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# Identifying and Ranking Indicators Affecting the Evaluation of Financial Performance in Private Banks using the Fuzzy AHP Method

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ABSTRACT

In the bank-oriented country of Iran, banks hold a crucial role as the primary financial markets. They provide vital support to businesses and offer financial assistance to other institutions. To ensure efficiency and achieve their goals, it is important to Continuous evaluate the financial performance of these banks. This research aims to identify and rank the indicators that are effective in evaluating the financial performance of private banks, using the fuzzy AHP method. This research has been conducted with a mixed approach, which is applied in terms of purpose and descriptive Survey in nature and has been conducted with a mixed approach. The statistical population for this study consists of managers and assistants from private banks, selected using the snowball method. The qualitative part of the research employed the grounded theory approach developed by Strauss and Corbin to identify relevant indicators, while the quantitative part involved ranking these indicators using the fuzzy AHP approach. The results indicate that eight indicators, including capital structure, management efficiency, asset management, operating profit, liquidity, cost, profitability, and income, significantly influence the evaluation of financial performance. This study provides valuable insights to private bank managers, assisting them in identifying important indicators for evaluating their bank's financial performance and improving efficiency accordingly.

## 1. Introduction

In today's financial landscape with the globalization of financial markets and the business activities of companies at the global level, banking as a main and basic business need in today's world, on the one hand, provides financing from different parts of the global financial markets for its customers, and on the other hand, provides various banking services to help and facilitate business interactions in the extreme points of the world

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provides for the value chain of its customers [33]. Banks, along with stock exchanges and insurance companies, are pivotal pillars of financial markets, serving as intermediaries for financial resources.

In the context of Iran's economy, banking holds even greater significance due to the underdevelopment of the capital market. In practice, these banks assume the responsibility of financing enterprises and production companies [10]. Consequently, the banking sector is the linchpin of the country's financial support, with its growth serving as a linchpin for overall economic expansion [1]. It is often referred to as the lifeblood of the economy [11]. Historically, the majority of banks in Iran have been state-owned, driven by the government's primary goal of providing public services and enhancing societal welfare. However, with the proliferation of private banks in Iran and the necessity for profitability to foster development in various economic sectors, the profitability of banks' activities in alignment with economic fluctuations has taken on paramount importance [26].

The pursuit of heightened bank profitability and efficiency necessitates a comprehensive assessment and analysis of banking operations. Measurement and evaluation represent the foundational steps in the quest to enhance performance and productivity [27]. Consequently, the measurement of financial performance indices of banks assumes particular importance [9] and has become a pivotal responsibility for bank managers [8]. Financial performance is related to the ability of an organization to implement plans and critical decisions to achieve goals and high efficiency [30]. This metric encapsulates the returns derived from resources under the bank's purview and stands as a suitable yardstick for gauging goal attainment [31]. Therefore, banks monitor their financial performance to improve their financial stability [13]. Numerous studies have underscored the pivotal role of financial performance, particularly in terms of efficiency, as banks represent a primary source of financing. Improved financial success not only incentivizes other businesses to enhance their performance but also exerts a substantial impact on the nation's economy as a whole [25]. As elucidated by Burke (1989), banks boasting high profitability typically maintain robust capital reserves [17].

The critical interplay between the financial performance of banks, particularly private banks, and its impact on the economic growth of the country, a matter of paramount importance in Iran, which is a bank-oriented nation. Private banks emerge as the primary drivers of profitability and economic advancement within the country. Hence, a favourable financial performance equips them with the requisite capabilities to attain their objectives, secure a competitive edge, and enhance operational efficiency, ultimately contributing to overall economic growth. To assess the financial performance of banks, various key indicators, including profitability and liquidity, among others, are scrutinized. These indicators serve as a yardstick for evaluating the financial health of banks and identifying avenues for improvement. Consequently, the identification and prioritization of these indicators represent a crucial preliminary step.

One effective method for ranking and assigning weights to indices is the hierarchical approach. The Analytic Hierarchy Process (AHP) is a well-established and widely used technique in Multiple Criteria Decision Making (MCDM) that relies on comparative assessments to determine alternative weights. However, it is essential to acknowledge some drawbacks associated with AHP, such as the substantial uncertainty that can surpass human judgment's calculable limits. The subjective nature of human perceptions often eludes the objective mechanisms of AHP. It has been demonstrated that integrating AHP with fuzzy logic provides a viable solution. Fuzzy integrated AHP (FAHP) methods, which utilize fuzzy numbers instead of crisp values, have proven to enhance stability while minimizing computational complexity [8]. Therefore, the adoption of the chain method technique, which incorporates different methods, is favoured in this research for its simplicity, flexibility in addressing complex and ambiguous problems, effectiveness in decision-making, and low computational complexity, rendering FAHP a popular method well-suited for prioritizing options and indicators under conditions of uncertainty.

Measuring the financial performance of private banks is imperative to ensure transparency and goal attainment. Notably, this research fills a significant gap in the literature as it pertains to the identification and ranking of indicators specific to private banks. While prior research has primarily focused on evaluating financial performance and examining the impact of various indicators and factors on performance, this study

introduces a thematic and theoretical innovation by delving into the identification and ranking of financial performance indicators in private banks. On a practical level, the insights garnered from identifying and ranking these indicators will enable banks to assess their financial health and leverage the research findings to enhance their overall financial performance. This inquiry holds the key to unlocking enhanced financial performance, not only for the banks themselves but for the broader economic landscape of the nation.

The article continues as follows. The next section (Section 2) examines the research related to the topic of the previous research. Section 3 presents the methodology and describes the fuzzy AHP algorithm. Section 4 deals with the findings of Section 3. Finally, Section 5 provides conclusions and suggestions for future studies.

## 2. Theoretical Frameworks

Financial performance encompasses the execution of various financial activities. In a broader context, it reflects the extent to which an entity achieves its financial objectives. The topic of financial performance has long been a focal point in the theoretical foundations of finance and holds paramount significance for stakeholders across diverse organizational domains. This importance stems from the fact that an organization's financial performance serves as a barometer of its health and is ultimately instrumental in its sustainability, enabling the realization of its objectives and fostering growth and advancement [23].

