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ORIGINAL ARTICLE

FINANCIAL PERFORMANCE ANALYSIS FOR NON-LIFE INSURANCE COMPANIES IN TURKEY WITH A NEW MCDM MODEL

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Abstract
Insurance markets have a dynamic structure and tend to grow, particularly in banking-based economies. Since the performance analysis of firms operating in the insurance market is of vital importance for lots of stakeholders, it is aimed in this work to suggest a novel multi-criteria performance evaluation model to rank and evaluate non-life insurance firms via financial indicators. The current study presents a novel hybrid multi-criteria decision-making (MCDM) framework to analyze the financial performance of non-life insurers in Turkey. The propounded approach is based on integrating two MCDM procedures: Grey decision-making trial and evaluation laboratory (DEMATEL) (GD), and Simple Ranking Process (SRP) methodologies. GD method is employed to compute the criterion weights. Afterwards, SRP is utilized to assess non-life insurance companies' financial performance regarding defined financial criteria. Finally, sensitivity and rank reversal tests are conducted to indicate the validation of the proffered decision-making methodology. The empirical findings from the GE model indicate that premium production, is the most critical performance criteria. Allianz is the most successful company in terms of financial performance compared to other non-life insurers. The present work is the first to integrate DEMATEL under interval grey numbers and SRP approaches and apply them to gauge financial performance in the non-life insurance sector.

Keywords
Non-life insurance industry, Financial performance, Grey DEMATEL, SRP.

JEL Classification
C69, G22,.

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1. INTRODUCTION

Insurance services play a fundamental role in the development of countries' economic activities. Based on an insurance policy drawn up between policyholders and the insurance company, individuals or reel sector companies can compensate for losses resulting from a pre-defined event by undertaking to pay a certain premium during the insurance period (Mourmouris and Poufinas, 2023; Işık et al., 2023).

Insurance companies, known as long-term investors in every country's economy, are one of the most important financial intermediaries in financial markets. They have a vital place in the daily life of modern society by measuring, managing, and sharing various kinds of risks (social, physical, economic, and political, etc.) that economic units such as individuals and real sector companies may face. Additionally, they are not only a risk-sharing mechanism but also an essential source of funds in financing economic activities (Bilbao-Terol et al., 2022; Işık et al., 2024). Because insurance services cover certain types of events, life insurance companies generally provide coverage against the risks of death or deterioration of the policyholder's health. However, non-life insurance companies typically protect against the risks of financial losses regarding property, income, and so on (Yao et al. 2007; Wang et al., 2019). Hence, non-life insurance companies, as well as life insurance companies, are an indispensable part of the financial system and have extremely vital functions in ensuring an environment of trust and economic stability in every economy (Yang, 2007). Therefore, thanks to the micro and macro functions of the insurance industry, on the one hand, individuals are protected from possible hazards in the future and on the other hand, entrepreneurial activities within the country are supported, which helps the development and growth of commercial and industrial activities (Işık, 2021a; Msomi, 2023). In recent years, insurance services and companies' operating results have attracted much attention from academics and practitioners (Yang, 2006; Rejikumar et al., 2021). For that reason, analyzing the performance of insurance companies is a quite significant issue. Evaluating the performance of insurance companies plays a significant role in establishing the sustainability of the insurance system by providing stakeholders (e.g., insurance managers, insurance agents, policyholders, investors, and regulatory and supervisory agencies) with a reliable tool in the insurance decision-making process.

Prioritizing insurers presents an important decision-making challenge for insurance managers. This paper aims to analyze the long-term financial performance of non-life insurers. To this end, it introduces a practical assessment framework. The developed assessment multi-criteria decision making (MCDM) framework is based on the integration of the Grey decision-making trial and evaluation laboratory (DEMATEL) (GD) and Simple Ranking Process (SRP) methods. In accordance with the identified purpose, this paper presents a case study based on criteria set that is updated and suitable for eight non-life insurers in the Turkish insurance industry. As far as the authors' knowledge, the long-term performance analysis of non-life insurers is conducted for the first time in the MCDM literature. Besides, managerial insights for industry-related decision-makers are provided to improve the insurance industry and create a sustainable insurance system. Consequently, the existing paper aims to fill the research gaps identified in the past literature via a robust combined methodology. Based on the current literature gap, this work attempts to address the following research questions:

Q1. Is any mathematical method or decision support model applied to evaluate the financial performance in the insurance market?

Q2. What are the main factors influencing financial performance for non-life insurers?

Q3. Which insurer in Turkey is more successful than its competitors?

Through the research questions, which highlight the gaps in the literature, researchers can determine a realistic, reliable, and applicable methodological frame for evaluating the insurers' financial performance.

The key contributions and novelties of the propounded MCDM tool can be summarized as follows:

* This work provides insurance-related DMs and practitioners with a methodological framework for the solution process of the financial performance evaluation problem.

* In the present manuscript, a new decision-making methodology is proposed by integrating Grey DEMTEL and SRP methods for the first time in the literature. The proposed method is adapted for the first time to the financial performance measurement problem in the non-life insurance sector.

* We conducted a real case study to evaluate the long-term performance of Turkish non-life insurers. For this purpose, the average of the data for the period of 2011-2019 is used in the analysis process. To the best of our knowledge, the present work is the first to analyze the long-term financial performance of insurers with an combined MCDM approach.

Section 2 provides an extensive literature survey. Section 3 represents the introduced MCDM framework employed in the analysis. Section 4 presents the data and gives the findings of the recommended approach. Sensitivity and rank reversal tests are conducted in Section 5. Section 6 discusses managerial implications. Finally, conclusions, limitations, and future directions are drawn in the last section.

2. LITERATURE REVIEW

The literature section is grouped into two subsections. In the first sub-section, insurance studies conducted using MCDM models are summarized to provide some background information. In the second sub-section, we present the literature on studies applying the GE, GD, and GRA procedures.

