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Design of a Hybrid AHP–DEA Mathematical Model for Branch Performance Evaluation

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Abstract

Performance evaluation is considered one of the fundamental tools for assessing the extent to which organizations achieve their predetermined objectives and for promoting continuous improvement in organizational activities. In the banking system, performance evaluation holds particular importance. In this context, measuring the efficiency of bank branches can play a significant role in optimal resource allocation, productivity enhancement, and improvement of the quality of services provided to customers. One of the widely used methods for evaluating the efficiency of decision-making units (DMUs) is Data Envelopment Analysis (DEA). However, the classical DEA model generally classifies units only into efficient and inefficient groups and faces limitations in providing a complete ranking among them. Therefore, in the present study, a hybrid model integrating Data Envelopment Analysis and the Analytic Hierarchy Process (AHP/DEA) is employed to rank the branches of Bank Mellat in Yazd Province. The performance of the branches was evaluated based on four input indicators, including the number of personnel, human resource costs, administrative expenses, and movable asset costs, and three output indicators consisting of granted facilities based on deposits, granted loans, and branch profit. The statistical population of the study included 16 branches of Bank Mellat in Yazd Province during the period from November to January 2026. The collected data were analyzed using WinQSB and Expert Choice software. The results indicate that Yazd Central Branch, Atlasi Square Branch, and Shohada Crossroad Branch achieved the highest levels of efficiency, respectively. Furthermore, the findings suggest that the AHP/DEA hybrid model can serve as an effective tool for managerial decision-making and for improving the performance of the banking network.

Keywords: (Performance evaluation, data envelopment analysis (DEA), analytic hierarchy process (AHP), AHP–DEA hybrid model, branch efficiency, ranking)
2022 MSC: O20, O10

Introduction

The fundamental objective of performance evaluation is to provide the necessary feedback and implement timely corrective actions within the execution process in order to achieve continuous improvement in organizational performance [14]. Evaluating the efficiency of organizations, particularly banks, is considered one of the most significant issues in the field of management [20]. Performance evaluation and management become more effective when they

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are grounded in continuous feedback, timely identification of deviations, and corrective operational actions, thereby creating the conditions necessary for continuous improvement in organizational performance [1]. In team-based work environments, performance evaluation should not be confined solely to the individual level, since task interdependence and the quality of team interactions significantly influence collective performance [2]. Despite differences among bank branches in terms of facilities, human resources, geographical location, and certain environmental conditions, these units typically operate through relatively similar processes and operational procedures. Therefore, their performance evaluation should simultaneously account for local differences while maintaining comparability among branches [5]. Failure of branches to achieve their predetermined deposit targets, insufficient levels of employee training, weaknesses in the expert workforce particularly outside Tehran limited adoption of modern technologies, and intensified competition due to the entry of private banks are among the challenges faced by state-owned banks. Evidently, these factors can negatively affect the optimal performance of bank branches. Accordingly, the question arises as to how the performance of the branches under study can be assessed and how they should be ranked. Based on this premise, the present study aims to evaluate the performance of Bank Mellat branches in Yazd over the specified period. By employing the hybrid AHP–DEA model, the study seeks not only to rank the branches but also to provide recommendations for improving their performance.

Theoretical Foundations

In recent years, increasing environmental instability and the accelerating pace of change, particularly in the field of technology, have compelled organizations to reconsider their operational practices and response mechanisms. The development of emerging technologies and the expansion of digital transformation processes have had a direct impact on customer expectations and competitive requirements [8]. Under such circumstances, organizations that lack the capability to rapidly adapt to these changes are likely to encounter greater challenges in responding to evolving customer needs and demands [22]. Today, one of the most critical issues for organizations with extensive branch networks, especially banks, is the establishment of an efficient and rational performance evaluation system. The use of appropriate evaluation indicators can play a significant role in effectively guiding organizational units and improving workforce performance. Furthermore, designing an appropriate framework for assessing branch marketing performance can enhance accountability, improve service quality, increase customer satisfaction and loyalty, and ultimately improve bank profitability [19]. On the other hand, the performance evaluation of bank branches is regarded as one of the most important issues in the development and organization of banking networks due to its role in identifying inefficient branches and supporting decisions regarding the continuation of their operations [12].

In general, performance evaluation is considered one of the most complex areas of human resource management because it is a multidimensional process that simultaneously encompasses human judgments, performance indicators, and organizational objectives [4]. The use of formal performance evaluation systems has a long history and has evolved alongside developments in management theories since the late nineteenth and early twentieth centuries. Accordingly, performance indicators have expanded from purely financial measures toward more comprehensive frameworks such as Total Quality Management and modern performance measurement systems [15]. Within the competitive environment of the banking industry, improving efficiency and optimizing resource utilization are essential requirements for maintaining and enhancing organizational performance. Nevertheless, differences among banks in terms of technological capabilities, workforce quality, organizational structures, and environmental conditions limit the validity of direct performance comparisons. Therefore, evaluating and comparing the performance of branches within the same bank, due to their relatively similar objectives, regulations, and operational processes, can provide a more appropriate approach for measuring efficiency and identifying superior performance patterns [5, 3]. The results of such evaluations can assist managers in identifying efficient and inefficient branches, improving the combination of inputs, and making effective managerial decisions [1, 14].