For proper financial planning, it is necessary to analyze and evaluate the financial performance of organizations, especially banks country and it also increases the living standards of the people [3]. Measuring the performance of the banking systems of countries helps solve the problems of the financial, banking, and economic systems [22]. Therefore, to evaluate and gauge financial performance within the banking sector, it becomes imperative to first identify the key indicators influencing the performance of a bank and subsequently rank these indicators by their relative importance. In this regard, a multi-criteria decision-making tool such as the Analytic Hierarchy Process (AHP) proves invaluable. AHP is widely employed across scientific engineering, operations research, and management science due to its effectiveness in handling complex MCDM challenges.

The concept of AHP, pioneered by Saaty, is founded on three fundamental principles: decomposition, comparative judgments, and synthesis of priorities [5]. The first principle entails breaking down intricate decision-making problems into a structured hierarchy consisting of multiple levels, including the objective level, criteria level, sub-criteria level, and alternative level. At each level, the second principle guides decision-makers in providing pairwise comparisons of objects based on the 1-9 fundamental scale, which are then stored in the form of pairwise comparison matrices. Following the construction of these matrices, the third principle aids in computing the priority weights of alternatives concerning each criterion and the priority weights of criteria in relation to the problem's overarching objective. In the final stage, global priority weights are synthesized to rank the available alternatives. In order to address certain limitations inherent in traditional AHP, a variant of AHP that operates in a fuzzy and intuitive environment has been proposed [6]. Extensive research has been conducted in the field of financial performance evaluation, which is elaborated in this section.

Iç et al. [13] conducted a research titled "Development of a Hybrid Financial Performance Measurement Model for Turkish Commercial Banks". This study focused on developing a hybrid financial performance measurement model using AHP and Design of Experiments (DOE) techniques. The objective was to obtain comprehensive financial performance scores by combining performance scores based on financial ratios for 18 Turkish commercial banks and their rankings within the commercial banking sector. The performance scores of banks were determined through a rationing process, with three distinct thresholds (quartiles: Q1, Q2, and Q3) established for each financial ratio. The study compared the results of the proposed hybrid model with those obtained from the AHP approach alone, revealing that the hybrid model produced statistically similar but more robust performance scores and ranking results.

Makki & Alqahtani [20] conducted research titled "Capturing the Effect of the COVID-19 Pandemic Outbreak on the Financial Performance Disparities in the Energy Sector: A Hybrid MCDM-Based Evaluation Approach". This research utilized MCDM approach, which followed by AHP and TOPSIS methods. The

research aimed to evaluate the financial performance of energy companies based on four financial dimensions and 11 performance indicators. The findings highlighted that efficiency and profitability were the most significant dimensions, followed by leverage and liquidity.

Singh and Milan [28] undertook a research endeavor titled "Analysis of Financial Performance of Public Sector Banks in India: CAMEL". The study utilized the CAMEL framework, which stands for Capital adequacy, Asset quality, Management efficiency, Earnings, and Liquidity, as performance determinants. The researchers employed the generalized method of system moments (GMM) to examine the impact of these determinants on the performance measurement of public sector banks. The study aimed to explore the interrelationship between bank-specific determinants and the performance of public sector banks, using conventional methods. The findings have significant implications for the banking sector's performance. However, it is important to note that this study relied on secondary data and focused solely on financial aspects, excluding non-financial aspects. The results indicate a negative relationship between asset quality and the performance of public sector banks. Liquidity and inflation are inversely related to the performance of public sector banks in India. Capital adequacy shows a positive relationship with banks' performance but an inverse relationship with their profit margins. GDP growth has a significant positive effect on bank performance but an inverse relationship with banks' interest incomes. Additionally, the inflation rate has an inverse relationship with banks' performance, while banking sector reforms exhibit limited correlation with bank performance.

Vibhakar et al. [32] undertook a research study entitled "Identifying Important Indicators of Financial Performance in Indian Construction Companies". They identified five Significant Financial Performance Factors (SFPFs) in their study: Investor Return, Business Efficiency, Operations Management, Activity Efficiency, and Risk Hedging, along with their relative importance through variance percentage explanation. These SFPFs provide critical information about a company's financial performance, aiding both the company and stakeholders in strategic planning and policy formulation. The research lays the foundation for a comprehensive financial performance evaluation framework to enhance the financial performance of construction companies.

Jam and Dabbagh [14] conducted a research titled "Investigating Factors Affecting the Performance of Banks Admitted to the Tehran Stock Exchange". They aimed at investigating factors influencing the performance of banks listed on the Tehran Stock Exchange. Employing a combined Decision-Making Trial and Evaluation Laboratory (DEMATEL) and Analytic Network Process (ANP) approach, they prioritized six main factors: Capital Adequacy, Asset Management, Management Ability, Income, Liquidity Management, and Risk Sensitivity. Among 23 sub-factors, criteria such as bank size, total facilities, total assets, granted facilities, and claims from non-governmental entities, total income, passive assets, other deposits, partnership bonds, cash, and operating profit and loss were deemed of high importance.

Türegün [31] on the financial performance evaluation of tourism companies listed on BIST, the analysis showed that the ranking results obtained through the TOPSIS and VIKOR methods were similar for the years 2018 and 2019. However, there was a slight difference in 2020. Interestingly, AVTUR emerged as the most significant alternative in both methods, while MARTI received the lowest ranking. Additionally, the study identified MERIT, KSTUR, and PKENT as fluctuating companies.

Baydaş & Elma [4] conducted a study an objectıve criteria proposal for the comparison of MCDM and weighting methods in financial performance measurement: An application in Borsa Istanbul. The results show that preference ranking organization method for enrichment of evaluations (PROMETHEE) method used with hybrid weighting technique produced by far the best performance rankings in 19 out of 20 quarterly periods when compared to technique for order preference by similarity to ideal solution (TOPSIS) and weighted sum approach (WSA).

Bozdoğan et al. [6] conducted a financial performance analysis of foreign banks with branches in Turkey, including Ziarat Bank with the highest assets. The study spanned data from the annual reports of banks between 2014 and 2018, using CAMELS criteria as financial performance indicators. Multi-criteria decision-making methods, specifically TOPSIS and ELECTRE, were employed to evaluate the financial performance of these

banks. This approach enabled the assessment of banks' financial performance and success values for each year, presenting results in a comparative perspective.

