

Comparative Financial Performance Analysis of Turkish and Global Pharmaceutical Companies with MCDM Methods

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ABSTRACT

In this study, using the financial data of 12 Turkish and global pharmaceutical companies for the period 2021–2025 and the most used financial performance metrics in the literature, the weights of these metrics were first calculated using the LOPCOW and MEREC methods. Once the metric weights had been determined, the company's financial performance was analysed using the EDAS and CoCoSo methods. The results of the performance analysis were evaluated comparatively. When selecting companies for the study, care was taken to include firms from developed countries, emerging markets, manufacturers, distributors, and biotechnology-focused firms. In selecting the criteria to determine the companies' financial performance, those deemed critical for the pharmaceutical sector were chosen. For the selection of the analysis period, the post-pandemic transformation and the use of current data were chosen. According to the joint weighting results obtained using the LOPCOW and MEREC methods, the most important criterion was identified as C1 (Return on Assets (ROA)) in 2021, C5 (Debt to Equity Ratio (D/E)) in 2022, C1 (Return on Assets (ROA)) in 2023, and C4 (Current Ratio (CR)), and C4 (Current Ratio (CR)) in 2025. According to the EDAS and CoCoSo methods, AstraZeneca and Selçuk Ecza Deposu were found to have the poorest financial performance in the 2021–2025 ranking. Conversely, according to the EDAS and CoCoSo methods, Roche and EIS Eczacıbaşı İlaç were found to have demonstrated the best performance in the financial performance ranking for the period 2021–2025.

Keywords: Pharmaceutical industry, Performance analysis, MCDM, LOPCOW, EDAS.

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Türk ve Küresel İlaç Şirketlerinin ÇKKV Yöntemleriyle Karşılaştırmalı Finansal Performans Analizi

ÖZET

Çalışmada Türk ve Küresel 12 ilaç şirketinin 2021-2025 yıllarına ait finansal verileri ile literatürde en çok kullanılan finansal performans ölçüm kriterleri kullanılarak öncelikle LOPCOW ve MEREK yöntemleri ile finansal performans ölçüm kriterlerinin ağırlıkları hesaplanmıştır. Kriter ağırlıkları belirlendikten sonra şirketlerin finansal performans analizi EDAS ve CoCoSo yöntemleriyle yapılmıştır. Performans analizi sonunda çıkan sonuçlar karşılaştırmalı olarak değerlendirilmiştir. Çalışmada şirket seçimi yapılırken gelişmiş ülke, gelişmekte olan piyasa, üretici firma, dağıtıcı firma, biyoteknoloji ağırlıklı firmalar olmasına dikkat edilmiştir. Şirketlerin Finansal Performansını belirleyecek kriterlerin seçiminde ise ilaç sektörü için kritik olabilecek kriterler seçilmiştir. Analiz dönemi seçiminde ise pandemi sonrası dönüşüm ve güncel verilerin kullanımı seçilmiştir. LOPCOW ve MEREK yöntemleri ile elde edilen ortak ağırlıklandırma sonuçlarına göre en önemli kriterin 2021 yılında C1 (Return on Assets (ROA)), 2022 yılında C5 (Debt to Equity Ratio (D/E)), 2023 yılında C1 (Return on Assets (ROA)), 2024 yılında C4 (Current Ratio (CR)), 2025 yılında C4 (Current Ratio (CR)) kriteri olduğu tespit edilmiştir. EDAS ve CoCoSo yöntemlerine göre 2021-2025 yılları arası finansal performans sıralamasında AstraZeneca ve Selçuk Ecza Deposu şirketinin en kötü performansı gösterdikleri belirlenmiştir. Buna karşın EDAS ve CoCoSo yöntemlerine göre 2021-2025 yılları arası finansal performans sıralamasında Roche ve EIS Eczacıbaşı İlaç şirketinin en iyi performansı gösterdikleri tespit edilmiştir.

Anahtar Kelimeler: İlaç sektörü, Performans analizi, ÇKKV, LOPCOW, EDAS.

1. Introduction

Due to the global outbreaks of infectious diseases, the importance of the healthcare sector has been reaffirmed, and countries have begun to invest more in it. In addition to developed nations, less developed and developing countries are also increasing their investments in the healthcare sector and technology, while governments strive to control rising healthcare expenditures. One of the key and dynamic sub-sectors of the healthcare industry is the pharmaceutical sector. In recent years, governments and international companies have been investing more in the pharmaceutical sector to combat pandemics and are conducting more R&D using emerging technologies (Kahraman & Çalışkan, 2024).

The healthcare sector provides employment opportunities across many different specialties and serves as a key focal point for medical research and technological innovation. As such, healthcare systems represent an ecosystem with a complex structure characterized by high resource consumption (Çakmak & Erdiñç, 2024). In recent years, the pharmaceutical sector has evolved into a sector with rising potential, offering not only therapeutic products but also consumer goods aimed at improving quality of life. Given that it is a sector with inelastic demand and the continued growth of the welfare state, it stands out as a highly sustainable sector. Although the pharmaceutical sector is a sector with high potential, it is also a sector that requires intensive R&D and capital, and due to the fact that drug production spans a period of approximately 10–15 years, it is a sector with a very high barrier to entry (Akgün & Ahmadzada, 2022). Whilst the pharmaceutical sector is growing by adapting to the dynamics of people's lives, beyond its dependence on the healthcare sector, it is also expanding its product range to include other factors that may affect daily life. In order to maintain the sector's strategic position, there is a need for substantial funding, investment in research and development, and a skilled workforce. Developments in the healthcare and pharmaceutical sectors are enhancing the standard of living of the population in terms of access to medicines and price competition. The most significant characteristic of the pharmaceutical sector in Turkey is the need for substantial financial resources from social security

institutions and the resulting financial difficulties arising from the fact that this need is generally linked to imports and foreign exchange (Gülençer & Hazar, 2020).

Analysing a business's financial performance is of great importance to decision-makers. When making decisions for the future, it is essential to forecast the business's financial position and assess its current situation. Whether an organisation is profit-oriented or not, the effective and efficient use of resources is always the objective. Indeed, this is of importance not only to the organisation itself but also to other organisations, market participants, banks and the national economy. Consequently, it can be stated that a company's financial analyses have a significant impact on economic decision-making processes. Investors make investment decisions by conducting future-oriented analyses and forecasts based on data from financial statements. Managers in the pharmaceutical sector must also have access to accurate, valid and interpretable financial data. In this process, there is a need for analyses that reflect the company's financial performance and make financial ratios more comprehensible, thereby facilitating decision-making. This is because financial analyses guide decision-makers in enhancing efficiency, effectiveness and profit maximisation. Failure to analyse the company's current circumstances accurately will make it difficult to forecast future periods and develop strategies accordingly. To ensure sustainability in the pharmaceutical sector, the companies that form the backbone of the sector must be financially sound. For this reason, the financial performance of pharmaceutical companies must be analysed using robust and effective methods (Ari, 2023).