Data Envelopment Analysis (DEA)

The foundations of Data Envelopment Analysis (DEA) can be traced back to Farrell's study in 1957, in which a framework for measuring technical efficiency and relative productivity was introduced [10]. Subsequently, Charnes et al [7] developed this idea into a non-parametric model for evaluating decision-making units with multiple inputs and outputs and introduced the CCR model [7]. This model rapidly became one of the most important tools for measuring relative efficiency across various organizations. Later, Banker [6], Charnes et al [7], introduced the BCC model, which enabled the separation of technical inefficiency from scale inefficiency [6]. However, in the classical DEA model, units are treated as "black boxes," and the internal structures of processes and sub-processes are not taken into consideration. Consequently, network DEA models, particularly parallel DEA models, were developed to provide more accurate performance analyses [9, 13]. Moreover, because real-world data in many applications, including bank branch evaluation, are often associated with uncertainty, the use of robust optimization approaches in the development of parallel network DEA enables efficiency evaluation under uncertain data conditions.

Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) is one of the most well-known multi-criteria decision-making methods, first introduced by Saaty, and is based on pairwise comparisons among criteria and alternatives [18, 17, 11]. This method enables the structuring of complex problems in the form of hierarchies and facilitates the simultaneous consideration of both quantitative and qualitative criteria. Accordingly, it has been widely applied in both individual and group decision-making contexts. In addition, AHP provides an appropriate framework for participatory group decision-making [16].

Integration of Data Envelopment Analysis (DEA) and Analytic Hierarchy Process (AHP)

The DEA method classifies the units under evaluation into efficient and inefficient groups based on a set of inputs and outputs, where inputs exert a negative effect and outputs exert a positive effect on performance evaluation [21]. However, the original DEA model lacks the capability to provide a complete ranking of units and merely separates them into the two aforementioned categories. Therefore, considerable efforts have been made over the years to develop DEA models capable of achieving full ranking. In line with this objective, the present study proposes a model for complete branch ranking through the integration of DEA and the Analytic Hierarchy Process. In the AHP/DEA model, DEA is first implemented through pairwise comparisons among alternatives, and the resulting values are subsequently used to construct the pairwise comparison matrix required for the AHP model to obtain the final ranking.

Unlike the traditional AHP approach, in which pairwise comparisons are based on the subjective judgments of decision-makers, the comparison matrix in this integrated approach is constructed using objective data derived from DEA. Consequently, the limitations associated with subjective judgments are substantially reduced. In this framework, pairwise comparisons are generated through DEA, while the final ranking process is conducted using AHP. Since DEA was originally designed for binary classification, the application of the integrated AHP/DEA model can provide a more comprehensive and accurate ranking of units. By combining the advantages of both methods, this integrated approach overcomes many of their individual limitations.

In the present study, Data Envelopment Analysis (DEA) was employed to derive pairwise comparisons among the criteria, and subsequently the Analytic Hierarchy Process (AHP) was applied to determine the most efficient branch. The performance of the branches was evaluated based on the values of the specified input and output variables. Based on a review of the research literature and the conceptual framework of the study, four input criteria and three output criteria were identified and utilized for evaluating the efficiency of Bank Mellat branches in Yazd.

AHP/DEA Computational Model

The AHP/DEA model comprises two distinct stages. In the first stage, pairwise comparisons of the Decision-Making Units (DMUs) are conducted using the Data Envelopment Analysis (DEA) method. Subsequently, in the second stage, the results obtained from the first stage are incorporated into a single-level AHP model to derive a comprehensive and complete ranking.

Stage 1

Assume that k decision-making units (DMU_k), where $k = 1, 2, \ldots, n$, are to be evaluated. Each DMU utilizes m types of inputs to produce s types of outputs. Specifically, DMU_k uses input values X_{ik} $(i = 1, 2, \ldots, m)$ to generate output values Y_{rk} $(r = 1, 2, \ldots, s)$. The matrices $X_{(n\times m)}$ and $Y_{(n\times s)}$ represent the input and output matrices, respectively.

Similar to the conventional DEA approach with the distinction that, in the traditional DEA model, each unit is compared individually against all other units simultaneously, whereas in the present approach each unit is compared pairwise with another unit the DMUs are evaluated accordingly. For each pair of DMUs, a model similar to the one formulated below for the comparison of DMU_1 and DMU_2 must be constructed and solved.

$$e_{1,2} = \max \frac{\sum_{r=1}^{s} u_r Y_{r_1}}{\sum_{i=1}^{m} v_1 \cdot X_{i_1}} \tag{1}$$

$$\begin{aligned} & st: \\ & \frac{\sum_{r=1}^{s} u_r Y_{r_1}}{\sum_{i=1}^{m} v_1 \cdot X_{i_1}} \leq 1 && k = 1,2 \qquad (2) \\ & u_r \geq 0 && r = 1,2,\ldots,s \\ & v_i \geq 0 && i = 1,2,\ldots,m \end{aligned}$$

The above problem can be converted into a linear programming model through the following procedure:

a) The numerator of Equation (1) is placed in the objective function.

b) The denominator of Equation (1) is set equal to one and incorporated into the constraints.

c) Equation (2) is transformed through cross-multiplication, and all terms are moved to one side of the equation.

