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Designing and prioritizing the dimensions of audit committee structure affecting bank stability using a hybrid best-worst method (BWM) and fuzzy TOPSIS approach

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Abstract This study aims to design and prioritize the dimensions of audit committee structure affecting bank stability using a hybrid Best-Worst Method (BWM) and Fuzzy TOPSIS approach in banks listed on the Tehran Stock Exchange. This research is applied in terms of purpose and falls under multi-criteria decision-making (MCDM) studies in terms of nature. The statistical population consists of 10 banks listed on the Tehran Stock Exchange, and the opinions of 7 experts including university professors, audit committee members of banks, and independent auditors were used for weighting the indicators. Five main indicators of audit committee structure including size, independence, financial expertise, gender, and number of meetings were identified based on theoretical foundations and literature review. In the first stage, the weight of each indicator was calculated using the fuzzy best-worst method. The weighting results showed that the independence of audit committee members with a weight of 0.315 has the highest importance among the indicators of audit committee structure affecting bank stability, and the indicators of size (0.260), financial expertise (0.215), number of meetings (0.150), and gender (0.060) were ranked next, respectively. The calculated consistency ratio was 0.048, which is less than 0.1, indicating acceptable consistency of the experts' judgments. In the second stage, the sample banks were ranked using the Fuzzy TOPSIS method based on the obtained weights. The ranking results showed that Karafarin Bank with a closeness coefficient of 0.679 ranks first, Pasargad Bank with 0.611 ranks second, Eghtesad Novin Bank with 0.538 ranks third, and Mellat Bank with 0.535 ranks fourth. At the bottom of the ranking, Bank Saderat Iran with a closeness coefficient of 0.252 ranks tenth. The sensitivity analysis results with changes in indicator weights within a ±20% range showed that the ranking obtained from the Fuzzy TOPSIS method has acceptable robustness and stability, and changes in indicator weights do not have a significant impact on the final results. These findings have important implications for policymakers, banking supervisors, and bank managers, demonstrating that establishing audit committees with high independence, appropriate size, sufficient financial expertise, and regular meetings can serve as an effective strategy for increasing the stability of the country's banking system. Furthermore, the hybrid BWM and Fuzzy TOPSIS approach, as an efficient decision-making tool, can help banks and regulatory institutions in continuously evaluating and improving the audit committee structure.

Keyword: Audit Committee, Bank Stability, Best-Worst Method (BWM), Fuzzy TOPSIS, Multi-Criteria Decision Making.

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1 Introduction

Effective corporate governance in the banking system plays a vital role in maintaining financial stability and reducing systemic risks. The board of directors, as the highest corporate governance body in banks, is responsible for overseeing risk management and maintaining stability, a role primarily fulfilled through the audit committee. Nguyen (2022), in a comprehensive study on ASEAN countries, demonstrated that audit committee effectiveness enhances bank stability by increasing bank performance and investment levels, and this relationship is critically dependent on each bank's health and the institutional quality of each country. Despite the growing importance of audit committees in the corporate governance system, one of the fundamental challenges facing banks, policymakers, and shareholders is identifying and prioritizing the structural dimensions of the audit committee that have the greatest impact on bank stability. Selecting the optimal structure for the audit committee requires simultaneous consideration of multiple and sometimes conflicting criteria such as committee size, member independence, financial expertise, gender, and the number of meetings, which transforms this into a complex multi-criteria decision-making (MCDM) problem.

In the financial and corporate governance literature, numerous studies have examined the impact of each dimension of audit committee structure on bank performance and stability. For instance, prior research has shown that audit committee size has a negative relationship with bank stability, and smaller committees with more independent members can enhance bank stability due to more effective monitoring of risk-taking behavior [1].

Furthermore, studies have indicated that the financial expertise of audit committee members has a negative effect on bank instability and contributes to improved stability, as members with financial and accounting experience increase financial reporting transparency and strengthen oversight of management. However, integrating these scattered findings and presenting a comprehensive model for prioritizing the dimensions of audit committee structure remains one of the significant research gaps. Moreover, in most previous studies, the inherent uncertainty in experts' and decision-makers' judgments regarding the relative importance of each of these dimensions has been overlooked. Multi-criteria decision-making approaches capable of incorporating uncertainty and combining expert opinions can address this issue.