Predicting the financial failure of businesses is of great importance in ensuring that resources are used effectively and appropriately. In particular, businesses' ability to detect warning signs of failure provides financial institutions with key guidance for decision-making. Models supported by certain financial ratios are used to predict failure in advance. These models are particularly decisive in terms of the measures financial institutions need to take to ensure their continued operation and future investments. The likelihood of businesses experiencing financial difficulties may vary depending on the general characteristics of the relevant sector. The adverse effects of financial difficulties are significant not only for the business concerned but also for the sector in which it operates (Bağcı & Sağlam, 2020). Financial failures within a business lead to a range of adverse consequences, such as the business struggling to meet or being unable to meet its debt obligations due to certain internal problems, a slowdown in the collection of receivables, difficulties in sourcing inputs for production, and difficulties in paying staff wages. The persistence of these adverse effects, in turn, leads to the business going into liquidation or facing legal issues such as a composition agreement or a stay of bankruptcy proceedings (Çelik & Dursun, 2021).

In this study, when selecting companies from among Turkish and global pharmaceutical firms, care was taken to include companies from developed countries, emerging markets, manufacturers, distributors, and biotechnology focused firms. In selecting the criteria to determine the companies' financial performance, those deemed critical for the pharmaceutical sector were chosen. For the analysis period, the post-pandemic transformation and the use of current data were selected. In addition to the selected companies and criteria, the pharmaceutical sector's current financial structure was evaluated comparatively using multi-criteria decision-making methods, taking into account the periods analyzed.

2. Literature

This section of the study summarizes the literature on Turkish and global pharmaceutical companies, as well as studies that utilize the LOPCOW, MEREC, EDAS, and CoCoSo methods. In this context, the literature includes studies on the commercial, welfare, peace, innovation, economic, and sustainable development performance of countries (Lukić, 2023; Kahreman, 2024; Lukic, 2024), as well as the selection problem (Ecer et al., 2023; Dhruva et al., 2024; Simic et al., 2023), a teacher performance evaluation decision support system (Putra et al., 2024), and risk assessment of R&D projects (Rong et al., 2024). A significant increase in studies using the LOPCOW method has been observed in recent years. A summary of studies conducted using the LOPCOW method is provided below.

Table 1: *Summary of studies conducted using the LOPCOW method*

Authors	Subject of the Study	Results	Method
Ecer et al., (2023)	An Assessment of the Role of Unmanned Aerial Vehicles in Agriculture	It shows that the most important criteria when selecting agricultural UAVs are, in order, the ‘camera’, the ‘power system’ and the ‘radar system’. Furthermore, it has been concluded that the most promising UAV is the DJ AGRAS T30.	LOPCOW, VIKOR
Lukić (2023)	A Study of the Economic Conditions of Western Balkan Countries	It has been concluded that Serbia is the leading country in the Western Balkans in terms of economic performance.	LOPCOW, EDAS
Simic et al, (2023)	The Problem of Selecting Material Handling Technologies in Industry 4.0-Based Smart and Sustainable Warehouse Systems	The research findings show that AGVs are the most favorable Industry 4.0-based material handling solution	LOPCOW, ARAS
Dhruva et al, (2024)	Selection of Appropriate Cloud Computing Providers for Healthcare Facilities	It is inferred that the proposed framework is methodical and reduces human intervention, subjectivity, and biases.	LOPCOW, CoCoSo
Kahreman (2024)	Economic Performance Analysis for D8 Countries	According to the results of the CoCoSo method, Malaysia was found to be the country with the highest performance, whilst Iran was identified as the country with the lowest economic performance.	CRITIC, LOPCOW, CoCoSo
Lukic (2024)	Analysis of Serbia’s Trade Performance	Serbian trade achieved its best performance in 2022, according to the findings of a study on the dynamics of performance positioning conducted using the LOPCOW-EDAS method.	LOPCOW, EDAS
Putra et al, (2024)	A Decision Support System Model for Teacher Performance Evaluation	The result is a teacher performance appraisal system featuring an electronic rating scale designed to assist schools and appraisers in assessing teacher performance and in obtaining teacher performance appraisal data more quickly, effectively and efficiently.	LOPCOW, MARCOS
Rong et al, (2024)	Risk Assessment of Industrial Robot R&D Projects in Offline Programming Systems	To test the feasibility of the proposed FMEA model, an example relating to the risks involved in an R&D project for an industrial robot offline programming system was used. The model’s robustness and advantages were also examined through sensitivity and comparative analyses, respectively	LOPCOW, ARAS

The selection problem of the MEREC method (Popović et al., 2022; Ulutaş et al., 2022), the banking sector (Mastilo et al., 2024), modeling tourism strategies (Mishra et al., 2022), and modeling to mitigate the effects of climate change on urban transportation (Simic et al., 2024). A summary of studies conducted using the MEREC method is presented in the table below.

Table 2: *Summary of studies conducted using the MEREC method*

Authors	Subject of the Study	Results	Method
Mishra et al., (2022)	Modeling a decision support system to evaluate a low-carbon tourism strategy	The results of the case study show that LCTS-I is the most suitable sustainable LCTS, with an overall assessment score of 0.208, followed by LCTS-II, which has a benefit score of 0.172.	MEREC, MULTIMOORA
Popović et al., (2022)	Selecting an e-commerce growth strategy	The final results have demonstrated the feasibility and reliability of the proposed MCDM model.	MEREC, COBRA
Ulutaş et al., (2022)	Selecting a pallet jack for a textile workshop	The results obtained. In order to verify whether the WISP-S method produced accurate results, the results of the WISP-S method were compared with those of the ROV and WASPAS methods. A comparison of the results of these methods revealed that the WISP-S method produced accurate results.	MEREC, WISP-S
Mastilo et al., (2024)	Analysis of the banking sector in Bosnia and Herzegovina	The findings of this research reveal that Raiffeisen Bank exhibits the most favourable financial indicators and demonstrates the highest level of efficiency within this context. Consequently, this research offers insights into identifying exemplary banks that can serve as models for enhancing the performance of others.	MEREC, MARCOS
Simic et al., (2024)	Modeling the mitigation of climate change impacts on urban transportation	Our practical findings indicate that land-use planning is the best sustainable policy for mitigating climate change effects of urban transportation. By applying this solution, municipalities may generate an extra budget from low emission zones and limited traffic zones in the short-term run.	MEREC, MARCOS

It has been observed that studies such as the evaluation of renewable energy sources using the EDAS method (Yazdani et al., 2020) and the commercial and economic performance of countries (Lukić, 2023; Lukic, 2024) are present in the literature. A summary of studies conducted using the EDAS method is provided in the table below.