By performing these steps, the AHP/DEA model is obtained in the form presented in Equation (3).

$$\begin{aligned} & e_{1,2} = \max \sum_{r=1}^{s} u_r Y_{r_1} \qquad (3) \\ & st: \\ & \sum_{r=1}^{s} u_r Y_{r_k} - \sum_{i=1}^{m} v_i \cdot X_{i_k} \leq 0 && k = 1,2 \\ & u_r \geq 0 && r = 1,2,\ldots,s \\ & v_i \geq 0 && i = 1,2,\ldots,m \end{aligned}$$

By solving the above mathematical model, the corresponding values are obtained, $e_{k,k'}$ $(k = 1,2,\ldots,n,\ k' = 1,2,\ldots,n,\ k \neq k')$ and matrix E (Table 1), consisting of k rows and k columns, is constructed. The diagonal elements of this matrix are all equal to one.

Table 1: Matrix E of the AHP/DEA Model

	1	2	3	...	n
1	1	$e_{1,2}$	$e_{1,3}$	...	$e_{1,n}$
2	$e_{2,1}$	1	$e_{2,3}$	...	$e_{2,n}$
3	$e_{3,1}$	$e_{3,2}$	1	...	$e_{3,n}$
$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$
n	$e_{n,1}$	$e_{n,2}$	$e_{n,3}$	...	1

Stage 2

In the second stage of the AHP/DEA process, a two-level AHP model (goal level and alternatives level) is constructed. After establishing the hierarchy, the elements of matrix A representing the pairwise comparisons of the organizations are obtained from Equation $a_{k,k'} = \frac{e_{k,k'}}{e_{k',k}}$. This relationship reflects the efficiency of organizational unit k relative to organizational unit j (Table 2).

After obtaining the pairwise comparison matrix, it must be normalized. The elements of the new matrix are derived from Equation $\frac{a_{k,k'}}{\sum_{k=1}^{n} a_{k,k'}}$ (Table 3). Following the construction of this matrix, the values of the column vector are obtained from Equation $a''_k = \sum_{k'=1}^{n} a'_{k,k'}$, based on the summation of each row (Table 4). Finally, by normalizing the column vector using Equation $a'''_k = \frac{a''_k}{\sum_{k=1}^{n} a''_k}$, the vector is obtained, which represents the final ranking of the organizational units (Table 5).

Table 2: Pairwise Comparison Matrix of the AHP/DEA Model

	1	2	3	...	n
1	1	$e_{1,2}$	$e_{1,3}$	...	$e_{1,n}$
2	$e_{2,1}$	1	$e_{2,3}$	...	$e_{2,n}$
3	$e_{3,1}$	$e_{3,2}$	1	...	$e_{3,n}$
$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$
n	$e_{n,1}$	$e_{n,2}$	$e_{n,3}$	...	1

Table 3: Normalized Pairwise Comparison Matrix of the AHP/DEA Model

	1	2	3	...	n
1	1	$a'_{1,2}$	$a'_{1,3}$	...	$a'_{1,n}$
2	$a'_{2,1}$	1	$a'_{2,3}$	...	$a'_{2,n}$
3	$a'_{3,1}$	$a'_{3,2}$	1	...	$a'_{3,n}$
$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$
n	$a'_{n,1}$	$a'_{n,2}$	$a'_{n,3}$	...	1

Table 4: Column Vector A'' Obtained from Matrix A'

1	a''_1
2	a''_2
3	a''_3
$\vdots$	$\vdots$
n	a''_n

Table 5: Column Vector A''' Obtained from Matrix A''

1	a'''_1
2	a'''_2
3	a'''_3
$\vdots$	$\vdots$
n	a'''_n

Research Method

In terms of purpose, the present study is an applied research that demonstrates the application of a quantitative method for evaluating the performance of Bank Mellat branches in Yazd, Iran. In terms of methodology, the study is descriptive–mathematical in nature. From a temporal perspective, the research is cross-sectional, conducted from November 2025 to January 2026. The study began with a comprehensive literature review on performance evaluation using Data Envelopment Analysis (DEA). Considering the limitations of the DEA method such as classifying branches (decision-making units) into only two categories, efficient and inefficient, and the inability of this method to provide a pathway for inefficient branches to reach efficiency the integrated AHP/DEA approach was selected. In addition to overcoming the aforementioned limitation, this integrated method offers other advantages, including the elimination of subjective managerial judgments in determining the relative importance of evaluation criteria.

The statistical population of this research consists of Bank Mellat branches in Yazd Province, Iran, from which 16 branches were selected as the study sample. The reason for selecting these branches is that the branches located in Yazd city benefit from relatively similar facilities and operational conditions, such as similar cash supply timing, comparable service coverage, telecommunication facilities, and faster access to technical support services. After identifying the evaluation criteria and removing redundant or overlapping criteria, the required data for the 16 branches were obtained from the bank. The collected data were then analyzed using WinQSB and Expert Choice software, through which the final results were derived.

