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The Importance of Risk Disclosure in Financial Management: A Neutrosophic Multi-Criteria Decision-Making Approach

Abdulaziz Ali Murayr
Accounting Department, Faculty of Business, University of Tabuk, Tabuk, Saudi Arabia, KSA
Email : amurayr@ut.edu.sa

Abstract: Risk disclosure plays a vital role in promoting transparency, stability, and efficiency in stock markets by providing investors with the necessary information to make well-informed decisions. However, its effectiveness varies across companies, industries, and regulatory frameworks, influencing market volatility, investor confidence, and overall financial stability. This study applies a Multi-Criteria Decision-Making (MCDM) methodology to analyze different factors affecting risk disclosure. Specifically, we use the Entropy method to determine the weight of each criterion and the MAIRCA method to rank alternatives based on their importance. To address uncertainty in the evaluation process, we incorporate the Type-2 Neutrosophic Set as a mathematical approach to deal with imprecise or incomplete information. To ensure the reliability and robustness of our findings, we conducted sensitivity and comparative analyses, testing the stability of the rankings and the effectiveness of our proposed approach. This study highlights the critical role of risk disclosure in financial management and provides a quantitative framework that can help companies and investors assess risks more accurately and make better financial decisions.

Keywords: Financial Management; Risk Management; Risk Disclosure; Multi-Criteria Decision Making; Neutrosophic Set.

1. Introduction

Risk disclosure is a fundamental component of financial management, ensuring transparency, stability, and informed decision-making in the corporate and investment landscape. In an increasingly complex financial environment, the need for clear and accurate risk disclosure has grown significantly, as businesses, investors, and regulators seek to mitigate uncertainties and enhance market confidence. Transparent risk disclosure promotes financial stability. It fosters trust among stakeholders.

The process involves revealing financial, operational, and strategic risks that may impact an organization's performance, enabling stakeholders to make data-driven decisions. The effectiveness of risk disclosure can determine the financial resilience of firms and influence broader economic stability[1], [2]. Accurate risk disclosure is essential for informed decision-making.

Regulatory compliance plays a crucial role in shaping risk disclosure practices, as governments and financial institutions impose stringent guidelines to ensure accuracy and prevent misleading financial reporting. Effective risk disclosure enhances investor confidence and promotes market stability.

Regulatory frameworks mandate companies to disclose potential risks that could affect their financial standing. The level of adherence to these regulations varies across industries and regions, influencing the consistency and reliability of disclosed information. Failure to comply with risk disclosure requirements can lead to severe legal penalties, financial losses, and reputational damage, making compliance a priority for financial management[3], [4].

Investor confidence is closely tied to the quality and comprehensiveness of risk disclosure. Investors rely on financial reports, risk assessments, and market analysis to make informed decisions about stock purchases, asset allocation, and long-term investments. Transparent risk disclosure helps build trust in financial markets by reducing uncertainty and providing stakeholders with a clear understanding of potential vulnerabilities. When companies openly communicate their financial risks, they demonstrate accountability and responsibility, leading to greater investor engagement and market stability. Conversely, inadequate disclosure can erode confidence, triggering volatility and adverse market reactions[5], [6].

From a corporate governance perspective, risk disclosure is instrumental in promoting ethical decision-making and strategic planning. Corporate boards and executives must balance growth initiatives with risk management strategies, ensuring that financial sustainability is not compromised by unforeseen challenges. High-quality risk disclosure enhances internal decision-making by allowing firms to identify, assess, and mitigate risks effectively. It also strengthens stakeholder relationships, as transparent communication fosters long-term partnerships with investors, creditors, and regulatory authorities. Companies with robust risk disclosure practices often experience improved access to capital and higher market valuations, as they are perceived as more reliable and trustworthy[7], [8].

Evaluating the importance of risk disclosure in financial management is essential for maintaining market integrity, protecting investor interests, and promoting sustainable corporate growth. Regulatory compliance, investor confidence, corporate governance, and technological integration all play significant roles in shaping effective risk disclosure practices. As financial markets become increasingly interconnected and complex, businesses must prioritize transparent risk communication to navigate uncertainties and foster a resilient financial ecosystem. Future research and industry efforts should focus on enhancing risk disclosure frameworks, leveraging emerging technologies, and developing standardized global reporting practices to ensure consistency and reliability in financial risk assessments. Multi-criteria decision making (MCDM) is used for evaluating the importance of risk disclosure in financial management.

By taking linguistic factors into account, the fuzzy set theory is founded on the idea of membership function value. This theory compares evaluations with membership function values and attempts to assess unclear data using expert views. Expert judgments do not, however, always center on membership ideals, particularly in situations when experience and competence are lacking. Furthermore, rather than being certain that their ideas are true, the experts might be certain that they are false. The neutrosophic set theory was presented by Smarandache to address these practical decision-making scenarios. Fuzzy theory and intuitionistic fuzzy sets (IFS) are extended by neutrophilic sets[9], [10].

It has been established that neutrophilic counts are a legitimate area of research for determining indeterminate and incompatible information. A triplet (X, Y, Z) is used to represent type-1 neutrosophic numbers, with each X, Y, and Z belonging to the interval [0, 1]. Their respective names are non-membership or falsity value (Z), neutral value or indeterminacy (Y), and membership or truth value (X). Since each neutrosophic component is divided into its truth, indeterminacy, and falsity subparts, T2NN is written as $<(X_T, X_I, X_F), (Y_T, Y_I, Y_F), (Z_T, Z_I, Z_F)>$. T2NN is an example of a sophisticated neutrosophic method. It is a useful technique for handling the ambiguity or incompleteness of expertise[11], [12].