2.1. MCDM studies in the insurance industry

Although there exist many studies in the field of insurance using MCDM techniques, a brief summary of some of these studies is given in this sub-section. For instance, Yao et al. (2007) applied the DEA approach to assessing the technical efficiency of 10 life insurers and 12 non-life insurers in the Chinese insurance industry. Tsai et al. (2008) evaluated and ranked Taiwanese insurance companies within the framework of the performance evaluation model using ANP and TOPSIS procedures. Yücenur and Demirel (2012) compared the performance of five Turkish insurance companies by applying the fuzzy VIKOR method to a foreign investor who wants to invest in a local insurance company. Doumpos et al. (2012), using a sample consisting of 2176 insurers operating in 91 countries for the period of 2005-2009, aimed to investigate the factors affecting financial performance based on the PROMETHEE-II method. Huang and Eling (2013) utilized DEA to compare the efficiency of non-life insurance companies operating in emerging economies such as Brazil, Russia, India, and China. Khodamoradi et al. (2014) integrated DEMATEL and PROMETHEE II methods to measure and rank the performance of 12 insurers registered on the Tehran stock exchange for the period 2010–2012. Using fuzzy AHP and TOPSIS procedures, Mandić et al. (2017) assessed the financial performance of 28 Serbian insurance companies in the period covering the years 2007-2014. Shen et al. (2017) proposed a rough knowledge-based hybrid MCDM model including the DEMATEL-based ANP method and the fuzzy integral technique to evaluate 5 life insurance companies' performance in Taiwan. Suvvari et al. (2019) conducted a performance analysis of 24 Indian life insurance companies using GRA. In their study, a performance analysis was carried out by using the average of the financial data of the companies for the period 2013-2016. Wang et al. (2019) assessed the efficiency performance of 19 general insurance companies in Malaysia utilizing the AHP-TOPSIS model based on single-valued neutrosophic numbers. Almulhim (2019) compared traditional and Takaful insurance companies with regard to their efficiency in the Saudi Arabian insurance market by applying the two-stage DEA. Akyüz et al. (2020) presented a hybrid MCDM approach based on Best-Worst method (BWM) and TOPSIS procedures for evaluating 38 non-life insurers in Turkey. Gharizadeh Beiragh et al. (2020) assessed the sustainability performance of 14 Iranian insurance companies using the analytic hierarchy process (AHP)–principal component analysis (PCA)–DEA model during 2019. Pattnaik et al. (2021) employed fuzzy TOPSIS to assess Indian life insurance companies in terms of purchasing an online policy. Ghosh et al. (2021) analyzed the efficiency of life insurers in India employing DEA over the 2010-2017 period. Mimovic et al. (2021) proposed a decision-making framework integrating the TOPSIS and the interval fuzzy rough sets to compare and rank 4 Serbian insurance companies during the period between the years 2006 and 2016. Pervan et al. (2021), employing DEA, analyzed the efficiency of life and non-life insurance companies operating in Croatia, Hungary, and Poland. Zhang et al. (2022) used an integrated TODIM-BSC framework with the neutrosophical logic for assessing the performance of 27 agencies working for private insurance companies in Iran. Bilbao-Terol et al. (2022) developed a hybrid model covering Extended Best-Worst and Multiple Reference Point approaches to evaluate 83 Spanish non-life insurance companies over the period 2007–2017. Vintilă et al. (2022), using 5-year data covering the period 2016-2020, compared the efficiency of Romanian insurance companies with the help of DEA method. Çamlıbel (2022) utilized a hybrid framework covering SD and MARCOS techniques to rank the financial performance of life and pension companies in the Turkish insurance industry. More recently, a spherical fuzzy TODIM framework based on cumulative prospect theory is presented by Zhang et al. (2023a) for commercial insurance evaluation. Zhang et al. (2023b) proposed a TODIM-balanced scorecard methodology under neutrosophic environment for private insurance companies' evaluation. To assess pension insurance system in China, Yao and Ran (2023) developed a neutrosophic GRA methodology. Işık et al. (2023) compared the performance of non-life insurers using an integrated decision-making methodology that includes LOPCOW, SWARA II, and MARCOS algorithms. Lastly, Işık et al. (2024) carried out multidimensional performance evaluation of insurance companies listed on BIST employing Pythagorean Fuzzy Analytical Hierarchy Process and MAIRCA approaches.

2.2. Articles applying Grey DEMATEL (GD) and Simple Ranking Process (SRP) Methods

Some recent studies performed GD procedure, a subjective weighting method, can be summarized as follows. It was used by Liang et al. (2016) to assess the sustainability of the biofuel sector. Han and Wang (2018), employing the GD approach, analyzed major barriers to off-site construction. Bhatia and Srivastava (2018) applied the GD method to investigate external barriers to remanufacturing in the electronic waste industry. Liu et al. (2019) designed an integrated model by combining GD with the uncertain linguistic MULTIMOORA method to evaluate electric vehicle charging stations. Xia and Ruan (2020) evaluated the obstacles related to developing a sustainable circular economy in the field of agriculture. Meidute-Kavaliauskiene et al. (2021), using the fuzzy Delphi method and GD methods, evaluated lean innovation practices in the pharmaceutical industry. Li et al. (2022) integrated GD with ANP for assessing the green mining performance of gold mines. Sohrabi (2022) applied GD-AHP method for assessing the elements influencing the agility of the cold supply chain. Zhao et al. (2022) identified the drivers of supply chain decarbonization in the plastics sector. Menon and Ravi (2022) proposed it to assess the impediments influencing sustainable supply chain implementations for the electronics sector. More recently, dos Santos Soares et al. (2023) and Konstantinou & Gkritza (2023) applied it for transportation, Gupta et al. (2023) for total quality management, Derse (2023) for site selection, and Debnath et al. (2023) for waste management.

As for SRP, it has been utilized in some fields such as choosing the proper material for knee orthoses (Mian et al., 2024) and ranking the performance of universities (Do, 2024).

