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Evaluation of Strategic Performance with Fuzzy Data Envelopment Analysis

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Abstract
This study intends to expand a set of proper performance evaluation indices which embraces strategies for sustaining top performance using SWOT analysis inside a balanced scorecard (BSC) outline for the large commercial bank branches in IRAN by operating a fuzzy Data Envelopment Analysis (FDEA). Through literature reviews and the banks' experts and managers opinions and who have real practical experiences in the bank strategy planning, satisfactory performance evaluation indices have been selected throughout SWOT analysis. Then, utilizing the decision making trial and evaluation laboratory (DEMATEL) and analytic network process (ANP), respectively, further establishes the causality between the four BSC perspectives as well as the relative weights between evaluation indices. An empirical grading of the bank strategies is exemplified by applying fuzzy data envelopment analysis. The DEA model ranks the DMUs based on mathematical and scientific logic. Fuzzy DEA technique is utilized for ranking the branches.

Keywords: Strategic Performance, Analytic Network Process, Balanced Scorecard, DEMATEL, Fuzzy Data Envelopment Analysis.

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1. Introduction

In the express development of financial markets, commercial banks are facing great rivalry. Performance is no longer solely a financial issue. The traditional performance management ignores the nonfinancial factors and appears to be inadequate in understanding how to compute all-round performance to meet the banking needs of strategic development. In that instant, financial indicators can only reflect the performance of banks in the past and do not reflect the bank's outlook in service circumstances. It is usually followed by performance management, putting prominence on traditional assets, and passing over intangible assets. Banks' fixed assets are important, but the banking sector is a knowledge intensive industry, and financial knowledge, intellectual resources and other intangible assets of banks are more imperative [1]. It is essential for the application of performance measurement that companies' tangible and intangible targets are defined in a way that is more appropriate to the requirements and objects of these targets and that its strategy is more extensively operationalized, quantified, and linked in a mutually supplementing way [2].

As emphasized by Ghalayini and Noble [3], the literature concerning performance measurement has had two phases. In the first phase, which went on until the 1980s, the centre of attention was performance measurement based on the financial criteria supplied by the management accounting system. The second phase started in the late 1980s and is still proceeding. During this period of time much has changed within performance measurement and the interest in this field has increased tremendously. In the late 1980s, the limitations of the traditional way of measuring performance were clearly known and researchers started to talk about introducing new performance measures, such as shareholder value, economic profit, customer satisfaction, internal operations performance, intellectual capital and intangible assets [4]. Organizations adopt strategic performance evaluation systems in their drive to evaluate and improve strategic efficiency and performance [5]. Several studies suggest the influence of strategic performance systems on company efficiency and performance [6]; [7]. The recent studies have stressed the role of motivational mechanisms in explaining the effect of strategic performance evaluation systems on managerial performance [6]; [8]; [9].

According to Luft [10], managers' understanding of strategy and performance is based on using strategic performance systems. To have a strategic performance system, we must have several strategies. These strategies are defined based on the tangible and intangible targets of a company [2]. Today, in such a competitive environment, organizations have developed the performance evaluation system, as it is seen as being of strategic importance [2]. There are many studies about performance evaluations, some studies identified and defined both tangible and intangible targets as performance indexes [2]; [11]. These indexes were determined based on tangible and intangible targets [2]. We can say that tangible and intangible targets were reflected in strategies, and strategies were designed based on these targets. However, the number of studies about strategic performance and performance indexes based on strategies are very low. In the literature, there are few fuzzy logic methods aimed at evaluating the relative performance by multi-dimensions. So, the main purpose of this paper is to evaluate performance with the focus on strategy and strategy performance.

To have a strategic performance evaluation system, it is necessary to have several strategies. These strategies reflect tangible and intangible targets of an

organization and are determined by strategic management. By applying strategic management; a manager can determine the strategies and how to implement them [5]. The organizations are then evaluated based on doing these strategies. We can say that the organizations that fulfill the strategies obtain a high degree of performance evaluation. So performance can be defined. Performance is doing the strategies better. The organizations performance is calculated by two concepts [5]:

- Understanding the strategies.
- Doing the strategies.

This idea is a new concept in organization performance evaluation. Most studies in efficiency and performance evaluation evaluate performance and efficiency based on historical data about the organization such as Golany and Storbeck [12], Avkiran [13], Kantor and Maital [14], Soteriou et al. [15], Cook et al. [16] and others. These studies have no strategic focus, but in this paper we focus on strategies and strategic performance. By applying this idea, we can determine and control the performance trend in the organizations. Several studies focus on evaluating performance based on Balanced Score Card (BSC) such as: Creamer [17], Kraus and Lind [18], Huang [19] and others. It must be mentioned that the BSC procedure is based on Vision and Strategies [20] and without understanding and determining the vision and strategies, organizations cannot evaluate their performances [20].