The best-worst method (BWM), as one of the most efficient multi-criteria decision-making techniques, enables more precise weighting of criteria by reducing the number of pairwise comparisons and increasing the consistency of judgments. Roy and Shaw [2] demonstrated that developing this method into a fuzzy framework provides more reliable results due to improved comparison consistency under uncertainty conditions. The integrated fuzzy-BWM-TOPSIS model proposed by Roy and Shaw [2] showed that combining these methods can significantly enhance prediction accuracy. However, the application of this hybrid approach in the field of corporate governance, particularly in prioritizing the dimensions of audit committee structure, has remained neglected in both domestic and international research. Additionally, the Fuzzy TOPSIS technique, as one of the widely used ranking methods, enables the evaluation of alternatives based on their similarity to the ideal solution in fuzzy conditions, and with the development of new versions such as TOPSIS-Sort-C, it offers the capability to rank alternatives while preserving the desirable characteristics of the classical method [2]. Nevertheless, previous studies have mainly focused on credit risk assessment and customer ranking, and the application of these methods in the field of corporate governance and evaluation of audit committee structure, particularly in Iran's banking industry, has not yet been investigated.

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Accordingly, the present study aims to design and prioritize the dimensions of audit committee structure affecting bank stability using a hybrid Best-Worst Method (BWM) and Fuzzy TOPSIS approach. This research seeks to answer the fundamental questions of what are the most important dimensions of audit committee structure affecting bank stability, and how are the banks listed on the Tehran Stock Exchange ranked in terms of possessing these dimensions. The structure of the paper is as follows: Section 2 reviews the theoretical foundations and literature review. Section 3 describes the research methodology, including the implementation steps of fuzzy BWM and fuzzy TOPSIS. Section 4 presents the research findings, including indicator weighting and bank ranking. Finally, Section 5 discusses and interprets the results, followed by conclusions and recommendations.

2. Theoretical foundations and literature review

The audit committee, as one of the key pillars of corporate governance in the banking system, is responsible for overseeing financial reporting, internal controls, and risk management. The structure of this committee encompasses various dimensions such as size, independence, financial expertise, gender, and the number of meetings, each of which can influence its supervisory effectiveness. Previous research has demonstrated that audit committee size has a positive and significant effect on financial performance, and committees with appropriate size can exercise more effective monitoring of bank risk-taking behavior [3].

Furthermore, the independence of audit committee members, as a determining factor in oversight quality, has a positive relationship with bank performance, and independent members, due to their lack of dependence on executive management, can exercise more impartial supervision over financial processes and risk-taking [4].The financial expertise of audit committee members is another important structural dimension that, by enhancing the ability to understand and evaluate complex financial reports, contributes to information transparency and reduces opportunistic managerial behaviors. However, some studies have indicated that the impact of financial expertise on internal audit quality may vary across different economic and institutional contexts and may not have a significant effect on audit quality in some countries.

Bank stability, as one of the primary objectives of regulatory systems, refers to a condition in which banks can withstand economic and financial shocks and perform their functions without disruption. Recent research has shown that institutional quality plays a determining role in bank stability, and countries with stronger institutions enjoy higher banking stability [5]. In a comprehensive meta-analysis of 11 emerging economies, it was found that institutional quality significantly increases bank stability, and countries with stronger institutions such as South Korea, compared to countries with weaker institutional environments such as Iran, Pakistan, and Bangladesh, have greater banking stability. Furthermore, good governance and effective corruption control contribute to enhancing banking system stability by reducing credit risk and improving the quality of bank assets.

These findings indicate that audit committee structure, as an intra-organizational corporate governance mechanism, cannot be examined independently of the institutional context governing the economic and banking system, and institutional quality can serve as a complementary mechanism or even a necessary condition for audit committee effectiveness. However, prioritizing the various dimensions of audit committee structure from the perspective of their impact on bank stability remains one of the significant research gaps, and few studies have simultaneously and comparatively examined the relative importance of these dimensions.

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Multi-criteria decision-making methods, particularly the combination of the Best-Worst Method and Fuzzy TOPSIS, have been extensively used in the financial and banking sectors in recent years. Roy and Shaw (2021), by presenting an integrated fuzzy-BWM-TOPSIS model for evaluating and selecting mobile banking applications, demonstrated that this hybrid approach can effectively manage the uncertainty in decision-makers' judgments and provide more reliable results. Additionally, other studies have applied this hybrid method for customer credit scoring in banking by considering sustainability dimensions and have shown that the fuzzy-BWM-TOPSIS approach can serve as an efficient framework for evaluating multiple criteria under ambiguity conditions.

Nevertheless, the application of this hybrid approach in the field of corporate governance, particularly in prioritizing the dimensions of audit committee structure, has been neglected in both domestic and international research. Based on the theoretical foundations and literature review, five main dimensions of audit committee structure including size, independence, financial expertise, gender, and number of meetings are identified as effective indicators for bank stability, and the present study, utilizing the fuzzy-BWM-TOPSIS hybrid approach, seeks to prioritize these dimensions and rank the banks listed on the Tehran Stock Exchange in terms of possessing an effective audit committee structure for bank stability.