1.1 Financial Management and MCDM

Business and financial decision-making issues have become more complicated and unpredictable because of the recent economic crisis, the globalization of financial markets, continuous social and technical advancements, and the new regulatory framework. Given the present financial obligations, this scenario presents additional problems that must be overcome. Tools like discriminant analysis, logistic regression, multivariate adaptive regression splines, and probit analysis are examples of statistical and economic models that are frequently used to make financial choices[13]. However, there are several issues with these methods that make it challenging to include qualitative factors in the decision-making process. New methods based on the principles of operations research (such as mathematical programming and multi-criteria decision-making techniques) and computational intelligence have been developed to address these drawbacks.

Because of the numerous aspects that make these operations research and management tools particularly well-suited for examining intricate real-world issues, MCDM models have gained significant traction in a variety of financial application areas in recent years. The ability of most MCDM approaches to handle both quantitative and qualitative data, as well as expert preferences and/or subjective judgments, is one of its primary features. Typically, a decision-making process includes the following steps: defining objectives, selecting criteria to measure them, identifying alternatives, converting criterion scales into comparable units, allocating weights to the criteria based on their relative importance, and using an algorithm to rank and select an alternative[14], [15].

To make "optimal" decisions based on the decision-makers' preference judgment, MCDM consists of a set of analytical techniques and methods for assessing the advantages and disadvantages of competing alternatives, solutions, or actions based on multiple (typically conflicting) criteria, attributes, or objectives of different nature. In this context, optimality indicates that the answer meets the decision-maker's preferences and is not overshadowed by alternative options, indicating that some compromise between the many points of view is necessary. A $m \times n$ decision matrix, where M is the number of possibilities and N is the number of decision criteria, can be used to represent a standard MCDM situation[16], [17].

Three categories of problems may be distinguished in MCDM: sorting, ranking, and choosing. Finding the best alternatives is the goal when choosing; the ranking approach gives the set of alternatives a preference order, typically from best to worst[18], [19]; and the sorting (or ordinal classification) process assigns each alternative to a category based on scores on specific criteria. Six steps make up a general procedure for solving multi-criteria problems:

(1) identifying and quantifying the relevant objectives.

(2) defining the decision between variables and constraints.

(3) gathering data.

(4) generating and valuing alternatives.

(5) choosing alternatives based on the decision-maker's preferences; and

(6) putting the chosen alternatives into practice.

1.2 Contributions of this study

We propose a decision-making approach for Evaluating the importance of risk disclosure in financial management.

We use two MCDM methods, such as Entropy methodology to compute the criteria weights and MAIRCA methodology to rank the alternatives. These methods are used under T2NN to overcome uncertainty information.

Nine criteria and nine alternatives are used in this study to show the best criterion and best alternative.

Sensitivity analysis is conducted to show the stability of the ranks under different cases in the criteria weights.

1.3 Organization of this study

The rest of this study is organized as follows: Section 2 shows the operations of T2NNs with the steps of the two MCDM methods to compute the criteria weights and ranking the alternatives. Section 3 shows the results of the proposed approach under the T2NN. Sensitivity analysis is conducted in section 4 to show the stability of the ranks of the alternatives. Section 5 shows the conclusion of this study.

2. Type-2 Neutrosophic-Entropy- MAIRCA (T2N-Entropy-MAIRCA)

This section shows the steps of the proposed approach under T2N to deal with uncertainty and vague information. We use the Entropy method to compute the criteria weights and the MAIRCA method to rank the alternatives.

Operations of T2NN [12]

Let two type-2 neutrosophic numbers (T2NNs) such as:

$B_1 = \left(\left(X_{T_{B_1}}(d), X_{I_{B_1}}(d), X_{F_{B_1}}(d)\right), \left(Y_{T_{B_1}}(d), Y_{I_{B_1}}(d), Y_{F_{B_1}}(d)\right), \left(Z_{T_{B_1}}(d), Z_{I_{B_1}}(d), Z_{F_{B_1}}(d)\right)\right)$ and

$B_2 = \left(\left(X_{T_{B_2}}(d), X_{I_{B_2}}(d), X_{F_{B_2}}(d)\right), \left(Y_{T_{B_2}}(d), Y_{I_{B_2}}(d), Y_{F_{B_2}}(d)\right), \left(Z_{T_{B_2}}(d), Z_{I_{B_2}}(d), Z_{F_{B_2}}(d)\right)\right)$

$$B_1 \oplus B_2 = \begin{pmatrix} \begin{pmatrix} X_{T_{B_1}}(d) + X_{T_{B_2}}(d) - T_{T_{A_1}}(x) X_{T_{B_2}}(d), \\ X_{I_{B_1}}(d) + X_{I_{B_2}}(d) - X_{I_{B_1}}(x) X_{I_{B_2}}(d), \\ X_{F_{B_1}}(d) + X_{F_{B_2}}(d) - X_{F_{B_1}}(x) X_{F_{B_2}}(d) \end{pmatrix}, \\ \left(Y_{T_{B_1}}(d) Y_{T_{B_2}}(d), Y_{I_{B_1}}(d) Y_{I_{B_2}}(d), Y_{F_{B_1}}(d) Y_{F_{B_2}}(d)\right), \\ \left(Z_{T_{B_1}}(d) Z_{T_{B_2}}(d), Z_{I_{B_1}}(d) Z_{I_{B_2}}(d), Z_{F_{B_1}}(d) Z_{F_{B_2}}(d)\right) \end{pmatrix} \tag{1}$$