Gupta & et al. [12] conducted a research study titled "A hybrid MCDM approach for evaluating the financial performance of public sector banks in India". The study employed a combined CRITIC-TOPSIS method to assess the financial performance of public sector banks in India. The objective was to evaluate the financial situation of public sector banks in the context of competition from private sector banks and foreign banks.

Kumar and Sharma [16] undertook a research study entitled "Benchmarking the financial performance of Indian commercial banks by a hybrid MCDM approach." The analysis revealed that return on equity emerged as the most crucial financial performance measure, with Bandhan Bank identified as the top performer among the examined banks. The study results proposed specific financial performance standards and emphasized the need for trailing institutions to enhance their financial status. The breadth of the study holds significant value for bank management and policymakers, aiding in strategic decision-making for the establishment of sustainable banking systems.

Ledhem and Mekidiche [17] conducted a research study titled "Economic growth and financial performance of Islamic banks: CAMELS approach" focusing on the relationship between economic growth and the financial performance of Islamic banks. Their findings highlighted that profitability, measured through return on equity (ROE), was the primary factor influencing endogenous economic growth. The study emphasized the importance of addressing and stimulating other factors of Islamic financial performance to make a substantial contribution to overall economic growth in the Islamic banking sector.

Mbilla et al. [21] carried out a research study titled "Evaluation of the impact of supervision, information, and communication on the performance of banks in Ghana." The study aimed to assess the influence of supervision, information, and communication on the financial performance of banks. The research findings indicated that information and communication had a weak but significant effect on financial performance. However, no significant relationship was observed between monitoring and financial performance. Based on these results, the study recommended that managers of listed banks in Ghana should allocate more resources and investments in information and communication to enhance their overall performance. Performance, as defined in the study, encompasses factors such as efficiency, profitability, sustainability, growth, and the ability to adapt to environmental opportunities and challenges.

Sargolzaei et al. [26] in a research "The effect of financial performance indicators on profitability in Bank Mellat," examined the relationship between various financial performance indicators and profitability. The findings revealed that variables such as the ratio of non-current facilities to total facilities, the ratio of debt to assets, the ratio of term deposits to total assets, and return on assets (ROA) exhibited a negative relationship with profitability in the long term. Conversely, the study identified a positive and significant relationship in the long term between the ratio of capital adequacy, the ratio of total net operating income to total assets, the ratio of granted facilities to total deposits, and the asset return variable with profitability. These findings suggest that Bank Mellat's profitability can be influenced by specific financial performance indicators, providing insights for strategic decision-making and performance improvement efforts.

## 3. Methodology

The current research is applied in terms of its purpose, in terms of a mixed approach (qualitative-quantitative), and in terms of the nature of a survey that was conducted in two stages. In the first phase, which was the qualitative stage, a grounded theory approach was employed. Semi-structured interviews were conducted with the statistical population, consisting of managers and assistants of private banks. The purpose of this phase was to identify the effective indicators for evaluating financial performance in private banks. The sampling method used in this stage was snowball sampling, and interviews continued until theoretical saturation was achieved. The selection criteria for the experts included having at least a master's degree and a minimum of 7 years of experience in management roles or teaching in the field of finance and banking. The characteristics of

the experts are provided in Table 1.

In the second phase of the research, which was the quantitative phase, the fuzzy analytical hierarchy process (fuzzy AHP) was utilized. Paired comparison questionnaires were employed to calculate the weights of the indicators identified in the first phase and determine their relative importance in private banks. The fuzzy AHP method allows for a comprehensive analysis of the indicators, taking into account their interrelationships and providing a meaningful ranking of their significance. This phase aimed to quantitatively assess and prioritize the identified indicators in the context of private banks.

**Table 1.** Profile of the interviewees present experts

| Row | education | Management experience | Row | education | Management experience |
|---|---|---|---|---|---|
| 1 | Master of Financial Management | 15 | 9 | Master of Banking Management | 15 |
| 2 | PhD in financial management | 18 | 10 | Master of Banking Management | 12 |
| 3 | PhD in banking management | 15 | 11 | Master of Financial Management | 13 |
| 4 | Master of Financial Management | 11 | 12 | Master of Financial Management | 10 |
| 5 | PhD in banking management | 9 | 13 | PhD in financial management | 15 |
| 6 | PhD in financial management | 13 | 14 | PhD in banking management | 8 |
| 7 | PhD in financial management | 17 | 15 | PhD in Islamic Banking | 15 |
| 8 | PhD in banking management | 15 | --- | --- | --- |

## 3.1.Fuzzy analytical hierarchy process algorithm

The hierarchical approach, a multi-criteria decision-making method introduced by Saaty (2008, 1988), proves to be a valuable tool for addressing complex multi-criteria decision-making challenges. It excels in determining the relative importance of multiple variables. Zadeh (1965) developed fuzzy set theory to capture the inherent biases present in human judgments. The introduction of clear values in this context serves to mitigate ambiguity and subjectivity in the decision-making process [16]. Consequently, the fuzzy Analytical Hierarchy Process (fuzzy AHP) method is highly regarded for its effectiveness in determining the weights and priorities of various indicators.

The implementation of fuzzy hierarchical analysis unfolds through the following steps:

1. Pairwise comparison of the main indicators based on the goal: For pairwise comparison, all elements of each cluster must be compared two by two. Therefore, if there are n elements in a cluster, Equation (1) is used [15]:

$$Pairwise\ comparison = \frac{n(n-1)}{2} \quad (1)$$

Next, expert opinions are gathered by utilizing verbal variables and fuzzy numbers, as outlined in Table 2 and illustrated in Figure 1.