2.3. Research gaps

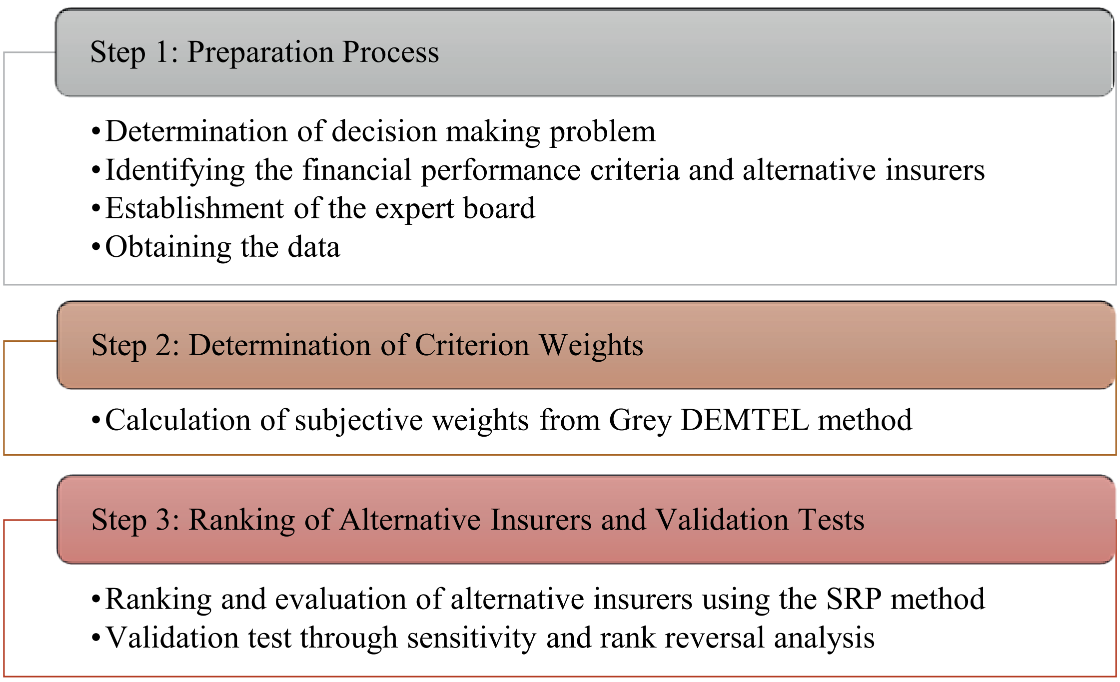
As a result of the review of previous studies in the literature, it is seen that the studies carried out with MCDM approaches in the insurance industry are mostly concentrated on the life insurance branch by employing different weighting and ranking methods. Therefore, the limited number of studies in the non-life branch, which is an indispensable part of the insurance industry, has constituted the first motivation for this study. Additionally, when the existing studies in the literature are reviewed, it can be concluded that previous performance analyses in the insurance market generally focused on one-year datasets or short-term performance analyses. However, given the critical economic functions of insurers, performance analyses that include short-term evaluations may not be successful in revealing the strengths and weaknesses of these companies, which may not provide sufficient and reliable information for top management to make operational and strategic decisions. Furthermore, based on the literature review, there are no generally applied and accepted criteria set for performance analysis in the insurance industry. Besides, taking into account the existing studies, it can be concluded that there is no widely accepted decision support tool or mathematical model for assessing alternatives in the evaluation process regarding real-life decision-makers and managers in the insurance industry.

Consequently, to assess the long-term financial performance of companies operating in the non-life insurance branch in this research, it has been developed a novel hybrid MCDM methodology that combines GD and SRP methods. The main purpose of employing two MCDM tools in the introduced integrated model is to help the decision-makers and managers in the insurance industry to make fast, reasonable, robust, and realistic decisions by taking advantage of these techniques. In this context, this work can fill the identified research gaps in the non-life insurance.

3. RESEARCH METHODOLOGY

This section presents the basic algorithm of the proffered framework. In this section, we gauge and evaluate the non-life insurers' financial performance in Turkey concerning the following steps, as shown in Fig. 1. According to the application steps of the proposed MCDM model, the subjective weights of the criteria are calculated with Grey DEMATEL, while the financial performance of the decision alternatives is ranked with SRP.

Figure 1
Flowchart of the proposed methodology



3.1. Grey DEMATEL (GD) Method

The application steps of the GD approach, which integrates the grey numbers and the DEMATEL method, are given below (Bai and Sarkis, 2013; Rajesh and Ravi, 2015; Gupta and Barua, 2018):

Step 1. Identifying initial relation matrices for all DMs.
Let the number of criteria included in the study and the number of selected decision makers (DMs) be "*n*" and "*k*", respectively. Each decision maker "l is responsible for evaluating the influence of criterion "*i*" on criterion "*j*" employing a five-level linguistic scale (0: no influence, 1: low influence, 2: medium influence, 3: high influence, 4: very high influence). The evaluation is conducted across a set of "*n*" pre-identified criteria. Table 1 presents the linguistic terms and the corresponding grey numbers (Tseng, 2009). Accordingly, the k initial relationship matrices are formed in accordance with the influence ratings from DMs.

Table 1
Grey Linguistic Expression Scale

Crisp Values	Linguistic Terms	Interval Grey Number
0	No influence	[0, 0]
1	Low influence	[0, 1]
2	Medium influence	[1, 2]
3	High influence	[2, 3]
4	Very high influence	[3, 4]

Step 2. Generating the grey relation matrices.
Based on the values determined in Step 1 and Table 1, the grey relation matrices are formed by specifying an upper range and a lower range of values, as shown in Table 1.

$$\otimes G_{ij}^{l} = (\underline{\otimes} G_{ij}^{l}, \overline{\otimes} G_{ij}^{l}) \quad (1)$$

where $1 \leq l \leq k;\ 1 \leq i \leq n;\ 1 \leq j \leq n.$

Step 3. Computing the average of grey relation matrices.
To get the average grey relational matrix $[\otimes\check{G}_{ij}]$, "k" grey relation matrices are combined.

$$\otimes \check{G}_{ij} = (\frac{\sum \underline{\otimes} G_{ij}^{l}}{k}, \frac{\sum \overline{\otimes} G_{ij}^{l}}{k}) \quad (2)$$

Where k is the number of DMs.