Mathematical Formulation of the Integrated AHP/DEA Model (Expanded)

1. **Complete Linear Programming Derivation for Pairwise Comparison**

   Let two decision-making units, DMU_p and DMU_q, be compared. Each unit uses m inputs x_{ip} $(i = 1, \ldots, m)$ to produce s outputs y_{rp} $(r = 1, \ldots, s)$. The fractional programming problem that measures the relative efficiency of DMU_p with respect to DMU_q is:

   $$\max E_{pq} = \frac{\sum_{r=1}^{s} u_r y_{rp}}{\sum_{i=1}^{m} v_i x_{ip}}$$

   subject to:

   $$\frac{\sum_{r=1}^{s} u_r y_{rq}}{\sum_{i=1}^{m} v_i x_{iq}} \leq 1$$

   and

   $$u_r, v_i \geq \varepsilon > 0, \qquad \forall r, i$$

   where u_r and v_i are the output and input weights, respectively, and ε is a non-Archimedean infinitesimal to prevent zero weights.

   Step 1 – Normalisation: Set the denominator of the objective function to unity:

   $$\sum_{i=1}^{m} v_i x_{ip} = 1$$

   Step 2 – Cross-multiplication: The constraint becomes:

   $$\sum_{r=1}^{s} u_r y_{rq} - \sum_{i=1}^{m} v_i x_{iq} \leq 0$$

   Thus the linear programming (LP) model for the pair (p, q) is:

   $$\begin{aligned} &\text{Maximize} E_{pq} = \sum_{r=1}^{s} u_r y_{rp} \\ &\text{subject to:} \\ &\sum_{i=1}^{m} v_i x_{ip} = 1, \\ &\sum_{r=1}^{s} u_r y_{rq} - \sum_{i=1}^{m} v_i x_{iq} \leq 0, \\ &u_r \geq \varepsilon, v_i \geq \varepsilon, \qquad \forall r, i. \end{aligned} \tag{4}$$

   Solving (4) for all ordered pairs (p, q) yields the efficiency matrix $\mathbf{E} = [E_{pq}]_{n \times n}$. By definition, $E_{pp} = 1$ for every p because the unit compared against itself achieves full efficiency.

2. **Dual Model and Interpretation of Weights**

   For theoretical completeness, the dual of (4) provides a different perspective. Let λ be the dual variable associated with the constraint $\sum_{i=1}^{m} v_i x_{ip} = 1$, and μ the dual variable for $\sum_{r=1}^{s} u_r y_{rq} - \sum_{i=1}^{m} v_i x_{iq} \leq 0$. The dual LP is:

   $$\begin{aligned} &\text{Minimize} \theta = \lambda \\ &\text{subject to:} \\ &\lambda x_{ip} - \mu x_{iq} \geq 0, i = 1, \ldots, m, \\ &\mu y_{rq} \geq y_{rp}, \qquad r = 1, \ldots, s, \\ &\mu \geq 0, \qquad \lambda \text{ free}. \end{aligned} \tag{5}$$

   The optimal value θ^* is exactly E_{pq}. The dual formulation shows that the relative efficiency is the minimal factor by which the inputs of DMU_p must be scaled to dominate a convex combination of DMU_q's outputs.

3. **Constructing the Pairwise Comparison Matrix for AHP**

After computing $\mathbf{E}$, we build the AHP comparison matrix $\mathbf{A} = [a_{jk}]$ where each entry a_{jk} represents the relative preference of DMU_j over DMU_k. A standard transformation is:

$$a_{jk} = \frac{E_{jj}/E_{jk}}{E_{kk}/E_{kj}} = \frac{1/E_{jk}}{1/E_{kj}} = \frac{E_{kj}}{E_{jk}}, \qquad j \neq k \tag{6}$$

and $a_{jj} = 1$. Because the DEA model may produce $E_{jk} > 1$ in some formulations, we cap the values using the rule:

$$a_{jk} = \min\left(9, \max\left(\frac{1}{9}, \frac{E_{kj}}{E_{jk}}\right)\right) \neq k \tag{7}$$

to respect Saaty's fundamental scale (1 to 9). This ensures the matrix A is consistent with the AHP's numerical range.

4. **Normalisation and Priority Vector Calculation**

Let $\mathbf{A} = [a_{jk}]_{n\times n}$ be the pairwise comparison matrix. The normalised matrix $\mathbf{A}^{\text{norm}}$ is obtained by dividing each column by its sum:

$$\overline{a}_{jk} = \frac{a_{jk}}{\sum_{\ell=1}^{n} a_{\ell k}}, \qquad \forall j, k \tag{8}$$

Then the priority vector $\mathbf{w} = (w_1, \ldots, w_n)^T$ is computed as the row average:

$$w_j = \frac{1}{n}\sum_{k=1}^{n} \overline{a}_{jk}, \qquad j = 1, \ldots, n \tag{9}$$

The final ranking of the DMUs is given by sorting $\mathbf{w}$ in descending order.

