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A Novel MCDM Framework for Evaluating Corporate Financial Performance: Evidence from the Turkish Insurance Sector

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Abstract: The corporate financial performance of Turkish insurance companies was evaluated through the development of a novel hybrid multi-criteria decision-making (MCDM) framework, integrating the Ranking Comparison (RANCOM), Simple Weight Calculation (SIWEC), and Multi-Attribute Ideal-Real Comparative Analysis (MAIRCA) methodologies. Within this framework, financial indicators were selected based on expert input, and indicator weights were determined through the combined application of RANCOM and SIWEC methods. Subsequently, company rankings were established by employing the MAIRCA method. To ensure the robustness and reliability of the proposed framework, extensive sensitivity analyses were conducted. The findings identified the current ratio, defined as the ratio of current assets to current liabilities, as a critical determinant of financial performance. Türkiye Sigorta was consistently ranked as the top-performing company over the analyzed period. The outcomes of the sensitivity analyses confirmed the stability and effectiveness of the proposed decision-making model in assessing corporate financial performance within the insurance industry. This study contributes to the financial performance evaluation literature by demonstrating the applicability and advantages of hybrid MCDM approaches in dynamic and highly regulated sectors such as insurance.

Keywords: Insurance sector; Corporate financial performance; MCDM; RANCOM; SIWEC; MAIRCA

1 Introduction

The insurance sector undertakes many important functions for different economic actors, from individuals to firms, sectors and countries. From the perspective of individuals, the insurance sector provides security against unexpected losses such as health problems, accidents and property damage, helping to reduce anxiety about the future [1]. For businesses, it supports stability and growth by reducing business risks while creating the necessary environment of trust for businesses to develop innovative solutions and achieve their growth objectives. It also contributes significantly to economic growth and the liquidity of the financial system by channeling the premiums collected by insurers from their customers into long-term assets [2].

In addition to its role in ensuring financial stability and managing risk, the insurance sector contributes significantly to economic development. By pooling financial resources through premium collection and channeling them into productive investment, the sector acts as a financial intermediary and supports capital accumulation in the economy. In addition, insurance mechanisms reduce uncertainty and improve confidence among economic agents, which in turn encourages investment, promotes entrepreneurship and stimulates economic activity. Particularly in developing countries, the growth of the insurance industry not only reflects economic progress but also becomes a driving force behind it, making the sector an indispensable component of a sustainable development strategy [3].

As for a country, insurance activities support economic sustainability by facilitating recovery after natural disasters and economic crises. The role of insurance companies in building sustainable economic models with long-term investments protects economies from financial losses due to unexpected risks and provides stability to economic activity [4]. In this context, the insurance sector contributes to the stability of financial markets by strengthening the resilience of the economy through the risk management solutions it provides, and is emerging as a key actor in building a sustainable economy [5]. The evaluation of the performance of insurance companies is of critical importance to managers, policyholders, regulators, policymakers and other stakeholders because of its micro and

macro implications for the sector. Negative conditions or failures that may occur in the insurance sector may first affect firms in the real sector and then destabilize the financial system as a whole, leading to an increase in systemic risk and serious damage to the economic structure [6].

As in other developing countries, it is important for the Turkish financial sector to analyze the financial performance of insurance operations on a regular basis. These analyses are necessary for the sector to continue to be efficient and to maintain the stability of the system. According to the literature, financial analysis and efficiency measurement not only increase the quality standards of insurance operations but also enable the timely detection of current or future problems and early action against these problems [7].

The aim of this study is to investigate the performance of insurance companies in terms of chosen performance indicators based on the existing literature. In this case study, a new decision framework, including RANCOM, SIWEC and MAIRCA methodologies, was proposed. The study aims to answer the following questions within this conceptual framework:

• Why is it important to assess the performance of insurance companies on a systematic or regular basis?
• Which performance criteria should be used to measure financial performance?
• What is the performance criterion with the highest impact on performance in the insurance sector?
• Which company outperforms others in the sector based on financial performance indicators?

This research makes contributions by filling the following gaps:

• The proposal of a conceptual decision framework for evaluating the performance of executive mechanisms in the insurance industry.
• The integration of RANCOM and SIWEC algorithms for calculating the final weights.
• The combination of MAIRCA with RANCOM and SIWEC in the insurance sample for the first time.
• Presentation of the implications for managing both internal and external stakeholders in terms of performance improvement.
• Sensitivity analyses show the suitability of the proposed model in the present study.

The subsequent sections of this study are structured as follows: Section 2 presents a review of the related literature with an emphasis on identifying key research gaps. Section 3 introduces the theoretical underpinnings of the MCDM methodologies utilized in the study. Section 4 provides a description of the scope and context of the empirical case study. Section 5 discusses the results obtained from the performance assessment of insurance companies through the proposed decision-making framework. Section 6 presents sensitivity analyses to analyze the reliability and robustness of the model. Finally, Section 7 concludes this study with a summary of the main findings and suggests directions for future research.

2 Literature Review

Insurance companies are one of the most important actors in a sustainable economic system. For this reason, a lot of studies have used MCDM approaches to analyze different aspects of the performance of the insurance sector. Table 1 summarizes some of the studies conducted in the insurance sector using MCDM approaches.

Table 1. Literature review

Author(s)	Method(s)	Research Framework
Hao and Chou [8]	AHP-TOPSIS	The financial performance of insurance firms in Taiwan was assessed for the period 1997-1999.
Kung et al. [7]	GIA	For the period 2000-2004, the performance of 16 insurance firms in the Taiwan insurance industry was analyzed.
Yao et al. [9]	DEA	The efficiency of 22 insurance companies operating in the insurance sector in China was analyzed for the period-19942004.
Luhnen [10]	DEA	The level of efficiency of insurance companies in Germany was analyzed for the period from 1995 to-2006.
Barros et al. [11]	DEA	Efficiency analysis of 71 insurance firms in Greece for the period-1994-2003.
Aleniagh and Roghayyeh [5]	ANPPROMETHEE	The financial efficiency of five insurance companies traded in the Tehran Stock Exchange was analyzed for the period 2011-2013.

