eta^1_{CA_3} = \frac{5}{0{,}5} = 10, \eta^1_{CA_4} = \frac{4{,}5}{0{,}5} = 9, \eta^1_{CA_5} = \frac{4{,}5}{0{,}5} = 9,$$

$$\eta^1_{CA_6} = \frac{5}{0{,}5} = 10, \eta^1_{CA_7} = \frac{3}{0{,}5} = 6, \eta^1_{CA_8} = \frac{4{,}5}{0{,}5} = 9, \eta^1_{CA_9} = \frac{4}{0{,}5} = 8$$

$$R^1 = (8, 10, 10, 9, 9, 10, 6, 9, 8)$$

The remaining elements of vectors R^2, R^3 and $R^4$are calculated in a similar manner.

The elements of the first expert's vector w_j^1 are calculated individually to create the weight coefficients vector by applying Equation (2) as follows.

$$w_1^1 = \frac{\ln(8)}{\ln(8.10.10.9.9.10.6.9.8)} = 0.1069 \quad w_2^1 = \frac{\ln(10)}{\ln(8.10.10.9.9.10.6.9.8)} = 0.1184$$

$$w_3^1 = \frac{\ln(10)}{\ln(8.10.10.9.9.10.6.9.8)} = 0.1184 \quad w_4^1 = \frac{\ln(9)}{\ln(8.10.10.9.9.10.6.9.8)} = 0.1130$$

$$w_5^1 = \frac{\ln(9)}{\ln(8.10.10.9.9.10.6.9.8)} = 0.1130 \quad w_6^1 = \frac{\ln(10)}{\ln(8.10.10.9.9.10.6.9.8)} = 0.1184$$

$$w_7^1 = \frac{\ln(6)}{\ln(8.10.10.9.9.10.6.9.8)} = 0.0921 \quad w_8^1 = \frac{\ln(9)}{\ln(8.10.10.9.9.10.6.9.8)} = 0.1130$$

$$w_9^1 = \frac{\ln(8)}{\ln(8.10.10.9.9.10.6.9.8)} = 0.1069$$

$$w_j^1 = (0.1069; 0.1184; 0.1184; 0.1130; 0.1130; 0.1184; 0.0921; 0.1130; 0.1069)$$

The values of weight coefficients obtained meet the condition of $\sum_{j=1}^{9} w_j^1 = 1$. The remaining elements of vectors w_j^2, w_j^3 and $w_j^4$are calculated in a similar manner.

$$w_j^2 = (0.1146; 0.1084; 0.1146; 0.1146;\ 0.1201; 0.1146; 0.0839; 0.1146; 0.1146)$$

$$w_j^3 = (0.1148; 0.1096; 0.1096; 0.1148; 0.1148; 0.1096; 0.971; 0.1148; 0.1148)$$

$$w_j^4 = (0.1133; 0.1188; 0.1133; 0.1133; 0.1133; 0.1188; 0.0715; 0.1188; 0.1188)$$

The aggregate vector of the weighting coefficients is obtained by applying Equation (3).

For instance, the value of 0.11241 is calculated by average values of w_j^e ($1 \leq e \leq 4$) for each expert where $w_1^1 = 0.1069$, $w_1^2 = 0.1146$, $w_1^3 = 0.1148$ and $w_1^4 = 0.1133$ as follows.

$$w_1 = \{0.1069\ \ 0.1146\ \ 0.1148\ \ 0.1133\}^{p,q=1}$$
$$= \sqrt{\frac{0.1069^1.0.1146^1 + 0.1069^1.0.1148^1 + 0.1069^1.0.1133^1 + \cdots + 0.1133^1.0.1069^1 + 0.1133^1.0.1146^1 + 0.1133^1.0.1148^1}{4(4-1)}}$$
$$= 0.11241$$

The remaining values of the vectors of the weight coefficients are obtained in a similar way.