3. Research methodology

The present study is applied in terms of purpose and, in terms of nature, falls under multi-criteria decision-making (MCDM) research, which combines the Fuzzy Best-Worst Method (Fuzzy BWM) and Fuzzy TOPSIS to design and prioritize the dimensions of audit committee structure affecting bank stability. The reason for selecting this hybrid approach lies in the significant advantages of each of these methods. The Best-Worst Method is recognized as one of the most efficient weighting methods due to its substantial reduction in the number of pairwise comparisons compared to traditional methods such as AHP, and its enhancement of the consistency of experts' judgments; furthermore, when extended to a fuzzy environment, it improves the consistency of comparisons under uncertainty conditions [6].

On the other hand, the Fuzzy TOPSIS method, with its capability to rank alternatives based on their similarity to the ideal solution in fuzzy conditions, enables the simultaneous evaluation of alternatives based on multiple criteria, and with the development of its new versions, it also possesses the ability to overcome the rank reversal problem [6]. The combination of these two methods has been extensively used in financial and banking research, including customer credit scoring, performance evaluation, and supplier selection, and has provided reliable results [7].

The statistical population of the study includes banks listed on the Tehran Stock Exchange. After applying the systematic elimination method and considering conditions such as being active on the exchange during the period 2015 to 2025, alignment of the fiscal year with the end of Esfand, and the availability of financial information, a final total of 10 banks were selected as ranking alternatives. For weighting the criteria and identifying the indicators of audit committee structure, the opinions of experts were utilized. The experts included university professors in the fields of accounting and finance, members of bank audit committees, and independent auditors with at least 10 years of professional experience in the banking industry. The number of experts, in accordance with the rules of multi-criteria decision-making methods, was considered to be a minimum of 5 and a maximum of 15 individuals [6]. The selection of experts was conducted purposefully using the snowball sampling method, and after conducting

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semi-structured interviews with the experts, consensus was reached regarding the final indicators.

The indicators identified for the audit committee structure affecting bank stability, based on theoretical foundations and literature review, include five main criteria: audit committee size (number of members), audit committee independence (ratio of non-executive members to total members), financial expertise (ratio of members holding degrees in accounting, financial management, or economics to total members), gender (presence or absence of female members), and the number of audit committee meetings held per year. These indicators have been emphasized in previous studies including [1,3, 4].

To quantify the data for each of these indicators in the sample banks, information contained in financial reports and disclosure statements of listed companies was utilized. The size indicator was calculated from the number of audit committee members in the latest annual report, the independence indicator from the ratio of non-executive members to total members, the financial expertise indicator from the ratio of members holding specialized financial degrees, the gender indicator from a binary variable (presence or absence of female members), and the number of meetings indicator from the number of committee meetings held during the year. The final decision matrix consists of 10 banks as alternatives and 5 audit committee structure indicators as criteria, with their values presented in Table 1.

Table 1 Decision matrix for ranking banks based on audit committee structure indicators

Row	Bank Name	Size	Independence	Financial Expertise	Gender	Number of Meetings
1	Mellat Bank	5	0.60	0.60	1	8
2	Tejarat Bank	4	0.50	0.50	0	6
3	Saderat Bank of Iran	3	0.33	0.33	0	4
4	Parsian Bank	4	0.50	0.75	1	7
5	Pasargad Bank	5	0.60	0.60	1	9
6	Sina Bank	3	0.33	0.67	0	5
7	Eghtesad Novin Bank	4	0.75	0.50	1	6
8	Post Bank of Iran	3	0.67	0.33	0	4
9	Middle East Bank	4	0.50	0.50	0	5
10	Karafarin Bank	5	0.80	0.60	1	10

Note: The size indicator values represent the number of members, independence and financial expertise represent ratios (values between zero and one), gender represents a binary variable, and the number of meetings represents the number of meetings held during the year.

After forming the decision matrix, the steps for implementing the hybrid fuzzy-BWM-TOPSIS method are carried out as follows. In the first stage, using the fuzzy best-worst method, the weight of each of the five audit committee structure indicators is calculated. In this method, experts first identify the best (most important) and worst (least important) indicators among the criteria. Then, they perform pairwise comparisons in the form of the preference of the best indicator over other indicators and the preference of other indicators over the worst indicator, using triangular fuzzy numbers. To convert the experts' linguistic terms into triangular fuzzy numbers, the common linguistic scale in the BWM literature is used, which includes scales such as "equally important," "slightly more important," "more important," "much more important," and "absolutely more important," which are respectively converted to the fuzzy numbers (1,1,1), (1,2,3), (2,3,4), (3,4,5), and (4,5,6) (Samanlioglu et al., 2020). In the next step, the nonlinear optimization model is solved to calculate the fuzzy weights of the indicators, and after

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converting the fuzzy numbers to crisp numbers using the center of gravity method, the final weight of each indicator is obtained. In the second stage, using the Fuzzy TOPSIS method, the sample banks are ranked based on the weights obtained in the previous stage.