In this paper we determine the strategies of organization. To do this the strategic management procedure is used [21], while the strategies are determined by sing SWOT matrix [21]. So the strategies are designed based on vision and tangible and intangible targets. We then evaluate an organization's performance based on doing these strategies. In the next step, critical indices are selected for building up a performance evaluation model to suit Iranian bank branches properly and then the information is provided as a reference to increase their running effectiveness.

The current article is comprised as follows, Section 2 provides a literature review, Section 3 introduces Performance evaluation framework and the proposed model in performance evaluation, Section 4 describes an empirical example for banking performance, including the hierarchical framework of BSC performance evaluation indexes and the result analyses and discussion to illustrate the proposed performance evaluation model. Section 6 is the conclusion.

2. Literature Review

There is a relatively small number of methods to make performance evaluation of units. The one chosen by management or decision makers for assessing performance depends on the status and type of the organization. However, the successful enterprises have some common features, including a specific vision, positive actions, and an effective performance evaluation.

In order to have sustainable operation and development, organizations should rely on continual innovation and growth. Further, Kaplan and Norton [20] pointed out that ''companies should regard some principles such as employee abilities enhancement, information systems performance, encouragement, authority consistence, etc.'' From another aspect, this perspective contains three main basic appraisal criteria which are employee's satisfaction, employee's continuation, and productivity of employees. Then again, organizations should establish performance appraisal indices based on these three criteria. So Kaplan and Norton [20] argued that the BSC provides managers with the means they need to

navigate future competitive success. It includes more non-financial measures derived specifically from the organization's strategy. BSC is one of the comprehensive and simplistic performance measurement tools that emphasizes both the aspects of the financial and non-financial, long-term and short-term strategies, and emphasizes internal and external business measures. The strongest point of BSC is its ability to illustrate the cause and effect relations between strategies and processes through four perspectives: "Financial perspective"; "Customer perspective"; "Internal business process perspective"; and "Learning and growth perspective". Based on this reasoning, to achieve its financial benefits, an organization has to take its customers' needs and expectations into account, initially. In the most of the paper about the BSC, the relationship between these aspects are constant but Shafiee et.al. focused on this issue. The applied DEMATEL approach to solve this problem.

Decision Making Trial and Evaluation Laboratory (DEMATEL), which was developed by the Science and Human Affairs Program of the Battelle Memorial Institute of Geneva between 1972 and 1976, was utilized in the research and solving a group of complicated and intertwined problems. DEMATEL approach [22] can recognize the interactions among alternative systems and evaluation criteria, since it can calculate the impacts among criteria successfully. On the other hand, there is a potentiality by DEMATEL to separate a set of composite factors into dispatcher group and receiver group effectively, and also, conversion into an outstanding structural model. Using this method of utilization, we can easily extract the mutual relationships of interdependencies among various criteria and the strength of interdependence [23].

Although BSC is a power fill technique, it cannot specify efficient and inefficient unit. So a large number of researches have been conduct on this issue. In order to solve this issue, some researcher applied hybrid method especially, they applied DEA and BSC.

DEA is a linear programming based methodology that can evaluate DMUs qualitatively as well as quantitatively, and also calculate multiple inputs and outputs. The term DMU stands for decision making unit and can be used either for comparing different firms or evaluating the efficiency of one firm over time. The first model of DEA was first proposed by Charnes, Cooper and Rhodes (CCR) in 1978 [24]. In 1984 Banker et al [25]. suggested the evolutionary form of the CCR model named BCC. In subsequent years, DEA received greater attention and a large number of researchers studied it and developed various models [26, 27]. In general, these models differ in orientation, disposability, diversification and returns to scale, and types of measures. DEA is a powerful method in evaluating DMUs, but it also has some limitations. One of the limitations of this method is that all models presented in DEA deal with exact and known, so these models are not suitable for real situations. In most situations, data are presented by natural languages including good, bad, to name but two which reflect the general situation of the DMU. After introducing the fuzzy theory and its progressive application in other sciences, researchers applied the fuzzy theory in evaluating the performance of DMUs with fuzzy data. Kao and Liu [28] illustrate the point in usage of $\propto -\text{cut}$ in solving the CCR model and evaluating DMUs with fuzzy data. In recent years, some researchers have applied the concept of comparison of fuzzy numbers and presented the methods for solving DEA models with fuzzy data, [29]. And also for further information you can see [30,31,32,33,34,35]