Step 4. Calculation of crisp matrices employing average grey matrices.
Crips matrices are obtained with the help of the three-step procedures shown below (Rajesh et al. 2015).

Step 4.1. Obtaining lower and upper normalized values.

$$\underline{\otimes} \dot{G}_{ij} = (\underline{\otimes} \check{G}_{ij} - j^{min} \underline{\otimes} \check{G}_{ij}) / \Delta_{min}^{max} \quad (3)$$

where $\underline{\otimes} \dot{G}_{ij}$ denotes the normalized lower limit value of the grey number $\underline{\otimes} \check{G}_{ij}$.

$$\overline{\otimes} \dot{G}_{ij} = (\overline{\otimes} \check{G}_{ij} - j^{min} \overline{\otimes} \check{G}_{ij}) / \Delta_{min}^{max} \quad (4)$$

where $\overline{\otimes}\dot{G}_{ij}$ denotes the normalized upper limit value of the grey number $\overline{\otimes}\check{G}_{ij}$.

$$\Delta_{min}^{max} = j^{max}\overline{\otimes}\check{G}_{ij} - j^{min}\underline{\otimes}\check{G}_{ij} \quad (5)$$

Step 4.2. Identifying the total normalized crisp value.

$$Y_{ij} = \left(\frac{\underline{\otimes}\dot{G}_{ij}(1 - \underline{\otimes}\dot{G}_{ij}) + (\overline{\otimes}\dot{G}_{ij} * \overline{\otimes}\dot{G}_{ij})}{(1 - \underline{\otimes}\dot{G}_{ij} + \overline{\otimes}\dot{G}_{ij})}\right) \quad (6)$$

Step 4.3. Determining final crisp values.

$$Y_{ij}^{*} = (min\,\underline{\otimes}\dot{G}_{ij} + (Y_{ij} \times \Delta_{min}^{max})) \quad (7)$$

and

$$Y = [Y_{ij}^{*}] \quad (8)$$

Step 5. Computing normalized direct-relation matrix.
The normalized direct relationship matrix "*D*" is determined with the help of Eqs. (9) and (10). The elements of this matrix take values between 0 and 1.

$$F = \frac{1}{1 \le i \le n^{max} \sum_{j=1}^{n} Y_{ij}^{*}} \quad (9)$$

$$D = F * Y \quad (10$$

where *F* and *Y* denote the normalization factor and the initial crisp relation matrix, respectively.

Step 6. Determining the total relationship matrix *S*.

$$S = D(I - D)^{-1} \quad (11)$$

where *I* denotes a unit matrix.

Step 7. Obtaining the cause and effect parameters.
These parameters can be calculated by applying Eqs. (12) and (13).

$$R_i = \sum_{j=1}^{n} s_{ij} \quad (12)$$

$$C_j = \sum_{i=1}^{n} s_{ij} \quad (13)$$

where *R* and *C* represent the sum of row elements and the sum of columns elements of total relation matrix "*S*", respectively. R_i gives direct and indirect impacts given by criterion *i* towards the other criteria. Whereas, C_j gives both direct and indirect impacts received by criterion *j* from other criteria.

Step 8. Calculation of criteria weights.
Eqs. (14) and (15) are employed for computing the weight coefficients of the criteria.

$$\omega_i = \sqrt{(R_i + C_i)^2 + (R_i - C_i)^2} \quad (14)$$

$$w_i = \frac{\omega_i}{\sum_{i=1}^{n} \omega_i} \quad (15)$$

Step 9. Generating the causal diagram.
Utilizing the values computed with the help of Eqs. (14) and (15), the causal diagram is set up.

3.2. Simple Ranking Process (SRP)

The steps to be followed for SRP approach are as follows (Zakeri et al., 2023):

Step 1. A decision matrix (*X*) consisting of *m* alternative and *n* criteria is formed as in Eq. (16).

$$E_{iJ} = r_{ij} \tag{16}$$

where r_{ij} : *i*. refers to the performance value of the alternative according to criteria *j*

Step 2. A ranking matrix is formulated in which the alternatives are ranked according to each criterion. When creating the new ranking matrix, if the criterion is benefit-oriented, the best alternative is the one with the highest performance value. The opposite is true when the criterion is cost-oriented. The new ranking matrix is given below.

$$S_{iJ} = R_i \tag{17}$$

Here, R_i is the rank of i-th alternative with respect to j-th criterion.

Step 3. Generate the weighted ranking matrix with the aid of Eq. (18).

$$F_{iJ} = R_i W_j \tag{18}$$

Step 4. The total ranking score of the alternatives is calculated. (19)

$$A_i = \sum_{j=1} R_i W_j \tag{19}$$

Step 5. Ranking of alternatives. The priority score for each alternative is computed by using Eq. (20)

$$K_i = m - A_i \tag{20}$$

Here, *m* is the number of alternatives.
In the last step, the alternative with the highest K_i is determined as the best alternative.

4. EMPIRICAL ANALYSIS AND RESULTS

4.1. Data

The present work concentrates on the financial performance of non-life Turkish insurance firms between the years 2011–2019. The first reason for choosing the period of 2011-2019 as the analysis period in this study is that as of 2020, Ziraat and Güneş insurance companies merged and took the name of Türkiye insurance. The other reason is that 8 non-life insurance companies included in the analysis are regularly in the top 10 list in terms of premiums produced in non-life branches during the analysis period. Besides, these 8 companies dominate 63.06% of the market premium production as of 2019. The 8 non-life insurance companies that we have handled as decision alternatives are represented by the codes indicated in Table 2. Additionally, the evaluation criteria employed in the analysis of the financial performance of the companies and their detailed explanations are given in Table 3. It should be noted that the criterion C6 is in %, while the other criteria are in TL (million). Performance criteria data indicated in Table 3 have been obtained from The Republic of Turkey Ministry of Treasury and Finance.