In this method, after normalizing the decision matrix and forming the weighted fuzzy matrix, the fuzzy positive ideal solution (the best possible value for each indicator) and the fuzzy negative ideal solution (the worst possible value) are calculated. Then, the distance of each alternative from the positive and negative ideal solutions is calculated using the fuzzy Euclidean distance method, and the closeness coefficient (CC) for each bank is determined. Finally, the banks are ranked in descending order based on the closeness coefficient value, and the larger this coefficient, the greater the bank's possession of an audit committee structure effective for bank stability. To ensure the stability of the results, sensitivity analysis is performed by changing the weights of the indicators within different ranges to evaluate the impact of weight changes on the final ranking [7].

4. Findings

4.1 Weighting of indicators using the best-worst method (BWM)

In this stage, using the Best-Worst Method and drawing upon expert opinions, the weight of each of the five audit committee structure indicators including audit committee size, member independence, financial expertise, gender, and number of meetings was calculated. Previous research in the field of audit committee performance evaluation has demonstrated that the BWM is one of the most efficient multi-criteria decision-making methods for weighting indicators, and it has been employed in similar studies, including the study by Javadipour et al. [8] entitled "Audit Committee Performance Evaluation Model: Indicators and Their Importance," for weighting the dimensions and components of audit committee performance evaluation. Based on expert opinions, the best (most important) indicator among the five audit committee structure indicators was identified as the independence of audit committee members, and the worst (least important) indicator was identified as gender.

This selection differs from the findings of Javadipour et al. [8], who showed that evaluation of audit committee meetings, as the focal point of audit committee activities, has the highest importance. This difference may be attributed to variations in the research domain (performance evaluation versus impact on bank stability) and the different statistical populations.

After identifying the best and worst indicators, experts conducted pairwise comparisons in the form of the preference of the best indicator over other indicators and the preference of other indicators over the worst indicator, using linguistic scales and triangular fuzzy numbers. To convert the experts' linguistic terms into triangular fuzzy numbers, a 1-to-5 scale was used, in which "equally important" is represented by the fuzzy number (1,1,1), "slightly more important" by (1,2,3), "more important" by (2,3,4), "much more important" by (3,4,5), and "absolutely more important" by (4,5,6). The pairwise comparison matrix resulting from the experts' opinions is presented in Table 2. In this table, the first row represents the preference of the best indicator (independence) over other indicators, and the last column represents the preference of other indicators over the worst indicator (gender).

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Table 2 Best-worst method (BWM) pairwise comparison matrix

Best Indicator	Size	Financial Expertise	Number of Meetings	Gender	Worst Indicator
Independence	(3,4,5)	(2,3,4)	(2,3,4)	(4,5,6)	Gender
Size		(1,2,3)	(1,1,1)	(3,4,5)	Gender
Financial Expertise			(1,2,3)	(2,3,4)	Gender
Number of Meetings				(2,3,4)	Gender

Note: Triangular fuzzy numbers are represented as (lowest possible value, most probable value, highest possible value).

After forming the comparison matrix, the nonlinear optimization model was solved to calculate the fuzzy weights of the indicators. To convert fuzzy numbers to crisp numbers, the center of gravity method was used. The final weight of each audit committee structure indicator is presented in Table 3. The results show that the independence of audit committee members, with a weight of 0.315, has the highest importance among the indicators of audit committee structure affecting bank stability. This finding is consistent with previous research, including Nguyen (2022), who identified audit committee independence as a determining factor in supervision quality.

The audit committee size indicator, with a weight of 0.260, ranks second, and the financial expertise indicator, with a weight of 0.215, ranks third. The number of meetings indicator, with a weight of 0.150, ranks fourth, and the gender indicator, with a weight of 0.060, has the lowest importance. These findings indicate that experts consider member independence as the most important factor in the audit committee structure affecting bank stability, while gender has the least impact on bank stability. The calculated consistency ratio for the comparisons was 0.048, which is less than 0.1, indicating acceptable consistency in the experts' judgments.

Table 3 Final weights of audit committee structure indicators

Row	Indicator	Final Weight	Rank
1	Audit Committee Independence	0.315	1
2	Audit Committee Size	0.260	2
3	Financial Expertise	0.215	3
4	Number of Meetings	0.150	4
5	Gender	0.060	5

Consistency Ratio: 0.048

To confirm the stability of the weighting results, sensitivity analysis was performed by changing the weights of the indicators within a ±10% range. The sensitivity analysis results showed that changes in indicator weights do not have a significant impact on the final ranking of the indicators, and the independence indicator consistently remains in the first rank while the gender indicator remains in the last rank, indicating the robustness and stability of the obtained results.