In the other methods, the analytic hierarchy process (AHP) and the analytic network process which possess qualitative and quantitative components (ANP), have been created by Professor Thomas Saaty [36]; [37]. The AHP offers a framework to aid managers in analyzing various factors, evaluating alternatives, as well as making final selections. As matter of fact, this approach combines complex and unstructured problem decomposition into a set of elements organized in a multilevel hierarchic form [36]. In reality, the conventional AHP, which is considered as criterion independence, is not suitable enough to analyze a multi criteria decision making problem since these criterions are not independent. Further, ANP is a generic form of AHP since it can take interdependent relationships into consideration, which results in the possibility of forming a network-like structural model, but in this research only a brief method description will be presented.

Step 1: Decision problem definition: As the first step, the problem character that will be solved should be well defined, since it will help in further levels decomposition down the structure up to the final level, as the usual scenarios or alternatives for selection.

Step 2: Super matrix formation by using criteria comparison: In order to compare the criteria in the whole system, the super matrix can be achieved via pair-wise comparisons by asking ‘‘How important is a criterion compared to another criterion with regard to our interests or preferences?’’ Conversely, the relative importance values of pair-wise comparisons can be classified from 1 (equal importance) to 9 (extreme inequality in importance) [36], [37].

Step 3: Super matrix calculation: The weighted super matrix is formed by all columns sum changes to unity exactly. Next, via $\lim_{k\to\infty} w^k$, the weighted super matrix will be multiplied several times and then converge into a limiting super matrix with a constant value to obtain the global priority vectors or weights.

Performance evaluation of an organization is an important point in a system but evaluation without identifying suitable strategies to improve efficiency and performance of a system is not effective. So Strategic management in a crucial point in each system. Strategic management is defined as the art and science of formulating, implementing, and evaluating cross-functional decisions that enable an organization to achieve its objectives [21]. Numerous analytical tools and techniques have been developed to aid strategic planning such as Porter’s five forces industry analysis, the BCG growth-share matrix, McKinsey’s 7S model and SWOT (strengths, weaknesses, opportunities, and threats) analysis. The typical approach to strategic planning would integrate an external environmental analysis to recognize the opportunities and warnings in front of the organization into an internal analysis to recognize the organization’s powers and defects or errors. The aim of SWOT analysis is to incorporate into the reflections on a socio economic program, both the intrinsic characteristics of the territory concerned and the determining factors in the environment in which the programme will be implemented. The tool is intended to reduce the areas of uncertainty related to the implementation of a project or measure applicable to the relevant territory. It enables the definition of strategy relevant to the context in which the action is to take place. The purposes of the tool are: -To highlight the dominant and determining factors, both within and outside of the territory that likely to influence the success of the project; and -To produce relevant strategic guidelines by linking the project

to its environment. SWOT analysis may be expanded by means of tools similar to those known as "portfolio management", such as the BCG matrix, to examine the validity of a strategy that has been proposed or is being applied, and to recommend changes where relevant. The classification of the different possibilities takes into account their feasibility (assets available "in house" = strengths and weaknesses), as well as their potential (attractive features in relation to the outside environment = opportunities and threats).

The implementation of a strategic approach such as SWOT analysis involves six steps:

1) "scan" of the environment of the program.

This step enables the detection of the major trends and problems likely to affect the future of the territory under consideration. Use should be made of socio-demographic, economic, political and physical indicators. Indicators of regional disparities and benchmarks are particularly useful for revealing opportunities and threats. This step should not be exhaustive as the aim is to obtain an overall picture to illustrate the key issues that the community in question will have to face.

2) The preparation of an inventory of possible actions.

The step involves the identification of possible actions, formulated in general terms, in relation to the main problems identified.

3) The external analysis of opportunities and threats.

This step consists of listing the parameters of the environment which are not under the direct control of the public authorities and which, it is assumed, will strongly influence socio-economic development.

4) Internal analysis of strengths and weaknesses.

This step involves making an inventory of the factors which are at least partly under the control of the public authority, and which may either promote or hinder development.

5) Classification of possible actions.

This step is aimed at highlighting those actions (strategic guidelines) most likely to reduce development problems by focusing on the strengths and reducing or even eliminating the weaknesses, with a view to maximizing opportunities and minimizing threats.

6) Evaluation of a strategy.