Sabet and Fadavi [12]	DEA	The level of financial efficiency of 20 insurance companies in the Iranian insurance sector for the period of 2006-2010 was analyzed.
Sehhat et al. [13]	AHP-TOPSIS	The performance of seven insurance companies in the Iranian insurance sector for the period up to 2015 was analyzed.
Ahmadi et al. [14]	AHP-TOPSIS	The financial performance of 13 insurance companies operating in-North Khorasan for the period 2012-2012 was analyzed.
Ksenija et al. [15]	Fuzzy AHPTOPSIS	The financial performance of 28 insurance companies operating in the insurance sector in Serbia for the period from 2007 to 2014 was analyzed.
Mimoxic et al. [16]	Fuzzy TOPSIS	For the period 2008-2018, the performance of the Serbian insurance-sector was compared.
Khodamoradi et al. [17]	DEMATELPROMETHEE	The financial performance of insurance companies listed on the Tehran Stock Exchange was assessed for the period 2010-2012.
Akbulut and Gümüskaya [18]	AHP-SVMAIRCA	Turkish non-life insurance sector performance was analyzed for the period 2010-2021.
Işık et al. [19]	LOPCOWSWARA IIMARCOS	An empirical analysis covering the period 2011-2019 was used to evaluate the financial performance of eight non-life insurance companies operating in Turkey.
Akbulut and Aydoğan [20]	SV-SAW-ARAS	The performance of the Turkish life and pension insurance sector for the period from-2010 to 2021 was analyzed.
Lukić [21]	AHP-TOPSIS	The financial performance of 20 insurance companies operating in Serbia was analyzed for the year 2021.
Işık et al. [22]	Fuzzy AHPMAIRCA	The performance of listed non-life insurance companies on the-BIST was analyzed for the period 2015-2019.
Venkateswarlu and Rao [23]	Equal Weight-GIA-TOPSIS	A performance analysis of 16 insurance companies operating in the Indian insurance-sector was conducted for the period-2008-2013.
Işık and Adalar [24]	Expert Opinion-Fuzzy-CRADIS	The research focused on the sustainability aspects of major non-life insurance providers, selected based on their premium production rankings.

3 Methodology

This section details the application steps of the hybrid model, consisting of the RANCOM, SIWEC and MAIRCA procedures, developed to solve the decision problem of performance in the insurance industry. The methodological framework developed in this study is illustrated in Figure 1, and detailed explanations of the suggested procedure are described below.

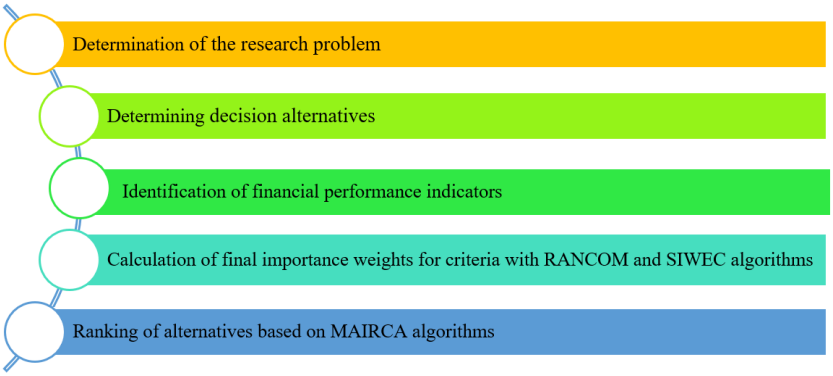

Figure 1. Proposed model

3.1 RANCOM Procedure

RANCOM is a subjective weighting method developed by Wieckowski et al. [25]. This method uses pairwise comparison matrices for evaluation. Unlike other subjective weighting methods, RANCOM allows decision-makers to use various techniques such as ranking, scoring, classification and tournament techniques [26]. The proposed methodology enables the creation of binary criteria rankings by ensuring that the vector sum is equal to 1. RANCOM provides a robust framework for decision-making in complex environments by effectively integrating expert opinions and subjective judgments. Its key strength lies in its flexibility to accommodate a variety of criteria, allowing for a detailed understanding of situations based on expert judgments. By incorporating multiple perspectives into the weighting process, RANCOM increases the accuracy and reliability of decision outcomes. In addition, its systematic approach ensures transparency in the decision-making process, making it easier to justify the choices made in both research and practice. These features make RANCOM an indispensable tool for solving multi-criteria problems, particularly in fields such as insurance and finance, where multiple interacting factors must be considered simultaneously. Applying the RANCOM technique consists of four steps [25, 26].

Step 1. In the first stage of the method, the selected criteria are evaluated and scored by the experts. At this stage, experts evaluate the criteria using a method that suits them (ranking, scoring, classification or tournament). The decision-makers determine the position of each criterion in relation to other factors by assigning lower values to more important criteria.

