Knowledge and Decision Systems with Applications

www.kadsa.org
eISSN: 3079-6318

Prioritizing Accounting Conservatism Strategies under Financial Constraints: An Integrated Fuzzy MCDM Framework for Enhancing Financial Reporting Quality

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ARTICLE INFO

Article history:
Received 25 September 2026
Received in revised form 3 November 2026
Accepted 9 November 2026
Available online 15 November 2026

Keywords:
Accounting Conservatism; Spherical Fuzzy Sets; LOPCOW; CoCoFISo; Multi-Criteria Decision Making

ABSTRACT

Conservative accounting strategies are essential for businesses to enhance the quality of their financial reporting. However, businesses with limited managerial and financial resources cannot implement all these strategies simultaneously; therefore, it is necessary to determine which conservative accounting strategies should be prioritized. The primary objective of this study is to identify the most suitable conservative accounting strategies for firms operating under resource constraints. To achieve this, an integrated multi-criteria decision-making model based on fuzzy logic is employed. First, expert evaluations are modeled using spherical fuzzy sets. Second, the LOPCOW technique is used to calculate the importance weights of the criteria. Third, conservative accounting strategies are prioritized using the CoCoFISo method. This study offers a distinct perspective to the literature by addressing conservative accounting not merely in terms of influencing factors, but as a strategy selection problem amidst limited resources. The findings demonstrate that an uncertainty-responsive conservative accounting framework is the optimal strategy for accounting conservatism, while stakeholder and creditor protection emerges as the most important criterion.

1. Introduction

The reliable preparation of financial statements is of critical importance for both the business itself and all its stakeholders. For accurate strategic decisions to be made during this process, these statements must be both reliable and transparent. However, factors such as financial risks, economic uncertainty, and rapidly changing regulations can sometimes negatively affect the quality of financial reporting. Conservative accounting practices can contribute to resolving these issues at an early stage. Consequently, businesses need to implement strategies to strengthen conservative accounting. There are numerous types of strategies available in this regard, and they can impact the business in various ways. Yet, businesses have limited managerial and financial resources, making it

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https://doi.org/10.59543/gngdcs63

unfeasible to implement all these strategies simultaneously. Therefore, firms must identify their highest-priority conservative accounting strategies by utilizing their existing resources most effectively. When making such decisions, cost factors should not be the sole consideration; factors such as resilience against economic uncertainty, the strengthening of corporate governance, and the strategies' contribution to financial reporting quality are also significant. In summary, a comprehensive analysis considering multiple factors is required to determine the optimal strategy for strengthening conservative accounting [1]. However, a review of the existing accounting literature reveals that analyses conducted in this area are quite limited. This situation represents a significant gap in the accounting literature, and this uncertainty gives rise to various problems for businesses. The lack of consensus regarding which conservative accounting strategies are the most appropriate can negatively affect the quality of financial reporting.

The primary objective of this study is to determine the most suitable conservative accounting strategy for firms operating under constraints of limited financial and managerial resources. Such resource limitations make it difficult for firms to simultaneously implement all strategies that could reinforce conservative accounting. Consequently, there is a need for a systematic decision-making model that evaluates various strategies from a multidimensional perspective and directs resources toward the most effective ones; this need serves as the primary motivation for the study. A fuzzy logic-based multi-criteria decision-making approach is employed to identify the optimal conservative accounting strategy under resource constraints. First, a comprehensive literature review was conducted to identify conservative accounting strategies and the evaluation criteria influencing their selection. In the second stage, expert evaluations were converted into spherical fuzzy sets using a fuzzy logic approach. In the third stage, the importance weights of the criteria were calculated using the LOPCOW technique. Finally, the most effective strategies were determined using the CoCoSo approach. The core research questions addressed by this study are as follows: (1) Which criteria are of greater importance in the selection of conservative accounting strategies? (2) Which conservative accounting strategies hold higher priority given limited financial and managerial resources?

The novelty of this study stems from its treatment of conservative accounting as a strategic decision-making problem under resource constraints, distinguishing it from traditional approaches that focus primarily on its determinants and consequences. In this context, the study determines the importance levels of criteria influencing the selection of conservative accounting strategies and compares alternative strategies based on these criteria. Another unique aspect of the study is its integration of the conservative accounting literature with a fuzzy multi-criteria decision-making approach. The study's primary contributions to the literature are as follows: (1) It introduces a new decision-making perspective to the conservative accounting literature. While existing studies predominantly examine the impact of factors such as economic uncertainty and sustainability on conservative accounting, this study approaches the subject from a different angle, focusing on which conservative accounting strategies firms should prioritize given their limited financial and managerial resources. (2) The second significant contribution is methodological. The use of spherical fuzzy sets allows for a more comprehensive representation of the uncertainty and hesitation inherent in expert evaluations. The combined application of the LOPCOW and CoCoFISo methods facilitates a systematic process for criterion weighting and alternative ranking. The LOPCOW method accounts for the data structure and variability among criteria when determining their importance weights, while CoCoFISo enables a more comprehensive ranking by considering various performance dimensions within an integrated framework during the evaluation of alternatives.

Economic policy uncertainty (EPU) refers to uncertainty associated with the content, timing, and implementation of prospective governmental economic policies, which limits the ability of economic