Table 2

Alternative non-life insurers

Alternatives	Codes
Aksigorta	I1
Allianz	I2
Anadolu	I3
Axa	I4
Güneş	I5
Mapfre	I6
Sompo Japan	I7
Ziraat	I8

Table 3

Assessment criteria

Criteria	Code	Optimization	Description	Reference
Total Assets	C1	Maximum	This indicator representing company size includes current assets and long-term assets.	Mandić et al. (2017), Gharizadeh Beiragh et al. (2020), Vintilă et al. (2022), Çamlıbel (2022), Işık et al. (2023)
Cash and Cash Equivalents	C2	Maximum	This amount, which shows the liquid assets of the companies, includes cash and assets with a high cash conversion rate.	Suvvari et al. (2019), Işık (2021b), Çamlıbel (2022)
Total Shareholders' Equity	C3	Maximum	This amount, which is calculated by taking the difference between total assets and total liabilities, indicates the financial health, creditworthiness and risk taking tendency of companies.	Diacon et al. (2002), Yao et al. (2007), Mandić et al. (2017), Almulhim (2019), Suvvari at al. (2019), Akyüz et al. (2020), Işık et al. (2023)
Investment Income	C4	Maximum	This amount consists of the sum of income from financial investment, valuation of financial investments, currency translation gains, income from affiliates, subsidiaries, and joint-venture, and income from other investments.	Barros et al. (2005), Yao et al. (2007), Wang et al. (2019), Gharizadeh Beiragh et al. (2020), Pervan et al. (2021), Ghosh et al. (2021), Mimovic et al. (2021)
Premium production	C5	Maximum	It includes direct and indirect premium production in various branches of non-life insurance.	Yao et al. (2007), Almulhim (2019), Wang et al. (2019), Gharizadeh Beiragh et al. (2020), Pervan et al. (2021), Işık (2021), Ghosh et al. (2021), Bilbao-Terol et al. (2022)
Market Share	C6	Maximum	This ratio is calculated by dividing the premium production of individual companies by the total premium production of the industry and represents the market share of the companies in terms of premium production in the non-life insurance branch.	Akyüz et al. (2020), Zhang et al. (2022), Işık et al. (2023)
Total Debts	C7	Minimum	This amount represents the sum of short-term and long-term liabilities.	Diacon et al. (2002), Shen et al. (2017), Işık (2021b), Gharizadeh Beiragh et al. (2020), Peng and Lian (2021), Çamlıbel (2022)
Operating Expenses	C8	Minimum	This amount includes administrative expenses, including personnel expenses, and commissions paid to insurance intermediaries.	Pervan et al. (2021), Gharizadeh Beiragh et al. (2020), Mimovic et al. (2021), Peng and Lian (2021), Vintilă et al. (2022)

4.2. Grey DEMATEL (GD) approach application finding

An expert committee consisting of 3 professionals with at least 15 years of experience in the insurance industry has been formed in order to obtain more reasonable and realistic results before applying the GD algorithm. Detailed information about the 3 experts selected to the evaluation committee is given in Table 4. By using opinions of three different experts separately, grey direct relationship matrices are created by employing Eq. (1) and shown in Table 1. These matrices are given in Table 5.

Table 4
Profile of experts

DMs	Duty	Graduation Degree	Experience	Age
DM-1	Insurance Supervisor	Business Management	22	61
DM-2	Agency Manager	Economics	16	53
DM-3	Insurance Broker	Industrial Engineering	15	47

Table 5
Grey direct relationship matrices for experts

	C1	C2	C3	C4	C5	C6	C7	C8
C1	[0,0],[0,0],[0,0]	[1,2],[1,2],[1,2]	[1,2],[1,2],[3,4]	[1,2],[1,2],[1,2]	[2,3],[3,4],[0,1]	[0,1],[2,3],[1,2]	[0,1],[0,1],[1,2]	[0,1],[0,1],[2,3]
C2	[0,1],[1,2],[1,2]	[0,0],[0,0],[0,0]	[0,1],[0,1],[1,2]	[2,3],[2,3],[2,3]	[2,3],[1,2],[1,2]	[2,3],[3,4],[0,1]	[1,2],[0,1],[1,2]	[0,1],[0,1],[2,3]
C3	[3,4],[3,4],[3,4]	[2,3],[2,3],[2,3]	[0,0],[0,0],[0,0]	[2,3],[2,3],[3,4]	[3,4],[2,3],[2,3]	[2,3],[0,1],[2,3]	[1,2],[0,1],[3,4]	[1,2],[0,1],[1,2]
C4	[1,2],[0,1],[0,1]	[2,3],[2,3],[0,1]	[2,3],[2,3],[0,1]	[0,0],[0,0],[0,0]	[2,3],[1,2],[1,2]	[1,2],[1,2],[1,2]	[0,1],[1,2],[1,2]	[0,1],[0,1],[2,3]
C5	[2,3],[1,2],[2,3]	[3,4],[3,4],[2,3]	[0,1],[0,1],[1,2]	[2,3],[2,3],[1,2]	[0,0],[0,0],[0,0]	[3,4],[3,4],[1,2]	[3,4],[1,2],[3,4]	[0,1],[2,3],[2,3]
C6	[2,3],[0,1],[2,3]	[0,1],[0,1],[1,2]	[1,2],[1,2],[1,2]	[2,3],[2,3],[1,2]	[3,4],[3,4],[1,2]	[0,0],[0,0],[0,0]	[3,4],[2,3],[3,4]	[3,4],[0,1],[3,4]
C7	[0,1],[1,2],[2,3]	[0,1],[0,1],[2,3]	[1,2],[1,2],[0,1]	[0,1],[0,1],[1,2]	[0,1],[1,2],[3,4]	[0,1],[0,1],[1,2]	[0,0],[0,0],[0,0]	[2,3],[0,1],[0,1]
C8	[0,1],[1,2],[3,4]	[0,1],[0,1],[1,2]	[0,1],[0,1],[0,1]	[3,4],[3,4],[1,2]	[0,1],[1,2],[1,2]	[0,1],[2,3],[2,3]	[3,4],[2,3],[2,3]	[0,0],[0,0],[0,0]

By applying Eq. (2), the combined grey direct relationship matrix is obtained by averaging the direct relationship matrices for all three DMs in the previous step. This matrix is shown in Table 6.