5. **Consistency Check of the AHP Matrix**

Because the matrix $\mathbf{A}$ is derived from DEA results (not from subjective judgments), it may not be perfectly consistent. We therefore compute the consistency ratio (CR) to validate the matrix. Let $\lambda_{\max}$ be the principal eigenvalue of $\mathbf{A}$, obtained from:

$$\mathbf{A}\mathbf{w} = \lambda_{\max}\mathbf{w} \tag{10}$$

The consistency index (CI) is:

$$CI = \frac{\lambda_{\max} - n}{n - 1} \tag{11}$$

The consistency ratio is $CR = CI/RI$, where RI is the random index (e.g., for $n = 16$, $RI \approx 1.60$). A $CR < 0.10$ indicates acceptable consistency. If $CR \geq 0.10$, the DEA pairwise comparisons must be re-examined (e.g., by adjusting the non-Archimedean ε or using a different transformation formula).

6. **Numerical Illustration for a Small Subset**

Assume three branches (DMU , DMU , DMU) with the following efficiency matrix $\mathbf{E}$ after solving (4):

$$\mathbf{E} = \begin{bmatrix} 1.000 & 0.825 & 0.760 \\ 1.150 & 1.000 & 0.910 \\ 1.210 & 1.080 & 1.000 \end{bmatrix}$$

Using (6), the comparison matrix $\mathbf{A}$ (before scaling) is:

$$a_{12} = \frac{1.150}{0.825} = 1.394, a_{13} = \frac{1.210}{0.760} = 1.592, a_{23} = \frac{1.080}{0.910} = 1.187$$

and reciprocals for a_{21}, a_{31}, a_{32}. Applying (7) with the 1-9 scale, all values remain within the scale, so:

$$\mathbf{A} = \begin{bmatrix} 1.000 & 1.394 & 1.592 \\ 0.717 & 1.000 & 1.187 \\ 0.628 & 0.842 & 1.000 \end{bmatrix}$$

Normalising via (8) and computing (9) gives:

$$\mathbf{w} = (0.420, 0.330, 0.250)^T$$

Thus the final ranking is $DMU_1 > DMU_2 > DMU_3$.

7. **Extending the Model to Weight-Restricted DEA (Optional)**

   If prior knowledge or expert opinion must be embedded, we can incorporate weight restrictions derived from AHP (as you mentioned in your earlier request). The LP model (3) becomes:

$$\text{Maximize} \sum_{r=1}^{s} u_r y_{rp}$$

subject to:

$$\begin{aligned}
&\sum_{i=1}^{m} v_i x_{ip} = 1, \\
&\sum_{r=1}^{s} u_r y_{rq} - \sum_{i=1}^{m} v_i x_{iq} \leq 0, \\
&\frac{u_{r_1}}{u_{r_2}} \leq \frac{W_{r_1}}{W_{r_2}}(1+\delta), \frac{u_{r_1}}{u_{r_2}} \geq \frac{W_{r_1}}{W_{r_2}}(1-\delta), && \forall r_1, r_2, \\
&\frac{v_{i_1}}{v_{i_2}} \leq \frac{W_{i_1}}{W_{i_2}}(1+\delta), \frac{v_{i_1}}{v_{i_2}} \geq \frac{W_{i_1}}{W_{i_2}}(1-\delta), && \forall i_1, i_2, \\
&u_r, v_i \geq \varepsilon. && (12)
\end{aligned}$$

   Where W_r, W_i are the normalised weights from a prior fuzzy AHP, and δ is a tolerance (e.g., 0.2). This variant combines both methods even more tightly.

Data Collection Instrument

Performance evaluation of bank branches using the AHP/DEA approach is considered a descriptive mathematical method. Since the first step in this evaluation process involves identifying the input and output criteria, an extensive review of available books, published journal articles, Persian and English websites, research projects, and academic theses conducted at universities was initially undertaken. Through this review, 17 input and output criteria were identified. After identifying the potential input and output criteria, these criteria were examined through unstructured interviews with experts and managers from Bank Mellat branches in Yazd. The discussions focused on the measurability of the criteria, the bank's software capabilities in providing the required data, and the significance of each criterion in reflecting the actual performance evaluation. Following several rounds of discussion and assessment, four input criteria and three output criteria were ultimately selected, as presented in Table 6.

Table 6: Input and Output Criteria of the Study for Efficiency Measurement

Inputs	Outputs
Movable Assets Expenses	Deposits
Personnel Costs	Loans Granted
Administrative Expenses	Branch Profit
Number of Branch Staff	

Validity and Reliability of Performance Evaluation Using the AHP/DEA Method

In the present study, the objective is to evaluate the performance of Bank Mellat branches in Yazd city using the AHP/DEA approach. Since the input and output criteria were extracted through an extensive review of previous banking studies and research, selected with the assistance of banking experts, and subsequently confirmed by academic supervisors, it is expected that the performance evaluation has been conducted appropriately. Therefore, the study possesses construct validity. Furthermore, because criteria representing all dimensions of balanced evaluation including financial, customer, internal process, and growth perspectives were selected as input and output variables, the study also demonstrates content validity. The AHP/DEA model is a mathematical model characterized by high stability and precision; therefore, it possesses strong reliability. In addition, because Data Envelopment Analysis (DEA) generates the pairwise comparison matrix required for performance evaluation, the need for questionnaire distribution and subjective personal judgments is eliminated. Consequently, the evaluation process is considered unbiased.

Given the critical importance of performance evaluation in modern organizations, together with the availability of existing software facilities, the cost of conducting performance evaluation using the AHP/DEA model is relatively low, which further highlights its practical applicability.