$$w_j = (0.11241;\ 0.11376;\ 0.11396;\ 0.11393;\ 0.11530;\ 0.11531;\ 0.08597;\ 0.11529;\ 0.11375)^T$$

In the evaluation made for FSPs for non-profit organizations, the Number of Successfully Completed Projects criterion (CA6) emerged as the most important criterion, while the Number of Terminated Projects criterion (CA7) emerged as the least important. This approach reveals that the successfully completion of a project is perceived as an important performance indicator for non-profit organizations such as Public Institutions, Special Provincial Administration, Chamber of Industry and Commerce, Organized Industrial Zone Directorate, Non-Governmental Organizations etc. The decision-makers strongly emphasize that the Number of Terminated Projects criterion placed at the bottom does not indicate that this criterion is insignificant, but it is in the last order relatively.

Priority vectors obtained with the opinions of four experts for calls towards FSPs for-profit organizations are given in Table 7.

Table 7. Priority Vector of Criteria for Calls Towards Profit Organizations

	CB1	CB2	CB3	CB4	CB5	CB6	CB7	CB8	CB9
DM1	4	5	5	4.5	4.5	5	3	4.5	4
DM2	4.5	4.5	4	4.5	5	4.5	3	4.5	4.5
DM3	5	4.5	4.5	5	4.5	4	3.5	5	5
DM4	4.5	5	4.5	4.5	4.5	5	3	5	5

By applying the same Equations, values for the vectors of the weight coefficients are obtained for calls towards profit organizations in a similar manner as indicated below.

$$w_j = (0.11188;\ 0.11475;\ 0.11189;\ 0.113940;\ 0.11342;\ 0.11324;\ 0.09333;\ 0.11474;\ 0.11320)^T$$

Total Call Budget (CB2) has emerged as the most important criterion in the calls for FSPs applied to profit organizations. The fact that this criterion is relatively high reveals the attitudes of Regional Development Agencies, especially towards industrial and service organizations. It indicates how important these sectors are in the regions they are responsible for. As in the evaluation of calls for FSPs for non-profit organizations, the Number of Terminated Projects criterion (CB7) is in the last order as well.

4.4. DNMA Method Application

By applying Equation (4) for the data in Table 3, the linear normalization matrix in Table 8 is obtained.

Table 8. Linear Normalization Matrix

	CA1	CA2	CA3	CA4	CA5	CA6	CA7	CA8	CA9
ALT1	0.2500	0.0588	0.2073	0.2548	0.1612	0.1768	0.5000	0.0182	0.0182
ALT2	0.4643	0.1371	0.2730	0.5541	0.2765	0.3453	0.9118	0.0376	0.0159
ALT3	0.2857	0.0957	0.3148	0.7312	0.1887	0.2209	0.3235	0.0299	0.0253
ALT4	0.1786	0.0305	0.0790	0.2357	0.1796	0.1669	1.0000	0.0265	0.0186
ALT5	0.5000	0.1366	0.2760	0.4204	0.2608	0.2848	0.8529	0.0926	0.0868
ALT6	0.6071	0.1260	0.3789	0.5605	0.3709	0.4370	0.6765	0.0917	0.1048
ALT7	0.2143	0.0473	0.0180	0.1134	0.1022	0.1260	0.4118	0.0548	0.0621
ALT8	0.2500	0.0672	0.0927	0.2306	0.2058	0.2373	0.7941	0.0712	0.0876
ALT9	0.1429	0.0321	0.1262	0.1312	0.0131	0.0180	0.6765	0.0039	0.0004
ALT10	0.1786	0.0302	0.0879	0.2611	0.1953	0.2046	0.7941	0.0438	0.0476
ALT11	0.1786	0.0075	0.0573	0.1376	0.1166	0.1342	0.7941	0.0272	0.0151
ALT12	0.1071	0.0272	0.0361	0.0828	0.0485	0.0376	0.8824	0.0125	0.0034
ALT13	0.3214	0.0740	0.1536	0.4153	0.1796	0.1620	0.7353	0.0708	0.0881
ALT14	0.3571	0.0767	0.2668	0.5019	0.2975	0.3764	0.9412	0.0559	0.0464
ALT15	0.3571	0.0834	0.1294	0.4497	0.2569	0.3257	0.1176	0.0447	0.0539
ALT16	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.6176	1.0000	1.0000
ALT17	0.4286	0.1793	0.2865	0.6357	0.3617	0.4517	0.5882	0.1278	0.1378
ALT18	0.5714	0.0948	0.2792	0.8497	0.2215	0.2439	0.3529	0.0349	0.0455
ALT19	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.8235	0.0000	0.0000
ALT20	0.3571	0.0550	0.1477	0.2854	0.2163	0.1751	0.7353	0.0878	0.1003
ALT21	0.2857	0.1310	0.3454	0.8522	0.3159	0.3175	0.3824	0.0479	0.0611
ALT22	0.3214	0.0552	0.1853	0.3682	0.1809	0.1915	0.0000	0.0400	0.0506
ALT23	0.2143	0.1087	0.1639	0.3516	0.2661	0.3208	0.4118	0.0816	0.1515
ALT24	0.1786	0.0387	0.0952	0.2242	0.1691	0.1686	0.7353	0.0530	0.0745
ALT25	0.4643	0.0249	0.2579	0.4408	0.3368	0.4141	0.4706	0.0368	0.0300
ALT26	0.2857	0.1235	0.2367	0.4955	0.3106	0.3110	0.5000	0.1313	0.2088