agents to forecast forthcoming economic conditions and make informed decisions. Increased EPU may negatively impact the investment, financing, and operational choices of firms [2]. Moreover, economic policy uncertainty exerts a considerable impact on the characteristics of accounting information as well as the disclosure strategies employed by firms [3]. Otherwise, economic uncertainty, characterized by unforeseen and uncontrollable factors within the economic landscape, engenders instability in the demand conditions, cost frameworks, and financial prospects of enterprises. As with economic policy uncertainty, economic uncertainty also affects firms' investment and financing choices [4]. Economic policy uncertainty, and the increased economic uncertainty that often occurs during periods of downturns and crisis, encourage firms to make income-reducing accounting adjustments and recognize potential losses sooner than gains, thus supporting the adoption of conservative accounting practices [5]. In their research, Adu & Barua [6], investigate the way accounting conservatism influences modifications to income and the overall performance of firms in times of economic downturns, while distinguishing between systemic conservatism and opportunistic conservatism. The findings of the study indicate firms practicing conservative accounting practices during stable economic conditions exhibit a reduced propensity to implement substantial income-decreasing adjustments during periods of crisis when contrasted with their non-conservative counterparts. Firms adhering to conservative accounting principles demonstrate superior earnings and market returns, signifying prudent strategic preparation for potential future economic uncertainties. Besides, Kim & Ann [3], examine the extent to which foreign ownership affects the relationship between economic policy uncertainty and accounting conservatism within firms operating in Korea. The study concludes that an increase in foreign ownership typically enhances conservatism in response to escalating uncertainty, particularly in instances where foreign shareholders hold the predominant stake; however, this phenomenon exhibits diminished intensity within firms affiliated with business groups due to the influence of controlling shareholders. In addition, in their research conducted within the context of the idea that global events increase the sense of uncertainty, leading to a 'uncertainty of uncertainty' where future levels of unpredictability themselves are uncertain, Cui *et al.*[7] use economic policy uncertainty as a control variable and examine how the uncertainty of uncertainty affects the conservative accounting. According to the findings of the research, uncertainty of uncertainty is positively and significantly associated with corporate accounting conservatism.

Legal regulations, which are binding rules issued by authorities to implement and enforce legislation, represent an additional determinant influencing conservative accounting practices. Legal regulations, including tax legislation, exert a profound impact on the financial disclosures and accounting practices of firms, which may result in a transition from their traditionally conservative approaches [1]. Moreover, accounting standards considered as legal frameworks, are emphasized as significant causal factors influencing conservatism. Specifically, principle-based accounting standards, by providing management with increased latitude, elicit concerns regarding opportunistic financial reporting [8]. In this context, Chouaibi & Belhouchet [9] endeavor to investigate the moderating influence of the adoption of International Financial Reporting Standards (IFRS) on the interrelationship between accounting conservatism and the cost of equity within Canadian firms that prioritize Environmental, Social, and Governance (ESG) criteria. The study reveals an inverse correlation between conservatism and the cost of equity. Importantly, the adoption of IFRS serves as a moderating factor in this relationship, indicating its substantial contribution to financial transparency and the cost of equity for these organizations. Besides, Jadiyappa & Hickman [10] examine the impact of legal regulations that strengthen creditor rights, on conservative accounting. Their findings indicate that strong creditor rights may reduce the need for conservative accounting

because increased legal protection for creditors diminishes the need for additional protection through conservative accounting. In a comparable research, Radhakrishnan *et al.* [11] investigate the influence of regulatory frameworks designed to safeguard stakeholder interests on conservative accounting practices. Their findings indicated that these regulatory frameworks, which permit managers to take stakeholder interests into account, result in a notable decrease in the level of accounting conservatism. Likewise, financial characteristics, including growth potential, return on equity, sales growth, return on assets, investment opportunities, financial distress, and financial leverage, are among the determinants of accounting conservatism; specifically, investment opportunity sets are positively associated with accounting conservatism, whereas firms with higher return on assets tend to adopt less conservative accounting practices [12]. Similarly, the utilization of leverage (debt financing) exerts an influence on the degree of conservatism; elevated levels of indebtedness compel creditors to advocate for conservative accounting practices to safeguard the security of their investments. In contrast, financial distress may induce management to diminish conservatism to enhance the appearance of financial statements, or alternatively, it may heighten conservatism owing to the prevailing uncertainty and the imperative for prudence [13]. Liang *et al.* [14] conduct a comprehensive examination of the effects of debt reduction policies on conservative accounting practices, utilizing data derived from firms listed on the A-share market in China between 2012 and 2018. The findings indicate that the implementation of debt reduction policies mitigates a firm's default risk, diminishes agency conflicts between creditors and shareholders, and leads to a decrease in accounting conservatism.

Corporate governance pertains to the frameworks and mechanisms that oversee the conduct of a corporation's board of directors, management, and various stakeholders [15], and represents a significant factor influencing conservative accounting practices. Ownership structure, the attitude of executive management and board characteristics, including board size, board independence, and gender diversity, are important corporate governance mechanisms that influence accounting conservatism. Large ownership as an ownership structure has a significant positive effect on the degree of accounting conservatism. [16]. Another ownership structure, the presence of large shareholders, creates a more balanced corporate power structure, reducing opportunistic behavior and conflicts of interest, and significantly improving the quality of decision-making and corporate accounting conservatism by bringing diverse perspectives and expertise to the board of directors [17]. Top management, serving as a critical administrative mechanism within the framework of corporate governance, exerts a significant influence on conservative accounting practices, wherein influential senior executives are inclined to diminish the degree of conservatism in accounting practices. This phenomenon is particularly evident in organizations characterized by deficient corporate governance structures and elevated levels of information asymmetry [18]. An alternative perspective suggests that managers can manipulate conservatism and engage in profit management by counteracting conservative accounting methodologies to attain designated financial objectives [19]. In this respect, Liu *et al.* [20] investigate the extent to which well-connected boards employ conservative accounting practices to rehabilitate their reputation following financial reporting discrepancies. The results of the research suggest that central boards proficiently employ conservative accounting methodologies to restore their diminished reputations, thereby leading to improved prospects for esteemed board positions, a rise in external directorships, and heightened compensation. In another similar study, Marisetty & Kommett [21] examines the influence of obligatory gender quotas on corporate boards within the context of India, specifically focusing on accounting conservatism.

The findings indicate that enterprises characterized by gender-diverse boards, notably those inclusive of female directors, demonstrate elevated levels of accounting conservatism, thereby implying enhancements in governance practices and the quality of financial reporting. Moreover, Collins *et al.* [22] conduct an empirical investigation into the influence of managerial sentiment on conditional conservatism. The results of their analysis indicate a negative correlation between managerial sentiment and conditional conservatism, suggesting that organizations tend to exhibit diminished conservatism during phases characterized by elevated managerial sentiment (over-optimism) and heightened conservatism during phases marked by diminished managerial sentiment (over-pessimism).