Table 3: *Summary of studies conducted using the EDAS method*

Authors	Subject of the Study	Results	Method
Yazdani et al., (2020)	Assessment of renewable energy sources	The authors have considered a distance measure, which originates from grey relational coefficient and targets to enhance the flexibility of the results. Hence, the weight of the alternatives is placed in the decision-making process with three equations. In the final stage, an aggregated multiplication rule is employed to release the ranking of the alternatives and end the decision process.	ENTROPİ, EDAS
Lukić (2023)	Research on the economic conditions of the Western Balkan countries	It has been concluded that Serbia is the leading country in the Western Balkans in terms of economic performance.	LOPCOW, EDAS
Lukic (2024)	Analysis of Serbia's trade performance	Serbian trade achieved its best performance in 2022, according to the findings of a study on the dynamics of performance positioning conducted using the LOPCOW-EDAS method.	LOPCOW, EDAS

Selection of cloud computing providers using the CoCoSo method (Dhruva et al., 2024), evaluation of alternative railway systems (Bouraima et al., 2023), evaluation of circular economy applications (Khan

& Haleem, 2021), analysis of countries' and nations' information and talent competitiveness, as well as their economic and development performance (Kahreman, 2023; Kahreman, 2024), and financial risk assessment (Peng & Huang, 2020). A summary of studies utilizing the CoCoSo method is presented in the table below.

Table 4: *Summary of studies conducted using the CoCoSo method*

Authors	Subject of the Study	Results	Method
Peng & Huang (2020)	Financial risk assessment	The most notable features of the proposed algorithm are that it does not involve a non-intuitive scenario and that it has a greater capacity to identify the best alternative.	CRITIC, CoCoSo
Khan & Haleem (2021)	Analysis of circular economy practices	This study helps managers draw up an action plan for implementing circular economy practices. By prioritising circular economy practices, managers and professionals can optimise their organisational resources to effectively adopt such practices.	CoCoSo
Bouraima et al., (2023)	Evaluation of alternative railway systems for sustainable transportation	Information systems are the most critical challenge for the rail transport system, whilst Nigeria's rail system is the best amongst the rest.	IRN SWARA, IRN CoCoSo
Kahreman (2023)	Analysis of the economic performance of G20 countries	According to the results of the COCOSO method, the countries with the best performance during the period under review were the US, Germany and South Korea, whilst those with the worst economic performance were Indonesia, Argentina and South Africa. It was also found that there was a decline in the overall situation of the US and EU countries following the 2008 crisis.	LOPCOW, CoCoSo
Dhruva et al, (2024)	Selection of suitable cloud computing providers for healthcare facilities	It is inferred that the proposed framework is methodical and reduces human intervention, subjectivity, and biases.	LOPCOW, CoCoSo
Kahreman (2024)	Analysis of the economic performance of D8 countries	According to the results of the CoCoSo method, Malaysia was found to be the country with the highest performance, whilst Iran was identified as the country with the lowest economic performance.	CRITIC, LOPCOW, CoCoSo

Among studies analysing the financial performance of companies in the pharmaceutical sector, Gülençer et al. (2024) In a study evaluating the financial risk and performance of pharmaceutical and healthcare sector companies listed on Borsa İstanbul, a financial performance assessment using the TOPSIS method between 2019 and 2023 concluded that ANGEN demonstrated the best performance in 2019, whilst RTALB demonstrated the best performance in 2020, 2021, 2022 and 2023. Şenol et al. (2023) Financial analysis of the sectoral impacts of the COVID-19 pandemic on healthcare companies: A case study of the Turkish pharmaceutical sector: an analysis of financial data using the TOPSIS method for seven pharmaceutical companies listed on the Borsa Istanbul between 2019 and 2022 revealed that whilst many sectors were driven into economic crisis during the pandemic, the pharmaceutical sector was positively affected by turning the crisis into an opportunity. The analysis concluded that RTALB performed best in 2019, in 2020, GENIL in 2021 and SEYKM in 2022 demonstrated the best performance.

The literature review presented above indicates that there are studies which conduct comparative financial performance analyses of pharmaceutical sector companies against firms in their respective countries. As no study in the literature has conducted a comparative financial performance analysis of

Turkish and global pharmaceutical companies using the MCDM methods across multiple years within a single study, this study will make a significant contribution to the literature.

3. Methodology

In this study, using the financial data for the years 2021–2025 from 12 Turkish and global pharmaceutical companies, along with the most commonly used financial performance metrics in the literature, the weights of these metrics were first calculated using the LOPCOW and MEREC methods. Once the metric weights had been determined, the companies' financial performance was analysed using the EDAS and CoCoSo methods. The results obtained from the performance analysis were evaluated comparatively. When selecting companies for the study, care was taken to include firms from developed countries, emerging markets, manufacturers, distributors and biotechnology focused companies. In selecting the criteria to determine the companies' financial performance, those deemed critical for the pharmaceutical sector were chosen. For the analysis period, the post pandemic transformation and the use of up to date data were selected. The data used for the analysis were obtained from the independent auditor's reports published on the websites of the companies under analysis.

3.1. Financial Performance Metrics

The study includes a total of six criteria to measure companies' financial performance: Return on Assets (ROA), which indicates how efficiently companies utilize their assets; Return on Equity (ROE), which indicates return on equity; Net Profit Margin (NPM), which indicates the proportion of sales converted into net profit; Current Ratio (CR), which indicates the ability to pay short-term debt; Debt to Equity Ratio (D/E), and Research and Development Intensity (R&D), which reflects a company's R&D investment relative to its sales. Among these criteria, the Debt to Equity Ratio is a cost criterion, while the others are benefit criteria. The details of the calculations for these criteria are presented in Table 5.