Step 2. After receiving the expert opinions, the pairwise comparison matrix (MAC) shown in Eq. (1) is constructed using the scale given in Eq. (2).

$$MAC = \begin{array}{c|cccc} & C_1 & C_2 & \cdots & C_m \\ C_2 & a_{11} & a_{12} & \cdots & a_{1m} \\ \vdots & a_{21} & a_{21} & \cdots & a_{2m} \\ C_n & \vdots & \vdots & \ddots & \vdots \\ & a_{n1} & a_{n2} & \cdots & a_{nm} \end{array} \tag{1}$$

$$a_{ij} = \left\{ \begin{array}{c} if\ f(C_i) < f(C_j)\ then\ \ 1 \\ if\ f(C_i) = f(C_j)\ then\ 0.5 \\ if\ f(C_i) > f(C_i)\ then\ \ 0 \end{array} \right\} \tag{2}$$

Step 3. Using the generated matrix, the horizontal vector of the summed criteria weights (SCW_j) is calculated using Eq. (3).

$$SCW_j = \sum_{j=1}^{n} a_{ij} \tag{3}$$

Step 4. Finally, using Eq. (4), the subjective importance weights (w_j) for the evaluation criteria are obtained.

$$w_j = \frac{SCW_j}{\sum_{j=1}^{n} SCW_j}; \sum_{j=1}^{n} w_j = 1 \tag{4}$$

3.2 SIWEC Procedure

The SIWEC method developed by Puška et al. [27] is one of the subjective criteria weighting approaches. In contrast to other subjective weighting methods, this method uses corrected steps for the ranking of decision alternatives. In this way, decision experts are given a different weight in the decision process. SIWEC is a widely employed approach for determining subjective weights, and in this study it was used to accurately reflect the relative importance of criteria based on the expert opinions of decision-makers. One of the key strengths of SIWEC is its ability to take into account the different perspectives and experiences of decision-makers, thereby facilitating the calculation of weights. In addition, the flexibility of the method, its compatibility with different types of data and its ease of application have proven to be significant advantages in the analyses conducted in the insurance sector. In addition, the effective use of SIWEC in similar studies in the literature supports the validity and reliability of the method, reinforcing its suitability for this research. The implementation process of the SIWEC method consists of the following six steps.

Step 1. Decision matrix is constructed according to Eq. (5).

$$X = \begin{bmatrix} x_{11} & \cdots & x_{1j} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ x_{21} & \cdots & x_{2j} & \cdots & x_{2n} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mi} & \cdots & x_{mn} \end{bmatrix} \tag{5}$$

Step 2. Initial matrix is normalized with Eq. (6).

$$n_{ij} = \frac{x_{ij}}{x_{ij_{\max}}} \tag{6}$$

where, $x_{ij_{\max}}$ represents the maximum value in the decision matrix.

Step 3. The standard deviation values of the evaluation criteria are determined using Eq. (7).

$$\sigma_j = \sqrt{\frac{\sum_{j=1}^{n} (n_{ij} - \bar{n}_j)^2}{m}} \tag{7}$$

Step 4. The normalized and standard deviation values are integrated using Eq. (8).

$$v_{ij} = n_{ij} \times \sigma_i \tag{8}$$

Step 5. The weighted sum matrix is created according to Eq. (9).

$$S_{ij} = \sum_{i=1}^{n} v_{ij} \tag{9}$$

Step 6. Subjective importance weights of the criteria are obtained by Eq. (10) in the final step of the SIWEC algorithm.

$$w_j = \frac{S_{ij}}{\sum_{j=1}^{n} S_{ij}}; \sum_{j=1}^{n} w_j = 1 \tag{10}$$

3.3 Procedure of the Final Weights

The use of various MCDM tools in the process of determining criterion importance weights can lead to differences in weight values [19]. In order to eliminate this situation, an aggregation operator that takes into account the effect of different MCDM procedures simultaneously was used in this case study [28, 29]. In the present case study, the weight values calculated by the RANCOM and SIWEC procedures were expressed as $w_j^{(RANCOM)}$ and $w_j^{(SIWEC)}$, respectively, and the final importance weight of each criterion was calculated using Eq. (11).

$$w_j = \Psi w_j^{(RANCOM)} + (1 - \Psi) w_j^{(SIWEC)} \tag{11}$$

3.4 MAIRCA Procedure

In the process of evaluating and ranking alternatives, the MAIRCA procedure developed by Pamucar et al. [30] is used to calculate the values of decision alternatives that are closest to the ideal ratings. The MAIRCA methodology is well suited to assessing performance in the insurance industry due to the dynamic structure of the sector, which involves the interaction of multiple criteria. MAIRCA approach allows both the ranking of alternatives and the clustering of criteria, providing a comprehensive analysis of the performance of companies within the sector. Compared to other methodologies, the main advantage of MAIRCA is its ability to take into account the interactions between criteria when working with complex data, a crucial aspect that is often overlooked by methodologies that focus solely on ranking. In addition, the flexible structure of the MAIRCA procedure and its compatibility with different types of data offer significant advantages in the insurance industry, a field characterized by variability and

multiple criteria. However, it has certain limitations, such as the computational cost and time required to apply the algorithm when dealing with large datasets. However, these limitations are outweighed by the ability of the method to provide robust and detailed analyses [22–30]. The application steps of this technique are as follows [18]:

Step 1. The initial matrix indicated in Eq. (5) is prepared below.

Step 2. The preference probability (P_{Bi}) value for each alternative is determined according to Eq. (12). For decision-makers to be neutral, the preference probability values for the alternatives are equal to each other and the sum is always equal to 1.

$$P_{Bi} = \frac{1}{m}; \sum_{i=1}^{m} P_{Bi} = 1 \tag{12}$$

Step 3. Criteria importance weights and preference probability values are integrated via Eq. (13).

$$K_p \begin{bmatrix} k_{p11} & k_{p12} & \cdots & k_{p1n} \\ k_{p21} & k_{p22} & \cdots & k_{p2n} \\ \vdots & \vdots & \ddots & \vdots \\ k_{pm1} & k_{pm2} & \cdots & k_{pmn} \end{bmatrix} = \begin{bmatrix} P_{B1}w_1 & P_{B1}w_2 & \cdots & P_{B1}w_n \\ P_{B2}w_1 & P_{B2}w_2 & \cdots & P_{B2}w_n \\ \vdots & \vdots & \ddots & \vdots \\ P_{Bm}w_1 & P_{B1}w_2 & \cdots & P_{Bm}w_n \end{bmatrix} \tag{13}$$