$$B_1 \otimes B_2 = \begin{pmatrix} \left(X_{T_{B_1}}(d) X_{T_{B_2}}(d), X_{I_{B_1}}(d) X_{I_{B_2}}(d), X_{F_{B_1}}(d) X_{F_{B_2}}(d)\right), \\ \begin{pmatrix} Y_{T_{B_1}}(d) + Y_{T_{B_2}}(d) - Y_{T_{B_1}}(x) Y_{T_{B_2}}(d), \\ Y_{I_{B_1}}(d) + Y_{I_{B_2}}(d) - Y_{I_{B_1}}(x) Y_{I_{B_2}}(d), \\ Y_{F_{B_1}}(d) + Y_{F_{B_2}}(d) - Y_{F_{B_1}}(x) Y_{F_{B_2}}(d) \end{pmatrix}, \\ \begin{pmatrix} Z_{T_{B_1}}(d) + Z_{T_{B_2}}(d) - Z_{T_{B_1}}(x) Z_{T_{B_2}}(d), \\ Z_{I_{B_1}}(d) + Z_{I_{B_2}}(d) - Z_{I_{B_1}}(x) Z_{I_{B_2}}(d), \\ Z_{F_{B_1}}(d) + Z_{F_{B_2}}(d) - Z_{F_{B_1}}(x) Z_{F_{B_2}}(d) \end{pmatrix} \end{pmatrix} \tag{2}$$

$$\curlywedge B_1 = \begin{pmatrix} \begin{pmatrix} \left(1-\left(1-X_{T_{B_1}}(d)\right)^{\curlywedge}\right), \\ \left(1-\left(1-X_{I_{B_1}}(d)\right)^{\curlywedge}\right), \\ \left(1-\left(1-X_{F_{B_1}}(d)\right)^{\curlywedge}\right) \end{pmatrix}, \\ \left(\left(Y_{T_{B_1}}(d)\right)^{\curlywedge}, \left(Y_{I_{B_1}}(d)\right)^{\curlywedge}, \left(Y_{F_{B_1}}(d)\right)^{\curlywedge}\right), \\ \left(\left(Z_{T_{B_1}}(d)\right)^{\curlywedge}, \left(Z_{I_{B_1}}(d)\right)^{\curlywedge}, \left(Z_{F_{B_1}}(d)\right)^{\curlywedge}\right) \end{pmatrix} \tag{3}$$

$$B_1^{\curlywedge} = \begin{pmatrix} \left(\left(X_{T_{B_1}}(d)\right)^{\curlywedge}, \left(X_{I_{B_1}}(d)\right)^{\curlywedge}, \left(X_{F_{B_1}}(d)\right)^{\curlywedge}\right), \\ \begin{pmatrix} \left(1-\left(1-Y_{T_{B_1}}(d)\right)^{\curlywedge}\right), \\ \left(1-\left(1-Y_{I_{B_1}}(d)\right)^{\curlywedge}\right), \\ \left(1-\left(1-Y_{F_{B_1}}(d)\right)^{\curlywedge}\right) \end{pmatrix}, \\ \begin{pmatrix} \left(1-\left(1-Z_{T_{B_1}}(d)\right)^{\curlywedge}\right), \\ \left(1-\left(1-Z_{I_{B_1}}(d)\right)^{\curlywedge}\right), \\ \left(1-\left(1-Z_{F_{B_1}}(d)\right)^{\curlywedge}\right) \end{pmatrix} \end{pmatrix} \tag{4}$$

T2N-Entropy

We use the entropy method to compute the criteria weights[20], [21].

S1-Create the decision matrix

The decision matrix is created

$$F = \begin{bmatrix} f_{11} & \cdots & f_{1n} \\ \vdots & \ddots & \vdots \\ f_{m1} & \cdots & f_{mn} \end{bmatrix}; i = 1, \dots, m; j = 1, \dots, n \tag{5}$$

S2-Obtain crip values

We apply T2N score function to obtain crisp values.

S3-Combine the decision matrix.

The decision matrixes are combined into one matrix.

S4-Obtain the normalized decision matrix.

The decision matrix is normalized as:

$$k_{ij} = f_{ij} / \sum_{i=1}^{m} f_{ij} \tag{6}$$

S5-Determine the entropy value.

The entropy value is determined as:

$$e_j = -h \sum_{i=1}^{m} k_{ij} \ln k_{ij} \tag{7}$$

$$h = \frac{1}{\ln m} \tag{8}$$

S6-Determine the criteria weights.

The criteria weights are computed as:

$$w_j = (1 - e_j) / \sum_{j=1}^{n} (1 - e_j) \tag{9}$$

T2N-MAIRCA

This method is used to rank the alternatives. We use the combined decision matrix from the Entropy method to apply the steps of the MAIRCA method[22], [23].

S7-Determine the components of $t_{p_{ij}}$ of the theoretical rating matrix between the criteria and alternatives.

$$t_{p_{ij}} = f_{ij} * w_j \tag{10}$$

S8-Determine the components of the real rating matrix such as:

$$y_{ij} = \left(f_{ij} - \min_i f_{ij}\right) / (\max_i f_{ij} - \min_i f_{ij}) \ \textit{positive criteria} \tag{11}$$

$$y_{ij} = \left(f_{ij} - \max_i f_{ij}\right) / (\min_i f_{ij} - \max_i f_{ij}) \ \textit{negative criteria} \tag{12}$$

Then we multiply the results of y_{ij} by the $t_{p_{ij}}$ such as:

$$V_{ij} = t_{p_{ij}} * y_{ij} \tag{13}$$

S9-Dternine the sum of gap matrix.

