“Analyzing the Turkish insurance companies’ financial performance traded on BIST implementing the critic-based PIV method”

AUTHORS	Mehmet Mete Karadağ

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Mehmet Mete Karadağ (Turkey)

ANALYZING THE TURKISH INSURANCE COMPANIES' FINANCIAL PERFORMANCE TRADED ON BIST IMPLEMENTING THE CRITIC-BASED PIV METHOD

Abstract

The insurance industry, which is an important component of the financial channel, is an essential part of the Turkish economy, and assessing the financial performance is critical for insurance companies to improve efficiency and productivity, increase competitiveness, and enhance fiscal health. The study presented a technique for assessing the financial performance of all insurance companies registered in Borsa Istanbul by implementing an integrated method that combines the Criteria Importance Through Intercriteria Correlation (CRITIC) and Proximity Indexed Value (PIV) methods. The rationale for implementing the PIV method is the lack of adequate financial studies available on the insurance companies that employed this specific model. Initially, 18 evaluation criteria were defined. The CRITIC method was applied for the criteria weights, and insurance companies were ranked using PIV. Subsequently, the COPRAS, VIKOR, ARAS, and SAW Multi-Criteria Decision-Making (MCDM) methodologies were applied. Performance rankings derived from PIV were compared with those obtained from other MCDM models employed. Finally, Spearman's Rank Correlation and Kendall's Rank Correlation Coefficient methods were applied to analyze the extent of correlations and interactions between ranking outcomes. The PIV assessment results pointed out that AGESA received the highest rank for financial performance, and AKGRT had the lowest rank. AGESA consistently received high rankings compared to all other methods examined. Nevertheless, RAYSG and AKGRT constantly ranked poorly. All deployed methods ranked AKGRT and RAYSG in the final two positions. The study's findings underscore that ranking outcomes of PIV largely align with alternate MCDM methodologies utilized.

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Mehmet Mete KaradAĞ, Assist. Prof., Dr., Department of Management and Organization, Anadolu Bil Vocational School, Istanbul Aydın University, Istanbul, Turkey.

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INTRODUCTION

Insurance companies protect individuals or businesses against specific risks in return for payment of premiums. They are a crucial financial intermediary that enables the transfer of funds between economic entities and aids in the buildup of savings in the financial system. Insurance companies that possess a sound financial structure significantly enhance the efficacy of the financial system. Consequently, well-functioning financial systems support economic growth and development by facilitating the allocation of funds towards productive investment projects.

Analyzing the insurance companies' financial performance can facilitate identifying their strengths and weaknesses, enhancing their financial structure, and bolstering their competitiveness. A comprehensive assessment of financial performance is essential for insurance companies and all stakeholders associated. For investors, for example,

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financial performance analysis helps them screen good and poor-performing firms and select the most appropriate insurance company to invest in.

Turkey, being an emerging market economy, possesses a financial system that is predominantly controlled by the banking sector. The banking industry is succeeded by the insurance sector in terms of the magnitude of its assets. Regarding this matter, the insurance industry holds the position of being the second-largest financial entity in the Turkish financial system. As of 2024, there are a total of 6 insurance companies traded on Borsa Istanbul (BIST).

The study, which specifically examines Turkish insurance companies traded on BIST, considers the identification of the most efficient insurance company in terms of financial performance regarding multiple indicators that may exert positive or negative effects and the ranking of companies as a Multi-Criteria Decision-Making (MCDM) problem. In this respect, the study employed the Criteria Importance Through Intercriteria Correlation (CRITIC) integrated Proximity Indexed Value (PIV), the Complex Proportional Assessment (COPRAS), Multicriteria Optimization and Compromise Solution (VIKOR), Additive Ratio Assessment (ARAS), and Simple Additive Weighting (SAW) MCDM methodologies to determine the insurance companies' financial performance ranking.

1. LITERATURE REVIEW

According to Zionts (1974), MCDM means "problem-solving with multiple conflicting objectives" (p. 94). Bhole and Desmukh (2018) indicated that it is a "technique that associates the alternative decision with qualitative and quantitative results in compact solutions" (p. 899). Multiple approaches exist for assessing financial performance. Several methods that can be used include econometric methods, statistical methods, and MCDM methodologies. As Baydaş et al. (2023) pointed out, "the application of MCDM methods appears suitable due to their effectiveness in addressing the multifaceted aspects of financial performance" (p. 24).

Recently, many studies have utilized the tools and applications of MCDM for solving problems in areas such as engineering, science, and technology (Mardani et al. 2015, p. 4126). These tools and applications have also been implemented in the field of finance to address several financial problems. Financial performance evaluation is among them.

The literature review section consists of two parts. In the first part, studies on financial performance evaluation methods for the insurance sector are summarized, and in the second part, the studies on PIV methods are presented.

Diverse MCDM approaches have been adopted to assess prominent financial organizations' financial performance within the financial system, such as insurance companies. Gökdemir and Emel (2023) used the CRITIC-based PROMETHEE II hybrid technique to assess the insurance companies' financial performance in BIST for 2020–2022. The analysis found that TURSG demonstrated the best level of performance from 2020 to 2021, whereas AGESA exhibited the highest performance in 2022. ANHYT consistently ranked at the bottom of the performance ranking for all three years.