Research Findings

In the first stage, after identifying the input and output variables of the efficiency measurement model, it is necessary to construct the pairwise comparison matrix. Therefore, the input and output values for the branches under study were first extracted and presented in Table 7.

As observed in the table of bank branch inputs and outputs, three branches reported losses (negative O3 values). Since, in Data Envelopment Analysis, all criteria must be non-negative and preferably positive, a constant value of 600 was added to the O3 column in order to convert all values into positive numbers.

Table 7: Input and Output Values of the Efficiency Measurement Model for the Branches under Study

No	Branch Name	Number of Staff (I1)	Movable Assets Expenses (I2)	Personnel Costs (I3)	Administrative Expenses (I4)	Deposits (O1)	Loans Granted (O2)	Profit (O3)	(O3 + 600)
1	Markazi	22	433	1182	240	48.600	65.900	2.500	3.100
2	Meydan Atlasi	10	259	626	136	22.500	16.700	747	1.347
3	Boulevar 17 Shahrivar	6	169	319	109	6.600	7.900	389	989
4	Boulevar Daneshjoo	4	126	215	67	6.400	6.300	-173	427
5	Boulevar Azadegan	5	183	285	50	6.900	5.900	207	807
6	Shahedieh	4	119	216	85	4.900	6.100	525	1.125
7	Shohada Crossroad	3	135	176	84	5.400	8.400	501	1.101
8	Moallem Crossroad	7	255	389	90	8.900	10.300	488	1.088
9	Meydan Imam Hossein	6	181	326	58	5.900	6.700	312	912
10	Meydan Homafar	6	171	324	87	14.600	11.300	296	896
11	Bazaar Yazd	5	158	275	64	28.600	10.800	-570	30
12	Farrokhi Yazdi	7	228	374	93	11.300	9.200	150	750
13	Ayatollah Kashani	6	157	335	117	8.000	14.300	957	1.557
14	Safaieh	4	307	236	46	13.600	8.100	161	761
15	22 Bahman Boulevar	4	162	211	55	11.100	6.400	295	895
16	Ebnesina	5	134	275	49	18.200	8.500	-330	270

To construct the pairwise comparison matrix, the bank branches must be compared with one another in pairs in order to obtain the elements of the pairwise comparison matrix. Since the number of branches under examination was 16, a total of 256 comparisons were theoretically involved. The comparison of each branch with itself yields a value of one; therefore, the elements located on the main diagonal of the matrix are equal to one. Furthermore, the reciprocal relationship holds among the elements of the pairwise comparison matrix. Furthermore, the elements of the pairwise comparison matrix satisfy relationship $a_{ij} = \frac{1}{a_{ji}}$. Therefore, the elements above the main diagonal were calculated directly, while the elements below the main diagonal were obtained using the aforementioned relationship. Consequently, 120 pairwise comparisons were conducted among the branches. The corresponding values of these binary comparisons are presented in Table 8.

Table 8: Pairwise Comparison Matrix of the Branches under Study

Branch	Markazi	Meydan Atlasi	Boulevar 17 Shahrivar	Boulevar Daneshjoo	Boulevar Azadegan	Shahedieh	Shohada Crossroad	Moallem Crossroad	Meydan Imam Hossein	Meydan Homafar	Bazaar Yazd	Farrokhi Yazdi	Ayatollah Kashani	Safaieh	22 Bahman Boulevar	Ebnesina
Markazi	1	2	2	1.7573	2	2	2	2	2	2	2	2	2	2	2	2
Meydan Atlasi	0.5	1	2	2	2	2	2	2	2	1	1	2	2	1	1	1
Boulevar 17 Shahrivar	0.5	0.5	1	1	2	1	1	1.4142	2	1	1.3778	2	1	1	1	1
Boulevar Daneshjoo	0.5690	0.5	1	1	2	2	1	2	2	1.8402	1	1	2	1	1	1
Boulevar Azadegan	0.5	0.5	0.5	0.5	1	2	1	2	2	1.967	1.4827	1	2	1	1	1
Shahedieh	0.5	0.5	1	0.5	0.5	1	1	2	2	1	1.2852	2	2	1	1	1
Shohada Crossroad	0.5	0.5	1	1	1	1	1	2	2	2	2	2	2	2	2	2
Moallem Crossroad	0.5	0.5	0.7071	0.5	0.5	0.5	0.5	1	2	1.9657	1	2	1	1	1	1
Meydan Imam Hossein	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1	1.4866	1	1	1	1	1
Meydan Homafar	0.5	1	1	0.5434	0.5084	1	0.5	0.5087	1	1	1	2	2	1	1	0.8047
Bazaar Yazd	0.5	1	0.7258	1	0.6744	0.7781	0.5	1	0.6727	1	1	2	2	2	2	2
Farrokhi Yazdi	0.5	0.5	0.5	1	1	0.5	0.5	0.5	1	0.5	0.5	1	2	1	1	1
Ayatollah Kashani	0.5	0.5	1	0.5	0.5	0.5	0.5	1	1	0.5	0.5	0.5	1	2	2	2
Safaieh	0.5	1	1	1	1	1	0.5	1	1	1	0.5	1	0.5	1	1	1.8824
22 Bahman Boulevar	0.5	1	1	1	1	1	0.5	1	1	1	0.5	1	0.5	1	1	1.0242
Ebnesina	0.5	1	1	1	1	1	0.5	1	1	0.5541	0.5	1	0.5	0.5312	0.9764	1
Σ	8.569	12.5	15.9329	14.8007	17.183	17.778	13.5	20.923	23.6727	19.327	17.132	23.5	23.5	19.5312	19.976	21.711

Using the pairwise comparison matrix, the sum of the values in each column was calculated and presented at the bottom of each column. Subsequently, each element was divided by the sum of its corresponding column in order to obtain the normalized matrix. Table 9 presents the resulting normalized matrix.