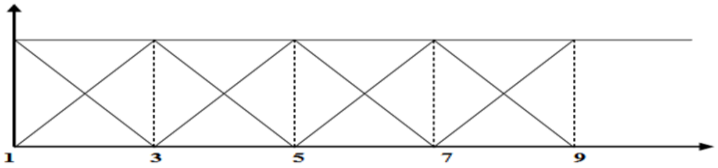


**Figure 1.** Scale of linguistic variables with triangular fuzzy numbers

**Table 2.** Fuzzy spectrum equivalent to the nine-degree Saaty scale in in the AHP technique [16].

| Verbal expression of the comparative situation of i with respect to j | Fuzzy equivalent | Inverse fuzzy equivalent |
|---|---|---|
| Equally Preferred | (1,1,1) | (1,1,1) |
| between | (1,2.3) | $\left(1,\frac{1}{2},\frac{1}{3}\right)$ |
| Moderately Preferred | (2,3,4) | $\left(\frac{1}{2},\frac{1}{3},\frac{1}{4}\right)$ |
| between | (3,4,5) | $\left(\frac{1}{3},\frac{1}{4},\frac{1}{5}\right)$ |
| Strongly Preferred | (4.5,6) | $\left(\frac{1}{4},\frac{1}{5},\frac{1}{6}\right)$ |
| between | (5,6.7) | $\left(\frac{1}{5},\frac{1}{6},\frac{1}{7}\right)$ |
| Very strongly preferred | (6.7,8) | $\left(\frac{1}{6},\frac{1}{7},\frac{1}{8}\right)$ |
| between | (7,8,9) | $\left(\frac{1}{7},\frac{1}{8},\frac{1}{9}\right)$ |
| Extremely Preferred | (9,9,9) | $\left(\frac{1}{9},\frac{1}{9},\frac{1}{9}\right)$ |

2. Forming the matrix of average pairwise comparisons of experts and geometric (triangular) average using Equation (2) [15]. This matrix is shown with the symbol $\tilde{\boldsymbol{X}}$ in Table 4.

$$F_{AGR} = (\prod(l), \prod(m), \prod(u)) \quad (2)$$

3. Eigenvector calculation: First, the fuzzy expansion of each line is calculated. Each row of the pairwise comparison matrix $\tilde{X}$ is represented as $\tilde{x}_{ij}$. The fuzzy expansion of each row is also represented by the symbol $\tilde{S}_i$. Therefore, the fuzzy expansion of each line is calculated using Equation (3) [19].

$$\tilde{S}_i = \sum_{j=1}^{n} x_{ij} \quad (3)$$

4. Fuzzy sum calculation: The sum of the elements of the preferences column is calculated according to Equation (4) [19].

$$\sum \tilde{S}_i = \sum_{i=1}^{n} \sum_{j=1}^{n} x_{ij} \quad (4)$$

5. Normalization of preferences of each index: the sum of the value of each index should be divided by the sum of all preferences (elements of the column). Since the values are fuzzy, the fuzzy sum of each row is multiplied by the inverse of the sum according to Equation (5) [2].

$$if\ \tilde{F} = (l, m, u)\ then\ \tilde{F}^{-1} = \left(\frac{1}{u}, \frac{1}{m}, \frac{1}{l}\right) \quad (5)$$

6. De-fuzzification of values: For de-fuzzification, the center of the surface method is used in the form of Equation (6) [16].

$$DF_{ij} = \frac{[(u_{ij} - l_{ij}) + (m_{ij} - l_{ij})]}{3} + l_{ij} \quad (6)$$

Using the calculations mentioned earlier, the priority vector of the main indicators, denoted as $W_1$ is derived. This vector represents the relative

Importance of the main indicators based on the pairwise comparisons conducted by the experts. Additionally, the degree of inconsistency of the pairwise comparison questionnaire is evaluated using the Gogos and Butcher method. If the calculated degree of inconsistency is found to be less than 0.1, it confirms that the pairwise comparison matrix is consistent and acceptable in terms of its coherence and reliability.

## 4. Research Findings

**First Stage:** The findings from the first stage of the research, which involved interviews with experts from private banks, were systematically analysed through a coding process. Three types of coding, namely open, central, and selective coding, were employed to structure and categorize the data. Following the selective coding phase, eight main indicators emerged as pivotal factors for evaluating financial performance within private banks. These primary indicators encompass profitability metrics, income, costs, liquidity, capital structure, asset management, management efficiency, and operating profit. They are visually represented in a hierarchical model as illustrated in Figure 2.

Additionally, to ensure the research's validity and reliability, the input of experts and expert professors was sought. The Kappa index, calculated using Equation (7), was utilized to assess the reliability of the coding process in the interviews [24].

$$k=\frac{Po-Pe}{1-Pe} \quad (7)$$

In this context, 'Po' represents the proportion of units for which there is a consensus or agreement among coders, while 'Pe' signifies the proportion of units for which agreement might occur by chance. The magnitude of the kappa coefficient serves as a measure of agreement between two coders. In the present study, the Kappa coefficient has been calculated to be 0.647 as can be seen in Table 3. This value is statistically significant and suggests that it is appropriate, particularly since the test statistic's value is less than 5%. This level of agreement indicates the reliability and validity of the coding process in assessing the identified indicators for evaluating financial performance in private banks.

**Table 3.** Cohen's kappa coefficient

| kappa coefficient | Value of the statistic |
|---|---|
| 0.647 | 0.000 |

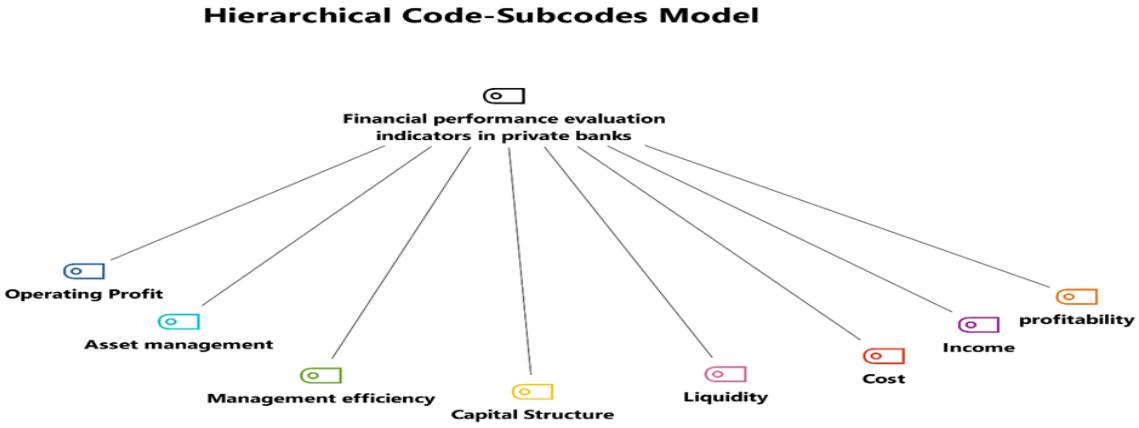


**Figure 2.** Hierarchical model of indicators affecting the evaluation of financial performance of private banks

**Second Stage:** In the second stage of the research, a questionnaire for pairwise comparisons was designed and distributed among a statistical population consisting of 15 experts from private banks. The purpose was to prioritize and rank the indicators identified in the qualitative stage of the research using the hierarchical technique. The completion of this phase signifies that the experts have provided their assessments and the data collection process has concluded. The findings from this stage will provide valuable insights into the relative importance and ranking of the identified indicators in the context of private banks.