Sustainability performance, which quantitatively assesses the efficacy with which an organization, initiative, or system harmonizes economic advancement, environmental stewardship, and social accountability over time [23], is shaped by the execution of sustainability initiatives and the establishment of robust governance structures, which, in turn, are influenced by the accounting decisions made by managers [24]. Furthermore, the implementation of corporate sustainability practices promotes a more judicious approach to financial reporting, and the environmental, social, and governance (ESG) performance of firms influences accounting conservatism, which constitutes a critical dimension of the quality of financial reporting [25]. In nations characterized by a deficiency in regulatory supervision, particularly, good ESG performance can be used to justify future earnings manipulation [26]. Conversely, an elevation in accounting conservatism addresses the requirements for transparency and actively improves the disclosure of Environmental, Social, and Governance (ESG) factors; consequently, a heightened level of accounting conservatism markedly enhances ESG disclosures [27]. Islam *et al.* [28] investigate the relationship between carbon risk, a critical environmental indicator for assessing corporate ESG (Environmental, Social and Governance) performance, and accounting conservatism, utilizing a dataset comprising 7,636 firm-year observations across 29 nations. The research concludes that firms with higher carbon risk demonstrate an increased level of conditional accounting conservatism. Ding *et al.* [29], in a parallel investigation, examine the extent to which climate risk influences accounting conservatism across a sample of 47 nations, while considering moderating variables such as governance quality and levels of uncertainty avoidance. The results indicate that firms facing elevated climate risk engage in a greater degree of conditional conservatism, whereas they demonstrate a reduced reliance on unconditional conservatism in their financial reporting practices.

Considering its fundamental significance in safeguarding the integrity and reliability of financial reporting, comprehending the determinants that influence conservative accounting has emerged as an important area within accounting scholarship. In this context, conservative accounting is not merely a financial reporting preference, but a dynamic practice shaped by a wide range of factors, including financial performance, corporate governance, economic uncertainty and recessions, regulatory compliance, and economic, environmental, and social sustainability performance. Despite the growing body of research, the multidimensional determinants of conservative accounting have not yet been examined within a comprehensive framework. Accordingly, this study addresses a significant gap in the literature by providing a comprehensive examination of the multidimensional factors influencing conservative accounting. Furthermore, it contributes to the ongoing debate by investigating the conditions under which conservative accounting enhances the quality of financial information and those under which it may serve as a mechanism for managerial manipulation.

2. Methodology

This section includes the formulations and definitions of interval-valued Spherical fuzzy sets (IV-SFSs), LOPCOW and combined compromise for ideal solution for multi-attribute decision making (CoCoFISo), respectively.

To minimize uncertainty in the linguistic expressions used by evaluators in decision-making models and in the execution of processes, it is suggested that fuzzy sets be integrated into the model. In this context, SFSs, which can analyze a wide range of uncertainty including membership, non-membership, and hesitation grades, are preferred for this manuscript. Additionally, by using interval values instead of single values for these grades, the aim is to provide a broad analysis that includes intermediate values as well. In other words, by integrating IV-SFSs into the LOPCOW and CoCoFISo methods, the goal is to increase the realism and accuracy of the analysis results.

LOPCOW is preferred for criterion weighting to provide objective weighting. Because LOPCOW combines the root mean square of a criterion with its dispersion in a single ratio, the dominance of a criterion with a large variance is prevented by logarithmic transformation. This ensures more balanced criterion weights. CoCoFISo is preferred in this manuscript for listing the alternatives.

CoCoFISo is preferred in this manuscript for ranking alternatives. This method is obtained by improving CoCoSo. The literature states that the method offers improved normalization and weighting, increasing the accuracy of the results. In CoCoSo, the denominator becomes zero if the value of a criterion is the same for every alternative. Furthermore, a computational problem arises in CoCoSo if one alternative has the worst values. CoCoFISo, developed to overcome these problems, is more robust and stable against changes in criterion weights. Figure 1 visualizes the methodology of this manuscript.

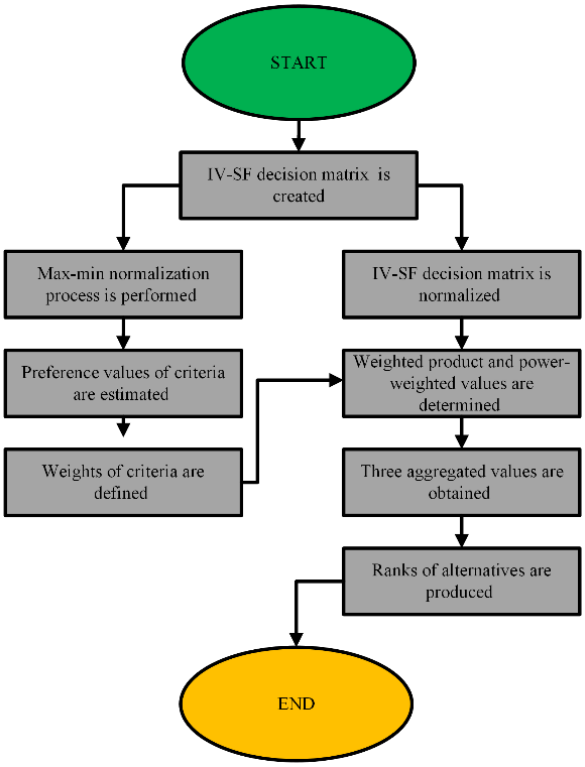


Fig. 1. Methodology of Manuscript

2.1. Preliminaries of IV-SFSs

Let $\mathcal{U}$ be a universe of discourse. Then, an interval-valued Spherical fuzzy set $(\widetilde{H}_S)$ is described as in Equation (1) [30].

$$\widetilde{H}_S = \left\{ \left\langle \varsigma, \left(\left[\gamma^-_{\widetilde{H}_S}(\varsigma), \gamma^+_{\widetilde{H}_S}(\varsigma) \right], \left[\eta^-_{\widetilde{H}_S}(\varsigma), \eta^+_{\widetilde{H}_S}(\varsigma) \right], \left[\theta^-_{\widetilde{H}_S}(\varsigma), \theta^+_{\widetilde{H}_S}(\varsigma) \right] \right) \middle| \varsigma \in \mathcal{U} \right\} \quad (1)$$