Table 5: *Financial performance metrics*

Criteria	Code	Calculation Method
Return on Assets (ROA),	C1	Net Income/Total Assets
Return on Equity (ROE)	C2	Net Income/Shareholders' Equity
Net Profit Margin (NPM)	C3	Net Income/Net Sales
Current Ratio (CR)	C4	Current Assets/Current Liabilities
Debt to Equity Ratio (D/E)	C5	Total Debt/Shareholders' Equity
Research and development Intensity (R&D)	C6	R&D Expenditure/Net Sales

3.2. Criterion Weighting and Financial Performance Methods

In this section, the decision matrix was first transformed into a positive matrix, and then the joint weights of the criteria were calculated using the LOPCOW and MEREC methods. Using the weighted criteria, the financial performance of the companies was analyzed using the EDAS and CoCoSo methods.

3.2.1. Positization Using the Z-Score

The first decision matrix, which forms the basis of the financial performance evaluation in this study, was constructed using data from 12 Turkish and global pharmaceutical companies for the 2021–2025 period. In the decision matrix used in the study, logarithmic calculations cannot be performed if there are zero or negative values (Ayçin, 2019; Sakarya & Budak, 2022). Equations (1) and (2) were used to convert negative values in the decision matrix to positive values using the Z-score. In these equations, $\bar{x}_j$ represents the mean of the j th criterion, σ_j represents the standard deviation of the j th criterion, and, $A > |\min_{zij}|$ A represents the shift width (Zhang et al., 2014).

$$z_{ij} = \frac{(x_{ij} - \bar{x}_j)}{\sigma_j} \quad (1)$$

$$z'_{ij} = z_{ij} + A \quad (2)$$

The decision matrix obtained through positive transformation using the Z-score was used in the LOPCOW and MEREC methods to determine the weight values of the criteria.

3.2.2. LOPCOW Method

Using the LOPCOW method, optimal solutions can be obtained for both benefit- and cost-oriented criteria without any constraints. In this method, the results can be expressed as the percentage of the standard deviation of the mean squared values of the series. Additionally, the discrepancy (gap) arising from the scale of the data can be eliminated. The LOPCOW method is not affected by negative raw values. The mathematical operations used for the four steps of the LOPCOW method are explained below (Bektaş, 2022; Ecer & Pamucar, 2022).

Step 1: Deriving the Decision Matrix

To solve the decision problem, an internal decision matrix (IDM) consisting of m alternatives and n criteria must first be constructed. This matrix is derived using Equation (3).

$$IDM = \begin{bmatrix} X_{11} & \cdots & X_{1j} & \cdots & X_{1n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ X_{m1} & \cdots & X_{mj} & \cdots & X_{mn} \end{bmatrix} \quad (3)$$

Step 2: Normalization of the Decision Matrix

The elements of the decision matrix are normalized using Equations (4) and (5). If the criteria are costoriented (minimization), Equation (4) is used; if the criteria are benefit-oriented (maximization), Equation (5) is used.

$$r_{ij} = \frac{x_{max} - x_{ij}}{x_{max} - x_{min}} \quad (4)$$

$$r_{ij} = \frac{x_{ij} - x_{min}}{x_{max} - x_{min}} \quad (5)$$

Step 3: Creating a Matrix of Percentage Values for the Criteria

In this step, the percentage value of the criteria, PV_{ij} , is calculated using Equation (6) as the percentage of the standard deviation of the criteria relative to the mean square value, in order to eliminate the difference (gap) arising from the data size.

$$PV_{ij} = \left| \ln \left(\frac{\sqrt{\frac{\sum_{i=1}^m r_{ij}^2}{m}}}{\sigma} \right) \cdot 100 \right| \quad (6)$$

Step 4: Calculation of Objective Weight Values

The objective weight (W_j).

$$W_j = \frac{PV_{ij}}{\sum_{i=1}^n PV_{ij}} \quad (7)$$

3.2.3. MEREC Method

The MEREC method was proposed by Keshavarz-Ghorabae et al. (2021) as one of the objective criterion weighting methods. In this method, the impact of omitting (removing) criteria is examined when determining their weights. In other words, when determining the importance level of any criterion, that criterion is excluded from the calculation, and the resulting change in the total criterion weight is examined. The application process of the MEREC method consists of six steps. The mathematical operations used in the steps of this method are shown below (Keshavarz-Ghorabae et al., 2021).

Step 1: Deriving the Decision Matrix

In the first step, a decision matrix consisting of m alternatives and n criteria is constructed using Equation (3).

Step 2: Deriving the Normalized Decision Matrix

The decision matrix is normalized using the mathematical expressions shown in Equation (8), based on whether the criteria are benefit-oriented or cost-oriented.

$$n_{ij}^x = \begin{cases} \frac{\min x_{ij}}{x_{ij}} & \text{if } j \in \text{Useful Criterion} \\ \frac{x_{ij}}{\max x_{ij}} & \text{if } j \in \text{Useless Criterion} \end{cases} \quad (8)$$

Step 3: Determining the Total Performance Value

The total performance values (S_i), of the alternatives are determined according to Equation (9).

$$S_i = \ln \left(1 + \left(\frac{1}{m} \sum_j |\ln(n_{ij}^x)| \right) \right) \quad (9)$$

Step 4: Determining the Performance of Alternatives

The performance of the alternatives (S'_{ij}), determined by applying the subtraction (omission) process to each criterion separately. To this end, the values of (S'_{ij}) are determined using Equation (10).

$$S'_{ij} = \ln \left(1 + \left(\frac{1}{m} \sum_{k, k \neq j} |\ln(n_{ik}^x)| \right) \right) \quad (10)$$

Step 5: Determining the Sum of Deviations

In this step, the total value of the absolute deviations is calculated. Equation (11) is used to determine the exclusion effect of the E_j j. criterion.

$$E_j = \sum_i |S'_{ij} - S_i| \quad (11)$$

Step 6: Calculation of Criterion Weight Values

The objective weight values (w_j) of the criteria are calculated using the exclusion effects (E_j) obtained in Step 5. Equation (12) is used here to determine the criterion weight values.

$$w_{j, merrec} = \frac{E_j}{\sum_k E_k} \quad (12)$$

3.2.4. Common Weighting

In this study, the criterion weight values were determined separately by following the steps of the LOPCOW and MEREC methods. The aim here was to create a more reliable analysis model using a common weighting method. Thus, more appropriate objective weight values were determined for the criteria. In the study, the criterion weight values calculated according to the LOPCOW and MEREC methods were combined using Equation (13) to calculate an objective common weight value for each criterion (Zavadskas & Podvezko, 2016).