Bektaş (2023) conducted a study that assessed insurance companies' financial performance trading on BIST during the four quarters of 2021. MABAC and CoCoSo methodologies were employed for performance ranking. MEREC was used to determine the criteria weights. CoCoSo's analysis reveals that AKGRT demonstrated the highest level of performance during the first and third quarters, while TURSG outperformed other companies in the second quarter. Finally, AGESA emerged as the top-performing firm in the last quarter. According to the MABAC analysis, AGESA was the top-performing corporation in the first and third quarters, while TURSG took the lead in the second and last quarters.

Gülcemal et al. (2023) examined the insurance companies' financial performance registered on BIST between 2020–2021 using the CoCoSo approach. The CRITIC methodology was employed to assign the criteria weights. The study's results

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indicate that TURSG obtained the top ranking in both 2020 and 2021. RAYSG exhibited the poorest performance during the analyzed years.

Aydın Ünal (2019) studied the insurance companies' financial performance registered on BIST. The entropy technique was used for weighting the criteria, and the EDAS approach was used for rankings. According to the findings, ANHYT ranked first in 2018, while RAYSG ranked last.

Aydın (2019) analyzed the performance of life/pension businesses in the Turkish insurance industry employing the CRITIC and TOPSIS methodologies. Koca and Bingöl (2022) examined the performance of non-life insurance businesses using the CRITIC-integrated MARCOS methodology. Çizgici Akyüz (2022) analyzed the non-life insurance companies' performance using CRITIC-weighted TOPSIS and MABAC methodologies. Erdoğan (2023) applied the CRITIC and MAIRCA approaches to examine non-life insurance companies' performance.

While several studies have analyzed the financial institutions' financial performance ranking by employing several MCDM methodologies, the application of the PIV approach has been limited. The insurance sector is relatively understudied. Two noteworthy studies were undertaken, one by Demir and Arslan (2021) and the other by Taşçı (2022). Demir and Arslan (2021) analyzed the premium production of the top 10 Turkish non-life insurance industry companies. The research developed a novel hybrid model that combines LBWA (Level Based Weight Assessment) and PIV methodologies. The LBWA approach was utilized to establish the coefficients for the criteria weights. The results of PIV were compared with WASPAS, TOPSIS, COPRAS, MABAC, WEDBA, and SAW methodologies. Spearman Rank Correlation analysis was used to establish the relationship between the ranking outcomes derived from employed methodologies. The correlation analysis displayed an average of 94.35% correlation between PIV and other MCDM methodologies. It is concluded the proposed ranking results are reliable. Taşçı (2022) analyzed the financial performance of non-life and life/pension insurance businesses operating in Turkey. The study employed the MABAC, TOPSIS, CRITIC, MAIRCA, PIV, COCOSO, and COPELAND methodologies to assess financial performance.

Studies by Yurttadur and Taşçı (2022) on the participation banks' financial performance, as well as the study by Erdoğan (2022) analyzing the deposit banks's performance, are examples of research utilizing the PIV method in the banking industry. Yurttadur and Taşçı (2022) utilized the PIV method to assess the financial performance of participating banks from 2019 to 2021. Erdoğan (2022) evaluated the performance of the 9 deposit banks registered on BIST from 2016 to 2020. The assessment criteria were weighted using AHP and SD methodologies. Financial performance was calculated using the PIV method.

Ersoy (2021) examined the applicability of the PIV approach when negative data are present. This study revealed that when negative data are present in the decision matrix, the most effective approach for achieving the result utilizing the PIV is the min-max method. Duc and Ngoc (2023) investigated a combined approach of Design of Experimental (DOE) and PIV approaches for addressing MCDM challenges. They determined that this integrated approach may be employed to swiftly establish a rating when a new solution is introduced to the existing list of alternatives.

The remaining studies conducted applying the PIV method were carried out for the following purposes: measuring the sustainability performance of energy companies (Ersoy & Taslak, 2023), analyzing the development performance of the countries (Kahreman & Kutlu, 2023), analyzing digital marketing technologies (Keleş & Alaca, 2023), examining budget transparency performance of G7 countries applying MEREC-based PIV method (Altıntaş, 2023), selecting suitable renewable energy plant by using MEREC-integrated PIV model (Goswami et al., 2022).

When assessing the literature, it is evident that a substantial amount of research has been undertaken on evaluating financial performance using MCDM methodologies. However, there is a lack of research implementing the PIV technique to analyze the insurance companies' financial performance. This study aims to fill a gap in the existing research by analyzing the financial performance of insurance companies registered in BIST by utilizing PIV and selected commonly used MCDM methodologies.

2. METHODOLOGY

This study encompasses a total of 6 insurance companies traded on the BIST. The insurance companies used for the study are presented in Table A1 (see Appendix A). Initially, a criterion set comprising 18 ratios categorized into capital adequacy, return and profitability, asset quality and liquidity, indebtedness, and operational performance was established as the criteria for evaluating financial performance. The relevant ratios were computed using financial data of insurance companies in 2023, which were collected from their published financial reports and statements on their websites. These ratios were utilized in forming the decision matrix and computing the criteria weights. The assessment criteria consist of ratios, codes, and impact directions displayed in Table B1 (see Appendix B).