Wherein $0 \le \gamma^-_{\widetilde{H}_S}(\varsigma) \le \gamma^+_{\widetilde{H}_S}(\varsigma) \le 1,\ 0 \le \eta^-_{\widetilde{H}_S}(\varsigma) \le \eta^+_{\widetilde{H}_S}(\varsigma) \le 1,\ 0 \le \theta^-_{\widetilde{H}_S}(\varsigma) \le \theta^+_{\widetilde{H}_S}(\varsigma) \le 1$ and $0 \le \left(\gamma^+_{\widetilde{H}_S}(\varsigma)\right)^2 + \left(\eta^+_{\widetilde{H}_S}(\varsigma)\right)^2 + \left(\theta^+_{\widetilde{H}_S}(\varsigma)\right)^2 \le 1$. For each $\varsigma \in \mathcal{U}$, $\gamma^+_{\widetilde{H}_S}(\varsigma)$, $\eta^+_{\widetilde{H}_S}(\varsigma)$ and $\theta^+_{\widetilde{H}_S}(\varsigma)$ is named the upper grades of membership, non-membership and hesitancy of ς to $\widetilde{H}_S$, respectively. For $\widetilde{H}_S$, the pair $\left(\left[\gamma^-_{\widetilde{H}_S}(\varsigma), \gamma^+_{\widetilde{H}_S}(\varsigma) \right], \left[\eta^-_{\widetilde{H}_S}(\varsigma), \eta^+_{\widetilde{H}_S}(\varsigma) \right], \left[\theta^-_{\widetilde{H}_S}(\varsigma), \theta^+_{\widetilde{H}_S}(\varsigma) \right] \right)$ is an IV-SFN and for convenience, it is symbolized by $\tilde{\beta} = ([x, y], [z, t], [k, l])$.

Suppose that $\tilde{\beta} = ([x, y], [z, t], [k, l])$, $\tilde{\beta}_1 = ([x_1, y_1], [z_1, t_1], [k_1, l_1])$ and $\tilde{\beta}_2 = ([x_2, y_2], [z_2, t_2], [k_2, l_2])$ are any three IV-SFNs. Then, some basic operators for these numbers are identified with Equations (2) – (7).

$$\tilde{\beta}_1 \cup \tilde{\beta}_2 = \{\max\{x_1, x_2\}, \max\{y_1, y_2\}, \min\{z_1, z_2\}, \min\{t_1, t_2\}, \min\{k_1, k_2\}, \min\{l_1, l_2\}\} \quad (2)$$

$$\tilde{\beta}_1 \cap \tilde{\beta}_2 = \{\min\{x_1, x_2\}, \min\{y_1, y_2\}, \max\{z_1, z_2\}, \max\{t_1, t_2\}, \min\{k_1, k_2\}, \min\{l_1, l_2\}\} \quad (3)$$

$$\tilde{\beta}_1 + \tilde{\beta}_2 = \left(\begin{array}{c} \left[\sqrt{x_1^2 + x_2^2 - x_1^2 x_2^2}, \sqrt{y_1^2 + y_2^2 - y_1^2 y_2^2} \right], [z_1 z_2, t_1 t_2], \\ \left[\sqrt{(1 - x_2^2)k_1^2 + (1 - x_1^2)k_2^2 - k_1^2 k_2^2}, \sqrt{(1 - y_2^2)l_1^2 + (1 - y_1^2)l_2^2 - l_1^2 l_2^2} \right] \end{array} \right) \quad (4)$$

$$\tilde{\beta}_1 \times \tilde{\beta}_2 = \left(\begin{array}{c} [x_1 x_2, y_1 y_2], \left[\sqrt{z_1^2 + z_2^2 - z_1^2 z_2^2}, \sqrt{t_1^2 + t_2^2 - t_1^2 t_2^2} \right], \\ \left[\sqrt{(1 - z_2^2)k_1^2 + (1 - z_1^2)k_2^2 - k_1^2 k_2^2}, \sqrt{(1 - t_2^2)l_1^2 + (1 - t_1^2)l_2^2 - l_1^2 l_2^2} \right] \end{array} \right) \quad (5)$$

$$\lambda\beta = \left(\begin{array}{c} \left[\sqrt{1 - (1 - x^2)^\lambda}, \sqrt{1 - (1 - y^2)^\lambda} \right], \left[z^\lambda, t^\lambda \right], \\ \left[\sqrt{(1 - x^2)^\lambda - (1 - x^2 - k^2)^\lambda}, \sqrt{(1 - y^2)^\lambda - (1 - y^2 - l^2)^\lambda} \right] \end{array} \right); \lambda > 0 \quad (6)$$

$$\beta^\lambda = \left(\begin{array}{c} \left[x^\lambda, y^\lambda \right], \left[\sqrt{1 - (1 - z^2)^\lambda}, \sqrt{1 - (1 - t^2)^\lambda} \right], \\ \left[\sqrt{(1 - z^2)^\lambda - (1 - z^2 - k^2)^\lambda}, \sqrt{(1 - t^2)^\lambda - (1 - t^2 - l^2)^\lambda} \right] \end{array} \right); \lambda > 0 \quad (7)$$

Assume that $\tilde{\beta}_i = ([x_i, y_i], [z_i, t_i], [k_i, l_i])$ are collection of IV-SFNs. Then, weighted arithmetic and geometric means are identified with the help of Equations (8) and (9), respectively.