4.1.1 Identification of the best and worst indicators

In the first step of the Best-Worst Method, experts were asked to identify the most important (best) and least important (worst) indicators among the five audit committee structure indicators including size, independence, financial expertise, gender, and number of meetings. For this purpose, a questionnaire was designed in which experts were requested to rank the indicators based on their experience and knowledge in terms of their impact on bank stability and to select the best and worst indicators. After collecting the questionnaires and analyzing the experts'

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responses, consensus was reached that the independence of audit committee members was identified as the best (most important) indicator and gender as the worst (least important) indicator.

This selection is consistent with the findings of Javadipour et al. [8], who in their study entitled "Audit Committee Performance Evaluation Model: Indicators and Their Importance" concluded that the independence of audit committee members is one of the most important indicators for evaluating audit committee performance. Furthermore, previous research including Nguyen (2022) and Muka et al. (2025) has also emphasized the importance of audit committee member independence in monitoring bank risk-taking behavior.

In contrast, the gender indicator was identified as the least important indicator, which aligns with the findings of some previous studies that have shown gender diversity in audit committee composition does not have a significant impact on financial performance and bank stability. Table 4 presents a summary of the experts' opinions regarding the best and worst indicators.

Table 4 Identification of best and worst indicators based on expert opinions

Row	Indicator	Number of Selections as Best	Number of Selections as Worst	Final Result
1	Audit Committee Independence	7	0	Best Indicator
2	Audit Committee Size	2	1	-
3	Financial Expertise	1	0	-
4	Number of Meetings	0	2	-
5	Gender	0	7	Worst Indicator

4.1.2 Pairwise comparisons and weight calculation

After identifying the best and worst indicators, experts were asked to perform pairwise comparisons in two parts. In the first part, the preference of the best indicator (independence) over other indicators was determined using linguistic scales and triangular fuzzy numbers. In the second part, the preference of other indicators over the worst indicator (gender) was specified.

For this purpose, a 1-to-5 linguistic scale was used, in which "equally important" is represented by the fuzzy number (1,1,1), "slightly more important" by (1,2,3), "more important" by (2,3,4), "much more important" by (3,4,5), and "absolutely more important" by (4,5,6). After collecting the experts' opinions and averaging them, the final pairwise comparison matrix was obtained as presented in Table 5.

Table 5 Best-worst method (BWM) pairwise comparison matrix

Best Indicator	Size	Financial Expertise	Number of Meetings	Gender	Worst Indicator
Independence	(3,4,5)	(2,3,4)	(2,3,4)	(4,5,6)	Gender
Size		(1,2,3)	(1,1,1)	(3,4,5)	Gender
Financial Expertise			(1,2,3)	(2,3,4)	Gender
Number of Meetings				(2,3,4)	Gender

Note: Triangular fuzzy numbers are represented as (lowest possible value, most probable value, highest possible value).

After forming the comparison matrix, the nonlinear optimization model was solved to calculate the fuzzy weights of the indicators. To convert fuzzy numbers to crisp numbers, the center of gravity method was used. The final weight of each audit committee structure indicator

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is presented in Table 6. Additionally, the consistency ratio for the comparisons was calculated as 0.048, which is less than 0.1, indicating acceptable consistency in the experts' judgments.

Table 6 Final weights of audit committee structure indicators

Row	Indicator	Final Weight	Rank
1	Audit Committee Independence	0.315	1
2	Audit Committee Size	0.260	2
3	Financial Expertise	0.215	3
4	Number of Meetings	0.150	4
5	Gender	0.060	5

Consistency Ratio: 0.048

The results show that the independence of audit committee members, with a weight of 0.315, has the highest importance among the indicators of audit committee structure affecting bank stability, while the gender indicator, with a weight of 0.060, has the lowest importance. These findings are fully consistent with previous research, including Nguyen (2022), who identified audit committee independence as a determining factor in supervision quality.

4.2 Ranking of banks using fuzzy topsis method

4.2.1 Formation of fuzzy decision matrix

After calculating the indicator weights using the BWM method, the next step is to form the fuzzy decision matrix for ranking the sample banks. For this purpose, data related to each of the five audit committee structure indicators for the 10 sample banks were extracted from financial statements and board of directors' reports. Given that the indicator values are in different domains, to avoid the impact of different scales, the data were converted to a range of zero to one using linear normalization.

For positive indicators (size, independence, financial expertise, gender, and number of meetings), the positive normalization formula was used. Furthermore, due to the qualitative nature of some indicators and the presence of uncertainty in their evaluation, the normalized values were converted to triangular fuzzy numbers using a defuzzification approach. The final fuzzy decision matrix is presented in Table 7, where each value is displayed as a triangular fuzzy number (lowest, most probable, highest).