Subjective or objective methods can be applied to compute criteria weights. In the study, the CRITIC was employed to assign criteria weights. This methodology is preferred as it facilitates the computation of objective weights using data about alternatives, eliminating the necessity for expert judgment. The application of all the MCDM methods in the study utilized criteria weights computed using the CRITIC. After determining the criteria weights, the PIV approach was implemented for measuring financial performance. During the application of the PIV method, the *Z*-score standardization technique established by Zhang et al. (2014) was employed to convert the negative values in the decision matrix into positive ones. This was followed by the application of the four MCDM methods, which are COPRAS, VIKOR, ARAS, and SAW. Finally, Spearman's Rank Correlation and Kendall's Rank Correlation Coefficient approaches were utilized to investigate the extent of correlations and interactions among the ranking results.

The subsequent sub-headings will briefly elucidate the employed methodologies.

2.1. CRITIC method

The CRITIC approach, proposed by Diakoulaki et al. (1995), intends to identify the objective weights of relative significance in MCDM problems. This methodology relies on the analysis of the evaluation matrix to obtain all pertinent information from the criteria for assessment (Diakoulaki et al., 1995, p. 764).

2.2. PIV method

The PIV approach is an MCDM method provided by Mufazzal and Muzakkir (2018). Mufazzal and Muzakkir (2018) asserted that the PIV assesses "the proximity of alternatives to the best possible value/ideal solution using the Proximity Index" (p. 430). MCDM methods have their strengths and weaknesses and each is formulated to deal with particular sorts of problems. The PIV method's advantage is minimizing the rank reversal problem (Yu et al., 2022, pp. 164-165).

The implementation of PIV can be summarized as follows (Mufazzal & Muzakkir, 2018, pp. 430-431): First, the decision matrix is constructed, and then it is normalized. After the normalizing process, the normalized weighted decision matrix is established. Then, the weighted proximity index u_i is computed via Equation (1).

$$u_i = v_{\max} - v_i \left\{ \begin{array}{l} v_{\max} - v_i \ \textit{associated with the benefit criteria} \\ v_i - v_{\min} \ \textit{associated with the cost criteria} \end{array} \right\}, \quad (1)$$

where v_i denotes the normalized weighted value.

During the last phase, the overall proximity value (d_i) is determined using Equation (2), and ranking is made.

$$d_i = \sum_{J=1}^{n} u_j = 1. \quad (2)$$

A lower value of (d_i) signifies a suitable alternative. Hence, the alternative having the minimum value of (d_i) will be preferred (Mufazzal & Muzakkir, 2018, p. 431).

2.3. Z-score standardization method

The negative values in the decision matrix have to be transformed into positive ones before the normalization process. For this purpose, the *Z*-score

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(standard score) standardization approach developed by Zhang et al. (2014) was integrated into the PIV method.

2.4. COPRAS method

The COPRAS methodology was developed by Zavadskas and Kaklauskas (1996). Kaklauskas et al. (2010) stated that the COPRAS approach employs "a stepwise ranking and evaluating procedure of the alternatives in terms of significance and utility degree" (p. 110). This methodology can assess both qualitative and quantitative criteria. The implementation of the COPRAS can be succinctly summarized as follows (Zavadskas et al., 2009, pp. 308-311; Kildienė et al., 2011, pp. 427-428).

First, the weighted normalized decision matrix is formed and total weighted normalized values are calculated. The sums of maximizing indices (S_{+j}) and minimizing indices (S_{-j}) are determined via Equation (3).

$$S_{+j} = \sum_{j=1}^{m} d_{+ij}, \quad S_{-j} = \sum_{J=1}^{m} d_{-ij}, \quad i = \overline{1,m}, \quad j = \overline{1,n}. \tag{3}$$

A higher value is preferred for "maximizing indices" and a lower value for "minimizing indices." In the subsequent phase, Q_j, which indicates the relative importance value of the compared options, is computed utilizing Equation (4). Q_j values are ranked from higher to lower. The higher Q_j, the greater its relative importance.

$$Q_j = S_{+j} + \frac{S_{-\min} \sum_{j=1}^{n} S_{-j}}{S_{-j} \sum_{j=1}^{n} \frac{S_{-\min}}{S_{-j}}}, \qquad j = \overline{1,n}. \tag{4}$$

In the concluding phase, the degree of each option utility and the degree of each alternative N_j are identified via Equation (5). The option with a utility rating of 100 is considered the best.

$$N_j = \frac{Q_j}{Q_{\max}} \cdot 100\%. \tag{5}$$

2.5. VIKOR method

The VIKOR approach, introduced by Opricovic in 1998, was designed for the multicriteria optimization of complex systems. This approach involves evaluating and selecting options in the existence of conflicting criteria (Opricovic & Tzeng, 2004, p. 447). The process of the VIKOR method can be summarized as follows (Opricovic & Tzeng, 2004, pp. 447-448).