In a similar manner, by applying Equation (5) for the data in Table 3, the vector normalization matrix in Table 9 is obtained.

Table 9. Vector Normalization Matrix

	CA1	CA2	CA3	CA4	CA5	CA6	CA7	CA8	CA9
ALT1	0.7503	0.4245	0.6001	0.7579	0.5870	0.6176	0.8164	0.3983	0.4349
ALT2	0.8217	0.4724	0.6332	0.8551	0.6438	0.6959	0.9676	0.4102	0.4336
ALT3	0.7622	0.4470	0.6543	0.9127	0.6006	0.6381	0.7516	0.4054	0.4390
ALT4	0.7266	0.4072	0.5353	0.7517	0.5961	0.6130	1.0000	0.4034	0.4352
ALT5	0.8336	0.4720	0.6347	0.8117	0.6361	0.6678	0.9460	0.4439	0.4744
ALT6	0.8692	0.4656	0.6867	0.8572	0.6903	0.7385	0.8812	0.4433	0.4847
ALT7	0.7384	0.4174	0.5046	0.7119	0.5580	0.5940	0.7840	0.4207	0.4602
ALT8	0.7503	0.4296	0.5423	0.7500	0.6090	0.6457	0.9244	0.4308	0.4748
ALT9	0.7147	0.4082	0.5592	0.7177	0.5141	0.5438	0.8812	0.3895	0.4246
ALT10	0.7266	0.4070	0.5398	0.7599	0.6038	0.6305	0.9244	0.4140	0.4518
ALT11	0.7266	0.3931	0.5244	0.7198	0.5651	0.5978	0.9244	0.4038	0.4331
ALT12	0.7028	0.4052	0.5137	0.7020	0.5315	0.5530	0.9568	0.3948	0.4264
ALT13	0.7741	0.4337	0.5730	0.8100	0.5961	0.6107	0.9028	0.4305	0.4752
ALT14	0.7860	0.4354	0.6301	0.8382	0.6541	0.7103	0.9784	0.4214	0.4511
ALT15	0.7860	0.4395	0.5608	0.8212	0.6341	0.6868	0.6760	0.4145	0.4555
ALT16	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.8596	1.0000	1.0000
ALT17	0.8098	0.4982	0.6400	0.8816	0.6858	0.7453	0.8488	0.4655	0.5038
ALT18	0.8573	0.4465	0.6363	0.9512	0.6167	0.6488	0.7624	0.4085	0.4506
ALT19	0.6671	0.3885	0.4955	0.6751	0.5077	0.5355	0.9352	0.3871	0.4244
ALT20	0.7860	0.4222	0.5700	0.7678	0.6141	0.6168	0.9028	0.4410	0.4821
ALT21	0.7622	0.4687	0.6697	0.9520	0.6632	0.6830	0.7732	0.4165	0.4596
ALT22	0.7741	0.4223	0.5890	0.7947	0.5967	0.6244	0.6329	0.4116	0.4536
ALT23	0.7384	0.4550	0.5782	0.7893	0.6387	0.6845	0.7840	0.4371	0.5116
ALT24	0.7266	0.4122	0.5435	0.7479	0.5909	0.6138	0.9028	0.4196	0.4673
ALT25	0.8217	0.4037	0.6256	0.8183	0.6735	0.7278	0.8056	0.4097	0.4417
ALT26	0.7622	0.4640	0.6149	0.8361	0.6606	0.6799	0.8164	0.4676	0.5446