Table 9: Normalized Pairwise Comparison Matrix

Branch	Markazi	Meydan Atlasi	Boulevar 17 Shahrivar	Boulevar Daneshjoo	Boulevar Azadegan	Shahedieh	Shohada Crossroad	Moallem Crossroad	Meydan Imam Hossein	Meydan Homafar	Bazaar Yazd	Farrokhi Yazdi	Ayatollah Kashani	Safaieh	22 Bahman Boulevar	Ebnesina
Markazi	0.12	0.16	0.13	0.12	0.12	0.11	0.15	0.10	0.08	0.10	0.12	0.09	0.09	0.10	0.10	0.09
Meydan Atlasi	0.06	0.08	0.13	0.14	0.12	0.11	0.15	0.10	0.08	0.05	0.06	0.09	0.09	0.05	0.05	0.05
Boulevar 17 Shahrivar	0.06	0.04	0.06	0.07	0.12	0.06	0.07	0.07	0.08	0.05	0.08	0.09	0.04	0.05	0.05	0.05
Boulevar Daneshjoo	0.07	0.04	0.06	0.07	0.12	0.11	0.07	0.10	0.08	0.10	0.06	0.04	0.09	0.05	0.05	0.05
Boulevar Azadegan	0.06	0.04	0.03	0.03	0.06	0.11	0.07	0.10	0.08	0.10	0.09	0.04	0.09	0.05	0.05	0.05
Shahedieh	0.06	0.04	0.06	0.03	0.03	0.06	0.07	0.10	0.08	0.05	0.08	0.09	0.09	0.05	0.05	0.05
Shohada Crossroad	0.06	0.04	0.06	0.07	0.06	0.06	0.07	0.10	0.08	0.10	0.12	0.09	0.09	0.10	0.10	0.09
Moallem Crossroad	0.06	0.04	0.04	0.03	0.03	0.03	0.04	0.05	0.08	0.10	0.06	0.09	0.04	0.05	0.05	0.05
Meydan Imam Hossein	0.06	0.04	0.03	0.03	0.03	0.03	0.04	0.02	0.04	0.05	0.09	0.04	0.04	0.05	0.05	0.05
Meydan Homafar	0.06	0.08	0.06	0.04	0.03	0.06	0.04	0.02	0.04	0.05	0.06	0.09	0.09	0.05	0.05	0.04
Bazaar Yazd	0.06	0.08	0.05	0.07	0.04	0.04	0.04	0.05	0.03	0.05	0.06	0.09	0.09	0.10	0.10	0.09
Farrokhi Yazdi	0.06	0.04	0.03	0.07	0.06	0.03	0.04	0.02	0.04	0.03	0.03	0.04	0.09	0.05	0.05	0.05
Ayatollah Kashani	0.06	0.04	0.06	0.03	0.03	0.03	0.04	0.05	0.04	0.03	0.03	0.02	0.04	0.10	0.10	0.09
Safaieh	0.06	0.08	0.06	0.07	0.06	0.06	0.04	0.05	0.04	0.05	0.03	0.04	0.02	0.05	0.05	0.09
22 Bahman Boulevar	0.06	0.08	0.06	0.07	0.06	0.06	0.04	0.05	0.04	0.05	0.03	0.04	0.02	0.05	0.05	0.05
Ebnesina	0.06	0.08	0.06	0.07	0.06	0.06	0.04	0.05	0.04	0.03	0.03	0.04	0.02	0.03	0.05	0.05

To obtain the ranking weight of each branch, the average of the elements in each row of the normalized matrix was calculated. Table 10 presents the ranking weight values of the branches under study.

Table 10: Ranking Weights of the Branches under Study

Branch Name	Ranking Weight	Rank
Markazi	0.110	1
Meydan Atlasi	0.086	2
Shohada Crossroad	0.080	3
Boulevar Daneshjoo	0.072	4
Boulevar Azadegan	0.066	5
Boulevar 17 Shahrivar	0.065	6
Bazaar Yazd	0.064	7
Shahedieh	0.061	8
Meydan Homafar	0.053	9
Safaieh	0.053	10
Moallem Crossroad	0.052	11
22 Bahman Boulevar	0.050	12
Ayatollah Kashani	0.050	13
Ebnesina	0.047	14
Farrokhi Yazdi	0.045	15
Meydan Imam Hossein	0.043	16

Discussion and Conclusion

In today's competitive and rapidly changing environment, continuous performance evaluation has become one of the essential tools for organizations, particularly banks, to improve decision-making and enhance productivity. Such evaluation should extend beyond financial indicators and also encompass dimensions such as customer satisfaction, internal processes, growth, and learning. Therefore, identifying effective indicators and selecting an appropriate evaluation method play a significant role in achieving accurate and practical results.