First, the best (f_i^*) and worst (f_i^-) values for all criterion functions were identified and S_j, R_j, and Q_j values were calculated. The alternatives are ranked, sorting by values *S*, *R*, and *Q* in ascending order. In the last phase, a compromise solution is determined. During this process, alternative $a^{(1)}$ is selected as a compromise solution that is ranked by the measure *Q* (minimum) if both conditions are fulfilled:

1. C1: Acceptable advantage:

$Q(a^{(ii)}) - Q(a^{(i)}) \geq DQ$, where $a^{(ii)}$ is the second-ranked alternative by the measure *Q*. $DQ = 1 / (J\text{-}1)$, where *J* indicates the number of alternatives.

2. C2: Acceptable stability:

In ranking based on S and/or R values, Alternative $a^{(1)}$ should be the best-ranked alternative.

Suppose one of the conditions cannot be fulfilled. In that case, the set of compromise consensus solutions is proposed: If condition C2 cannot be fulfilled, $a^{(1)}$ and $a^{(11)}$ alternatives are selected as the best compromise solution. If condition C1 cannot be satisfied, then $a^{(1)}, a^{(11)}, \ldots, a^{(M)}$ alternatives are determined as the best set of compromise solutions.

2.6. ARAS method

The ARAS method is created by Zavadskas and Turskis (2010). During the implementation process of the ARAS, the decision matrix was initially normalized, followed by the weighted normalized decision matrix ($\hat{x}$) created by applying the "$\hat{x} = \bar{x}_{ij} w_j$" equation, where w_j indicates the weight of criteria *j* and $\bar{x}_{ij}$ is the normalized rating of the *j* criterion. Following the obtaining the optimality function values S_i by employing the equation,

$$S_i = \sum_{j=1}^{n} \overline{x}_{ij}, \quad (6)$$

the utility degree K_i is determined by the $K_i = S_i / S_0$ equation (Zavadskas & Turskis, 2010, pp. 163-165; Zavadskas et al., 2010, pp. 126-129), where "S_i indicates the optimality function value of the i-th alternative" (Zavadskas, et al., 2010, p. 128).

2.7. SAW method

The SAW is a widely used MCDM method. This methodology involves computing a weighted aggregate of performance evaluations for each option or alternative, taking into account all attributes (Khoiry & Amelia, 2023, pp. 284; Taherdoost, 2023, pp. 23-24). In the execution phase of the SAW method, the decision matrix initially gets normalized, followed by the determination of the performance value for each alternative P_i using the formula

$$P_i = \sum_{j=1}^{n} w_j \widetilde{r}_{ij}, \quad (7)$$

where w_j represents weights of each criterion and $\widetilde{r}_{ij}$ represents the normalized performance value of the *i*-th criteria for the *j*-th alternative. In the last phase, the alternatives are sorted according to performance metrics.

2.8. Correlatıon tests

Following the construction of the rankings by applying MCDM methodologies, Spearman's and Kendall's Rank Correlation Coefficient tests, which are nonparametric measures of the degree of correlation, were performed to investigate the relationships and interactions among the ranking results of MCDM methodologies. Table C1 was used to interpret the correlation degree (see Appendix C).

3. RESULTS

3.1. Determination of the weights by CRITIC

The criteria weights were calculated using the CRITIC. The 18-criteria decision matrix of 6 insurance companies is displayed in Table 1.

After conducting the decision matrix, it was normalized. In the final phase, criteria weights were computed. The criteria weights were obtained as presented in Table 2.

In subsequent phases, the earlier established decision matrix in Table 1 was used for the PIV, COPRAS, VIKOR, ARAS, and SAW methodologies.

3.2. Ranking by PIV

The Z-score was standardized, and the "Decision Matrix Adjusted by Z-Value Standardization" was constructed. Following the construction of the Decision Matrix Adjusted with Z-Value

Table 1. Constructing the decision matrix

Company	Criteria																	
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
ANHYT	0.04	0.362	0.841	0.014	0.352	0.208	0.553	0.345	0.216	1.042	1.036	0.165	0.83	0.152	0.96	24.081	0.966	0.77
AGESA	0.017	0.159	2.11	0.007	0.411	–0.032	0.286	0.318	0.129	5.583	5.457	5.379	0.862	0.121	0.983	57.08	0.971	0.747
TURSG	0.196	0.451	3.162	0.082	0.417	0.164	0.167	0.002	0.76	1.172	1.088	0.901	0.146	0.671	0.804	4.108	0.566	0.446
ANSGR	0.273	0.501	1.948	0.101	0.371	0.252	0.245	–0.007	0.882	1.266	1.199	0.897	0.212	0.576	0.727	2.666	0.722	0.428
AKGRT	0.158	0.304	6.635	0.042	0.267	0.062	0.042	–0.02	0.896	1.146	1.057	0.699	0.293	0.522	0.842	5.323	0.372	0.503
RAYSG	0.214	0.517	4.475	0.092	0.43	0.096	0.104	0.008	0.653	1.204	1.086	0.692	0.295	0.389	0.786	3.681	0.384	0.397
Criteria Direction	max.	max.	min.	max.	max.	max.	max.	max.	min.	max.	max.	max	min.	max.	min.	min.	max.	max.