Table 6
Combined grey direct relationship matrix

	C1	C2	C3	C4	C5	C6	C7	C8
C1	[0.000,0.000]	[0.667,1.667]	[2.000,3.000]	[0.667,1.667]	[1.667,2.667]	[1.000,2.000]	[0.333,1.333]	[0.667,1.667]
C2	[0.667,1.667]	[0.000,0.000]	[0.667,1.667]	[1.667,2.667]	[1.333,2.333]	[1.667,2.667]	[0.667,1.667]	[0.667,1.667]
C3	[3.000.4.000]	[2.000,3.000]	[0.000,0.000]	[1.667,2.667]	[2.333,3.333]	[1.333,2.333]	[1.333,2.333]	[0.667,1.667]
C4	[0.333,1.333]	[1.000,2.000]	[1.667,2.667]	[0.000,0.000]	[1.333,2.333]	[1.000,2.000]	[0.667,1.667]	[0.667,1.667]
C5	[1.667,2.667]	[2.333,3.333]	[0.333,1.333]	[1.333,2.667]	[0.000,0.000]	[2.333,3.333]	[2.333,3.333]	[1.333,2.333]
C6	[1.333,2.333]	[0.333,1.333]	[1.333,2.333]	[1.333,2.333]	[2.333,3.333]	[0.000,0.000]	[2.667,3.667]	[2.000,3.000]
C7	[1.000,2.000]	[0.667,1.667]	[0.333,1.333]	[0.667,1.667]	[1.333,2.333]	[0.333,1.333]	[0.000,0.000]	[0.667,1.667]
C8	[1.333,2.333]	[1.000,2.000]	[0.000,1.000]	[1.667,2.667]	[0.667,1.667]	[1.333,2.333]	[2.333,3.333]	[0.000,0.000]

Employing Eqs. (3) – (8), crisp relation matrix "*Y*" is computed. While the normalized direct relationship matrix "*D*" is formed with the help of Eqs. (9) and (10), the total relationship matrix "*S*" is calculated by Eq. (11). Next, the causal parameters (i.e., the sum of rows and the sum of columns) as shown in Table 7 are calculated by applying Eqs. (12) and (13). The criteria weights are given in Table 7 after employing Eqs. (14)-(15).

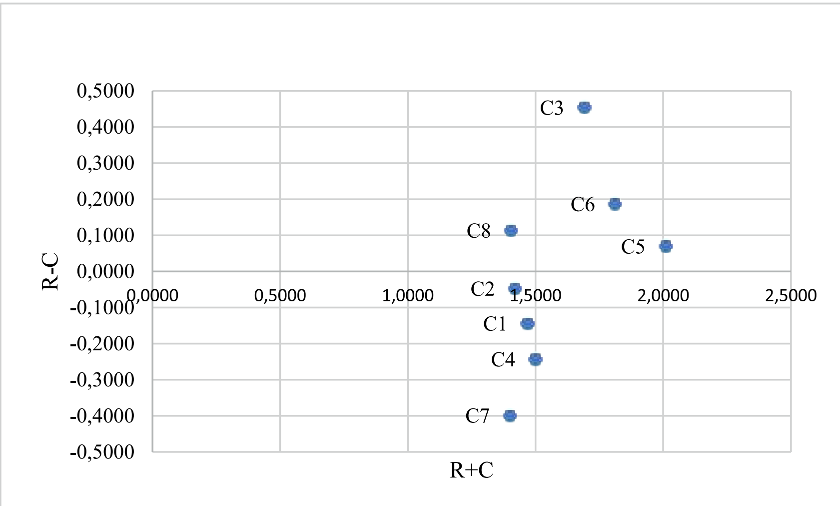
Table 7
Row and column totals of the total relationship matrix

	R	C	R+C	R-C	Weights	Rank
C1	0,6633	0,8060	1,4693	-0,1428	0,1147	5
C2	0,6869	0,7332	1,4201	-0,0463	0,1104	7
C3	1,0732	0,6184	1,6916	0,4549	0,1362	3
C4	0,6292	0,8710	1,5002	-0,2419	0,1181	4
C5	1,0400	0,9694	2,0094	0,0707	0,1563	1
C6	1,0000	0,8119	1,8119	0,1881	0,1416	2
C7	0,5012	0,8986	1,3999	-0,3974	0,1131	6
C8	0,7597	0,6450	1,4047	0,1147	0,1096	8

The criteria having positive values of *(R-C)* influence other criteria. The higher the *(R-C)* value, the stronger is the impact. The criteria having negative values of *(R-C)* are influenced by other criteria. As seen in column 5 of Table 7, the criteria such as C3, C5, C6 and C8 represent the cause group criteria, while the C1, C2, C4 and C7 criteria represent the effect group criteria.

In the last step of this method, using the *(R+C)* and *(R-C)* values, the interactions among the criteria are determined with the help of the effect diagram as shown in Figure 2.

Figure 2
Effect diagram indicating causal relations among the criteria



(R+C) values represent the relative importance of each criterion. Considering the *(R+C)* values, it is seen that the C5 criterion has the highest value. This criterion is followed by the C6 and C3.