According to Equation (1), when there are 8 indicators, the number of pairwise comparisons can be calculated as $\frac{8(8-1)}{2}$, which equals 28. This means that a group of experts has made 28 pairwise comparisons from their perspective. Subsequently, the matrix of pairwise comparisons is adjusted based on Equation (2),

resulting in a matrix that is presented in Table 4. This adjusted matrix reflects the relative comparisons and judgments made by the experts regarding the indicators.

**Table 4.** Pairwise comparison matrix of the main criteria

| | C1 | | | C2 | | | C3 | | | C4 | | | C5 | | | C6 | | | C7 | | | C8 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | L | M | U | L | M | U | L | M | U | L | M | U | L | M | U | L | M | U | L | M | U | L | M | U |
| C1 | 1.000 | 1.000 | 1.000 | 1.320 | 2.748 | 4.810 | 0.150 | 0.214 | 0.376 | 0.183 | 0.289 | 0.707 | 0.186 | 0.297 | 0.758 | 0.179 | 0.280 | 0.660 | 0.179 | 0.280 | 0.660 | 0.154 | 0.224 | 0.408 |
| C2 | 0.208 | 0.364 | 0.758 | 1.000 | 1.000 | 1.000 | 0.169 | 0.258 | 0.575 | 0.196 | 0.330 | 0.660 | 0.175 | 0.272 | 0.644 | 0.480 | 0.660 | 0.933 | 0.290 | 0.456 | 0.933 | 0.342 | 0.515 | 0.871 |
| C3 | 2.656 | 4.676 | 6.684 | 1.732 | 3.873 | 5.916 | 1.000 | 1.000 | 1.000 | 0.152 | 0.219 | 0.392 | 0.134 | 0.183 | 0.289 | 0.144 | 0.204 | 0.354 | 0.163 | 0.245 | 0.517 | 0.149 | 0.213 | 0.379 |
| C4 | 1.414 | 3.464 | 5.477 | 1.516 | 3.031 | 5.102 | 2.551 | 4.573 | 6.581 | 1.000 | 1.000 | 1.000 | 0.216 | 0.388 | 0.896 | 0.188 | 0.306 | 0.679 | 0.196 | 0.330 | 0.749 | 0.435 | 0.660 | 1.000 |
| C5 | 1.320 | 3.366 | 5.378 | 1.552 | 3.680 | 5.720 | 3.464 | 5.477 | 7.483 | 1.116 | 2.578 | 4.625 | 1.000 | 1.000 | 1.000 | 0.224 | 0.408 | 1.000 | 0.447 | 0.577 | 1.000 | 0.435 | 0.871 | 1.741 |
| C6 | 1.516 | 3.565 | 5.578 | 1.072 | 1.516 | 2.083 | 2.828 | 4.899 | 6.928 | 1.473 | 3.266 | 5.320 | 1.000 | 2.449 | 4.472 | 1.000 | 1.000 | 1.000 | 0.525 | 0.644 | 1.000 | 0.871 | 2.132 | 3.893 |
| C7 | 1.516 | 3.565 | 5.678 | 1.072 | 2.195 | 3.452 | 1.933 | 4.076 | 6.119 | 1.335 | 3.028 | 5.094 | 1.000 | 1.732 | 2.236 | 1.000 | 1.552 | 1.904 | 1.000 | 1.000 | 1.000 | 0.871 | 1.431 | 2.091 |
| C8 | 2.449 | 4.472 | 6.481 | 1.149 | 1.943 | 2.927 | 2.639 | 4.704 | 6.732 | 1.000 | 1.516 | 2.297 | 0.574 | 1.149 | 2.297 | 0.258 | 0.469 | 1.149 | 0.478 | 0.699 | 1.149 | 1.000 | 1.000 | 1.000 |

Once the matrix of pairwise comparisons is established, the next step involves calculating the fuzzy expansion of each row. This calculation is performed using Equation (3). The results of this calculation, representing the fuzzy expansion of each row, are presented in Table 5.

**Table 5.** Fuzzy summation and fuzzy compound expansion are the main criteria

| **Fuzzy composite expansion ($S_i$)** | | | **Fuzzy sum of each row** | | | **Indicators** |
|---|---|---|---|---|---|---|
| **U** | **M** | **L** | **U** | **M** | **L** | |
| 0.159053 | 0.050539 | 0.020619 | 9.37964 | 5.332424 | 3.350489 | **C1** |
| 0.108119 | 0.036524 | 0.017596 | 6.375973 | 3.853681 | 2.859294 | **C2** |
| 0.263349 | 0.100581 | 0.037726 | 15.5302 | 10.61251 | 6.130353 | **C3** |
| 0.364314 | 0.130343 | 0.046257 | 21.48429 | 13.75266 | 7.516567 | **C4** |
| 0.473924 | 0.170192 | 0.058818 | 27.94819 | 17.95722 | 9.557674 | **C5** |
| 0.513361 | 0.184553 | 0.063291 | 30.27385 | 19.4754 | 10.28451 | **C6** |
| 0.465865 | 0.176082 | 0.059856 | 27.47292 | 18.57869 | 9.726364 | **C7** |
| 0.407503 | 0.151186 | 0.05875 | 24.03118 | 15.95193 | 9.546586 | **C8** |

Following the calculation of the fuzzy expansion of each row, the next step is to determine the magnitude of possibility and the degree of preference using the 4th and 5th grade Equations. These formulas are applied to the fuzzy expansion values obtained from the previous step. The results, representing the magnitude of possibility and the degree of preference for each indicator, are presented in Table 6.