Table 2. Criteria and weights (W_j)

Criteria	R1	R2	R3	R4	R5	R6	R7	R8	R9
W_j	0.054	0.048	0.037	0.062	0.041	0.042	0.038	0.079	0.066
Criteria	R10	R11	R12	R13	R14	R15	R16	R17	R18
W_j	0.051	0.057	0.049	0.065	0.062	0.054	0.059	0.064	0.073

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Table 3. Decision matrix adjusted with Z-value standardization

Company	Criteria																	
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
ANHYT	0.00	0.13	0.71	0.00	0.12	0.04	0.31	0.12	0.05	1.09	1.07	0.03	0.69	0.02	0.92	579.90	0.93	0.59
AGESA	0.00	0.03	4.45	0.00	0.17	0.00	0.08	0.10	0.02	31.17	29.78	28.93	0.74	0.01	0.97	3258.16	0.94	0.56
TURSG	0.04	0.20	10.00	0.01	0.17	0.03	0.03	0.00	0.58	1.37	1.18	0.81	0.02	0.45	0.65	16.87	0.32	0.20
ANSGR	0.07	0.25	3.79	0.01	0.14	0.06	0.06	0.00	0.78	1.60	1.44	0.81	0.05	0.33	0.53	7.11	0.52	0.18
AKGRT	0.03	0.09	44.02	0.00	0.07	0.00	0.00	0.00	0.80	1.31	1.12	0.49	0.09	0.27	0.71	28.34	0.14	0.25
RAYSG	0.05	0.27	20.03	0.01	0.18	0.01	0.01	0.00	0.43	1.45	1.18	0.48	0.09	0.15	0.62	13.55	0.15	0.16

Table 4. Normalized decision matrix

Company	Criteria																	
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
ANHYT	0.093	0.367	0.092	0.085	0.379	0.540	0.792	0.735	0.133	0.169	0.173	0.029	0.642	0.136	0.458	0.385	0.558	0.552
AGESA	0.040	0.161	0.232	0.043	0.443	0.083	0.409	0.676	0.079	0.906	0.912	0.958	0.667	0.108	0.469	0.914	0.560	0.536
TURSG	0.455	0.458	0.347	0.493	0.450	0.428	0.239	0.005	0.467	0.190	0.182	0.160	0.113	0.602	0.384	0.066	0.326	0.320
ANSGR	0.634	0.508	0.214	0.611	0.400	0.655	0.351	0.015	0.542	0.205	0.201	0.160	0.164	0.516	0.347	0.043	0.417	0.307
AKGRT	0.367	0.309	0.728	0.255	0.288	0.162	0.060	0.043	0.551	0.186	0.177	0.124	0.227	0.468	0.402	0.085	0.214	0.361
RAYSG	0.496	0.525	0.491	0.555	0.464	0.249	0.149	0.017	0.401	0.195	0.182	0.123	0.228	0.349	0.375	0.059	0.221	0.285

Table 5. Weighted normalized decision matrix

Company	Criteria																	
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
ANHYT	0.005	0.018	0.003	0.005	0.016	0.023	0.03	0.058	0.009	0.009	0.01	0.001	0.042	0.008	0.025	0.023	0.035	0.04
AGESA	0.002	0.008	0.009	0.003	0.018	0.004	0.015	0.053	0.005	0.046	0.052	0.047	0.043	0.007	0.025	0.054	0.036	0.039
TURSG	0.025	0.022	0.013	0.031	0.018	0.018	0.009	0	0.031	0.01	0.01	0.008	0.007	0.037	0.021	0.004	0.021	0.023
ANSGR	0.034	0.024	0.008	0.038	0.016	0.028	0.013	0.001	0.036	0.01	0.011	0.008	0.011	0.032	0.019	0.003	0.026	0.022
AKGRT	0.02	0.015	0.027	0.016	0.012	0.007	0.002	0.003	0.037	0.009	0.01	0.006	0.015	0.029	0.022	0.005	0.014	0.026
RAYSG	0.027	0.025	0.018	0.035	0.019	0.011	0.006	0.001	0.027	0.01	0.01	0.006	0.015	0.022	0.02	0.003	0.014	0.021

Table 6. Weighted proximity index

Company	Criteria																	
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18
ANHYT	0.029	0.008	0	0.033	0.003	0.005	0	0	0.004	0.037	0.042	0.045	0.034	0.029	0.006	0.02	0	0
AGESA	0.032	0.017	0.005	0.035	0.001	0.024	0.014	0.005	0	0	0	0	0.036	0.031	0.007	0.051	0	0.001
TURSG	0.01	0.003	0.009	0.007	0.001	0.01	0.021	0.057	0.026	0.036	0.042	0.039	0	0	0.002	0.001	0.015	0.017
ANSGR	0	0.001	0.005	0	0.003	0	0.017	0.057	0.031	0.035	0.041	0.039	0.003	0.005	0	0	0.009	0.018
AKGRT	0.014	0.01	0.024	0.022	0.007	0.021	0.028	0.054	0.031	0.036	0.042	0.041	0.007	0.008	0.003	0.003	0.022	0.014
RAYSG	0.007	0	0.015	0.003	0	0.017	0.024	0.056	0.021	0.036	0.042	0.041	0.008	0.016	0.002	0.001	0.022	0.019

Standardization, the decision matrix was normalized using this newly implemented transformation. Table 4 illustrates the normalized decision matrix.