$$W_{j, ortak} = \frac{w_{j, merrec} w_{j, lopcow}}{\sum_{j=1}^m w_{j, merrec} w_{j, lopcow}} \quad (13)$$

3.2.5. EDAS Method

The EDAS (Evaluation Based on Distance from Average Solution) method is based on evaluating the performance of alternatives according to their distance from the average solution. The EDAS method does not require the identification of ideal or rare solutions. However, in methods such as TOPSIS, VIKOR, and CP, the distances from the ideal or anti-ideal solution must be calculated. These correspond to positive distance from the average (PDA) and negative distance from the average (NDA). The EDAS method consists of eight steps (Keshavarz-Ghorabae et al., 2015; Kundakcı, 2019; Apan & Öztel, 2020; Bektaş, 2022; Li et al., 2023).

Step 1: The most important criteria for evaluating the alternatives are selected.

Step 2: A decision matrix containing m alternatives and n criteria is constructed as shown in Equation (3).

Step 3: The average solution for the evaluation criteria is determined using Equations (14) and (15).

$$AV_j = [AV_j]_{1 \times n} \quad (14)$$

$$AV_j = \frac{\sum_{i=1}^m x_{ij}}{m} \quad (15)$$

Step 4: The positive deviation from the mean (PDA) and the negative deviation from the mean (NDA) are calculated using the following equations, depending on the type of criterion (benefit and cost).

$$PDA_{ij} = [PDA_{ij}]_{m \times n} \quad (16)$$

$$NDA_{ij} = [NDA_{ij}]_{m \times n} \quad (17)$$

If criterion j . is utility-oriented,

$$PDA_{ij} = \frac{\max(0, (x_{ij} - AV_j))}{AV_j} \quad (18)$$

$$NDA_{ij} = \frac{\max(0, (AV_j - x_{ij}))}{AV_j} \quad (19)$$

and if criterion j . is cost-oriented,

$$PDA_{ij} = \frac{\max(0, (AV_j - x_{ij}))}{AV_j} \quad (20)$$

$$NDA_{ij} = \frac{\max(0, (x_{ij} - AV_j))}{AV_j} \quad (21)$$

Here, PDA_{ij} and NDA_{ij} , represent, respectively, the positive and negative deviations of alternative i from the average solution with respect to criterion j .

Step 5: The weighted sums of the PDA and NDA deviations for the alternatives are calculated using Equations (22) and (23).

$$SP_i = \sum_{j=1}^n w_j PDA_{ij} \quad (22)$$

$$NP_i = \sum_{j=1}^n w_j NDA_{ij} \quad (23)$$

Here, w_j , represents the weight of the j . criterion.

Step 6: The normalized values of SP and SN for the alternatives are calculated according to Equations (24) and (25).

$$NSP_i = \frac{SP_i}{\max_i(SP_i)} \quad (24)$$

$$NSN_i = 1 - \frac{SN_i}{\max_i(SN_i)} \quad (25)$$

Step 7: Evaluation scores (ES) for alternatives are calculated according to Equation (26) below.

$$AS_i = \frac{1}{2} (NSP_i + NSN_i) \quad (26)$$

Step 8: The alternatives are ranked in descending order based on their evaluation scores (ES). The alternative with the highest ES value is identified as the best option compared to the others..

3.2.6. CoCoSo Method

The CoCoSo method is a new MCDM method introduced to the literature by Yazdani et al., (2019). This method is based on a combination of an integrated simple weighted sum and an exponential weighted product model (Yazdani et al., 2019; Topal, 2021). What distinguishes this method from other MCDM methods stems from three different integration strategies. These strategies include the simple weighted sum, the exponential weighted product, and the ability to handle a decision matrix containing negative values (Özdağoğlu et al., 2022). The CoCoSo method consists of five steps (Yazdani et al., 2019; Ecer & Güneş, 2024).

Step 1: Deriving the Decision Matrix

The decision matrix is derived using Equation (3).

Step 2: Deriving the Normalized Decision Matrix

To normalize the values in the decision matrix, Equation (27) is used if the criteria are benefit-oriented, and the formulation in Equation (28) is used if they are cost-oriented.

$$r_{ij} = \frac{x_{ij} - \min x_{ij}}{\max x_{ij} - \min x_{ij}} \quad (27)$$

$$r_{ij} = \frac{\max x_{ij} - x_{ij}}{\max x_{ij} - \min x_{ij}} \quad (28)$$

Step 3: Calculation of the Simple Weighted Sum (S_i) and Exponential Weighted Product (P_i)

The weighted sum of the comparability series, S_i s determined by Equation (29). The sum of the power weights of the comparability series for the alternatives, P_i is calculated by Equation (30).

$$S_i = \sum_{j=1}^n (w_j r_{ij}) \quad (29)$$

$$P_i = \sum_{j=1}^n (r_{ij})^{w_j} \quad (30)$$

Step 4: Calculation of Relative Weight Values ($k_{ia} k_{ib} k_{ic}$)

Here, the relative weight values of the alternatives are calculated using Equations (31), (32), and (33), based on three different aggregation strategies.

$$k_{ia} = \frac{P_i + S_i}{\sum_{i=1}^m (P_i + S_i)} \quad (31)$$

$$k_{ib} = \frac{S_i}{\min S_i} + \frac{P_i}{\min P_i} \quad (32)$$

$$k_{ic} = \frac{\lambda(S_i) + (1-\lambda)(P_i)}{(\lambda \max S_i + (1-\lambda) \max P_i)}; \quad 0 \leq \lambda \leq 1 \quad (33)$$

Step 5: Determining the Final Ranking of Alternatives (k_i)

The final ranking of the alternatives is determined using Equation (34).

$$k_i = (k_{ia} k_{ib} k_{ic})^{1/3} + \frac{1}{3} (k_{ia} + k_{ib} + k_{ic}) \quad (34)$$

4. Empirical Analysis

In this study, an initial decision matrix was created to determine the financial performance of 12 Turkish and global pharmaceutical companies for the period 2021–2025. The rows of this decision matrix

contain the alternatives, while the columns contain the criteria. The decision matrix for the years 2021–2025 was used for empirical analyses. The dataset for the analyses conducted using the MCDM methods employed in this study is provided in Table 6 below.