Step 4. The actual assessment matrix (K_r) is established with the aid of Eq. (14) for the beneficial criterion and Eq. (15) for the non-beneficial criterion.

$$k_{rij}{=}k_{pij} = \frac{d_{ij} - d_i^-}{d_i^+ - d_i^-} \tag{14}$$

$$k_{rij}{=}k_{pij} = \frac{d_{ij} - d_i^+}{d_i^- - d_i^+} \tag{15}$$

where, $\mathrm{d_i^+} = \mathrm{mak}\,(\mathrm{d_1}, \ldots,\ \mathrm{d_m})$ and $\mathrm{d_i^-} = \min\,(\mathrm{d_1}, \ldots,\ \mathrm{d_m})$.

Step 5. Eqs. (16)-(17) are used to obtain F, which is expressed as the total gap matrix.

$$\begin{aligned} F = K_p - K_r &= \begin{bmatrix} f_{11} & f_{12} & \cdots & f_{1n} \\ f_{21} & f_{22} & \cdots & f_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ f_{m1} & f_{m2} & \cdots & f_{mn} \end{bmatrix} \\ &= \begin{bmatrix} k_{p11} - k_{r11} & k_{p12} - k_{r12} & \cdots & k_{p1n} - k_{r1n} \\ k_{p21} - k_{r21} & k_{p22} - k_{r22} & \cdots & k_{p2n} - k_{r2n} \\ \vdots & \vdots & \ddots & \vdots \\ k_{pm1} - k_{rm1} & k_{pm2} - k_{rm2} & \cdots & k_{pmn} - k_{rmn} \end{bmatrix} \end{aligned} \tag{16}$$

$$f_{ij} = \begin{cases} 0, & if \quad k_{pij} = k_{rij} \\ k_{pij} - k_{rij}, & if \quad k_{pij} > k_{rij} \end{cases} \tag{17}$$

Step 6. The evaluation score (U_i) for the decision alternatives is calculated based on Eq. (18).

$$U_i = \sum_{i=1}^{n} f_{ij} \tag{18}$$

The best alternative is the one with the lowest U_i value.

4 Performance Assessment for the Insurance Industry

The insurance industry plays a key role in the financial ecosystem by providing various risk-sharing mechanisms and financial intermediation services that benefit both individuals and institutions. Monitoring the financial performance of firms in this sector is essential to maintain stability and enhance market competitiveness. To address this need, the current study introduces an integrated MCDM-based evaluation framework aimed at measuring the financial performance of Turkish non-life insurance companies. The analysis focuses on the top nine insurers by premium volume, using a case study approach. The financial data used in the study were collected from publicly available company reports and industry databases to ensure reliability and comprehensiveness. The data used to assess the financial performance of the insurance companies analyzed in this study were obtained from the annual financial reports and activity reports regularly published by each company. These data were chosen carefully to accurately reflect the overall performance of the sector and the position of each company in the market. In addition, market share information was obtained from the Türkiye Sigorta Birliği (TSB) database. This approach strengthened the reliability of the data used in the analysis and allowed for the creation of a comprehensive dataset, allowing for an accurate assessment of the current state of the insurance sector. Table 2 shows the companies examined in the analysis, and Table 3 details the performance indicators used in the evaluation process.

Table 2. Alternative insurance companies

Code	Alternative	Market Share(%)
I1	Türkiye Sigorta	0.1372
I2	Allianz-Sigorta	0.1115
I3	Anadolu Anonim Türk Sigorta	0.0942
I4	Axa Sigorta	0.0827
I5	Aksigorta	0.0476
I6	HDI Sigorta	0.0472
17	Quick Sigorta	0.0464
18	Sompo Sigorta	0.0425
I9	Ray Sigorta	0.0409

Table 3. Performance indicators

Code	Definition	Optimization
EC1	Total equity/total assets	Max
EC2	Current assets/current liabilities	Max
EC3	Net profit/total equity	Max
EC4	Net profit/total-assets	Max
EC5	Net premiums received/gross premiums received	Max
EC6	Gross premiums received/total assets	Max
EC7	Total liabilities/total equity	Min
EC8	Gross premiums received/total shareholders' equity	Min
EC9	Gross claims paid/gross premiums received	Min
EC10	Operating expenses/gross premiums received	Min

5 Implementation of the RANCOM-SIWEC-MAIRCA Model

This section contains the outcomes of the proposed model for measuring the performance of insurance companies. In this study, the RANCOM and SIWIEC approaches were chosen for subjective weighting due to their ability to provide more accurate and reliable results in MCDM processes. The RANCOM procedure provides high flexibility in determining weights by considering the interactions between criteria and is particularly notable for its ability to integrate different expert opinions. This capability is particularly valuable in the insurance industry, where the combination of different perspectives allows for a more comprehensive and accurate assessment. On the other hand, SIWIEC allows for a systematic reflection of the subjective judgments of decision-makers, thus allowing for more reliable weightings. Both methods provide more nuanced and flexible results than traditional weighting approaches, making them more suitable for analysis in dynamic and diverse fields such as insurance.

5.1 Results of the RANCOM Procedure

RANCOM is a subjective weighting method that takes into account the judgments of decision-makers in the weighting of criteria. In order to obtain the importance weights for the criteria using this method, the views

of decision-makers were consulted. Information on the decision-makers consulted and their opinions is given in Table 4.