By means of Equation (6), the standard deviations of the criteria are calculated in order to adjust the criterion weights and the results are given in Table 10.

Table 10. Standard Deviations of the Criteria

σ_1	σ_2	σ_3	σ_4	σ_5	σ_6	σ_7	σ_8	σ_9	**Total**
0.1657	0.1744	0.1782	0.2281	0.1717	0.1802	0.2298	0.1736	0.1716	1.6733

Normalization of standard deviation values is carried out with Equation (7) and the results are given in Table 11.

Table 11. Normalized Standard Deviation Values

w_1^σ	w_2^σ	w_3^σ	w_4^σ	w_5^σ	w_6^σ	w_7^σ	w_8^σ	w_9^σ	Total
0.0990	0.1043	0.1065	0.1364	0.1026	0.1077	0.1373	0.1037	0.1025	1.0000

Adjusted weight values are calculated by Equation (8) and the calculated values are summarized in Table 12.

Table 12. Adjusted Weight Values

$\widetilde{w}_1$	$\widetilde{w}_2$	$\widetilde{w}_3$	$\widetilde{w}_4$	$\widetilde{w}_5$	$\widetilde{w}_6$	$\widetilde{w}_7$	$\widetilde{w}_8$	$\widetilde{w}_9$	**Toplam**
0.1060	0.1094	0.1107	0.1252	0.1093	0.1119	0.1092	0.1099	0.1085	1.0000

CCM, UCM and ICM utility functions obtained by using Equations (9), (10) and (11), respectively are given in Table 13.

Table 13. CCM, UCM and ICM Values

	CCM	Descending Order	UCM	Ascending Order	ICM	Descending Order
ALT1	0.1837	20	0.1079	20	0.5742	19
ALT2	0.3381	4	0.1068	18	0.6247	6
ALT3	0.2538	11	0.1066	16	0.5983	12
ALT4	0.2129	16	0.1069	19	0.5728	20
ALT5	0.3242	6	0.0997	4	0.6291	5
ALT6	0.3750	2	0.0998	5	0.6519	3
ALT7	0.1271	24	0.1110	24	0.5563	23
ALT8	0.2260	15	0.1021	7	0.5903	15
ALT9	0.1268	25	0.1099	23	0.5446	24
ALT10	0.2056	18	0.1061	15	0.5770	17
ALT11	0.1624	21	0.1086	21	0.5572	22
ALT12	0.1363	23	0.1148	25	0.5446	25
ALT13	0.2465	12	0.1021	8	0.5955	14
ALT14	0.3272	5	0.1037	10	0.6220	8
ALT15	0.2057	17	0.1050	12	0.5889	16
ALT16	0.9583	1	0.0417	1	0.9871	1
ALT17	0.3596	3	0.0958	2	0.6532	2
ALT18	0.3070	8	0.1060	14	0.6132	9
ALT19	0.0899	26	0.1252	26	0.5269	26
ALT20	0.2400	13	0.1034	9	0.5960	13
ALT21	0.3132	7	0.1046	11	0.6245	7
ALT22	0.1578	22	0.1092	22	0.5719	21
ALT23	0.2321	14	0.1009	6	0.6059	11
ALT24	0.1933	19	0.1052	13	0.5760	18
ALT25	0.2775	10	0.1067	17	0.6076	10
ALT26	0.2925	9	0.0959	3	0.6312	4