We compute the sum of the gap matrix such as:

$$r_{ij} = t_{p_{ij}} - V_{ij} \tag{14}$$

S10-Determine the score value of each alternative, then we rank the alternatives based on the highest score value.

$$Q_i = \sum_{i=1}^{m} r_{ij} \tag{15}$$

3. Results and Discussion

This section shows the results of Risk Disclosure in Financial Management. This study uses nine main criteria and nine alternatives to evaluate the Risk Disclosure in Financial Management. These criteria can aid the ranking methodology to rank the alternatives. The criteria of this study are:

- Financial Performance Impact
- Risk Identification and Mitigation
- Market Stability
- Decision-Making for Stakeholders
- Technological Integration in Disclosure
- Corporate Governance
- Transparency and Reporting Quality
- Investor Confidence
- Regulatory Compliance

The alternatives of this study are:

- Real-Time Risk Monitoring Systems
- Investor Education Programs
- Blockchain-Based Transparency Systems
- Third-Party Audits and Independent Risk Assessments
- Voluntary Risk Disclosure Enhancement
- Integrated Reporting Approach
- Mandatory Risk Reporting
- Standardized Risk Disclosure Frameworks
- AI-Driven Risk Analysis

Results of T2N-Entropy

S1-S3-Three decision makers use the T2NNs to create the decision matrix as shown in Tables 1-3. Then we replaced these numbers with crisp values. Then we combine these matrices into a single matrix.

S4-Then we normalized the decision matrix using Eq. (6) as shown in Table 4.

S5-Then we determine the entropy value using Eq. (7).

S6-Then we determine the criteria weights using Eq. (9) as shown in Fig 1.

Table 1. First decision matrix.

	$RCFM_1$	$RCFM_2$	$RCFM_3$	$RCFM_4$	$RCFM_5$	$RCFM_6$	$RCFM_7$	$RCFM_8$	$RCFM_9$
$RCFMA_1$	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))
$RCFMA_2$	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))
$RCFMA_3$	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))
$RCFMA_4$	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))
$RCFMA_5$	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))
$RCFMA_6$	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))
$RCFMA_7$	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))
$RCFMA_8$	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))
$RCFMA_9$	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))

Table 2. Second decision matrix.

	$RCFM_1$	$RCFM_2$	$RCFM_3$	$RCFM_4$	$RCFM_5$	$RCFM_6$	$RCFM_7$	$RCFM_8$	$RCFM_9$
$RCFMA_1$	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))
$RCFMA_2$	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))
$RCFMA_3$	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))
$RCFMA_4$	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))
$RCFMA_5$	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))
$RCFMA_6$	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))
$RCFMA_7$	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))
$RCFMA_8$	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))
$RCFMA_9$	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))

Table 3. Third decision matrix.

	$RCFM_1$	$RCFM_2$	$RCFM_3$	$RCFM_4$	$RCFM_5$	$RCFM_6$	$RCFM_7$	$RCFM_8$	$RCFM_9$
$RCFMA_1$	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))
$RCFMA_2$	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))
$RCFMA_3$	((0.20,0.20,0.10), (0.65,0.80,0.85), (0.45,0.80,0.70))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))
$RCFMA_4$	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))
$RCFMA_5$	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))
$RCFMA_6$	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))
$RCFMA_7$	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))
$RCFMA_8$	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))	((0.70,0.75,0.80), (0.15,0.20,0.25), (0.10,0.15,0.20))	((0.95,0.90,0.95), (0.10,0.10,0.05), (0.05,0.05,0.05))

$RCFMA_9$	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.60,0.45,0.50), (0.20,0.15,0.25), (0.10,0.25,0.15))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.40,0.45,0.50), (0.40,0.45,0.50), (0.35,0.40,0.45))	((0.35,0.35,0.10), (0.50,0.75,0.80), (0.50,0.75,0.65))	((0.50,0.30,0.50), (0.50,0.35,0.45), (0.45,0.30,0.60))

Table 4. Normalization decision matrix.

	$RCFM_1$	$RCFM_2$	$RCFM_3$	$RCFM_4$	$RCFM_5$	$RCFM_6$	$RCFM_7$	$RCFM_8$	$RCFM_9$
$RCFMA_1$	0.099187	0.101832	0.116047	0.135602	0.138812	0.101228	0.136655	0.135359	0.110945
$RCFMA_2$	0.145699	0.112877	0.06709	0.100505	0.096216	0.139154	0.120996	0.062922	0.113038
$RCFMA_3$	0.105071	0.101562	0.116047	0.135602	0.127788	0.102865	0.101068	0.128607	0.114833
$RCFMA_4$	0.131129	0.073815	0.127531	0.098644	0.047106	0.115416	0.08968	0.143646	0.152512
$RCFMA_5$	0.119361	0.127155	0.141432	0.111407	0.117013	0.106958	0.123369	0.11725	0.091507
$RCFMA_6$	0.105912	0.15167	0.093986	0.073385	0.119519	0.101501	0.136655	0.100061	0.101675
$RCFMA_7$	0.145699	0.102909	0.096102	0.082159	0.095214	0.115689	0.100356	0.108656	0.091507
$RCFMA_8$	0.085738	0.102371	0.113327	0.138527	0.130544	0.104229	0.090154	0.099141	0.110945
$RCFMA_9$	0.062202	0.125808	0.128438	0.124169	0.127788	0.11296	0.101068	0.104359	0.113038