Table 6: *Initial decision matrix*

Companies	Years	C1	C2	C3	C4	C5	C6
Deva Holding	2021	0,230	0,429	0,861	2,066	0,862	0,054
EIS Eczacıbaşı İlaç	2021	0,091	0,102	2,212	3,310	0,117	0,000
Gen İlaç	2021	0,146	0,242	0,680	1,841	0,650	0,000
Selçuk Ecza Deposu	2021	0,073	0,211	0,425	1,428	1,910	0,000
Pfizer	2021	0,118	0,277	0,973	1,399	1,343	0,628
Johnson & Johnson	2021	0,115	0,282	0,327	1,348	1,459	0,230
Merck & Co.	2021	0,123	0,342	0,375	1,268	2,496	0,352
Eli Lilly and Company	2021	0,115	0,622	0,252	1,226	2,739	0,317
Novartis	2021	0,182	0,354	0,649	1,513	0,943	0,258
Roche	2021	0,162	0,527	0,823	0,927	2,257	0,815
AstraZeneca	2021	0,001	0,003	0,005	1,162	1,682	0,390
Sanofi	2021	0,068	0,118	0,302	1,435	1,742	0,211
Deva Holding	2022	0,158	0,346	0,580	1,358	1,191	0,070
EIS Eczacıbaşı İlaç	2022	0,180	0,223	6,292	2,025	0,239	0,009
Gen İlaç	2022	0,296	0,388	0,954	2,890	0,313	0,000
Selçuk Ecza Deposu	2022	0,110	0,374	0,476	1,370	2,387	0,000
Pfizer	2022	0,147	0,303	0,924	1,216	1,059	0,436
Johnson & Johnson	2022	0,096	0,234	0,281	0,991	1,440	0,229
Merck & Co.	2022	0,133	0,316	0,339	1,474	2,228	0,316
Eli Lilly and Company	2022	0,126	0,586	0,287	1,052	2,026	0,331
Novartis	2022	0,059	0,117	0,191	1,288	0,977	0,275
Roche	2022	0,153	0,423	0,774	1,241	1,753	0,917
AstraZeneca	2022	0,034	0,089	0,103	0,859	1,604	0,305
Sanofi	2022	0,084	0,142	0,336	1,420	1,686	0,212
Deva Holding	2023	0,151	0,229	0,713	1,665	0,518	0,226
EIS Eczacıbaşı İlaç	2023	0,063	0,079	1,252	1,605	0,248	0,048
Gen İlaç	2023	0,059	0,093	0,251	1,457	0,587	0,000
Selçuk Ecza Deposu	2023	0,005	0,015	0,024	1,327	1,973	0,000
Pfizer	2023	0,011	0,028	0,043	0,907	1,541	0,183
Johnson & Johnson	2023	0,210	0,511	0,600	1,156	1,436	0,257
Merck & Co.	2023	0,003	0,010	0,006	1,252	2,529	0,524
Eli Lilly and Company	2023	0,082	0,486	0,190	0,943	2,400	0,338
Novartis	2023	0,149	0,318	0,434	1,155	1,138	0,333
Roche	2023	0,137	0,372	0,803	1,347	1,720	0,922
AstraZeneca	2023	0,059	0,152	0,159	0,820	1,582	0,291
Sanofi	2023	0,062	0,106	0,245	1,267	1,701	0,209
Deva Holding	2024	0,002	0,003	0,011	1,608	0,429	0,101
EIS Eczacıbaşı İlaç	2024	0,018	0,023	0,344	2,019	0,252	0,029
Gen İlaç	2024	0,012	0,020	0,050	1,382	0,685	0,000
Selçuk Ecza Deposu	2024	0,030	0,088	0,158	1,330	1,954	0,000

Table 6: Initial decision matrix (continued)

Pfizer	2024	0,038	0,093	0,129	0,403	0,487	0,170
Johnson & Johnson	2024	0,078	0,197	0,229	1,111	1,519	0,281
Merck & Co.	2024	0,146	0,370	0,387	1,365	2,259	0,406
Eli Lilly and Company	2024	0,135	0,746	0,327	1,154	2,541	0,340
Novartis	2024	0,117	0,271	0,307	1,035	1,317	0,258
Roche	2024	0,090	0,254	0,685	1,482	1,815	1,141
AstraZeneca	2024	0,068	0,172	0,161	0,927	1,545	0,310
Sanofi	2024	0,055	0,093	0,233	1,460	1,706	0,238
Deva Holding	2025	-0,021	-0,031	-0,128	1,651	0,430	0,159
EİS Eczacıbaşı İlaç	2025	0,028	0,034	0,634	2,009	0,229	0,024
Gen İlaç	2025	0,041	0,078	0,200	1,269	0,883	0,012
Selçuk Ecza Deposu	2025	-0,005	-0,013	-0,027	1,380	1,700	0,000
Pfizer	2025	0,036	0,088	0,121	0,353	0,428	0,167
Johnson & Johnson	2025	0,135	0,329	0,419	1,028	1,443	0,229
Merck & Co.	2025	0,133	0,347	0,415	1,536	2,198	0,359
Eli Lilly and Company	2025	0,184	0,778	0,523	1,579	1,911	0,338
Novartis	2025	0,126	0,300	0,325	1,117	1,383	0,261
Roche	2025	0,137	0,364	0,747	1,383	1,658	0,723
AstraZeneca	2025	0,090	0,210	0,213	0,938	1,341	0,296
Sanofi	2025	0,050	0,088	0,188	1,092	1,768	0,233

The negative values in the initial decision matrix were converted to positive values using the Z-score. This resulted in a new decision matrix containing only positive values. Using this matrix, the importance levels of the criteria were determined according to the LOPCOW and MEREC methods. The combined criterion weight values were calculated using the importance levels of the criteria determined according to the LOPCOW and MEREC methods. The criterion values obtained in this context are presented in Table 7 for a comparative analysis by year, while the criterion rankings are shown in Table 8 below..