The performance scores of the alternatives are obtained by integration of utility functions with Equation (12) which is based on Euclidean distance. The values for φ, w_1, w_2 and w_3 are deemed appropriate by the experts to consider as $\varphi = 0.5$ $w_1 = 0.6$ $w_2 = 0.1$ and $w_3 = 0.3$. The calculated performance values and the ranking of the alternatives are given in Table 14.

Table 14. Performance Ranking of RDA's for Calls towards Non-Profit Organizations

Regional Development Agencies	DN	Descending Order
Ahiler Development Agency	0.245	20
Ankara Development Agency	0.617	4
West Mediterranean Development Agency	0.447	11
Western Black Sea Development Agency	0.304	17
Bursa Eskişehir Bilecik Development Agency	0.614	5
Çukurova Development Agency	0.704	2
Tigris Development Agency	0.149	24
Eastern Mediterranean Development Agency	0.373	15
Eastern Anatolia Development Agency	0.136	25
Eastern Black Sea Development Agency	0.298	18
Eastern Marmara Development Agency	0.206	21
Euphrates Development Agency	0.152	23
Southern Aegean Development Agency	0.428	12
Southern Marmara Development Agency	0.595	6
Silk Road Development Agency	0.326	16
İstanbul Development Agency	0.976	1
İzmir Development Agency	0.699	3
Karacadağ Development Agency	0.531	9
North Anatolian Development Agency	0.094	26
Northeast Development Agency	0.417	14
Mevlana Development Agency	0.570	7
Central Anatolia Development Agency	0.198	22
Middle Black Sea Development Agency	0.422	13
Serhat Development Agency	0.279	19
Thrace Development Agency	0.481	10
Zafer Development Agency	0.575	8

The data in Table 14 reveal that Istanbul Development Agency is the most successful institution in terms of Financial Support Programs implemented by Regional Development Agencies for non-profit organizations. Within the scope of this evaluation, it is also revealed that the institution with the lowest performance is the North Anatolian Development Agency.

When all the steps of the DNMA method are re-applied to the data regarding the Financial Support Programs applied by the Regional Development Agencies to the profit organizations, the performance values have emerged as indicated in Table 15.

Table 15. Performance Ranking of RDA's for Calls Towards Profit Organizations

Regional Development Agencies	DN	Descending Order
Ahiler Development Agency	0.391	18
Ankara Development Agency	0.728	4
West Mediterranean Development Agency	0.565	10
Western Black Sea Development Agency	0.241	24
Bursa Eskişehir Bilecik Development Agency	0.401	17
Çukurova Development Agency	0.939	1
Tigris Development Agency	0.210	25
Eastern Mediterranean Development Agency	0.705	5
Eastern Anatolia Development Agency	0.458	16
Eastern Black Sea Development Agency	0.288	23
Eastern Marmara Development Agency	0.664	6
Euphrates Development Agency	0.620	8
Southern Aegean Development Agency	0.522	13
Southern Marmara Development Agency	0.313	21
Silk Road Development Agency	0.366	19
İstanbul Development Agency	0.540	12
İzmir Development Agency	0.664	7
Karacadağ Development Agency	0.785	3
North Anatolian Development Agency	0.288	22
Northeast Development Agency	0.557	11
Mevlâna Development Agency	0.796	2
Central Anatolia Development Agency	0.602	9
Middle Black Sea Development Agency	0.347	20
Serhat Development Agency	0.467	15
Thrace Development Agency	0.199	26
Zafer Development Agency	0.487	14

The data in Table 15 unfold that Çukurova Development Agency is the most successful institution in terms of Financial Support Programs implemented for profit organizations by Regional Development Agencies. It is also revealed that Thrace Development Agency has the lowest performance within the scope of the same evaluation.