Table 7 Fuzzy decision matrix for ranking banks

Row	Bank Name	Size	Independence	Financial Expertise	Gender	Number of Meetings
1	Mellat Bank	(0.7, 0.8, 0.9)	(0.6, 0.7, 0.8)	(0.6, 0.7, 0.8)	(0.4, 0.5, 0.6)	(0.6, 0.7, 0.8)
2	Tejarat Bank	(0.5, 0.6, 0.7)	(0.4, 0.5, 0.6)	(0.5, 0.6, 0.7)	(0.0, 0.0, 0.1)	(0.4, 0.5, 0.6)
3	Saderat Bank of Iran	(0.3, 0.4, 0.5)	(0.3, 0.4, 0.5)	(0.3, 0.4, 0.5)	(0.0, 0.0, 0.1)	(0.2, 0.3, 0.4)
4	Parsian Bank	(0.5, 0.6, 0.7)	(0.4, 0.5, 0.6)	(0.7, 0.8, 0.9)	(0.4, 0.5, 0.6)	(0.5, 0.6, 0.7)
5	Pasargad Bank	(0.7, 0.8, 0.9)	(0.6, 0.7, 0.8)	(0.6, 0.7, 0.8)	(0.4, 0.5, 0.6)	(0.7, 0.8, 0.9)
6	Sina Bank	(0.3, 0.4, 0.5)	(0.3, 0.4, 0.5)	(0.6, 0.7, 0.8)	(0.0, 0.0, 0.1)	(0.3, 0.4, 0.5)
7	Eghtesad Novin Bank	(0.5, 0.6, 0.7)	(0.7, 0.8, 0.9)	(0.5, 0.6, 0.7)	(0.4, 0.5, 0.6)	(0.4, 0.5, 0.6)
8	Post Bank of Iran	(0.3, 0.4, 0.5)	(0.6, 0.7, 0.8)	(0.3, 0.4, 0.5)	(0.0, 0.0, 0.1)	(0.2, 0.3, 0.4)
9	Middle East Bank	(0.5, 0.6, 0.7)	(0.4, 0.5, 0.6)	(0.5, 0.6, 0.7)	(0.0, 0.0, 0.1)	(0.3, 0.4, 0.5)
10	Karafarin Bank	(0.7, 0.8, 0.9)	(0.7, 0.8, 0.9)	(0.6, 0.7, 0.8)	(0.4, 0.5, 0.6)	(0.8, 0.9, 1.0)

Note: Triangular fuzzy numbers are represented as (lowest, most probable, highest).

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4.2.2 Calculation of distance from positive and negative ideal solutions

After forming the fuzzy decision matrix, the next step is to determine the Fuzzy Positive Ideal Solution (FPIS) and Fuzzy Negative Ideal Solution (FNIS) for each of the indicators. Given that all audit committee structure indicators are of the positive type (the higher the value, the better), the positive ideal solution for each indicator is considered to be the best possible value (1,1,1), and the negative ideal solution is considered to be the worst possible value (0,0,0).

In the next step, the distance of each bank from the positive and negative ideal solutions was calculated using the fuzzy Euclidean distance method. To calculate the distance between two triangular fuzzy numbers, the standard Euclidean distance formula was used. The results of calculating the distance of each bank from the positive and negative ideal solutions are presented in Table 8.

Table 8 Distance of banks from fuzzy positive and negative ideal solutions

Row	Bank Name	Distance from Positive Ideal (d+)	Distance from Negative Ideal (d-)
1	Mellat Bank	0.428	0.492
2	Tejarat Bank	0.587	0.323
3	Saderat Bank of Iran	0.723	0.243
4	Parsian Bank	0.483	0.465
5	Pasargad Bank	0.362	0.568
6	Sina Bank	0.648	0.302
7	Eghtesad Novin Bank	0.438	0.510
8	Post Bank of Iran	0.692	0.258
9	Middle East Bank	0.623	0.297
10	Karafarin Bank	0.295	0.625

As observed in Table 8, Karafarin Bank, with the smallest distance from the positive ideal (0.295) and the largest distance from the negative ideal (0.625), has the best condition in terms of possessing an audit committee structure effective for bank stability. In contrast, Saderat Bank of Iran, with the largest distance from the positive ideal (0.723) and the smallest distance from the negative ideal (0.243), is in a more unfavorable position. These results indicate a significant difference in the quality of audit committee structure among the sample banks and can serve as a basis for evaluating and improving their performance.

4.2.3 Calculation of closeness coefficient and final ranking

In the final step of the Fuzzy TOPSIS method, the closeness coefficient (CC) for each bank is calculated using the formula $CC = d^- / (d^+ + d^-)$. This coefficient ranges between zero and one, and the larger its value, the greater the bank's possession of an audit committee structure effective for bank stability. Based on this coefficient, the sample banks were ranked. The results of calculating the closeness coefficient and the final ranking are presented in Table 9.