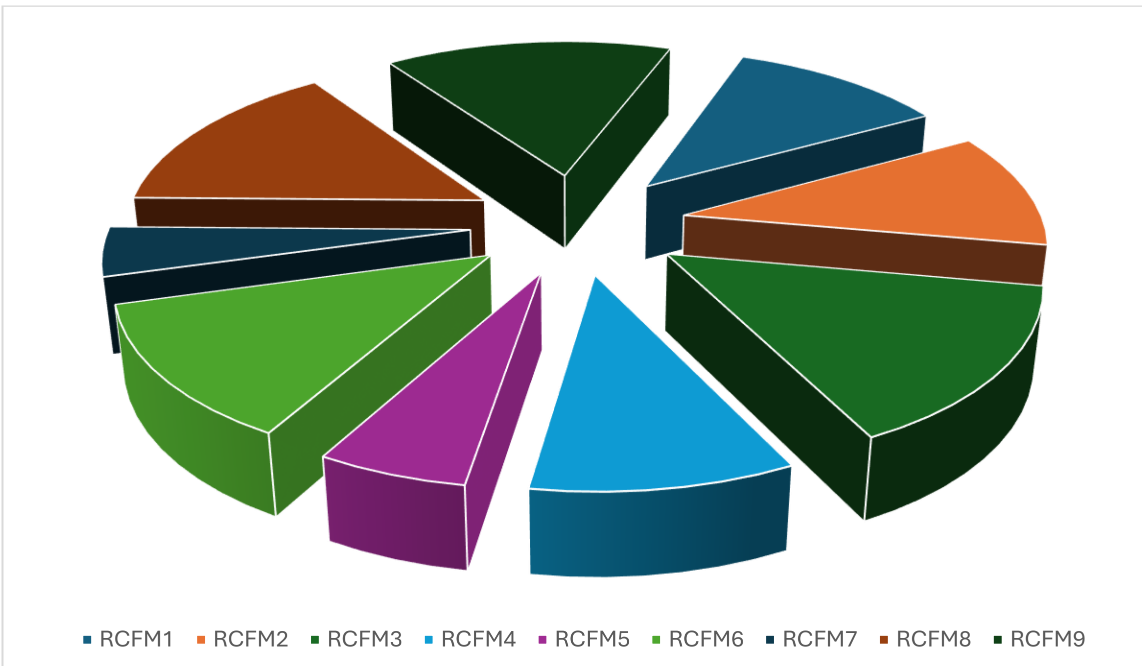

Fig 1. The criteria weights.

T2N-MAIRCA

S7-We determine the components of $t_{p_{ij}}$ of the theoretical rating matrix between the criteria and alternatives using Eq. (10) as shown in Table 5.

S8-We determine the components of the real rating matrix using Eqs. (11 and 12) as shown in Table 6.

Then we multiply the results of y_{ij} by the $t_{p_{ij}}$ using Eq. (13) as shown in Table 7.

S9-Then we determine the sum of gap matrix using Eq. (14) as shown in Table 8.

S10-then we determine the score value of each alternative using Eq. (15) as shown in Fig 2. Then we rank the alternatives as shown in Fig 3.

Table 5. The theoretical rating matrix.

	$RCFM_1$	$RCFM_2$	$RCFM_3$	$RCFM_4$	$RCFM_5$	$RCFM_6$	$RCFM_7$	$RCFM_8$	$RCFM_9$
$RCFMA_1$	0.05610039	0.056913	0.079279	0.069672	0.043236	0.064662	0.036724	0.092195	0.078515
$RCFMA_2$	0.082407353	0.063086	0.045833	0.051639	0.029969	0.088889	0.032516	0.042857	0.079997
$RCFMA_3$	0.059428379	0.056763	0.079279	0.069672	0.039802	0.065708	0.02716	0.087596	0.081267
$RCFMA_4$	0.074166617	0.041254	0.087124	0.050683	0.014672	0.073726	0.0241	0.097839	0.107932
$RCFMA_5$	0.067510639	0.071066	0.096621	0.05724	0.036446	0.068323	0.033153	0.07986	0.064759
$RCFMA_6$	0.059903806	0.084767	0.064208	0.037705	0.037227	0.064837	0.036724	0.068153	0.071955
$RCFMA_7$	0.082407353	0.057515	0.065653	0.042213	0.029656	0.0739	0.026969	0.074007	0.064759
$RCFMA_8$	0.048493558	0.057214	0.077421	0.071174	0.040661	0.06658	0.024227	0.067526	0.078515
$RCFMA_9$	0.035181601	0.070313	0.087744	0.063797	0.039802	0.072157	0.02716	0.07108	0.079997

Table 6. The real rating matrix.

	$RCFM_1$	$RCFM_2$	$RCFM_3$	$RCFM_4$	$RCFM_5$	$RCFM_6$	$RCFM_7$	$RCFM_8$	$RCFM_9$
$RCFMA_1$	0.442953	0.359862	0.658537	0.955102	1	0	1	0.897338	0.318627
$RCFMA_2$	1	0.50173	0	0.416327	0.535519	1	0.666667	0	0.352941
$RCFMA_3$	0.513423	0.356401	0.658537	0.955102	0.879781	0.043165	0.242424	0.813688	0.382353
$RCFMA_4$	0.825503	0	0.813008	0.387755	0	0.374101	0	1	1
$RCFMA_5$	0.684564	0.685121	1	0.583673	0.762295	0.151079	0.717172	0.673004	0
$RCFMA_6$	0.52349	1	0.361789	0	0.789617	0.007194	1	0.460076	0.166667
$RCFMA_7$	1	0.373702	0.390244	0.134694	0.52459	0.381295	0.227273	0.56654	0
$RCFMA_8$	0.281879	0.366782	0.621951	1	0.909836	0.079137	0.010101	0.448669	0.318627
$RCFMA_9$	0	0.66782	0.825203	0.779592	0.879781	0.309353	0.242424	0.513308	0.352941

Table 7. The multiplication of the results of y_{ij} by the $t_{p_{ij}}$.