The values in Table 4 were multiplied by the criteria weights in Table 5 to create the Weighted Normalised Decision Matrix. In the study, relevant weights (wj) were predetermined according to objective criteria using the CRITIC approach.

The weighted proximity index was derived using Equation (1) (Table 6).

Following forming the weighed proximity index, the overall proximity value (d_i) was computed via Equation (2) (Table 7).

Table 7. Overall proximity values

Insurance Company	Overall proximity value (d_i)
ANHYT	0.2959
AGESA	0.2601
TURSG	0.2957
ANSGR	0.2624
AKGRT	0.3880
RAYSG	0.3299

The alternative exhibiting the lowest "overall proximity value" (d_i) is identified as the most feasible option; therefore, the alternative with the lowest value of (d_i) gets the highest rank.

Table 8. Ranking results based on PIV

Insurance Company	Rank
AGESA	1
ANSGR	2
TURSG	3
ANHYT	4
RAYSG	5
AKGRT	6

3.3. Ranking by COPRAS

The weights (w) for each criterion, pre-calculated using the CRITIC and displayed in Table 2, were employed for the COPRAS.

The total values of maximizing indices (S_{+j}) and minimizing indices (S_{-j}) were calculated using Equation (3). Q_i, which indicates that the relative importance value of the compared options, is calculated using Equation (4). The utility degree of each option N_j is omputed using Equation (5).

3.4. Ranking by VIKOR

Table 10 presents the ranking of alternatives, structured by values S, R, and Q.

The number of alternatives (J) is 6, and $DQ = 1 / (6 - 1)$; $DQ = 0.2$. The first condition C1 is not satisfied, but the second condition C2 is satisfied. Ranking alternative Q_i v = 0.1 is selected as the best compromise solution. Ranking results from the best to worst is presented in Table 11.

Table 11. Ranking results based on VIKOR

Alternative	Rank
ANHYT	1
AGESA	2
ANSGR	3
TURSG	4
RAYSG	5
AKGRT	6

3.5. Ranking by ARAS

The weights (w) for each criterion, previously calculated using the CRITIC and given in Table 5, were used in the ARAS. Optimality function values S_i, utility degrees K_i, and ranking outcomes R were displayed in Table 12.

Table 9. Relative importance levels of decision alternatives and ranking

Company	S_{+j}	S_{-j}	Q_j	N_j	Rank
ANHYT	0.134853	0.050995	0.17523245	0.857812284	3
AGESA	0.176054	0.072958	0.204278318	1	1
TURSG	0.109811	0.034988	0.168665893	0.825667134	4
ANSGR	0.1248	0.03487	0.183853877	0.900016598	2
AKGRT	0.075536	0.049049	0.117517867	0.575283115	6
RAYSG	0.097327	0.038761	0.150451595	0.736503004	5

Table 10. Ranked S_i, R_i, and Q_i values

Company	S_i	Company	R_i	Company	Q_i v = 0.1	Company	Q_i v = 0.5	Company	Q_i v = 1
ANSGR	0.44249	ANHYT	0.06216	ANHYT	0.026412	ANHYT	0.928755	ANSGR	0
AGESA	0.48964	AGESA	0.065084	AGESA	0.177514	AGESA	0.975566	AGESA	0.180565
TURSG	0.497391	RAYSG	0.072588	RAYSG	0.613402	ANSGR	1.209895	TURSG	0.210247
ANHYT	0.511459	TURSG	0.073792	TURSG	0.655416	TURSG	1.254259	ANHYT	0.264119
RAYSG	0.559025	ANSGR	0.075797	ANSGR	0.743759	RAYSG	1.33582	RAYSG	0.446277
AKGRT	0.703617	AKGRT	0.078661	AKGRT	1	AKGRT	1.796696	AKGRT	1

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Table 12. S_i, K_i, and ranking (R)

Company	S_i	K_i	R
ANHYT	0.132828	0.519423	3
AGESA	0.157202	0.614736	1
TURSG	0.124011	0.484943	4
ANSGR	0.137615	0.538142	2
AKGRT	0.085319	0.333638	6
RAYSG	0.107302	0.419602	5
OPTIMUM	0.255723	1	

3.6. Ranking by SAW

The option with the highest performance value is considered optimal (Table 13).

Table 13. Ranking the alternatives

Company	Performance Value (P_i)	Rank
ANHYT	0.541999	4
AGESA	0.584479	2
TURSG	0.554648	3
ANSGR	0.611865	1
AKGRT	0.390129	6
RAYSG	0.484771	5

3.7. Comparison of the overall ranking outcomes

The ranking findings of PIV indicate that AGESA ranked first in financial performance with the lowest Overall Proximity Value (d_i). ANSGR ranked second. AKGRT ranked the last. According to the COPRAS' ranking results, AGESA ranks first and AKGRT last. According to the ranking findings obtained from VIKOR, ANHYT ranked first, while AKGRT ranked last. Based on the ranking results obtained by ARAS, AGESA ranked first, while AKGRT ranked last. According to the ranking result of SAW, ANSGR ranks first and AKGRT last.