Table 7: Criterion weight values

Years/Criteria	C1	C2	C3	C4	C5	C6
2021	0,235	0,189	0,105	0,135	0,205	0,130
2022	0,196	0,167	0,089	0,164	0,229	0,155
2023	0,197	0,158	0,102	0,185	0,195	0,164
2024	0,145	0,114	0,094	0,365	0,173	0,109
2025	0,150	0,100	0,101	0,435	0,122	0,092

Table 8: *Criterion weight rankings*

Years/Criteria	C1	C2	C3	C4	C5	C6
2021	1	3	6	4	2	5
2022	2	3	6	4	1	5
2023	1	5	6	3	2	4
2024	3	4	6	1	2	5
2025	2	5	4	1	3	6

In empirical analyses, by combining the results of the LOPCOW and MEREC methods using a common weighting method, it was found that the most important criterion used in measuring financial performance was C1 (Return on Assets (ROA)) in 2021 and 2023, and C5 (Debt to Equity Ratio (D/E)) in 2022, and C4 (Current Ratio (CR)) in 2024 and 2025. It was also found that the criterion of least importance was C3 (Net Profit Margin (NPM)) in 2021, 2022, 2023 and 2024, and C6 (Research and Development Intensity (R&D)) in 2025.

4.1. EDAS Method

To determine the financial performance evaluation and ranking of 12 Turkish and global pharmaceutical companies for the years 2021–2025 using the EDAS method, the positive-valued initial decision matrix used in the LOPCOW and MEREC methods was employed. Subsequently, following the steps of the EDAS method, the evaluation scores for each alternative were determined using the relevant equations. In this context, the performance evaluation (AS_i) scores for the 12 Turkish and global pharmaceutical companies were calculated by year. These AS_i scores were calculated correctly in descending order and ranked accordingly. The alternative with the highest AS_i value is considered to have demonstrated the best performance.

The financial performance rankings of 12 Turkish and global pharmaceutical companies for the 2021–2025 period, determined using the EDAS method, are presented in Table 9.

Table 9: *EDAS financial performance ranking*

Years	2021		2022		2023		2024		2025	
Companies	ASi	Ranking	ASi	Ranking	ASi	Ranking	ASi	Ranking	ASi	Ranking
Deva Holding	0,410	9	0,434	7	0,432	5	0,558	5	0,571	5
EIS Eczacıbaşı İlaç	0,511	5	0,481	4	0,410	6	0,727	4	0,805	2
Gen İlaç	0,434	7	0,599	2	0,281	8	0,392	10	0,404	8
Selçuk Ecza Deposu	0,237	10	0,313	8	0,077	11	0,397	9	0,371	10
Pfizer	0,572	4	0,460	5	0,057	12	0,120	12	0,083	12
Johnson & Johnson	0,413	8	0,230	10	0,899	2	0,462	8	0,521	7
Merck & Co.	0,485	6	0,487	3	0,263	10	0,769	3	0,778	4
Eli Lilly and Company	0,573	3	0,457	6	0,568	4	0,783	2	0,995	1
Novartis	0,598	2	0,126	11	0,683	3	0,522	7	0,535	6
Roche	0,734	1	0,659	1	1,000	1	0,886	1	0,804	3
AstraZeneca	0,032	12	0,011	12	0,274	9	0,374	11	0,394	9
Sanofi	0,237	11	0,256	9	0,359	7	0,536	6	0,369	11

According to a financial performance analysis carried out using the EDAS method, the best performance among 12 Turkish and global pharmaceutical companies was demonstrated by Roche in 2021, 2022, 2023 and 2024, whilst the worst performance was recorded by AstraZeneca in 2021 and 2022, and by Pfizer in 2023, 2024 and 2025.

4.2. CoCoSo Method

The financial performance rankings of 12 Turkish and global pharmaceutical companies for the 2021–2025 period, obtained by analyzing their financial data using the CoCoSo method, are presented in Table 10. By following the steps of the CoCoSo method, the final performance values of the alternatives were obtained using the relative weight (*kia*, *kib*, and *kic*) values. The results of the alternatives' final performance (*ki*) values are presented in Table 10.

Table 10: CoCoSo financial performance ranking

Years	2021		2022		2023		2024		2025	
Companies	ki	Ranking	ki	Ranking	ki	Ranking	ki	Ranking	ki	Ranking
Deva Holding	2,142	1	2,044	5	2,349	1	1,549	11	1,599	10
EIS Eczacıbaşı İlaç	1,982	4	2,269	2	2,187	5	1,919	2	2,027	3
Gen İlaç	1,891	6	2,326	1	1,936	7	1,641	8	1,802	7
Selçuk Ecza Deposu	1,640	11	1,647	11	1,562	10	1,614	9	1,607	9
Pfizer	2,006	3	2,121	4	1,673	9	1,583	10	1,585	11
Johnson & Johnson	1,877	7	1,878	8	2,293	3	1,801	5	1,878	5
Merck & Co.	1,824	8	1,919	7	1,396	12	1,907	3	1,872	6
Eli Lilly and Company	1,797	9	2,005	6	1,943	6	1,793	6	2,072	1
Novartis	2,060	2	1,874	9	2,195	4	1,853	4	1,888	4
Roche	1,950	5	2,178	3	2,345	2	1,997	1	2,039	2
AstraZeneca	1,367	12	1,333	12	1,443	11	1,444	12	1,513	12
Sanofi	1,641	10	1,734	10	1,821	8	1,705	7	1,658	8

According to a financial performance analysis carried out using the CoCoSo method, among 12 Turkish and global pharmaceutical companies, Deva Holding demonstrated the best performance in 2021 and 2023, Gen İlaç in 2022, Roche in 2024, and Eli Lilly and Company in 2025, whilst the worst performance was recorded by AstraZeneca in 2021, 2022, 2024 and 2025, whilst Merck & Co recorded the worst performance in 2023.

Table 11 presents a comparative ranking of financial performance based on annual performance metrics calculated using the EDAS and CoCoSo methods, based on the financial data of 12 Turkish and global pharmaceutical companies for the 2021–2025 period.