5. Sensitivity Analysis

Sensitivity analysis in this study is applied by checking the impact of the rank reversal matrix.

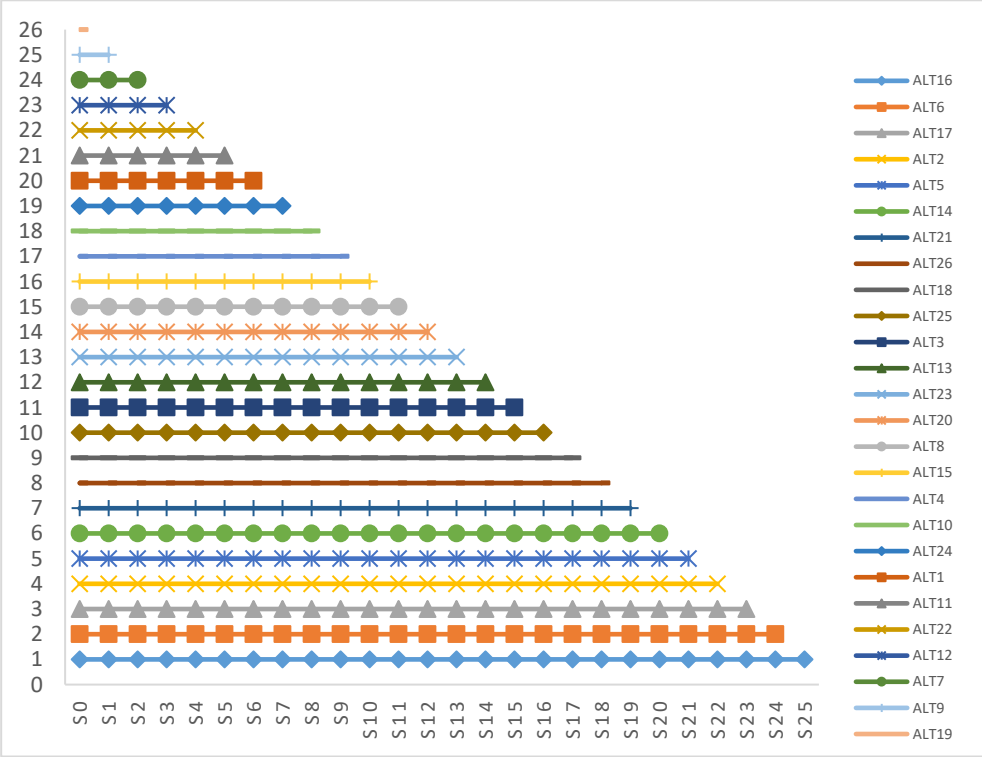
5.1. Effect of Rank Reversal Matrix

One of the options to observe the persistence of MCDM methods is to include new alternatives to the initial cluster or to remove weak alternatives from the cluster. In such cases, it is counted that the MCDM method will not depict a significant change in terms of the order of alternatives. This phenomenon is defined as the popular rank reversal problem, and much attention has been paid to it in the literature (Mukhametzyanov and Pamucar, 2018; Pamucar et. al., 2017).

For this purpose, a sensitivity analysis is implemented to measure the resistance of the model against the rank reversal problem. Within the scope of this test, 25 scenarios are created to simulate the change in financial support program data offered to non-profit

organizations by Regional Development Agencies. As an accepted principle, 25 scenarios should be built (total number of Regional Development Agencies minus one). Following the first trial where the DNMA method is applied, the Regional Development Agencies are ordered according to the results as shown in the S0 scenario (original ranking). In the following scenario (S1), the least ranked alternative is disposed of. Thereafter, the remaining 24 alternatives are sorted again. Thus, 25 scenarios (S1–S25) are built, thereby eliminating the alternative with the least performance from the cluster in each next scenario. The final ranking obtained from different scenarios is indicated in Figure 3.