**Table 6.** Degree of possibility and degree of preference

| Normaq.q.lizati on preferably | Degree of preference | Great degree of possibility | | | | | | | | Indicators |
|---|---|---|---|---|---|---|---|---|---|---|
| | | C8 | C7 | C6 | C5 | C4 | C3 | C2 | C1 | |
| 0.068793 | 0.416761 | 0.499143 | 0.441385 | 0.416761 | 0.455846 | 0.58565 | 0.707984 | 1 | 1 | C1 |
| 0.038368 | 0.232442 | 0.300974 | 0.256963 | 0.232442 | 0.269461 | 0.397365 | 0.52356 | 1 | 0.861942 | C2 |
| 0.116265 | 0.704356 | 0.801708 | 0.729383 | 0.704356 | 0.746079 | 0.879438 | 1 | 1 | 1 | C3 |
| 0.139876 | 0.847394 | 0.936142 | 0.86939 | 0.847394 | 0.886411 | 1 | 1 | 1 | 1 | C4 |
| 0.159488 | 0.966207 | 1 | 0.985975 | 0.966207 | 1 | 1 | 1 | 1 | 1 | C5 |
| 0.165066 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | C6 |
| 0.161664 | 0.97939 | 1 | 1 | 0.97939 | 1 | 1 | 1 | 1 | 1 | C7 |
| 0.150479 | 0.911629 | 1 | 0.933174 | 0.911629 | 0.948312 | 1 | 1 | 1 | 1 | C8 |

Based on the calculations from Equation (6), the special priority vector of the main indicators will be $W_{\backslash}$ (Table 7).

**Table 7.** Weight of the main criteria

| rank | Weight factors | | symbol |
|---|---|---|---|
| 7 | 0.068793 | C1 | profitability |
| 8 | 0.038368 | C2 | Income |
| 6 | 0.116265 | C3 | Cost |
| 5 | 0.139876 | C4 | Liquidity |
| 3 | 0.159488 | C5 | Asset management |
| 1 | 0.165066 | C6 | Capital Structure |
| 2 | 0.161664 | C7 | Management efficiency |
| 4 | 0.150794 | C8 | Operating Profit |

According to the Gogos and Butcher method, the inconsistency rate of the paired comparison questionnaire has been calculated and is presented in Table 8. It is observed that the inconsistency rate of the questionnaire is 0.020, which is less than 1.0. This indicates that the questionnaire is considered acceptable in terms of inconsistency. The low inconsistency rate suggests that the experts' pairwise comparisons were consistent and reliable for the decision-making process in this study.

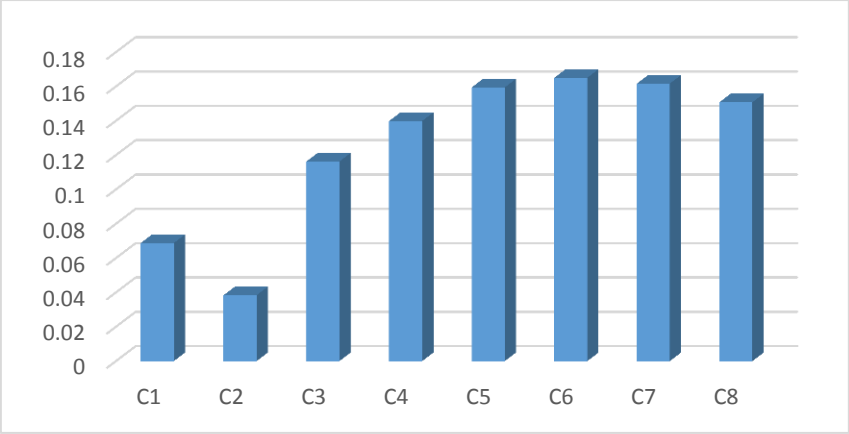


**Figure 3.** A graphic representation of the priority of the main research criteria

**Table 8.** Inconsistency rate of the paired comparison questionnaire of the main criteria of the research

| Compatibility of the questionnaire | CIM compatibility check | CIG compatibility check |
|---|---|---|
| confirmation | 0.020 | 0 |

## 5. Conclusions

Effective performance evaluation is a crucial benchmark for the success of any business, particularly in the banking sector, which serves as a fundamental pillar of the financial system. Accurate measurement and evaluation of the financial structures of banks are imperative, with the outcomes requiring meticulous analysis and presentation to relevant stakeholders. Financial criteria are utilized to assess the performance of each bank, ranking them based on their financial performance. This evaluation holds significance not only for the bank itself but also for decision-makers operating within the banking sector [6].

The primary objective of this study was to identify and prioritize the indicators that influence the assessment of financial performance in private banks, employing the fuzzy Analytical Hierarchy Process (fuzzy AHP) method. These indicators encompass profitability criteria, such as income, cost, liquidity, capital structure, asset management, management efficiency, and operating profit. Like any organization, private banks, too, share the primary goal of maximizing profitability and income. Research conducted by Linawati and Aisjah underscores the correlation between a bank's profitability and its overall value [18].

Hence, higher profitability and income empower private banks to better cater to customer demands, establish a competitive edge, operate efficiently, and expand their service offerings. However, it's crucial to note that banks also incur costs, such as those related to providing loans or financing other institutions, in their pursuit of profitability. Therefore, boosting revenues and curbing expenses can enhance a bank's profitability. Consequently, indicators like profitability, income, and cost hold pivotal positions in measuring and evaluating the financial performance of private banks.

Moreover, every private bank, akin to its counterparts, must maintain a certain level of liquidity, typically at least 3% of the bank's assets, to leverage competitive opportunities. Liquidity in private banks is determined through cash balances and current ratios. Another instrumental metric for assessing financial performance is the capital structure index, which hinges on leverage ratios within the bank. Capital structure pertains to the composition or mix of financing methods, encompassing both debt and equity capital [7]. Sormin and Onesimus [29] posits that a bank's capital structure serves as a protective barrier, playing a pivotal role in preserving the bank's security and mitigating potential risks or losses.

Asset management indicators, management efficiency, and operating profit constitute three additional critical indicators when evaluating the financial performance of private banks. Effective management of bank

assets serves to reduce costs, while management efficiency hinges on the adept and efficient allocation of bank resources, gauged through activity ratios within banks. Operating profit, another vital metric, encapsulates operating ratios, including profit per capita and personnel cost per capita.