Table 4. Features of the decision-makers

Decision-maker	Position	Experience
DM-I	Deputy chairman of the board and CEO	20
DM-II	Member of the corporate governance committee	25
DM-II	Member of the early risk detection committee	15
DM-IV	Member of the audit committee	28
DM-V	Independent board member	18

In the interview with the decision-makers shown in Table 4, the objective of the study and the identified evaluation criteria were explained in detail. The decision-makers were asked to assess the criteria using a scoring method according to Eq. (2). Then the consensus views obtained were combined according to Eq. (1) and the pairwise comparison matrix shown in Table 5 was formed.

Table 5. Pairwise comparison matrix

	EC1	EC2	EC3	EC4	EC5	EC6	EC7	EC8	EC9	EC10
EC1	1	1	1	0	1	0	0	0	1	0
EC2	0	1	1	1	1	1	1	1	1	1
EC3	0	0	1	0	0	0	1	0	0	0
EC4	1	0	1	1	1	0	0	0	1	1
EC5	0	0	1	0	1	0	0	0	1	0
EC6	1	0	1	1	1	1	0	0	1	1
EC7	1	0	1	1	1	1	1	0.5	1	0
EC8	1	0	1	1	1	1	0.5	1	1	1
EC9	0	0	1	0	0	0	0	0	1	0.5
EC10	1	0	1	0	1	0	1	0	0.5	1

With the help of the pairwise comparison matrix, the horizontal vector of the weights of the criteria (SCW_j) was obtained by means of Eq. (3). The subjective importance weights (w_j) of the criteria were then determined by applying Eq. (4). The results are presented in Table 6.

Table 6. RANCOM results

	SCW_j	w_j	Rank
EC1	5.0000	0.0893	7
EC2	9.0000	0.1607	1
EC3	2.0000	0.0357	10
EC4	6.0000	0.1071	5
EC5	3.0000	0.0536	8
EC6	7.0000	0.1250	4
EC7	7.5000	0.1339	3
EC8	8.5000	0.1518	2
EC9	2.5000	0.0446	9
EC10	5.5000	0.0982	6

5.2 Results of the SIWEC Procedure

Subjective importance weights for the criteria were determined in the second part of the analysis process using the SIWEC methodology. In the first step of this method, the decision matrix was constructed according to Eq. (5). During the construction of the decision matrix, the individual opinions of the decision-makers, whose information is given in Table 4, were taken into account. Decision-makers were asked to rate the performance criteria on a scale of 1-10. They were asked to assign higher scores to the criteria they considered more important and lower scores to the criteria they considered less important. The decision matrix formed as a result of the decision-makers' scores is shown in Table 7.

Table 7. Decision matrix

	EC1	EC2	EC3	EC4	EC5	EC6	EC7	EC8	EC9	EC10
DM-I	7	9	8	6	10	9	5	7	7	9
DM-II	6	8	8	6	10	9	6	7	7	9
DM-II	5	8	7	8	9	9	6	8	7	9
DM-IV	6	9	7	8	9	8	8	8	8	8
DM-V	6	9	6	7	9	9	6	8	6	10

Eq. (6) was applied to normalize the decision matrix generated according to the opinions of the decision-makers. The normalized values are shown in Table 8.

Table 8. Normalized decision matrix

	EC1	EC2	EC3	EC4	EC5	EC6	EC7	EC8	EC9	EC10
DM-I	0.7000	0.9000	0.8000	0.6000	1.0000	0.9000	0.5000	0.7000	0.7000	0.9000
DM-II	0.6000	0.8000	0.8000	0.6000	1.0000	0.9000	0.6000	0.7000	0.7000	0.9000
DM-II	0.5000	0.8000	0.7000	0.8000	0.9000	0.9000	0.6000	0.8000	0.7000	0.9000
DM-IV	0.6000	0.9000	0.7000	0.8000	0.9000	0.8000	0.8000	0.8000	0.8000	0.8000
DM-V	0.6000	0.9000	0.6000	0.7000	0.9000	0.9000	0.6000	0.8000	0.6000	1.0000

The standard deviation values for the criteria were first determined using Eq. (7) in the last step of the method. Then the normalized values and standard deviation values were integrated using Eq. (8). Finally, the S_{ij} values, which are expressed as the weighted sum matrix, and the w_j values, which express the importance weights of the performance criteria, were obtained using Eqs. (8)-(9), respectively. The findings of the calculations are indicated in Table 9.

Table 9. Normalized decision matrix

	S_{ij}	w_j	Rank
EC1	0.4102	0.0787	9
EC2	0.5842	0.1121	4
EC3	0.4902	0.0941	6
EC4	0.4683	0.0899	8
EC5	0.6420	0.1232	1
EC6	0.6032	0.1158	3
EC7	0.4098	0.0787	10
EC8	0.5140	0.0987	5
EC9	0.4690	0.0900	7
EC10	0.6190	0.1188	2

5.3 Final Weighting Results

The subjective importance weights obtained based on the RANCOM and SIWEC methodologies were integrated by the aggregation operator given in Eq. (10) in the final stage of the weighting process. The aim is to eliminate inconsistencies in the decision-makers' opinions and to obtain more reliable findings for the criteria. Considering the methods employed in similar studies [28, 29], the Ψ value in this study was taken to be 0.5. This value assumes that both methods are equally important and reliable, ensuring that equal weight is given to each technique. The Ψ parameter was set to maintain a balance between the results provided by the RANCOM and SIWIEC methodologies, consistent with similar applications in the literature, ensuring that the contributions of both methods are assessed equally. Table 10 shows the final weights calculated for each of the criteria.

Based on the final weighting findings, the most impactful indicators in assessing the performance of insurance companies are EC2 (current assets to current liabilities), EC8 (gross premiums written to total equity), and EC6 (gross claims paid to gross premiums). In contrast, EC3 (return on equity), EC9 (gross claims paid to gross premiums) and EC1 (total equity to total assets) are the least impactful indicators in the assessment process.