Table 14. Ranking results of MCDM methodologies

Company	Method				
	PIV	COPRAS	VIKOR	ARAS	SAW
ANHYT	4	3	1	3	4
AGESA	1	1	2	1	2
TURSG	3	4	4	4	3
ANSGR	2	2	3	2	1
AKGRT	6	6	6	6	6
RAYSG	5	5	5	5	5

When comparing the PIV with SAW, ANHYT has a similar ranking, but it is lower than COPRAS, VIKOR, and ARAS methodologies. PIV, which is compatible with COPRAS and ARAS methods, ranked AGESA in the highest position, whereas VIKOR and SAW methods ranked second. TURSG achieved the third position based on PIV and SAW methods and the 4th position according to COPRAS, VIKOR, and ARAS methods. Unlike the VIKOR and SAW, the PIV method ranks ANSGR as second, aligning with COPRAS and ARAS rankings. Based on the PIV, AKGRT is ranked as the lowest, consistent with other methods. Like other methods, RAYSG ranked fifth based on the PIV method.

Spearman's correlation coefficient values between rankings derived from PIV and selected MCDM methodologies are displayed in Table 15.

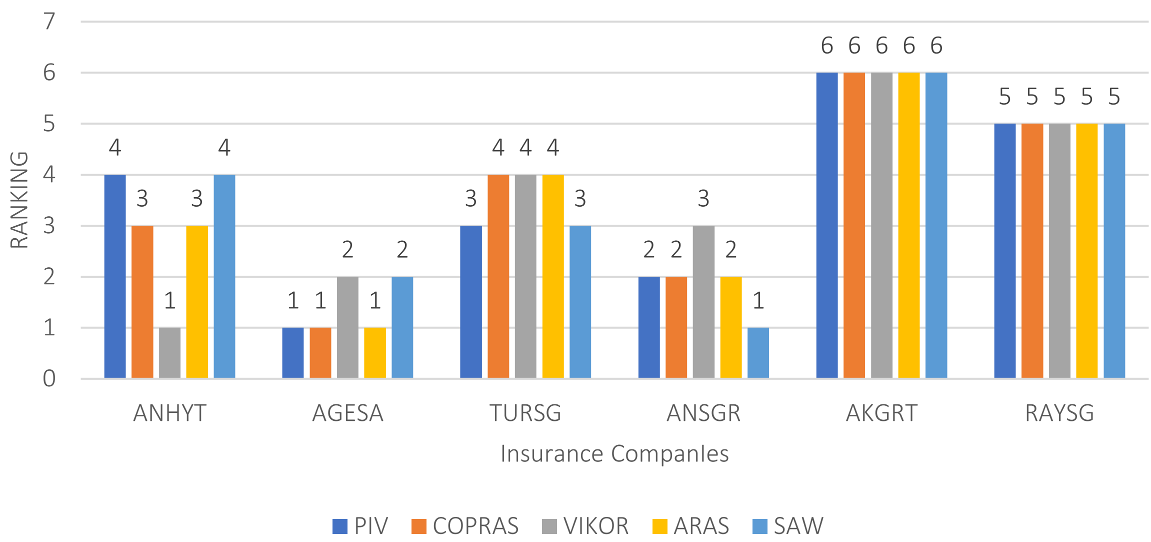

Figure 1. Comparative rankings derived from MCDM methods

Table 15. Spearman coefficient of rank correlation

VariablMethodes	PIV	COPRAS	VIKOR	ARAS	SAW
PIV	1	0.943	0.657	0.943	0.943
COPRAS	0.943	1	0.829	1	0.886
VIKOR	0.657	0.829	1	0.829	0.600
ARAS	0.943	1	0.829	1	0.886
SAW	0.943	0.886	0.600	0.886	1

Table 15 indicates a very strong positive correlation between rankings of "PIV and COPRAS", "PIV and SAW", and "PIV and ARAS" methodologies. The ranking of PIV and VIKOR exhibits a moderate positive correlation. However, this correlation is weaker compared to the correlations observed between PIV and other MCDM methods.

Table 16 illustrates Kendall's correlation coefficient values between the ranks derived from the PIV and selected MCDM methods.

Table 16. Correlation matrix (Kendall)

Variables	PIV	COPRAS	VIKOR	ARAS	SAW
PIV	1	0.867	0.600	0.867	0.867
COPRAS	0.867	1	0.733	1	0.733
VIKOR	0.600	0.733	1	0.733	0.467
ARAS	0.867	1	0.733	1	0.733
SAW	0.867	0.733	0.467	0.733	1

4. DISCUSSION

In the study, the criterion with the highest weight value was identified as Financial Profit (Gross)/ Premiums Received. Consequently, this ratio was determined to be the most significant parameter affecting the performance of insurance businesses listed on Borsa Istanbul.