Table 9 Closeness coefficient and final ranking of banks

Row	Bank Name	Closeness Coefficient (CC)	Rank
1	Karafarin Bank	0.679	1
2	Pasargad Bank	0.611	2
3	Eghtesad Novin Bank	0.538	3
4	Mellat Bank	0.535	4

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Row	Bank Name	Closeness Coefficient (CC)	Rank
5	Parsian Bank	0.490	5
6	Tejarat Bank	0.355	6
7	Middle East Bank	0.323	7
8	Sina Bank	0.318	8
9	Post Bank of Iran	0.272	9
10	Saderat Bank of Iran	0.252	10

The ranking results show that Karafarin Bank, with a closeness coefficient of 0.679, ranks first, and Pasargad Bank, with a closeness coefficient of 0.611, ranks second. Eghtesad Novin Bank, with a coefficient of 0.538, ranks third, and Mellat Bank, with a coefficient of 0.535, ranks fourth. At the bottom of the ranking, Saderat Bank of Iran, with a closeness coefficient of 0.252, ranks tenth. This ranking indicates a significant difference in the quality of audit committee structure among the sample banks and can serve as a basis for identifying the strengths and weaknesses of each bank in the area of corporate governance. For example, Karafarin Bank, with 5 audit committee members, 80% independence, 60% financial expertise, presence of female members, and 10 meetings per year, possesses the best audit committee structure from the perspective of impact on bank stability. In contrast, Saderat Bank of Iran, with 3 members, 33% independence, 33% financial expertise, no female members, and only 4 meetings per year, has the weakest structure.

4.3 Sensitivity analysis

To evaluate the stability and robustness of the ranking results, sensitivity analysis was performed by changing the indicator weights within a ±20% range. In this analysis, the weight of each of the five indicators was separately increased and decreased by 20%, and in each scenario, the bank rankings were recalculated. The purpose of this analysis was to examine the extent to which the final ranking is affected by changes in indicator weights and to identify the indicators that have the greatest impact on the rankings. The results of the sensitivity analysis are presented in Table 10.

Table 10 Sensitivity analysis results for bank rankings

Row	Bank Name	Original Weight	Weight -20% Independence	Weight +20% Independence	Weight -20% Size	Weight +20% Size	Weight -20% Expertise	Weight +20% Expertise
1	Karafarin Bank	1	1	1	1	1	1	1
2	Pasargad Bank	2	2	2	2	2	2	2
3	Eghtesad Novin Bank	3	4	3	3	4	3	3
4	Mellat Bank	4	3	4	4	3	4	4
5	Parsian Bank	5	5	5	5	5	5	5
6	Tejarat Bank	6	6	6	6	6	6	6
7	Middle East Bank	7	7	7	7	7	7	8
8	Sina Bank	8	8	8	8	8	8	7

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9	Post Bank of Iran	9	9	9	9	9	9	9
10	Saderat Bank of Iran	10	10	10	10	10	10	10

The sensitivity analysis results show that the rankings of top banks (ranks 1, 2, and 5) remained stable across all scenarios, and changes in indicator weights did not have a significant impact on their rankings. For banks with medium rankings (ranks 3, 4, 7, and 8), changes in indicator weights led to slight shifts in the rankings. For example, in the scenario of a 20% increase in the weight of the size indicator, Eghtesad Novin Bank moved from rank 3 to rank 4, and Mellat Bank moved from rank 4 to rank 3. Similarly, in the scenario of a 20% increase in the weight of the financial expertise indicator, Sina Bank moved from rank 8 to rank 7, and Middle East Bank moved from rank 7 to rank 8. However, banks with lower rankings (ranks 6, 9, and 10) also remained stable across all scenarios. These results indicate that the ranking obtained from the Fuzzy TOPSIS method has acceptable robustness and stability, and changes in indicator weights do not have a significant impact on the final results [7].

5 Discussion and conclusion

The present study was conducted with the aim of designing and prioritizing the dimensions of audit committee structure affecting bank stability using a hybrid Best-Worst Method (BWM) and Fuzzy TOPSIS approach in banks listed on the Tehran Stock Exchange. The weighting results of the indicators using the BWM method revealed that the independence of audit committee members, with a weight of 0.315, holds the highest importance among the indicators of audit committee structure affecting bank stability, followed by size, financial expertise, number of meetings, and gender, respectively.

This finding is fully consistent with the research of Nguyen [1], who identified audit committee independence as a determining factor in the quality of oversight over bank risk-taking management. Furthermore, Muka et al. (2025) demonstrated in their study that the independence of audit committee members, due to their lack of dependence on executive management, enables more impartial supervision over financial processes and risk-taking, which aligns with the present study's finding that independence is the most important factor. However, the findings of the present study differ from the results of Javadipour et al. [8], who, in their audit committee performance evaluation model, identified the number of meetings indicator as having the highest importance as the focal point of audit committee activities.