	$RCFM_1$	$RCFM_2$	$RCFM_3$	$RCFM_4$	$RCFM_5$	$RCFM_6$	$RCFM_7$	$RCFM_8$	$RCFM_9$
$RCFMA_1$	0.02485	0.020481	0.052208	0.066543	0.043236	0	0.036724	0.08273	0.025017
$RCFMA_2$	0.082407	0.031652	0	0.021499	0.016049	0.088889	0.021677	0	0.028234
$RCFMA_3$	0.030512	0.02023	0.052208	0.066543	0.035017	0.002836	0.006584	0.071275	0.031073
$RCFMA_4$	0.061225	0	0.070833	0.019652	0	0.027581	0	0.097839	0.107932
$RCFMA_5$	0.046215	0.048689	0.096621	0.033409	0.027783	0.010322	0.023777	0.053746	0
$RCFMA_6$	0.031359	0.084767	0.02323	0	0.029395	0.000466	0.036724	0.031356	0.011992
$RCFMA_7$	0.082407	0.021494	0.025621	0.005686	0.015557	0.028178	0.006129	0.041928	0
$RCFMA_8$	0.013669	0.020985	0.048152	0.071174	0.036994	0.005269	0.000245	0.030297	0.025017
$RCFMA_9$	0	0.046957	0.072406	0.049736	0.035017	0.022322	0.006584	0.036486	0.028234

Table 8. The gap matrix.

	$RCFM_1$	$RCFM_2$	$RCFM_3$	$RCFM_4$	$RCFM_5$	$RCFM_6$	$RCFM_7$	$RCFM_8$	$RCFM_9$
$RCFMA_1$	0.031250553	0.036432	0.027071	0.003128	0	0.064662	0	0.009465	0.053498
$RCFMA_2$	0	0.031434	0.045833	0.03014	0.01392	0	0.010839	0.042857	0.051763
$RCFMA_3$	0.028916493	0.036532	0.027071	0.003128	0.004785	0.062872	0.020576	0.01632	0.050194
$RCFMA_4$	0.012941826	0.041254	0.016292	0.03103	0.014672	0.046145	0.0241	0	0
$RCFMA_5$	0.021295302	0.022377	0	0.023831	0.008663	0.058001	0.009377	0.026114	0.064759
$RCFMA_6$	0.028544767	0	0.040978	0.037705	0.007832	0.06437	0	0.036797	0.059962
$RCFMA_7$	0	0.036022	0.040032	0.036527	0.014099	0.045722	0.02084	0.032079	0.064759
$RCFMA_8$	0.034824233	0.036229	0.029269	0	0.003666	0.061311	0.023983	0.037229	0.053498
$RCFMA_9$	0.035181601	0.023357	0.015337	0.014061	0.004785	0.049835	0.020576	0.034594	0.051763

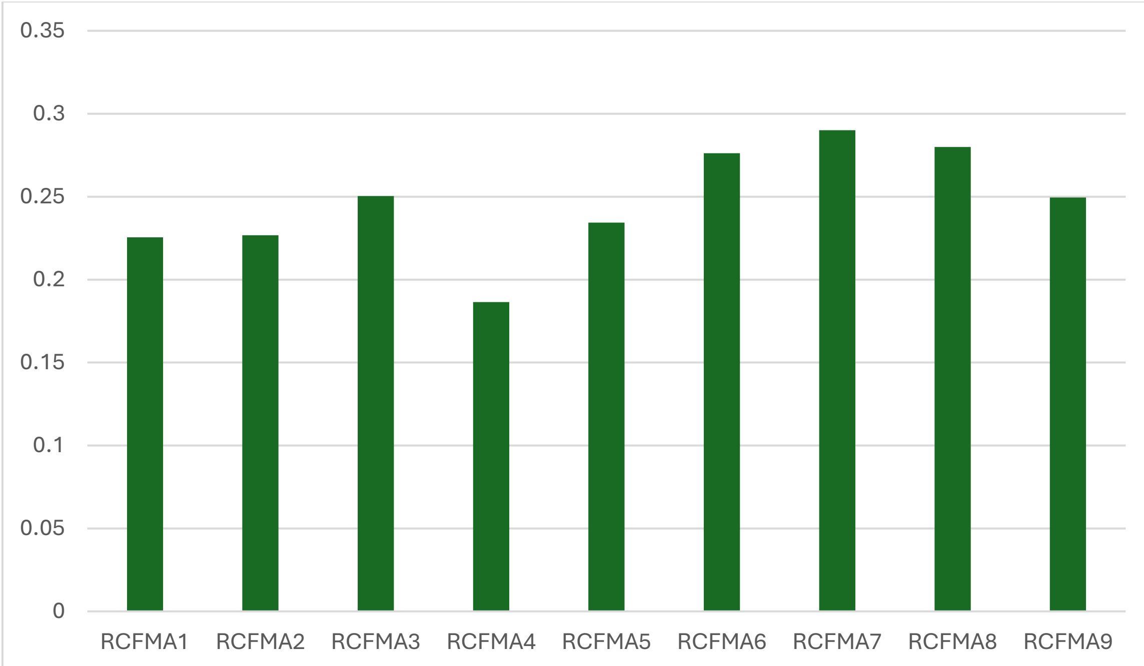

Fig 2. The score value of each alternative.