In the present study, the performance of 16 branches of Bank Mellat in Yazd Province was evaluated and ranked using Data Envelopment Analysis (DEA) and the integrated AHP/DEA approach. In this study, the number of personnel, property expenses, human resource costs, and administrative expenses were considered as inputs, while deposits, granted facilities, and branch profits were regarded as outputs. The results indicated that some branches, through the efficient utilization of resources and effective cost control, demonstrated superior performance and were located on the efficiency frontier. In contrast, several branches, despite having relatively high resources and expenditures, failed to generate proportional outputs and were therefore classified as inefficient branches. The findings also revealed that financial indicators and profitability had a significant effect on branch ranking, and branches that established a proper balance between costs and revenues achieved higher rankings. Furthermore, considering the structure of the country's banking system and its dependence on in-person customer referrals, the geographical location of branches was also identified as an influential factor affecting performance. In this regard, identifying the strengths of efficient branches can provide opportunities for benchmarking and transferring successful experiences to other branches. Based on the research findings, improving the performance of inefficient branches requires restructuring costs, optimizing human resources, increasing the attraction of financial resources, and expanding banking services. Moreover, employing comprehensive performance evaluation methods instead of single-criterion assessments can provide a more accurate picture of the actual condition of branches. Accordingly, it is recommended that branch managers and employees become familiar with modern performance evaluation methods and receive the necessary training. Additionally, identifying and reporting the strengths and weaknesses of branches in financial, customer, internal process, and growth and learning dimensions can contribute significantly to improving the performance of the banking network. Furthermore, encouraging successful branches and utilizing their managerial experiences can facilitate the improvement of other branches.

Based on the results of the conducted analysis, the following recommendations are proposed for the branches under study:

- Markazi Branch: This branch, which has granted facilities significantly exceeding its deposits, can considerably increase branch profitability through the effective utilization of its large number of personnel in timely installment collection, follow-up activities, and recovery of overdue claims.

- Shohada Crossroad Branch: Considering its low input criteria, this branch has performed satisfactorily in attracting deposits and granting facilities. It is recommended that the number of personnel, as an effective input criterion, be increased in order to preserve and strengthen this desirable performance.
- Daneshjoo Boulevar Branch: This branch is one of the three branches that not only failed to generate profits but also operated at a loss. This situation is mainly attributed to the excessive increase in overdue claims beyond the normal level. Therefore, by adding one employee to its personnel, the branch can simultaneously increase efforts in both granting new facilities and recovering outstanding claims.
- 17th Shahrivar Boulevar Branch: This branch possesses normal levels of input criteria; however, its performance regarding output criteria, particularly deposits, has been weak. Therefore, it should intensify its efforts toward attracting deposits.
- Azadegan Boulevar Branch: Due to its geographical location, this branch should strengthen its activities related to deposit attraction and the recovery of overdue claims, which are reflected in reduced branch profitability.
- Yazd Bazaar Branch: Despite having low values for input criteria, this branch has successfully performed in output criteria, namely deposit attraction and facility granting; however, it has recorded the highest loss among the evaluated branches. Considering the volume of granted facilities, increasing the number of personnel could help reduce overdue claims and branch losses, ultimately leading to higher profitability.
- Shahedieh Branch: This branch should maintain its current profitability status while strengthening its deposit attraction performance.
- Homafar Square Branch: This branch has successfully utilized its personnel in attracting deposits and granting facilities. It should also strengthen the profitability dimension by taking steps toward increasing profits.
- Safaieh Branch: This branch has not been successful in achieving desirable profitability. Given the high volume of granted facilities and low input costs, this issue appears to stem from increased overdue claims. Therefore, by following up and collecting outstanding claims, the branch can substantially improve its profitability.
- Moallem Crossroad Branch: Saadi Branch, considering its geographical location, has utilized its input criteria effectively and generated high outputs; however, it should make greater efforts in attracting deposits.
- 22 Bahman Boulevar Branch: Due to its location in a residential area, this branch has been successful in attracting deposits. It should increase its activities in granting appropriate facilities in order to achieve higher profitability.
- Ayatollah Kashani Branch: Despite having high values in input criteria, particularly the number of personnel and human resource costs, this branch has performed very poorly in attracting deposits and ranked thirteenth. The branch should significantly increase its activities in this area.
- Ibn Sina Branch: Although this branch has appropriate input values and has been successful in attracting deposits, it ranks very low due to operating at a loss. Improving this position requires greater effort in the timely collection of installments and overdue claims.
- Farrokhi Yazdi Street Branch: Despite high input values, this branch has not achieved desirable profitability and therefore ranked fifteenth. Efforts toward attracting more deposits and collecting overdue installments can substantially improve its ranking.
- Meydan Imam Hossein Branch: Among the 16 branches under study, this branch demonstrated the weakest performance. Despite having high input values, it performed poorly in attracting deposits and granting facilities. The branch should utilize all available resources and capabilities to improve these two output criteria and achieve a more favorable ranking.

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