Having identified these indicators, the fuzzy AHP methodology was applied to determine their significance and ranking. These indicators, ranked in descending order of importance, are as follows: capital structure, management efficiency, asset management, operating profit, liquidity, cost, profitability, and income. As indicated in Table 7 and Figure 4, the capital structure index stands as the most pivotal factor influencing the evaluation of financial performance in private banks, earning the top rank and the most extensive allocation of importance. Conversely, the income index holds the lowest rank and importance, occupying the smallest area in the evaluation framework.

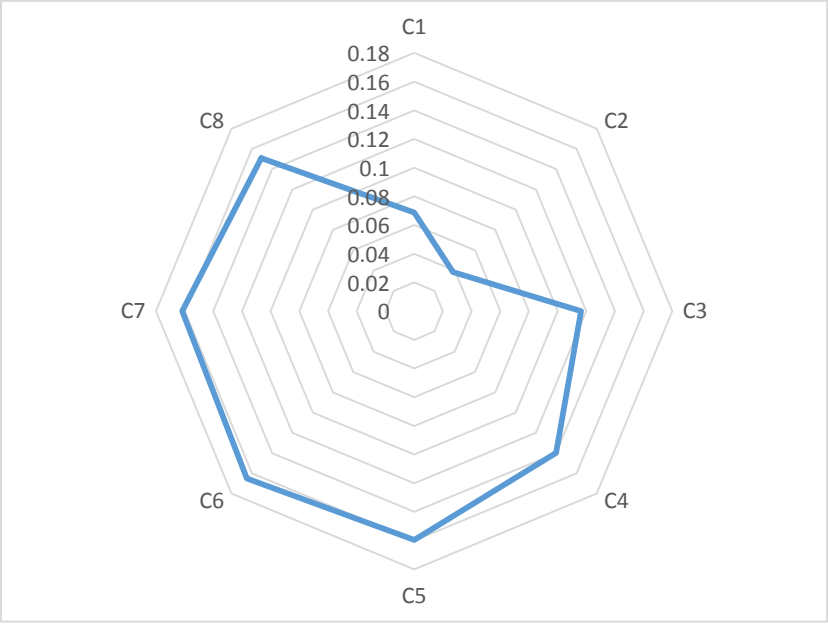


**Figure 4.** Spider web model of the main research indicators

The findings of this study are partially in line with previous research conducted by Jam & Dabagh [14], Makki & Alqahtani [20], Vibhakar et al. [32], Iç et al. [13], Baydaş & Elma [4], Singh & Milan [24], and others. However, previous studies, including those by Jam & Dabbagh and Makki & Alqahtani, focused on examining the factors affecting financial performance under specific and unambiguous conditions, disregarding the inherent uncertainty in decision-making processes. In order to address this, the fuzzy hierarchy method was employed as an effective and suitable approach in this study, considering the uncertain environment. Another distinction of this research from previous studies, such as that of Singh and Milan, is the inclusion of both financial and non-financial aspects as important and influential factors in evaluating financial performance. Experts conducting interviews were not bound by any specific restrictions, allowing for a comprehensive consideration of financial and non-financial aspects as effective indicators in evaluating financial performance. Therefore, this research fundamentally differs from prior studies and identifies a greater number of indicators.

The evaluation of financial performance indicates the financial health and stability of banks and makes them survive in today's dynamic and competitive environment, so it should always be measured and evaluated and the indicators affecting the financial performance of banks should be identified and considered. So that it helps the managers to always be aware of the financial situation of their organization and to identify the strengths and weaknesses. Therefore, by continuously evaluating financial performance, banks can improve their performance over time by reducing weaknesses and using strengths. Private banks typically employ expert teams specialized in financial performance evaluation. These teams continually measure indicators and assess the financial situation. Whenever weaknesses are identified, they inform bank managers, who can then implement necessary

strategies and policies. Private banks also maintain updated databases of indicators that are effective in evaluating financial performance.

Furthermore, future researchers are encouraged to conduct similar studies among state banks and other financial institutions, comparing the results with those of this study. This would contribute to the development of models and theories in the field of financial performance evaluation, expanding the understanding of performance factors across various types of banks and financial organizations.