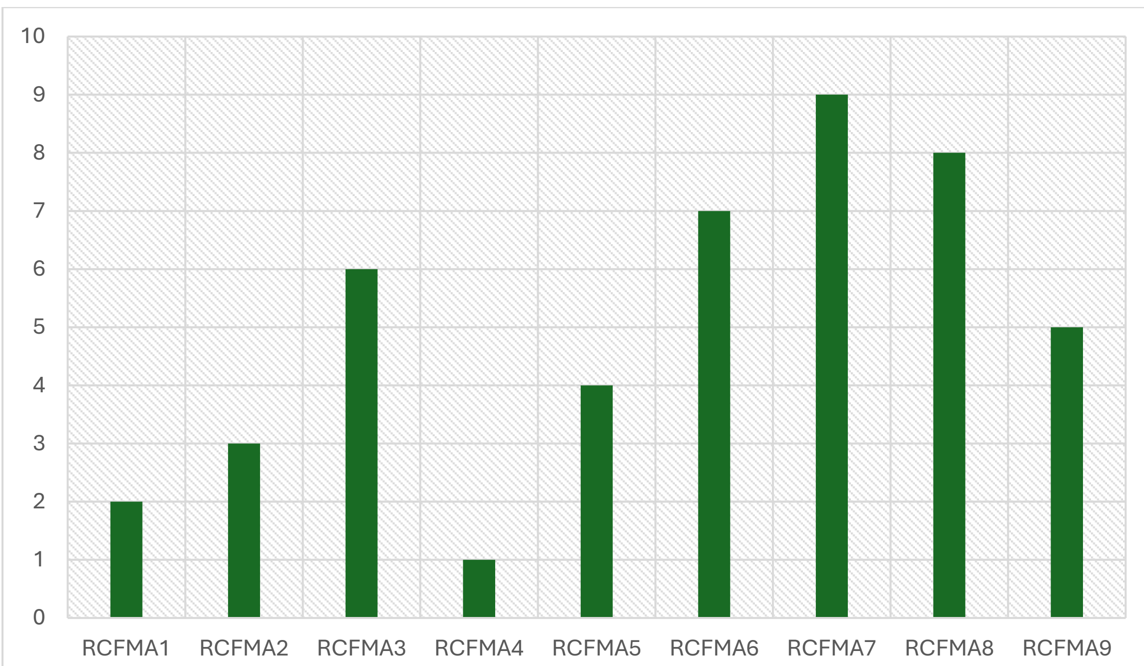

Fig 3. The rank of the alternatives.

4. Analysis

This section shows the sensitivity analysis of the ranks of the alternatives. We conducted this analysis to show the stability of the ranks under different cases. First, we change the criteria weights under ten alternatives.

- First case, the criteria have the same weights. Each criterion has 0.11 weight.
- Second case, first criterion has increased 15% and other criteria have the same weight.
- Third case, second criterion has increased 15% and other criteria have the same weight, and so one to the ten cases. Fig 4 shows the different criteria weights.

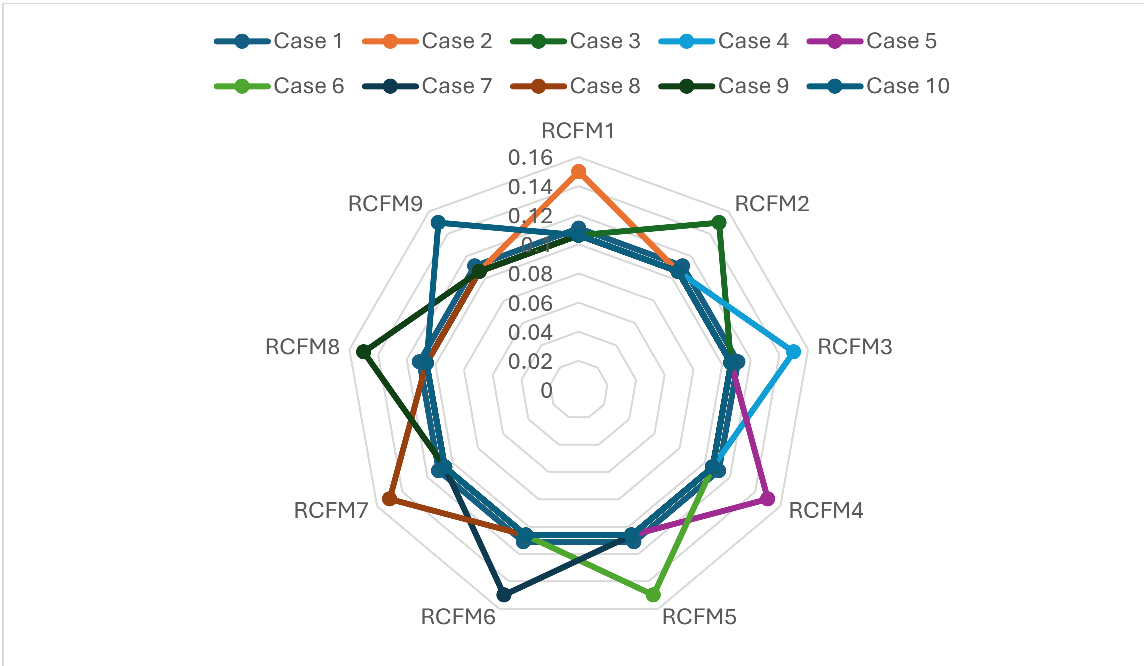

Fig 4 Different ten cases.

Then we apply the ranking method to obtain the score value of each alternative and ranking the alternatives. Fig 5 shows the score values of ten cases. Fig 6 shows the ten ranks of the alternatives under ten cases. We show the ranks of the alternatives as:

- In the first case, we show alternative 7 is the best followed by alternative 8 and alternative 3. We show alternative 1 is the worst.
- In the second case, we show alternative 7 is the best, followed by alternative 8 and alternative 3. We show alternative 1 is the worst.
- In the first case, we show alternative 7 is the best, followed by alternative 8 and alternative 3. We show alternative 1 is the worst.