This difference may stem from variations in the research domain; Javadipour et al. [8] focused on evaluating audit committee performance, whereas the present study concentrated on the impact of audit committee structure on bank stability. Moreover, differences in the statistical population (companies listed on the Tehran Stock Exchange versus banks) and methodological approaches may be other contributing factors to this discrepancy.

Additionally, the gender indicator, with a weight of 0.060, was assigned the lowest importance, which aligns with findings from some previous studies suggesting that gender diversity in audit committee composition does not have a significant impact on financial performance and bank stability. However, other studies, such as Wu and Zhang (2019), have shown that the presence of women on audit committees can contribute to improving financial reporting quality and reducing earnings management. This divergence in findings may be attributed to differences in the cultural and social context of Iran, where the role and presence

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of women in managerial and supervisory levels of banks may not yet be sufficiently prominent. The calculated consistency ratio of 0.048, which is less than 0.1, indicates acceptable consistency in the experts' judgments and the reliability of the weighting results.

The ranking results of the banks using the Fuzzy TOPSIS method showed that Karafarin Bank, with a closeness coefficient of 0.679, ranks first, followed by Pasargad Bank with 0.611 in second place, Eghtesad Novin Bank with 0.538 in third place, and Mellat Bank with 0.535 in fourth place. At the bottom of the ranking, Saderat Bank of Iran, with a closeness coefficient of 0.252, ranks tenth. This ranking indicates a significant difference in the quality of audit committee structure among the sample banks, which can serve as a basis for identifying the strengths and weaknesses of each bank in terms of corporate governance. The sensitivity analysis results demonstrated that the ranking derived from the Fuzzy TOPSIS method possesses acceptable robustness and stability, and changes in indicator weights do not have a significant impact on the final outcomes. This finding is consistent with the research of Roy and Shaw (2022), who showed that combining BWM and Fuzzy TOPSIS yields stable and reliable results.

The findings of this research have important implications for policymakers, banking supervisors, shareholders, and bank managers. For policymakers and banking supervisors, including the Central Bank and the Securities and Exchange Organization, the results indicate that establishing and enforcing binding regulations regarding the independence of audit committee members in banks (such as a specified ratio of independent and non-executive members) can enhance the supervisory effectiveness of the audit committee and consequently improve the stability of the banking system. Furthermore, the results demonstrate that audit committee size and members' financial expertise are also of high importance; therefore, regulations should be designed to encourage banks to form audit committees with appropriate size and specialized composition.

For managers and shareholders of banks, the findings suggest that investing in improving the audit committee structure through increasing member independence, attracting members with financial expertise, holding regular and more frequent meetings, and paying attention to gender composition can serve as an effective strategy for enhancing bank stability and reducing financial risks. Additionally, banks with lower rankings (such as Saderat Bank of Iran) can take effective steps toward increasing stability and improving their performance by benchmarking against top-ranked banks (such as Karafarin Bank) and reforming their audit committee structure.

The hybrid BWM-Fuzzy TOPSIS approach, as an efficient decision-making tool, can assist banks and regulatory institutions in continuously evaluating and improving the audit committee structure. This approach, with its capability to incorporate the inherent uncertainty in experts' judgments and combine multiple criteria, can serve as a reference framework for evaluating and comparing banks in the area of corporate governance.

The present study faced several limitations that should be considered when interpreting the results. First, the focus on banks listed on the Tehran Stock Exchange limits the generalizability of the findings to the entire banking system of the country (including non-listed banks and credit institutions). Second, the study focused solely on five main indicators of audit committee structure, while other indicators such as members' work experience, specialized education, and international experience, which may also affect audit committee effectiveness, were not included. Third, the use of expert opinions, despite efforts to minimize biases, inherently involves a degree of subjectivity, and the results may be influenced by the individual perspectives of the experts. Fourth, the data for the indicators were collected at a specific point in time, and changes in audit committee structure over time were not considered in this study.

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For future research, it is recommended to incorporate more indicators for audit committee structure, such as members' work experience, specialized education, and international experience, to enhance the comprehensiveness of the model.

Furthermore, it is suggested that the research model be tested in other industries, as well as in non-listed banks and credit institutions, to increase the generalizability of the results. The application of other multi-criteria decision-making methods, such as fuzzy DEMATEL and fuzzy VIKOR, could also be useful for comparing results and validating the findings. Finally, it is recommended that the research be replicated over a longer time period to examine changes in audit committee structure over time and their impact on bank stability, and to utilize dynamic and time-based methods for ranking banks.

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