$$\mathcal{A}_W(\beta) = \left(\begin{array}{c} \left[\sqrt{1 - \prod_{i=1}^{k} (1 - x_i^2)^{w_i}}, \sqrt{1 - \prod_{i=1}^{k} (1 - y_i^2)^{w_i}} \right], \left[\prod_{i=1}^{k} z_i^{w_i}, \prod_{i=1}^{k} t_i^{w_i} \right], \\ \left[\sqrt{\prod_{i=1}^{k} (1 - x_i^2)^{w_i} - \prod_{i=1}^{k} (1 - x_i^2 - k_i^2)^{w_i}}, \sqrt{\prod_{i=1}^{k} (1 - y_i^2)^{w_i} - \prod_{i=1}^{k} (1 - y_i^2 - l_i^2)^{w_i}} \right] \end{array} \right) \quad (8)$$

$$\mathcal{G}_W(\beta)=\left(\begin{array}{c}\left[\prod_{i=1}^{k}x_i^{w_i},\prod_{i=1}^{k}y_i^{w_i}\right],\left[\sqrt{1-\prod_{i=1}^{k}(1-z_i^2)^{w_i}},\sqrt{1-\prod_{i=1}^{k}(1-t_i^2)^{w_i}}\right],\\ \left[\sqrt{\prod_{i=1}^{k}(1-z_i^2)^{w_i}-\prod_{i=1}^{k}(1-z_i^2-k_i^2)^{w_i}},\sqrt{\prod_{i=1}^{k}(1-t_i^2)^{w_i}-\prod_{i=1}^{k}(1-t_i^2-l_i^2)^{w_i}}\right]\end{array}\right) \quad (9)$$

Wherein w_i is the weight vector for numbers and $\sum_{i=1}^{k}w_i=1$. In addition, the score, normalized score and accuracy functions of IV-SFN are calculated using Equations (10) – (12), respectively.

$$\mathbb{S}(\beta)=\frac{x^2+y^2-z^2-t^2-\left(\frac{k}{2}\right)^2-\left(\frac{l}{2}\right)^2}{2} \quad (10)$$

$$\overline{\mathbb{S}(\beta)}=\frac{1+\mathbb{S}(\beta)}{2} \quad (11)$$

$$\hbar(\beta)=\frac{x^2+y^2+z^2+t^2+k^2+l^2}{2} \quad (12)$$

2.2. LOPCOW-based CoCoFISo with IV-SFSs

In this hybrid model, which begins with the definition of criteria and alternatives, each alternative is evaluated by evaluators using linguistic expressions according to each criterion. For this, linguistic terms in Table 1 are used [31].

Table 1
Linguistics and IV-SFNs

Linguistic	IV-SFN
AMI	([.85,.95],[.10,.15],[.05,.15])
VHI	([.75,.85],[.15,.20],[.15,.20])
HI	([.65,.75],[.20,.25],[.20,.25])
SMI	([.55,.65],[.25,.30],[.25,.30])
EI	([.50,.55],[.45,.55],[.30,.40])
SLI	([.25,.30],[.55,.65],[.25,.30])
LI	([.20,.25],[.65,.75],[.20,.25])
VLI	([.15,.20],[.75,.85],[.15,.20])
ALI	([.10,.15],[.85,.95],[.05,.15])

Afterwards, these linguistic evaluations are transformed into IV-SFNs regarding to Table 1. Next, the elements of IV-SF decision matrix illustrated in Equation (13) are computed with the help of Equation (14).

$$\widetilde{D}=\begin{bmatrix}\tilde{d}_{11} & \cdots & \tilde{d}_{1n}\\ \vdots & \ddots & \vdots\\ \tilde{d}_{m1} & \cdots & \tilde{d}_{mn}\end{bmatrix} \quad (13)$$

$$\tilde{d}_{ij} = \left(\begin{array}{c} \left[\sqrt{1 - \prod_{r=1}^{e} \left(1 - x_{r_{ij}}^2\right)^{w_r}}, \sqrt{1 - \prod_{r=1}^{e} \left(1 - y_{r_{ij}}^2\right)^{w_r}} \right], \left[\prod_{r=1}^{e} z_{r_{ij}}^{w_r}, \prod_{r=1}^{e} t_{r_{ij}}^{w_r} \right], \\ \left[\sqrt{\prod_{r=1}^{e} \left(1 - x_{r_{ij}}^2\right)^{w_r} - \prod_{r=1}^{e} \left(1 - x_{r_{ij}}^2 - k_{r_{ij}}^2\right)^{w_r}}, \sqrt{\prod_{r=1}^{e} \left(1 - y_{r_{ij}}^2\right)^{w_r} - \prod_{r=1}^{e} \left(1 - y_{r_{ij}}^2 - l_{r_{ij}}^2\right)^{w_r}} \right] \end{array} \right) \quad (14)$$

Wherein m, n, and e are the numbers of alternatives, criteria and evaluators, respectively. Later, the max-min normalization process is performed for LOPCOW method using Equations (15) and (16).

$$y_{ij} = \frac{\overline{\mathbb{S}(\tilde{d}_{ij})} - \min_i \left(\overline{\mathbb{S}(\tilde{d}_{ij})}\right)}{\max_i \left(\overline{\mathbb{S}(\tilde{d}_{ij})}\right) - \min_i \left(\overline{\mathbb{S}(\tilde{d}_{ij})}\right)}; for\ Benefit\ Criterion \quad (15)$$

$$y_{ij} = \frac{\max_i \left(\overline{\mathbb{S}(\tilde{d}_{ij})}\right) - \overline{\mathbb{S}(\tilde{d}_{ij})}}{\max_i \left(\overline{\mathbb{S}(\tilde{d}_{ij})}\right) - \min_i \left(\overline{\mathbb{S}(\tilde{d}_{ij})}\right)}; for\ Non-benefit\ Criterion \quad (16)$$

Subsequently, preference values of criteria are estimated via Equation (17).

$$pv_j = \left| \ln \left(\frac{\sqrt{\frac{\sum_{i=1}^{m} y_{ij}^2}{m}}}{\sigma_j} \right) \times 100 \right| \quad (17)$$

Wherein σ_j is the standard deviation of criterion and established by Equation (18).

$$\sigma_j = \sqrt{\frac{1}{m} \sum_{i=1}^{m} \left(y_{ij} - \frac{1}{m} \sum_{i=1}^{m} y_{ij} \right)^2} \quad (18)$$

Lastly, the weights of criteria are defined with Equation (19).

$$w_j = \frac{pv_j}{\sum_{j=1}^{n} pv_j} \quad (19)$$

According to LOPCOW method, the criterion with the maximum weighting is the most important criterion. The order of magnitude of the criterion weightings indicates the importance of the criteria. In other words, if the criterion weightings are ordered from largest to smallest, the importance of the criteria is ordered.