**Conflict 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.

## References


1. Akber, S. M., & Dey, A. (2020). Evaluation of the financial performance between traditional private commercial banks and Islamic banks in Bangladesh. *International Journal of Islamic Banking and Finance Research*, 4(2), 1-10.
2. Ali, A. Y. (2021). Fuzzy AHP for determining the optimal location of schools: The case of pastoral communities. *Fuzzy Optimization and Modeling Journal*, 2(1), 42-49.
3. Ali, B. J., & Oudat, M. S. (2020). Financial risk and the financial performance in listed commercial and investment banks in Bahrain bourse. *International Journal of Innovation, Creativity and Change*, 13(12), 160-180.
4. Baydaş, M., & Elma, O. E. (2021). An objectıve criteria proposal for the comparison of MCDM and weighting methods in financial performance measurement: An application in Borsa Istanbul. *Decision Making: Applications in Management and Engineering*, 4(2), 257-279.
5. Bhat, S. A., Singh, A., & Qudaimi, A. A. (2021). A new pythagorean fuzzy analytic hierarchy process based on interval-valued pythagorean fuzzy numbers. *Fuzzy Optimization and Modeling Journal*, 2(4), 38-51.
6. Bozdoğan, T., ODABAS, A., & Shegiwal, A. H. (2021). Analysis of financial performance of foreign banks having branches in Turkey by TOPSIS and ELECTRE methods. *Alanya Akademik Bakış*, 5(2), 1049-1067.
7. Chalise, D. R., & Adhikari, N. R. (2022). The impact of capital structure and firm size on financial performance of commercial Bbanks in Nepal. The EFFORTS, *Journal of Education and Research*, 4(1), 102-111.
8. Chen, X., Fang, Y., Chai, J., & Xu, Z. (2022). Does intuitionistic fuzzy analytic hierarchy process work better than analytic hierarchy process*? International Journal of Fuzzy Systems*, 24(2), 909-924.
9. Experts, A., Bahraminasab, A., Memashli, R. (2017). The impact of the domestic financial crisis on the performance of banks and non-operational activities. *Two scientific-research quarterly journals of Iran's economic essays*. Year 15, (30) ,118-93.
10. Farahani, T., Sabouri, M. (2019). The effect of capital adequacy, capital structure and liquidity on the financial performance of banks admitted to the stock exchange. *Scientific Quarterly of Islamic Economics and Banking*, No. 31, pp. 247-262.
11. Gudarzi Farahani, Y., Baratinia, M., & Abniki, M. (2022). The impact of financial and banking variables on the financial Performance and return of banks listed on the Tehran Stock Exchange. *Quarterly Studies in Banking Management and Islamic Banking*, 8(18), 141-162.
12. Gupta, S., Mathew, M., Syal, G., & Jain, J. (2021). A hybrid MCDM approach for evaluating the financial performance of public sector banks in India. *International Journal of Business Excellence*, 24(4), 481-501.
13. Ic, Y. T., Yurdakul, M., & Pehlivan, E. (2022). Development of a hybrid financial performance measurement model using AHP and DOE methods for Turkish commercial banks. *Soft Computing*, 1-21.
14. Jam, M., & Dabbagh, R. (2022). Investigating the effective factors on the performance of banks listed on the Tehran Stock Exchange with the combined approach of DEMATEL-ANP. *Journal of Development & Capital/Majallah-i tusiah & Sarmāyah*, 7(1), 135-155.
15. Kabir, G., Ahmed, S. K., Aalirezaei, A., & Ng, K. T. W. (2022). Benchmarking Canadian solid waste management system integrating fuzzy analytic hierarchy process (FAHP) with efficacy methods. *Environmental Science and Pollution Research*, 29(34), 51578-51588.
16. Kumar, P., & Sharma, D. (2023). Benchmarking the financial performance of Indian commercial banks by a hybrid MCDM approach. *International Journal of Process Management and Benchmarking*, 15(3), 285-309.
17. Ledhem, M. A., & Mekidiche, M. (2020). Economic growth and financial performance of Islamic banks: a CAMELS approach. *Islamic Economic Studies*, 28(1), 47-62.
18. Linawati, N., & Aisjah, S. (2022). The effect of profitability and Bank size on firm. *Investment Management and Financial Innovations*, 19(2), 331- 343.
19. Ma, B., Han, Y., Cui, S., Geng, Z., Li, H., & Chu, C. (2020). Risk early warning and control of food safety based on an improved analytic hierarchy process integrating quality control analysis method. *Food Control*, 108, 106824.
20. Makki, A. A., & Alqahtani, A. Y. (2023). Capturing the effect of the COVID-19 pandemic outbreak on the financial performance disparities in the energy sector: A Hybrid MCDM-Based evaluation approach. *Economies*, 11(2), 61-73.
21. Mbilla, S. A. E., Nyeadi, J. D., Gbegble, M. K., & Ayimpoya, R. N. (2020). Assessing the impact of monitoring, information and communication on banks performance in Ghana. Asian Journal of Economics, *Business and Accounting*, 14(3), 58-71.
22. Mohagheghnia, M., Alijani, P., Valimoradi, M. (2022). Evaluation and comparison of the financial performance of the banking system of Iran and the banking system of Malaysia. Quarterly journal of studies in banking management and Islamic banking. *Higher Institute of Banking Education*, Volume 8, Number 20, 49-80.

23. Mohsenpour, Z., Godarzi, Ra. (2021). Investigating the effect of general self-efficacy on the financial performance of managers and employees of banks in Kazeron city. *Journal of New Achievements in Humanities Studies*, year 4, number 43, pp. 42-60.
24. Moons, F., & Vandervieren, E. (2023). Measuring agreement among several raters classifying subjects into one-or-more (hierarchical) nominal categories. *A generalisation of Fleiss' kappa. arXiv preprint arXiv*:2303.12502.
25. Rajesh, G. A., Sivaranjani, M. P., Prakash, M. P., & Gokulanathan, M. S. (2021). Impact of capital structure on financial performance of small finance banks. *International Journal of Mechanical Engineering*, 6, 753-757.
26. Sargolzaei, M., Jalali Farahani, A., Afsari Badi, R., & Ahmadi, R. (2020). The effect of financial performance indicators on profitability in bank Mellat (in Persian*). Journal of Monetary and Banking Research*, 13(43), 69-98.
27. Selvakumar, S., & Abima, D. (2020). Appraisal of financial performance of regional rural banks with special reference to Assam Gramin Vikash bank, Maharashtra Gramin Vikash bank and Karnataka Gramin Vikash bank. *International Journal of Research in Engineering, Science and Management*, 3(12), 191-196.
28. Singh, Y., & Milan, R. (2023). Analysis of financial performance of public sector banks in India: CAMEL. *Arthaniti: Journal of Economic Theory and Practice*, 22(1), 86-112.
29. Sormin, P., & Onesimus, J. H. (2022). The Effect of credit risk, operational efficiency, and capital structure on profitability (Empirical Study on the Banking Industry Listed On the Idx). *Journal of Pharmaceutical Negative Results*, 1274-1281.
30. Su, M. C., Wang, Y. J., Chen, T. J., Chiu, S. H., Chang, H. T., Huang, M. S., ... & Chen, Y. C. (2020). Assess the performance and cost-effectiveness of LACE and HOSPITAL re-admission prediction models as a risk management tool for home care patients: an evaluation study of a medical center affiliated home care unit in Taiwan. *International Journal of Environmental Research and Public Health*, 17(3), 927-934.
31. Türegün, N. (2022). Financial performance evaluation by multi-criteria decision-making techniques. *Heliyon*, 8(5), 1-13.
32. Vibhakar, N. N., Tripathi, K. K., Johari, S., & Jha, K. N. (2023). Identification of significant financial performance indicators for the Indian construction companies. *International Journal of Construction Management*, 23(1), 13-23.
33. Yousefi Ghaleh Roudkhani, M. A., Tehrani, R., & Mirlouhi, S. M. (2021). Investigating the impact of financial performance metrics on financial stability of banks in the financial crisis. *Management Research in Iran*, 25(2), 1-21.



Fazeli, Z., Bikzadeh Abbasi, F., & Sardar, S. (2023). Identifying and Ranking Indicators Affecting the Evaluation of Financial Performance in private banks using the fuzzy AHP method. *Fuzzy Optimization and Modeling Journal*, *4*(3), 40-53.

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