Figure 3. Results of Ranks Reversal Analysis for FSPs towards Non-Profit Organizations



According to Figure 3, it can be easily observed that the DNMA model provides consistent results and the model for FSPs towards non-profit organizations has a strong resistance to the rank reversal problem. The same process steps were applied to the FSPs offered by Regional Development Agencies for-profit organizations, and the results are given in Figure 4.

Figure 4. Results of Ranks Reversal Analysis for FSPs Towards Profit Organizations

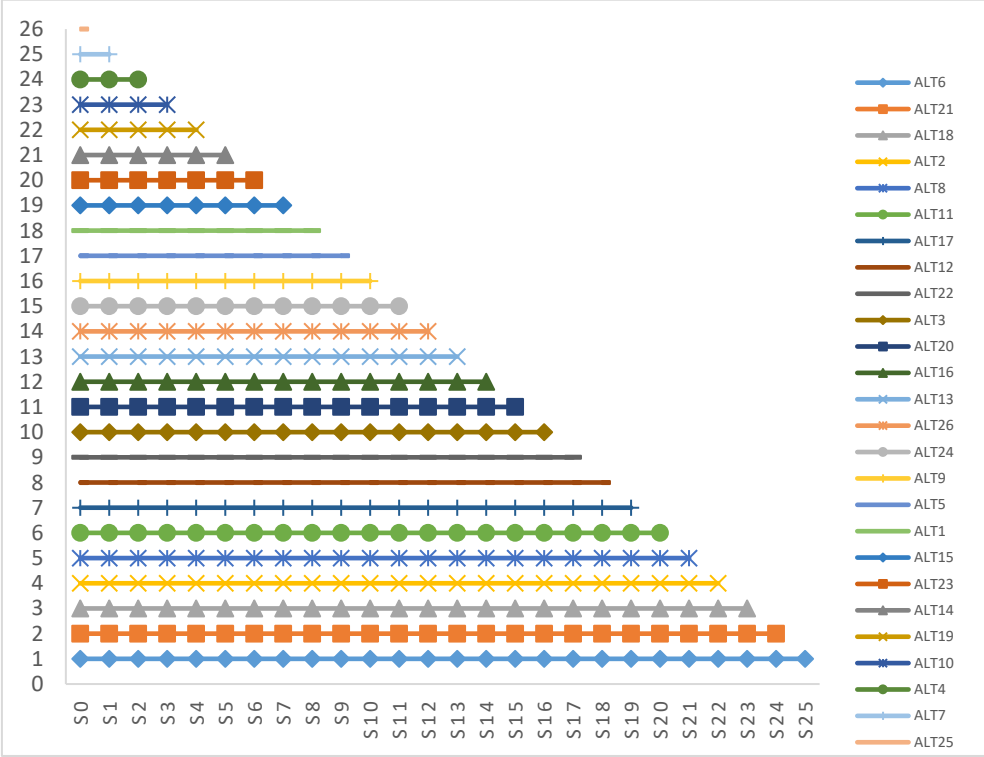


Figure 4 indicates that the DNMA model provides consistent results and the model for FSPs towards profit organizations has a strong resistance to rank reversal problems as well.

6. Results and Discussion

As a requirement of the pre-accession process to the European Union, 26 Regional Development Agencies were established in Türkiye beginning in the year 2006. Regional Development Agencies, whose job descriptions are extremely wide, announce periodic calls for financial support programs according to the priorities and requirements of the region they are responsible for.

In this study, the performances of 26 Regional Development Agencies operating in Türkiye were evaluated in terms of financial support programs they have implemented since the date of their foundation. Because of the calls for financial support programs applied separately for-profit and non-profit organizations, two different evaluation processes were carried out.