Table 11: EDAS and CoCoSo comparative financial performance ranking

Years	2021		2022		2023		2024		2025	
Companies	EDAS	CoCoSo	EDAS	CoCoSo	EDAS	CoCoSo	EDAS	CoCoSo	EDAS	CoCoSo
Deva Holding	9	1	7	5	5	1	5	11	5	10
EIS Eczacıbaşı İlaç	5	4	4	2	6	5	4	2	2	3
Gen İlaç	7	6	2	1	8	7	10	8	8	7
Selçuk Ecza Deposu	10	11	8	11	11	10	9	9	10	9
Pfizer	4	3	5	4	12	9	12	10	12	11
Johnson & Johnson	8	7	10	8	2	3	8	5	7	5
Merck & Co.	6	8	3	7	10	12	3	3	4	6
Eli Lilly and Company	3	9	6	6	4	6	2	6	1	1
Novartis	2	2	11	9	3	4	7	4	6	4
Roche	1	5	1	3	1	2	1	1	3	2
AstraZeneca	12	12	12	12	9	11	11	12	9	12
Sanofi	11	10	9	10	7	8	6	7	11	8

Differences were observed in the financial performance rankings of the Turkish and Global 12 pharmaceutical companies when using the EDAS and CoCoSo methods. According to the EDAS method, the best financial performance among the Turkish and Global 12 pharmaceutical companies was achieved by Roche in 2021, 2022, 2023, and 2024, while according to the CoCoSo method, the best financial performance was achieved by Deva Holding in 2021 and 2023, Gen İlaç in 2022, Roche in 2024, and Eli Lilly and Company in 2025. Among the 12 Turkish and global pharmaceutical companies, the worst financial performance, according to the EDAS method, was recorded by AstraZeneca in 2021 and 2022, and by Pfizer in 2023, 2024, and 2025; according to the CoCoSo method, it was recorded by AstraZeneca in 2021, 2022, 2024, and 2025, and Merck & Co in 2023.

When examining the financial performance rankings based on the EDAS and CoCoSo methods, it was observed that although the rankings differed, they were similar across both methods. According to the EDAS and CoCoSo methods, AstraZeneca and Selçuk Ecza Deposu were found to have the worst financial performance in the 2021–2025 period. In contrast, it was found that Roche and EIS Eczacıbaşı İlaç demonstrated the best performance in the financial performance rankings for the 2021–2025 period according to both the EDAS and CoCoSo methods.

The differing results obtained from financial performance rankings using the EDAS and CoCoSo methods may stem from the computational structure of the weighting and performance evaluation methods employed (Bektaş, 2022).

5. Conclusion

This study analyzes the financial performance of Turkish and global pharmaceutical companies during the 2021–2025 period. To assess the financial performance of pharmaceutical companies, six financial criteria were selected from among the most commonly used metrics in financial performance measurement. For the analyses, four different MCDM methods were used within the framework of the LOPCOW-MEREC based EDAS-CoCoSo methodology (Bektaş, 2022). The LOPCOW and MEREC methods were preferred for determining criterion weights due to their objectivity and relative ease of calculation. Subsequently, the criterion weights determined using the LOPCOW and MEREC methods were converted into common weight values (Zavadskas & Podvezko, 2016). In the study, the EDAS and CoCoSo methods were used to address the performance and ranking problem. The rankings of the alternatives obtained using the EDAS and CoCoSo methods were analyzed.

In the performance evaluation, the objective criterion weights obtained using the LOPCOW and MEREC methods were combined using a common weighting method. Upon examining these joint criterion weighting results, it was determined that the most important criterion was C1 (Return on Assets (ROA)) in 2021, C5 (Debt to Equity Ratio (D/E)) in 2022, C1 (Return on Assets (ROA)) in 2023, and C4 (Current Ratio (CR)), and C4 (Current Ratio (CR)) in 2025.

When the performance of Turkish and global pharmaceutical companies was analyzed using the EDAS method, the best performance was shown by Roche in 2021, 2022, 2023, and 2024, while Eli Lilly and Company demonstrated the best performance in 2025. It was also found that AstraZeneca had the worst performance in 2021 and 2022, and Pfizer had the worst performance in 2023, 2024, and 2025.

On the other hand, when performance was analyzed using the CoCoSo method, Deva Holding showed the best performance in 2021 and 2023, Gen İlaç in 2022, Roche in 2024, and Eli Lilly and Company in 2025, while the worst performance was observed in 2021, 2022, 2024, and 2025, and in 2023 by Merck & Co.

Based on the results of both methods used in the study, it was found that AstraZeneca had the worst results across the periods analysed. Upon examining AstraZeneca's financial statements, it is evident that the reasons for this poor performance were that current liabilities significantly exceeded current assets in every period, and that R&D expenditure exceeded net sales. It is evident that the reason Roche,

Eli Lilly and Company, and Deva Holding achieved the best results across the analysed periods was that their current liabilities were lower than their current assets and were at a manageable level. This study has shown that maintaining debt levels at a manageable level and aligning R&D expenditure with revenue in each period would make a significant contribution to the financial performance of both Turkish and global pharmaceutical companies.

As no study using the criteria, time periods and companies employed in this study has been found in the literature, the results were compared with those of similar studies on the pharmaceutical sector conducted during the same analysis periods, namely the study Gülençer et al. (2024) and the study Şenol et al. (2023), it was found that the results of these studies differed; it was understood that this difference stemmed from variations in the criteria and their weighting.

What sets this study apart is that, for the first time, it analyses a dataset covering a five year post COVID-19 period (2021–2025) for both Turkish and global pharmaceutical companies, determines the importance levels of the criteria, and conducts the analyses using an integrated methodology that combines four different MCDM analysis methods to assess performance and ranking. Furthermore, the analysis of both Turkish and global pharmaceutical companies using this integrated methodology is expected to make a significant contribution to the pharmaceutical sector literature, serve as a guide for company executives and investors, and play a key role in filling a gap in the literature.

Declarations

Study Limitations

In selecting companies from among Turkish and global pharmaceutical firms for this study, care was taken to include companies from developed countries, emerging markets, manufacturers, distributors, and biotechnology-focused firms. In selecting the criteria to determine the companies' financial performance, those deemed critical for the pharmaceutical sector were chosen. For the analysis period, the post-pandemic transformation and the use of current data were selected.

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Competing Interests

There is no conflict of interest in this study.

Authors' Contributions

Define the contribution of each researcher named in the paper to the paper.

Corresponding Author Zafer ÖZDİL: Contribution to the article. (Formulating an idea or hypothesis for a research study and/or article, Taking responsibility for planning the tools and methods to reach the results, organizing and reporting the data, providing a logical explanation and presentation of the findings, conducting a literature review during the research, drafting the entire manuscript, and revising the manuscript before submission not only for spelling and grammar but also for its intellectual content or making other contributions...)

2. Author's Sudenaz ÖZDİL: Contribution to the article. (Formulating an idea or hypothesis for a research study and/or article, Taking responsibility for planning the tools and methods to reach the results, organizing and reporting the data, providing a logical explanation and presentation of the findings, conducting a literature review during the research, drafting the entire manuscript, and revising the manuscript before submission not only for spelling and grammar but also for its intellectual content or making other contributions...)

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