Table 10. Final weight values of criteria

	$w_j^{(\text{RANCOM})}$	$w_j^{(SIWEC)}$	**Final** w_j	**Rank**
EC1	0.0893	0.0787	0.0840	8
EC2	0.1607	0.1121	0.1364	1
EC3	0.0357	0.0941	0.0649	10
EC4	0.1071	0.0899	0.0985	6
EC5	0.0536	0.1232	0.0884	7
EC6	0.1250	0.1158	0.1204	3
EC7	0.1339	0.0787	0.1063	5
EC8	0.1518	0.0987	0.1252	2
EC9	0.0446	0.0900	0.0673	9
EC10	0.0982	0.1188	0.1085	4

5.4 Results of the MAIRCA Procedure

After determining the final weights for criteria, the final stage of the analysis process was to assess the success of insurance companies in terms of corporate financial performance by means of the MAIRCA procedure. In the first stage of the MAIRCA procedure, a decision matrix was constructed according to Eq. (5) and is presented in Table 11. The data in the decision matrix consist of the averages of the insurance companies for the period 2021-2023.

Table 11. Decision matrix

	EC1	**EC2**	**EC3**	**EC4**	**EC5**	**EC6**	**EC7**	**EC8**	**EC9**	**EC10**
I1	0.2404	5.9671	0.2472	0.0581	0.2119	0.8270	1.3250	3.5211	0.2119	0.0811
I2	0.1144	1.5216	0.3390	0.0389	0.5031	0.2246	7.7463	1.9670	0.5031	0.1488
I3	0.2104	1.1860	0.2553	0.0564	0.5194	0.7238	3.8075	3.4642	0.5194	0.1329
I4	0.2538	1.3425	0.3913	0.0987	0.4540	0.6012	2.9479	2.3745	0.4540	0.1496
I5	0.1497	1.1531	0.2015	0.0304	0.5129	1.0982	5.6914	7.3169	0.5129	0.0815
I6	0.1652	1.1690	0.2969	0.0510	0.4076	0.8934	5.1106	5.4751	0.4076	0.1614
I7	0.2468	1.0680	0.3456	0.0906	0.4240	0.6013	3.1520	2.4616	0.4240	0.1066
I8	0.2405	5.1076	0.2855	0.0678	0.5423	0.7049	3.2325	3.0688	0.5423	0.1180
I9	0.1807	1.1699	0.2682	0.0487	0.3685	1.0942	4.5620	6.1029	0.3685	0.0851

With the help of Eq. (12), the probability of preference values was then determined as $P_{Bi} = 1/9 = 0.1111$. Then, in the third step, the theoretical evaluation matrix K_p obtained by Eq. (13) was formed, as shown in Table 12.

Table 12. Theoretical evaluation matrix

	EC1	**EC2**	**EC3**	**EC4**	**EC5**	**EC6**	**EC7**	**EC8**	**EC9**	**EC10**
I1	0.0093	0.0152	0.0072	0.0109	0.0098	0.0134	0.0118	0.0139	0.0075	0.0121
I2	0.0093	0.0152	0.0072	0.0109	0.0098	0.0134	0.0118	0.0139	0.0075	0.0121
I3	0.0093	0.0152	0.0072	0.0109	0.0098	0.0134	0.0118	0.0139	0.0075	0.0121
I4	0.0093	0.0152	0.0072	0.0109	0.0098	0.0134	0.0118	0.0139	0.0075	0.0121
I5	0.0093	0.0152	0.0072	0.0109	0.0098	0.0134	0.0118	0.0139	0.0075	0.0121
I6	0.0093	0.0152	0.0072	0.0109	0.0098	0.0134	0.0118	0.0139	0.0075	0.0121
I7	0.0093	0.0152	0.0072	0.0109	0.0098	0.0134	0.0118	0.0139	0.0075	0.0121
I8	0.0093	0.0152	0.0072	0.0109	0.0098	0.0134	0.0118	0.0139	0.0075	0.0121
I9	0.0093	0.0152	0.0072	0.0109	0.0098	0.0134	0.0118	0.0139	0.0075	0.0121

The actual evaluation matrix (K_r) in Table 13 is the result of the application of Eqs. (14)-(15) for the beneficial and non-beneficial criteria.

In Table 14, the total gap matrix values (F) were first calculated with Eqs. (16)-(17). Then, the success scores (U_i) for the selected insurance companies and the success rankings based on these scores were reported by means of Eq. (18).

According to the findings of the MAIRCA model presented in Table 14, Türkiye Sigorta (I1) emerged as the best-performing insurance company in terms of corporate financial performance in 2021-2023. It is followed by Sompo (I8), Quick (I7), Axa (I4), Ray (I9), Anadolu Anonim Türk (I3), Aksigorta (I5), HDI (I6) and Allianz (I2).

Table 13. Actual evaluation matrix

	EC1	EC2	EC3	EC4	EC5	EC6	EC7	EC8	EC9	EC10
I1	0.0084	0.0152	0.0017	0.0044	0.0000	0.0092	0.0118	0.0099	0.0075	0.0121
I2	0.0000	0.0014	0.0052	0.0014	0.0087	0.0000	0.0000	0.0139	0.0009	0.0019
I3	0.0064	0.0004	0.0020	0.0042	0.0091	0.0076	0.0072	0.0100	0.0005	0.0043
I4	0.0093	0.0008	0.0072	0.0109	0.0072	0.0058	0.0088	0.0129	0.0020	0.0018
I5	0.0024	0.0003	0.0000	0.0000	0.0089	0.0134	0.0038	0.0000	0.0007	0.0120
I6	0.0034	0.0003	0.0036	0.0033	0.0058	0.0102	0.0048	0.0048	0.0031	0.0000
I7	0.0089	0.0000	0.0055	0.0097	0.0063	0.0058	0.0085	0.0126	0.0027	0.0082
I8	0.0084	0.0125	0.0032	0.0060	0.0098	0.0074	0.0083	0.0110	0.0000	0.0065
I9	0.0044	0.0003	0.0025	0.0029	0.0047	0.0133	0.0059	0.0032	0.0039	0.0115