After creating the weight vector of the criteria, the second stage of the hybrid model, the ranking of alternatives using CoCoFISo, is carried out. Firstly, IV-SF decision matrix is normalized for CoCoFISo using Equation (20).

$$x_{ij} = \frac{\overline{\mathbb{S}(\tilde{d}_{ij})}}{\sqrt{\sum_{i=1}^{m} \left(\overline{\mathbb{S}(\tilde{d}_{ij})}\right)^2}} \quad (20)$$

Behind, the weighted product and power-weighted values are determined with the help of Equations (21) and (22), respectively [32].

$$S_i = \sum_{j=1}^{n} w_j x_{ij} \tag{21}$$

$$P_i = \sum_{j=1}^{n} x_{ij}^{w_j} \tag{22}$$

Subsequently, three aggregated values are obtained by Equations (23) – (25).

$$k_{i_a} = \frac{S_i + P_i}{\sum_{i=1}^{m}(S_i + P_i)} \tag{23}$$

$$k_{i_b} = \frac{S_i + P_i}{1 + \frac{S_i}{1+S_i} + \frac{P_i}{1+P_i}} \tag{24}$$

$$k_{i_c} = \frac{\zeta S_i + (1-\zeta)P_i}{\zeta \max S_i + (1-\zeta)\max P_i}; 0 \le \zeta \le 1 \tag{25}$$

Finally, the ranks of alternatives are produced via Equation (26).

$$k_i = \left(k_{i_a} k_{i_b} k_{i_c}\right)^{\frac{1}{3}} + \frac{1}{3}\left(k_{i_a} + k_{i_b} + k_{i_c}\right) \tag{26}$$

3. Result

This section presents the results of a decision-making analysis conducted to rank accounting conservatism strategies under financial constraints. For this, criteria and strategies are determined. All criteria are determined in a way that will benefit the system. The eight criteria thus determined, and their abbreviations, are shown in Table 2.

Table 2
Criteria and Abbreviations

Criterion	Abbr
Financial Reporting Quality Improvement	FRQI
Earnings Management Risk Reduction	EMRR
Economic Uncertainty Resilience	EUR
Regulatory and IFRS Compliance	RIC
Corporate Governance Effectiveness	CGE
Stakeholder and Creditor Protection	SCP
ESG and Sustainability Transparency	EST
Implementation Cost and Resource Requirement	ICRR

Likewise, 6 strategies are defined for aim of manuscript. These strategies are given in Table 3 with abbreviations of strategies.

Table 3
Strategies and Abbreviations

Strategy	Abbr.
AI-Enabled Conservative Financial Reporting System	ACFRS
Independent Governance and Audit Strengthening Program	IGASP
Uncertainty-Responsive Conservative Accounting Framework	URCAF
Integrated ESG–Conservative Reporting Framework	IECRF
Regulatory and IFRS Compliance Enhancement Program	RICEP
Creditor and Investor Protection Reporting Strategy	CIPRS

After determining the criteria and strategies, evaluators are selected. Ten evaluators are selected, each with at least eight years of experience in accounting and finance departments. 70% of these evaluators hold a bachelor's degree, 20% a master's degree, and 10% a doctorate. Additionally, six evaluators have less than 20 years of experience, while four have more than 20 years of experience. These designated evaluators evaluate the strategies according to each criterion using the scale in Table 1. These linguistic evaluations are converted to IV-SFNs regarding Table 1. Next, IV-SF decision values are computed for constructing the IV SF decision matrix using Equations (13) and (14). The IV-SF decision matrix is displayed in Table 4.

Table 4
IV-SF Decision Matrix

	FRQI	EMRR	EUR	RIC	CGE	SCP	EST	ICRR
ACFRS	([.145,.194],[.766,.867],[.135,.195])	([.155,.204],[.746,.846],[.148,.205])	([.173,.223],[.707,.807],[.172,.223])	([.143,.193],[.768,.868],[.136,.193])	([.165,.214],[.726,.827],[.161,.214])	([.132,.180],[.796,.896],[.111,.181])	([.170,.219],[.716,.816],[.166,.219])	([.157,.205],[.745,.845],[.148,.206])
IGASP	([.162,.209],[.740,.841],[.152,.211])	([.186,.234],[.689,.791],[.181,.236])	([.195,.244],[.664,.765],[.194,.245])	([.162,.211],[.734,.834],[.157,.212])	([.176,.225],[.704,.805],[.173,.226])	([.190,.238],[.680,.781],[.186,.240])	([.179,.228],[.701,.802],[.175,.229])	([.169,.218],[.721,.823],[.164,.219])
URCAF	([.426,.507],[.407,.483],[.250,.310])	([.531,.617],[.338,.409],[.245,.313])	([.467,.554],[.374,.445],[.241,.301])	([.478,.564],[.374,.451],[.237,.296])	([.494,.570],[.383,.465],[.262,.336])	([.419,.493],[.431,.513],[.256,.323])	([.491,.566],[.396,.478],[.256,.331])	([.506,.589],[.347,.418],[.259,.327])
IECRF	([.323,.369],[.611,.714],[.231,.311])	([.291,.337],[.617,.719],[.225,.297])	([.321,.367],[.619,.722],[.228,.309])	([.317,.363],[.629,.732],[.223,.305])	([.383,.430],[.569,.672],[.253,.344])	([.276,.321],[.664,.766],[.205,.279])	([.287,.332],[.633,.735],[.219,.292])	([.241,.287],[.665,.767],[.199,.265])
RICEP	([.346,.424],[.524,.607],[.204,.260])	([.340,.388],[.552,.653],[.256,.331])	([.552,.647],[.298,.360],[.226,.284])	([.429,.505],[.449,.531],[.237,.306])	([.442,.525],[.403,.480],[.242,.302])	([.495,.576],[.379,.456],[.248,.318])	([.445,.524],[.445,.528],[.229,.297])	([.195,.244],[.664,.765],[.196,.246])
CIPRS	([.399,.464],[.502,.591],[.243,.319])	([.313,.373],[.548,.642],[.235,.296])	([.382,.449],[.488,.576],[.247,.315])	([.229,.278],[.595,.696],[.230,.279])	([.436,.509],[.436,.518],[.256,.329])	([.494,.575],[.349,.420],[.267,.335])	([.343,.391],[.543,.644],[.260,.334])	([.348,.416],[.522,.611],[.228,.290])

3.1. Weighting of Criteria

Firstly, the IV-SF decision matrix is defuzzfied using normalized score function. The decision matrix is exhibited in Table 5.