Different methods may produce different ranking results. Based on the rankings provided by computed methods, AGESA generally scored high-ranking results among all the methods employed, whereas RAYSG and AKGRT consistently scored low-ranking results. According to all MCDM methods applied, AKGRT and RAYSG were ranked in the last two places.

The overall ranking results for AKGRT and RAYSG, both positioned at the lowest tiers, and AGESA, positioned at the top rankings, are consistent with the research findings of Gökdemir and Emel (2023) for 2022 utilizing PROMETHEE, Bektaş (2023) for December 2021 employing CoCoSo and MABAC, and Gülcemal et al. (2023) for 2021 using CoCoSo.

The coefficients provide important insights into how consistent the rankings are among the different methods. The findings of Spearman's correlation coefficient test reveal that the ranking outcomes of the employed MCDM methodologies in the study are not significantly different from each other. According to Kendall's rank correlation method, there is a strong relationship between "PIV and COPRAS", "PIV and ARAS", and "PIV and SAW" methods. There is a moderate relationship between the "PIV and VIKOR" methods. Most correlation coefficients are generally high, demonstrating strong positive connections between the ranks determined by different methods. This implies that the methods generally produce similar findings among each assessed insurance company. Overall, the PIV method's ranks are consistent with other methods' rankings; nonetheless, there were insignificant disparities for some insurance companies. The findings demonstrate that the ranking outcomes derived from the PIV were substantially consistent with the results of the other implemented MCDM approaches. Additionally, the PIV appears to be both practical and efficient for assessing the financial performance of insurance businesses.

CONCLUSION

Various methods exist for assessing the financial performance of financial institutions, including MCDM methodologies. In the study, the PIV and other MCDM methodologies were implemented to evaluate

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and rank the insurance companies' financial performance. To achieve this, a financial performance ranking of all insurance companies listed on BIST was established, and the results were compared.

This study focuses on the PIV method as a performance measurement technique, highlighting that implementing MCDM methods in assessing the financial performance of insurance firms will benefit companies, investors, and other stakeholders. Insurance businesses may evaluate their financial performance based on this study's findings and compare themselves to competitors, while investors may improve their financial decisions by utilizing this data.

The study suggests that utilizing many methods for financial performance rankings, rather than depending on a singular MCDM approach, will yield a more reliable selection of the optimal alternative. In subsequent research, the PIV method may be applied to assess financial performance or soundness of various financial organizations in conjunction with other MCDM methods, allowing for a comparative analysis of the data from all these methodologies. This work is anticipated to provide a beneficial contribution to finance literature.

AUTHOR CONTRIBUTIONS

Conceptualization: Mehmet Mete Karadağ.
Data Curation: Mehmet Mete Karadağ.
Formal Analysis: Mehmet Mete Karadağ.
Funding Acquisition: Mehmet Mete Karadağ.
Investigation: Mehmet Mete Karadağ.
Methodology: Mehmet Mete Karadağ.
Project Administration: Mehmet Mete Karadağ.
Resources: Mehmet Mete Karadağ.
Software: Mehmet Mete Karadağ.
Supervision: Mehmet Mete Karadağ.
Validation: Mehmet Mete Karadağ.
Visualization: Mehmet Mete Karadağ.
Writing – Original Draft: Mehmet Mete Karadağ.
Writing – Review & Editing: Mehmet Mete Karadağ.

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APPENDIX A

Table A1. Insurance companies traded on BIST and their codes

Source: Borsa Istanbul (2023).

Code	Company Name
ANSGR	Anadolu Sigorta
TURSG	Türkiye Sigorta
ANHYT	Anadolu Hayat Emeklilik
AKGRT	Aksigorta
AGESA	Agesa Hayat Emeklilik
RAYSG	Ray Sigorta

APPENDIX B

Table B1. Groups, evaluation criteria, codes and impact directions

Group	Criteria	Code	Impact Direction
Capital Adequacy	Equity / Total Assets	R1	max
	Equity / Technical Reserves (Net)	R2	max
	Written Premiums / Equity	R3	min
Returns and Profitability	Return on Asset Ratio	R4	max
	Return on Equity Ratio	R5	max
	Technical Profit / Premiums Received	R6	max
	Income Before Tax / Premiums Received	R7	max
	Financial Profit (Gross) / Premiums Received	R8	max
	Loss/Premium Ratio (Net)	R9	min
Asset Quality and Liquidity	Current ratio	R10	max
	Liquidity Ratio	R11	max
	Cash Ratio	R12	max
	Receivables from Premium and Reinsurance / Total Assets	R13	min
	Liquid Assets / Total Assets	R14	max
Indebtedness	Debt Ratio (Financial Leverage Ratio)	R15	min
	Debt / Equity Ratio	R16	min
Operational	Retention Ratio	R17	max
	Claim Payment Ratio	R18	max

APPENDIX C

Table C1. Example of correlation coefficient interpretation

Source: Schober et al. (2018).

Absolute Magnitude of the Observed Correlation Coefficient	Interpretation
0.00-0.10	Negligible correlation
0.10-0.39	Weak correlation
0.40-0.69	Moderate correlation
0.70-0.89	Strong Correlation
0.90-1.00	Very strong correlation

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