Table 14. Actual evaluation matrix

	EC1	EC2	EC3	EC4	EC5	EC6	EC7	EC8	EC9	EC10	U_i	Rank
I1	0.0009	0.0000	0.0055	0.0065	0.0098	0.0042	0.0000	0.0040	0.0000	0.0000	0.0309	1
I2	0.0093	0.0138	0.0020	0.0096	0.0012	0.0134	0.0118	0.0000	0.0066	0.0102	0.0778	9
I3	0.0029	0.0148	0.0052	0.0068	0.0007	0.0057	0.0046	0.0039	0.0070	0.0078	0.0593	6
I4	0.0000	0.0143	0.0000	0.0000	0.0026	0.0076	0.0030	0.0011	0.0055	0.0103	0.0444	4
I5	0.0070	0.0149	0.0072	0.0109	0.0009	0.0000	0.0080	0.0139	0.0068	0.0001	0.0697	7
I6	0.0059	0.0148	0.0036	0.0076	0.0040	0.0031	0.0070	0.0091	0.0044	0.0121	0.0717	8
I7	0.0005	0.0152	0.0017	0.0013	0.0035	0.0076	0.0034	0.0013	0.0048	0.0038	0.0431	3
I8	0.0009	0.0027	0.0040	0.0049	0.0000	0.0060	0.0035	0.0029	0.0075	0.0055	0.0379	2
I9	0.0049	0.0148	0.0047	0.0080	0.0052	0.0001	0.0060	0.0108	0.0035	0.0006	0.0585	5

6 Sensitivity Analysis

As part of the current research, a two-step sensitivity analysis was conducted to demonstrate the applicability of the proposed model for comparing insurance companies. First, the effects of changes in the importance weight values of the criteria preferred in the current research on the ranking performance of the alternatives were analyzed over 50 different scenarios. Secondly, the results obtained based on the proposed MCDM model were compared with different MCDM algorithms and the results obtained were evaluated.

6.1 Exploration of the Changes in Criteria Weights

The impact of changing the importance weights of the criteria on the final ranking results was examined in accordance with the approach proposed by Božanić et al. [31]. In this context, the score of the criterion with the highest impact on performance (EC2) was reduced by 2% in each scenario. This 2% difference was then equally distributed among the other nine criteria and new weight values were obtained for each criterion. The new weightings obtained were integrated into the MAIRCA methodology and the performance rankings of the insurance companies were observed. The findings for the alternatives are shown in Figure 2. There is no significant change in alternative ranking. This is an important result in terms of the reliability of the model.

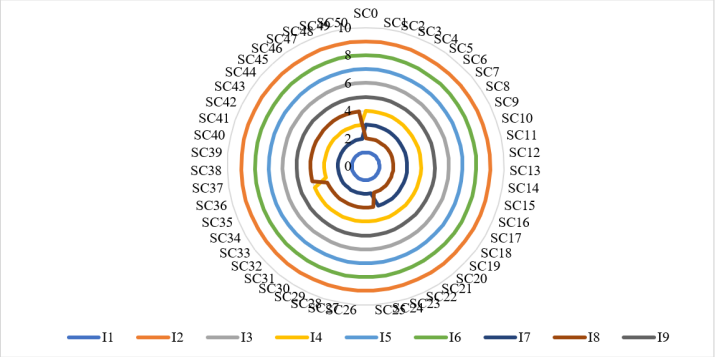

Figure 2. Ranking of alternatives according to new weights

6.2 Comparison of the Proposed Model with other MCDM Approaches

In the present study, the robustness of the ranking results obtained based on the proposed decision framework was compared with Multi-Objective Optimization on the Basis of Simple Ratio Analysis (MOOSRA) [32], Root Assessment Method (RAM) [33] and Simple Additive Weighting (SAW) [34] MCDM procedures. Figure 3 shows the results of this comparison. Accordingly, it can be stated that the proposed integrated model is robust and reliable.

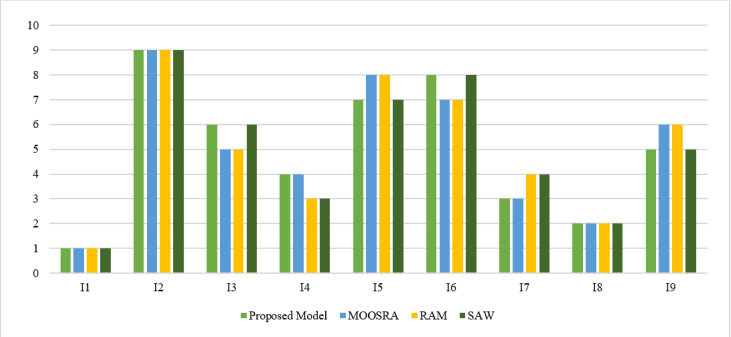

Figure 3. Ranking of alternatives according to different MCDM methodologies

Table 15 shows the correlation coefficients between the proposed integrated decision support tool and the ranking results obtained from other MCDM models. According to the information given in the table, there is a high similarity between the proposed decision tool and the other MCDM procedures.