Table 5
Decision Matrix

	FRQI	**EMRR**	**EUR**	**RIC**	**CGE**	**SCP**	**EST**	**ICRR**
ACFRS	.177	.194	.227	.175	.211	.151	.220	.195
IGASP	.200	.242	.262	.205	.230	.250	.232	.215
URCAF	.500	.585	.538	.542	.540	.482	.533	.566
IECRF	.330	.316	.324	.316	.378	.281	.305	.271
RICEP	.407	.372	.618	.480	.510	.546	.490	.262
CIPRS	.433	.372	.434	.315	.487	.558	.379	.403

Behind, the max-min normalized decision matrix is created using Equation (15) since all criteria are benefit. The result is exhausted in Table 6.

Table 6
Max-min Normalized Decision Matrix

	FRQI	**EMRR**	**EUR**	**RIC**	**CGE**	**SCP**	**EST**	**ICRR**
ACFRS	.000	.000	.000	.000	.000	.000	.000	.000
IGASP	.071	.121	.088	.080	.056	.243	.039	.053
URCAF	1.000	1.000	.795	1.000	1.000	.814	1.000	1.000
IECRF	.474	.312	.248	.384	.506	.319	.271	.203
RICEP	.713	.456	1.000	.830	.909	.972	.863	.179
CIPRS	.794	.455	.530	.380	.838	1.000	.508	.561

Subsequently, preference and weight values of criteria are estimated via Equations (17) – (19), respectively. These results are summarized in Table 7.

Table 7
Preference and Weight Values of Criteria

	FRQI	**EMRR**	**EUR**	**RIC**	**CGE**	**SCP**	**EST**	**ICRR**
PV	53.281	45.778	45.270	45.809	53.180	56.191	43.002	32.463
Weight	.142	.122	.121	.122	.142	.150	.115	.087

When Table 7 is examined, stakeholder and creditor protection is the most important criterion with .150. Similarly, financial reporting quality improvement and corporate governance effectiveness are the second and third important criteria, respectively.

3.2. Ranking of Strategies

Firstly, the vector normalized decision matrix is constructed using Equation (20). This matrix is presented in Table 8.

Table 8
Vector Normalized Decision Matrix

	FRQI	EMRR	EUR	RIC	CGE	SCP	EST	ICRR
ACFRS	.199	.215	.218	.197	.208	.150	.237	.232
IGASP	.225	.267	.251	.230	.226	.249	.250	.255
URCAF	.565	.648	.516	.608	.533	.481	.574	.672
IECRF	.373	.350	.311	.354	.372	.280	.328	.322
RICEP	.460	.412	.593	.538	.503	.545	.528	.311
CIPRS	.490	.412	.417	.353	.480	.556	.408	.479

Behind, the weighted product and power-weighted values are determined via Equations (21) and (22), respectively. The values are shared in Table 9.

Table 9
Weighted Product and Power-weighted Values

	S	P
ACFRS	.204	6.558
IGASP	.243	6.706
URCAF	.567	7.450
IECRF	.337	6.980
RICEP	.493	7.312
CIPRS	.453	7.239

Using these values in Table 9, three aggregated values are obtained by Equations (23) – (25). The results are presented in Table 10.

Table 10
Three Aggregated Values of Strategies

	ka	kb	kc ($\zeta = .5$)
ACFRS	.152	3.319	.843
IGASP	.156	3.364	.867
URCAF	.180	3.573	1.000
IECRF	.164	3.441	.913
RICEP	.175	3.532	.974
CIPRS	.173	3.512	.959

Finally, the rank values of strategies are produced via Equation (26). The result is reported in Table 11.

Table 11
Ranking Values of Strategies

	k
ACFRS	2.190
IGASP	2.231
URCAF	2.448
IECRF	2.308
RICEP	2.405
CIPRS	2.383

According to ranking values of strategies in Table 11, uncertainty-responsive conservative accounting framework is the most optimal strategy for accounting conservatism under financial constraints. Likewise, regulatory and IFRS compliance enhancement program is the second optimal strategy.

3.3. Sensitivity Analysis

A series of analyses are performed to assess the sensitivity and robustness of the ranking results. The first step is to compare the results with those of different ranking methods accepted in the literature. In this context, the TOPSIS and SAW methods are applied to the same IV-SF decision matrix. The results obtained with both methods are presented in Table 12.

Table 12
Results of TOPSIS and SAW

	TOPSIS	SAW
ACFRS	.000	.359
IGASP	.127	.429
URCAF	.898	1.000
IECRF	.355	.593
RICEP	.704	.869
CIPRS	.635	.799

As can be seen from comparative results in Table 12, the ranking results are the same. In other words, the Spearman rank correlation coefficients among three methods are one. Similarly, the Pearson correlation coefficient between our model and TOPSIS is .998 and between our model and SAW is .996. These high correlation values indicate the robustness of the ranking results. Next, the potential changes in ranking results caused by minimal variations in criterion weights are examined. For this purpose, different criterion weight vector scenarios are constructed using Monte Carlo simulation. In this scenario-based approach, a similarity factor of 100 and a Dirichlet distribution are chosen. This prevents extreme variations and guarantees that the sum remains at 1. Twenty different scenarios are constructed using the simulation performed in Python. The ranking values of strategies for twenty different scenarios are visualized in Figure 2.