Considering the affecting criteria, it is seen that the criterion with the highest *(R-C)* value is C3. This criterion is followed by the C6, C8, and C5 criteria, respectively. Thus, it is concluded that these criteria have the most impact on other criteria. Once the effect group criteria are considered, it is found that the C7 criterion with the smallest value of *(R-C)* is the most affected criterion by the other criteria, followed by C4, C1, and C2.

4.3. SRP approach application finding

The initial decision matrix required for the application of the SRP algorithm is given in Table 8. The ranking matrix obtained by using Eq. (17) is presented in Table 9. The weighted ranking matrix obtained by applying Eq. (18) is given in Table 10.

Table 8
Initial decision matrix

	C1	C2	C3	C4	C5	C6	C7	C8
Aim	Max.	Max.	Max.	Max.	Max.	Max.	Min.	Min.
I1	2288.67	1066	540.67	260.22	152.44	7.02	1748.33	344.67
I2	5494.89	1661.56	1531.44	585.44	355.11	12.51	3963.22	725.67
I3	5255.33	2478.67	1251	594.11	204.44	12.13	4004.44	637.89
I4	4951.44	1048.56	944.56	510.89	63.78	11.03	4006.78	593.56
I5	1796.22	646.11	535.22	138.22	10.78	4.69	1260.89	199
I6	2411.89	964.56	630.56	201.22	68.22	6.09	1781.67	292.67
I7	2059	1531	565.22	294.78	146.78	4.18	1494	205.78
I8	824.11	593.56	302.67	83.56	166.67	3.47	521.56	94.22

Table 9
Ranking matrix

	C1	C2	C3	C4	C5	C6	C7	C8
I1	5	4	6	5	4	4	4	5
I2	1	2	1	2	1	1	6	8
I3	2	1	2	1	2	2	7	7
I4	3	5	3	3	7	3	8	6
I5	7	7	7	7	8	6	2	2
I6	4	6	4	6	6	5	5	4
I7	6	3	5	4	5	7	3	3
I8	8	8	8	8	3	8	1	1

Table 10
Weighted ranking matrix

	C1	C2	C3	C4	C5	C6	C7	C8
I1	0.5735	0.4416	0.8172	0.5905	0.6252	0.5664	0.4524	0.548
I2	0.1147	0.2208	0.1362	0.2362	0.1563	0.1416	0.6786	0.8768
I3	0.2294	0.1104	0.2724	0.1181	0.3126	0.2832	0.7917	0.7672
I4	0.3441	0.552	0.4086	0.3543	1.0941	0.4248	0.9048	0.6576
I5	0.8029	0.7728	0.9534	0.8267	1.2504	0.8496	0.2262	0.2192
I6	0.4588	0.6624	0.5448	0.7086	0.9378	0.708	0.5655	0.4384
I7	0.6882	0.3312	0.681	0.4724	0.7815	0.9912	0.3393	0.3288
I8	0.9176	0.8832	1.0896	0.9448	0.4689	1.1328	0.1131	0.1096

While A_i values were obtained via Eq. (19), K_i values were computed with the aid of Eq. (20) and these values are reported in Table 11. When Table 11, which includes the SRP method results, is examined, it is seen that the best option is Allianz (I2), the second best alternative is Anadolu (I3), and the option with the worst performance score is Güneş (I5).

Table 11

A_i and K_i values and Ranks

	A_i	K_i	Rank
I1	4.6148	3.3852	4
I2	2.5612	5.4388	1
I3	2.885	5.115	2
I4	4.7403	3.2597	5
I5	5.9012	2.0988	8
I6	5.0243	2.9757	6
I7	4.6136	3.3864	3
I8	5.6596	2.3404	7

5. VALIDATION OF THE RESULTS

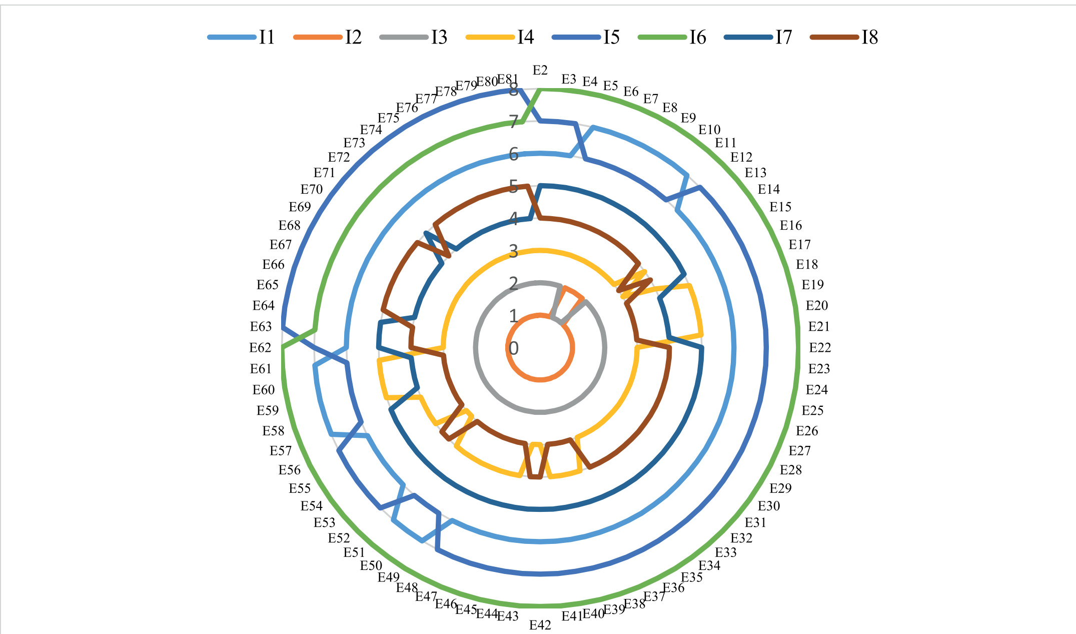
5.1. Sensitivity analysis of rankings according to changes in the importance of criteria

Examining the modifications in the weights of the criteria is a vital issue for the strength and dependability of the initial outcome. To test whether the initial outcome from the recommended methodology is stable and robust, 80 different experimental cases are formed (Görçün et al., 2022). For this purpose, regardless of which criterion is the most important, starting from the first criterion, the new values of each criterion are determined by decreasing the previous values of the relevant criteria by 10%,20%,...,100%, respectively, in each case.