The LMAW method is used in the weighting phase of 9 criteria, and the DNMA method is applied for the performance evaluation of 26 alternatives within the scope of the study.

It has been determined that the most important criterion in terms of financial support program calls for non-profit organizations is the "Number of Successfully Completed Projects". However, the criteria of "Total Call Budget" for calls aiming profit organizations is determined as the prominent one.

When these evaluations are examined carefully, it is eliciting that non-profit organizations attach more importance to the completion of projects. Considering that successfully completion of projects is an important indicator of performance evaluation for public institutions, it becomes quite meaningful for managers to especially emphasize the criterion. However, it is revealed that private sector representatives focus on the total budget criterion to finance their investments. This approach also reveals important findings in terms of monitoring the difference between the perspectives of the private sector and public institutions.

In the performance order made for 26 Regional Development Agencies; Istanbul Development Agency, Çukurova Development Agency and İzmir Development Agency are in the top three in terms of financial support programs announced for non-profit organizations. If the data is examined carefully, it can be inferred that Istanbul Development Agency is in a superior position compared to the closest alternative in terms of the Number of Successfully Completed Projects for Non-Profit Organizations criteria. Considering that İstanbul hosts 18.7% of Türkiye's population, it should be taken into account that the number of non-profit institutions providing services to all segments of society should be higher. This situation can be evaluated as a reflection of the financial requirement for public services. It is thought that the high performance of Çukurova and İzmir Development Agencies is due to the fact that they started their activities as the first pilot scheme in Türkiye in 2006, while the remaining ones were established in 2008 and 2009. Therefore, Çukurova and İzmir Development Agencies had more opportunities to implement financial support programs. According to the evaluation made for financial support programs announced towards non-profit organizations, North Anatolian Development Agency showed the lowest performance. When the criteria for financial support programs applied for non-profit institutions are examined, it can be deducted that it performs quite poorly compared to other Regional Development Agencies. The fact that the population of the region, which consists of Kastamonu, Çankırı and Sinop provinces, is less than 1% compared to the population of Türkiye may indicate that public resources are less required and less used. This situation can be considered a topic that should be questioned by the Ministry.

In terms of the financial support program implemented by for-profit organizations; Çukurova Development Agency, Mevlana Development Agency and Karacadağ Development Agency share the best performance, respectively. In addition to being one of the first two development agencies to be established, the promising position of Adana and Mersin in the industry and agriculture sectors and the fact that Mersin is a Mediterranean port city is thought to have affected Çukurova Development Agency to achieve high performance in this sense. Similarly, it is observed that the number of successfully completed projects within the scope of financial support programs for the developing industry and agriculture sectors in Konya province is quite high, which contributes to the performance of the Mevlana Development Agency. According to the evaluation made for financial support programs announced towards profit organizations, it is deducted that Thrace Development Agency has the worst performance in this regard. Kırklareli and Tekirdağ are the provinces where the industrial sector is developed. Despite this fact, the low performance of this region in terms of financial support is a situation that should be questioned by the Ministry.

In this study, Regional Development Agencies were examined in terms of the financial support programs they implemented. In addition to these supports, their performance can be

also evaluated in terms of supports such as Guided Projects, Technical Support and Funding Support mechanisms.

This study on the financial support performance of the Regional Development Agencies operating in Türkiye can be applied to other grant-providing institutions such as the Small and Medium Enterprises Development Organization (KOSGEB) and the Agriculture and Rural Development Support Institution (TKDK) in the future. It is also a viable method in terms of carrying out similar studies for the General Directorate of Incentive Implementation and Foreign Capital, which is the centre of incentive applications for investments in Türkiye. In addition, this study can be a reference for grant or incentive provider institutions operating around the world. This method can be used in the performance evaluation of funding institutions, as well as a tool that contributes to inter-institutional competition.

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