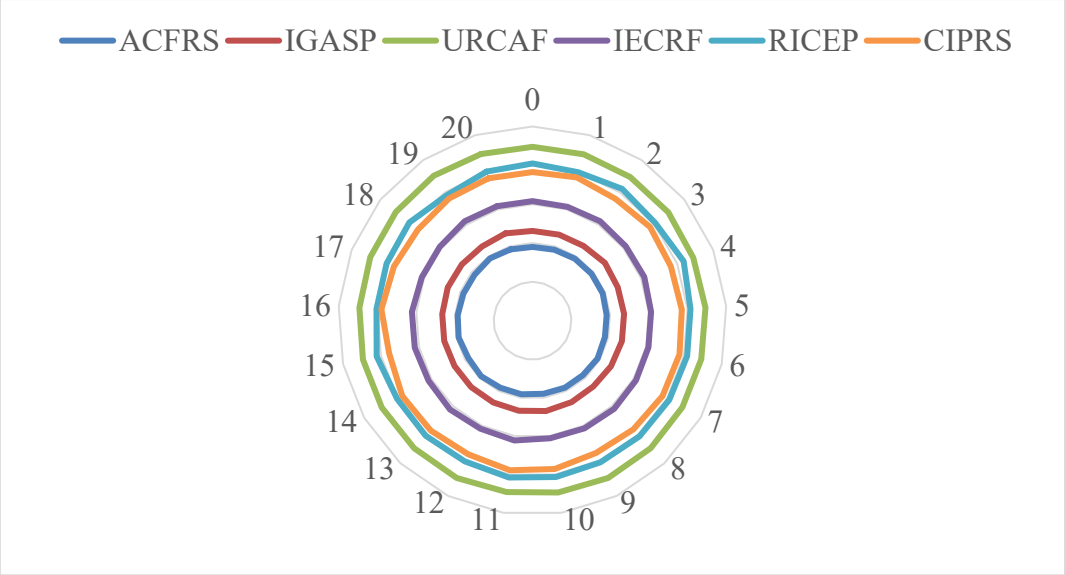


Fig. 2. Scenario Results

In Figure 2, Scenario_0 is original result. The other scenario results are shown with index. According to the results in Figure 2, minimal changes in criterion weights do not cause a significant change in the ranking results of the strategies. In other words, the ranking results remain the same. Therefore, the ranking results are robust to changes in criterion weights.

4. Conclusion

The protection of stakeholders and creditors has been identified as the most critical criterion in determining accounting conservatism strategies aimed at enhancing financial reporting quality under financial constraints. Indeed, while stakeholder protection posits that a firm's actions must align with the expectations of its diverse stakeholders, high-quality financial reporting plays a vital role in meeting stakeholder demands for transparency, reliability, and effective risk management. Furthermore, accounting conservatism, a key element of financial reporting, can effectively mitigate information asymmetry among stakeholders [25]. In other words, when accounting information is conservative, stakeholders can rapidly detect contractual breaches and avert losses by modifying or terminating contracts; thus, conservatism reduces information asymmetry. For instance, in environments where access to financial resources is limited, the early recognition of potential losses enables creditors and investors to more accurately assess the business's risk profile [17]. Kim *et al.* [33] examine the direct relationship between accounting conservatism and financial constraints by developing composite measures for these constructs. A firm's constrained financial position limits the course of its economic activities, a situation stemming from information asymmetries that render external financing costly. Meanwhile, Avabruth *et al.* [34] investigate the relationship between accounting conservatism and the practice of a firm's controlling shareholders pledging their shares as collateral to obtain loans. Consequently, the pledging of shares by a firm's controlling shareholders can lead to changes in the return and risk structure for those shareholders.

The uncertainty-sensitive conservative accounting framework has been identified as a key alternative for determining accounting conservatism strategies aimed at enhancing financial reporting quality under financial constraints. Indeed, for firms facing financial constraints, rising uncertainty regarding future cash flows, asset values, and financing opportunities creates a need for

more prudent assessments in financial reporting [35]. The uncertainty-based conservative accounting approach represents not merely a static, uniform practice but a fundamental aspect of financial reporting that allows firms to update accounting figures—through changes in accounting estimates—as new information emerges or uncertainty dissipates [36]. Lantto [37] investigates how financial accountants acquire firm-specific information used in preparing financial statements and how they manage the uncertainty inherent in the situation. In doing so, the study addresses new types of firm-specific information and argues that the primary issue with such practices is the increasing reliance of accountants on the knowledge held by corporate managers. Meanwhile, Fuad *et al.* [38] aim to examine the contrasting effects of risk and uncertainty on accounting conservatism. Their findings demonstrate that conservatism serves as a rational response to risk; however, in situations of heightened uncertainty, where outcomes become unpredictable because the situation lies beyond the company's control, management tends to reduce conservative accounting practices.

The primary objective of this study is to determine the most suitable conservative accounting strategies for firms. To achieve this, an integrated multi-criteria decision-making model based on fuzzy logic was employed. Uncertainties and hesitations inherent in expert evaluations were modeled using spherical fuzzy sets. Subsequently, the importance weights of the criteria were calculated using the LOPCOW method, and alternative conservative accounting strategies were prioritized using the CoCoFISO approach. The study identified the "uncertainty-responsive conservative accounting framework" as the optimal strategy, while "stakeholder and creditor protection" emerged as the most important criterion. This study has certain limitations. First, since the analysis relies on expert opinions, the results may be influenced by the experts' knowledge, experience, and assessments; future studies could mitigate this limitation by incorporating the views of a broader group of experts. Second, the study was conducted within the scope of specific criteria and conservative accounting strategies; future research could incorporate different criteria into the analysis process in different fuzzy environment [39-42]. Finally, as the study is based on a specific decision-making framework, the generalizability of the resulting strategy rankings to different countries, sectors, or firm conditions may be limited; therefore, future studies could evaluate specific country groups, such as emerging economies.

Author Contributions

Conceptualization, F.D. and S.Y.; methodology, S.E.; software, S.E.; validation, H.D., S.Y. and E.E.; formal analysis, S.E.; investigation, S.Y.; resources, F.D.; data curation, S.Y.; writing—original draft preparation, S.Y.; writing—review and editing, S.E.; visualization, H.D.; supervision, S.Y.; project administration, S.Y.; funding acquisition, E.E. All authors have read and agreed to the published version of the manuscript.

Funding

This research received no external funding.

Data Availability Statement

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgement

This research was not funded by any grant.

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