When the findings obtained by the experimental cases seen in Figure 3 are investigated, it is concluded that the position of I2, the best alternative in the initial ranking, does not change except for 5 cases. Similarly, I3, the second best alternative in the initial ranking, was determined to be the second best option in 75 cases. The sensitivity analysis, which is performed by varying the criteria weights, also yields slightly different ranking results for other alternatives. However, these changes do not significantly influence overall outputs, confirming that the proffered assessment methodology is consistent and stable on a large scale.

Figure 3

Ranking the alternatives for modified weights of criteria



5.2. Analysis of the influences of the rank reversal problem regarding the ranking results

The rank reversal issue is a major problem in most of the existing MCDM procedures. In this study, we have generated 6 different experimental cases by deleting the worst alternative in each case to test whether the proposed methodology is resistant to the rank reversal problem (Zolfani et al., 2021). The ranking results of 6 different experimental cases are given in Table 12. As can be seen from Table 12, the worst alternative is deleted in each case, starting with the first case, and changes in the ranking results are observed. Consequently, the new ranking results indicate that I2 has remained the best alternative in all experimental cases. This result, showing that the proposed model resists the rank reversal problem, supports that the result from the initial ranking is consistent and stable.

Table 12
The re-rankings of the alternative insurers by the scenarios.

Scenario	Ranks							
Original	I2	I3	I7	I1	I4	I6	I8	I5
Exp-1	I2	I3	I7	I1	I4	I6	I8	
Exp-2	I2	I3	I7	I1	I4	I6		
Exp-3	I2	I3	I7	I1	I4			
Exp-4	I2	I3	I7	I1				
Exp-5	I2	I3	I7					
Exp-6	I2	I3						

*: “Exp” stands for experiment

6. DISCUSSION

Analyzing the performance of the insurance industry, which is one of the indispensable elements of the financial system, is of critical importance with regard to covering the losses of policyholders, improving the quality of service offered to customers, and developing new products. It is also of paramount importance for improving the synergy between insurance companies and insurance intermediaries (i.e., insurance agents, bank branches, and brokers) within the service network and for the development of non-bank financial markets. Economic, environmental, geopolitical, social, and technological risks lead to increased risks on a global scale. Owing to the rapid increase in global risks, there is a growing need for the development and application of modern methodical tools that can support a variety of stakeholder groups related to the insurance industry to make stronger, rational, and practical decisions. Hence, this paper provides a critical decision-making framework for identifying the factors that influence the financial performance of insurers and measuring their financial success in accordance with these factors.

Our paper, which analyzes non-life insurers’ financial performance, has the following practical and theoretical implications.

The most essential practice implication is to present a novel integrated framework to assess the financial performance of non-life insurers. The evaluation framework covering two decision-making procedures (i.e., Grey DEMATEL and SRP) is a new combined multi-criteria decision-making methodology.

- This model methodologically provides an assessment framework for solving decision-making problems in the field of insurance. Besides, the introduced framework in this study is employed for the first time in solving a decision problem.
- This model can be included in the solution of other decision-making problems in the insurance

market, and it can be employed to compare companies operating in other economic sectors.

• This model does not suffer from the rank reversal problem.

• This study can help decision-makers in insurance markets make accurate and reasonable decisions by providing a flexible, easy-to-use, and modifiable evaluation framework.

7. Conclusion, limitations, and future directions

Considering both the economic role and the social role of the services provided by insurers, it is necessary to measure and compare the performance of companies operating in the insurance industry in certain periods. Performance evaluation studies are also of critical importance for all insurance companies owing to the necessity of improving the competitive environment and service quality among insurance companies. The current study proposes a novel integrated decision-making tool forming from GD and SRP to assess non-life insurers' long-term financial performance in the Turkish insurance market. In line with the model proposed for performance analysis, GD is implemented to compute the weights of insurers' performance indicators. The financial success of non-life insurers is then ranked and evaluated with the help of SRP. Based on the weighting results, it has been determined that the following criteria are the three most influential criteria on the financial performance of non-life insurers in Turkey: premium production, market share, and total shareholders' equity. The ranking results from introduced methodology demonstrate that I2 (Allianz) is the most successful insurer with the highest performance value. Other insurers are ranked, respectively, as follows: Anadolu, Sompo Japan, Aksigorta, Axa, Mapfre, Ziraat, and Güneş. To indicate the stability and feasibility of the suggested decision-making framework, we also perform extensive sensitivity control stages: the impact of changes in criteria weights on the initial ranking, the influence of the rank reversal problem, and a comparison with well-known multi-criteria techniques. Findings from the sensitivity analyzes demonstrate that the introduced integrated model provides maximally consistent and stable results.

As expected, this research has some limitations. The scope of current study is limited to the analysis of the financial performance of non-life insurers operating in the Turkish insurance industry. Therefore, our results cannot be generalized to Turkish life insurers or to insurers in other economies. In future research, the scope of the research can be expanded by adding non-financial indicators (i.e., environmental, social, and governance factors) as well as financial indicators. Besides, research subject can be investigated with a variety of MCDM techniques based on various fuzzy sets such as Fermatean fuzzy, hesitant fuzzy sets, intuitionistic fuzzy, neutrosophic fuzzy, picture fuzzy, Pythagorean fuzzy, q-rung orthopair fuzzy, and spherical fuzzy sets.

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