Table 15. Coefficients of correlation between MCDM models

	Proposed Model	**MOOSRA**	**RAM**	**SAW**
Proposed model	1.0000			
MOOSRA	0.9667	1.0000		
RAM	0.9500	0.9833	1.0000	
SAW	0.9833	0.9500	0.9667	1.0000

6.3 Impact analysis of criterion elimination on the initial ranking result

In the final stage of the sensitivity analysis process, evaluations were made based on the sequential removal of each criterion. This allowed for the observation of how performance rankings were affected by the removal of criteria. According to the results presented in Figure 4, the rankings of the top three and the lowest-performing companies did not change despite the removal of criteria, indicating that the performance of these companies is not dependent on specific criteria. On the other hand, the rankings of other insurance companies showed slight changes with the removal of some criteria. These results demonstrate that certain criteria have a stronger impact on the ranking, and removing these criteria can significantly alter the rankings.

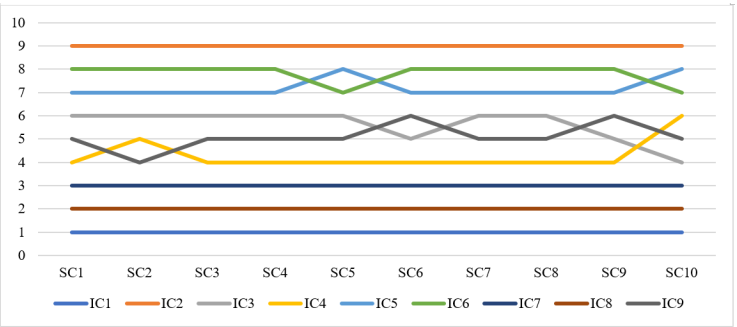

Figure 4. Impact of criterion removal on rankings

7 Conclusions and Directions for Future Research

The insurance sector is a main actor in the money and capital markets and makes a significant contribution to the economy. As one of the indispensable parts of the financial system, insurance firms play a critical role in managing risk and mitigating economic uncertainties. Therefore, regular analysis of the performance of companies operating in the sector is of great importance for maintaining economic stability and creating a sustainable insurance sector. This study focuses on the performance of Turkish insurance firms. In order to provide an objective and systematic analysis, the study proposes a new MCDM approach by combining RANCOM, SIWEC and MAIRCA methodologies. RANCOM and SIWEC are preferred for subjective weighting of criteria, while MAIRCA is preferred for ranking companies.

The final weighting results, calculated by integrating the RANCOM and SIWEC procedures, show that the ratio of current assets to current liabilities, the ratio of gross earned premiums to total equity and the ratio of gross earned premiums to total assets are the most important performance indicators. However, the criteria with the lowest impact on performance are the ratio of return on equity, the ratio of gross claims paid to gross premiums written and the ratio of total equity to total assets. The MAIRCA results show that the most financially successful insurance company is Türkiye Sigorta, followed by Sompo $>$ Quick $>$ Axa $>$ Ray $>$ Anadolu Anonim Türk $>$ Aksigorta $>$ HDI $>$ Allianz.

A two-step sensitivity analysis was applied to test the accuracy and validity of the conceptual framework developed for the research. Firstly, the effects of changing the weights of the criteria on the ranking of the options were investigated. Secondly, the reliability of the model was measured by comparing the results of the model with different MCDM approaches. The sensitivity analyses show that the proposed model provides a reliable and robust structure in decision-making processes.

The research focuses on the performance of insurance firms, one of the key elements of the financial system, and provides important information both for those involved in the regulation and supervision of the sector and for company managers in terms of monitoring long-term performance. In this context, the results of the research can guide managers to improve the performance of insurance companies and achieve a significant competitive advantage in the sector. In addition, the knowledge gained from the research can be used as a reference in the development of policies implemented by decision-making mechanisms and in the process of improving the use of resources. In addition, the results of this research provide critical insights for decision-makers in the Turkish non-life insurance sector. Based on key financial performance indicators and company rankings, the following managerial implications can be drawn:

• Customer relationship management and policyholder loyalty programs should be strengthened to retain profitable customers.

• Cost control strategies such as process automation, digital claims management and operational efficiency improvements should be implemented to reduce expenses without compromising service quality.

• Companies should focus on sustainable growth and capital allocation strategies to improve financial stability.

Practical implications based on the results of the developed decision methodology are as follows:

• Market leaders should continue to leverage their financial strength while exploring further expansion and efficiency improvements.

• Bottom performers should reassess their financial strategies, particularly with regard to premium retention, cost control and capital utilization, in order to enhance their competitive strength.

• Efficient underwriting practices and premium collection strategies are key to financial success. Companies should prioritize increasing net premiums by improving customer risk assessment, pricing strategies and policyholder (customer) retention.

• Cost control and operational efficiency are critical. Companies with high operating expenses should optimize their cost structures by reducing administrative costs, improving claims management and investing in digitalization.

• Improving profitability through strong return on equity should be a priority. Insurers should focus on profitability-driven investment strategies and capital efficiency to increase shareholder value.

As with many empirical analyses, this study has certain limitations. It focuses specifically on assessing the financial performance of non-life insurers in the Turkish market, which limits the generalizability of the findings to the broader insurance industry. Another limitation of this research is that the data utilized covers a short period of time (2021-2023). While the findings provide valuable insights into the current state of the sector, a long-term analysis could provide a more comprehensive understanding. Therefore, future research should consider extending the data collection period to cover a longer timeframe. This would allow for the observation of more distinct patterns, long-term effects and the sustainability of results over time. In future empirical studies conducted by researchers, the research topic could be revisited by using different financial metrics. In addition, the inclusion of sustainability indicators alongside financial indicators could add depth to the literature. Furthermore, financial performance analysis could also be adapted to decision-making approaches based on fuzzy set theory by using expert opinion.

Data Availability

The data used to support the research findings are available from the corresponding author upon request.

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Conflicts of Interest

The author declares that there is no conflict of interest in the study.

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