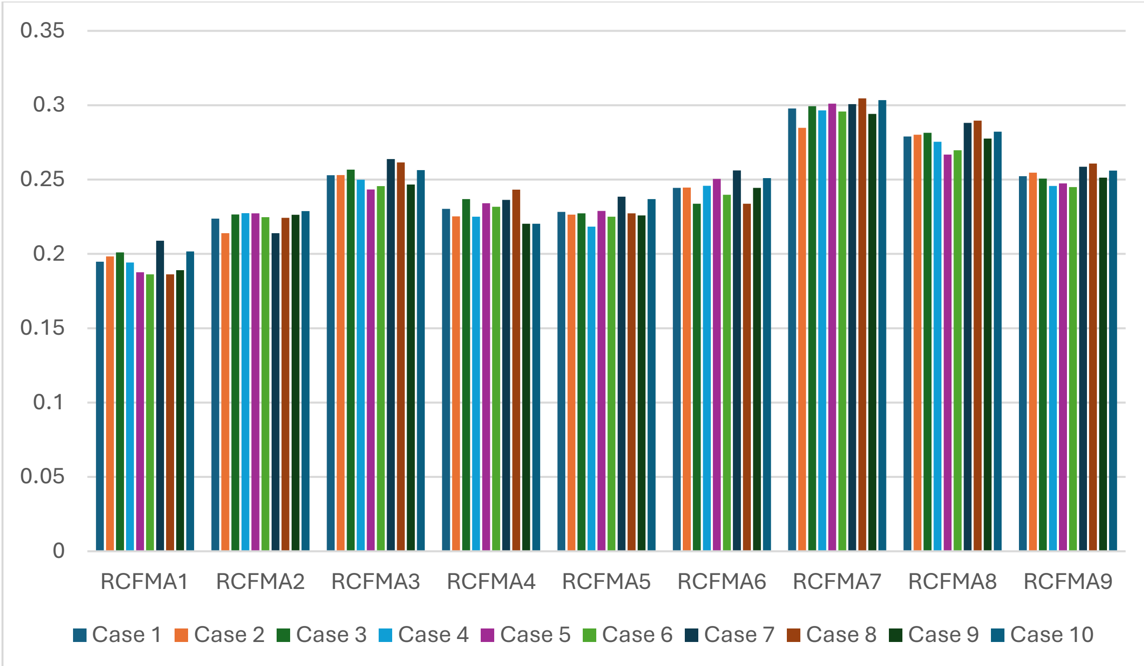

Fig 5. Ten cases of score values.

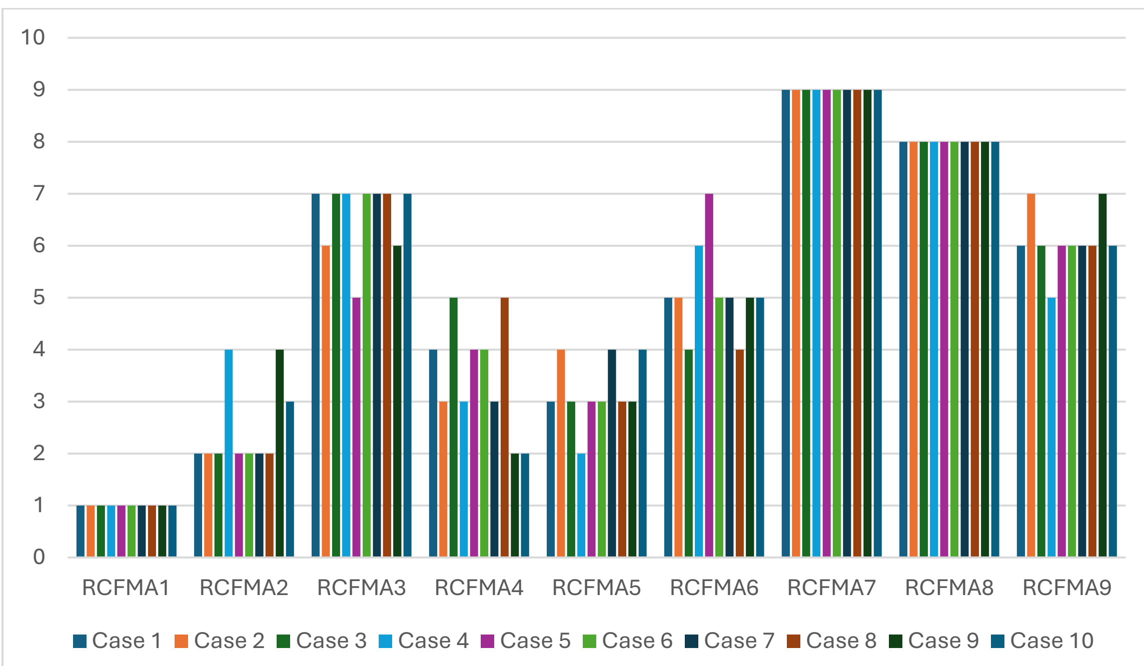

Fig 6. Ten cases of ranking of the alternatives.

5. Conclusions and Future Study

We proposed two MCDM methods such as Entropy method to compute the criteria weights and the MAIRCA method to rank the alternatives. The proposed is used for evaluating the importance of risk disclosure in financial management. We used the type-2 neutrosophic set to deal with uncertainty and vague information. Nine criteria and nine alternatives are used in this study. The results show alternative 7 and alternative 4. The sensitivity analysis was conducted to show the stability of the ranks.

In the future work, the proposed approach can be used to evaluate the MCDM issues to compute the criteria weights and ranking the alternatives. Different MCDM methods can be used in evaluating the importance of risk disclosure in financial management such as AHP, TOPSIS, and VIKOR. Different neutrosophic extensions can be used to overcome the uncertainty and vague information.

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