This optional step may be included if it is appropriate for judging the relevance of a strategy already being implemented or being planned. The step may be designed on the basis of a "portfolio of activities" analysis. Like a firm with its products and markets, a socio-economic program contains a set of interventions, some of which build on strengths and opportunities, while others try to compensate for weaknesses or to warn of threats. The evaluator should place interventions on a plane with two axes: (1) internal feasibility, strengths and weaknesses, and (2) external environment, opportunities and threats. The discussion of the map thus produced can be used to judge the relevance of strategy being evaluated.

3. Method

According to the analysis of the previous literature review, the performance evaluation model of EGTESAD NOVIN bank proposed by this research is shown as Fig 1. The analytical process is divided and carried out in four stages: (1) The banks' weaknesses, strengths, threats and opportunities are analyzed from SWOT literature and are stated based on BSC literature; (2) The DEMATEL method is applied to determine causal relationships and mutual influence among perspectives; (3) ANP is used to analyze the relative weights of organizational SO, ST, WO and WT strategies; (4) an empirical analysis of synthetic performance evaluation of the

bank is made throughout Fuzzy DEA to grade the order among the organizations. On the other hand, based on the degree of accessing the banks' determined strategies, its' branches are ranked by means of fuzzy DEA. The analytical methods, DEMATEL, ANP, and fuzzy DEA employed by this research, are introduced in brief as follows.

In this proposal model, the organizations are ranked based on doing the strategies. So in the first stage, the organizations determine mission, vision and other components based on the strategic management shown in Fig1.

For determining the strategies, the organizations must determine the weaknesses, strengths (internal environment), threats and opportunities (external environment). Then, they design the strategies with SWOT matrix. These strategies are financial and non-financial; so in this stage we combine SWOT matrix with four perspectives of BSC, the organizational performance can be evaluated with financial and non-financial indexes. Since the BSC is based on causal relationships, DEMATEL was used to determine these relationships in the next stage. These relationships organize an ANP structure. In the next stage, we used ANP to determine the strategies ranking. We rank the strategies with this ANP method.

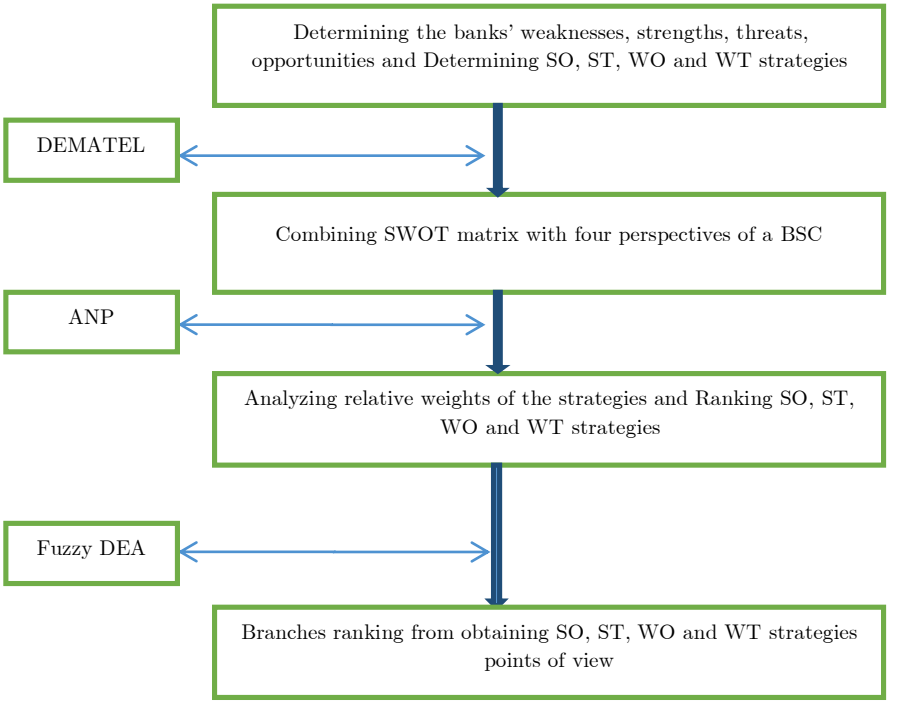

Fig.1. Proposed performance evaluation model of EGTESADE NOVIN bank

We said that organizational performance is doing the strategies and the organizations that fulfilled the strategies obtain high degree of performance evaluation. So we

can define performance. Performance is doing the strategies better. Based on this definition, we want to rank organizational performance. Since the ANP strategies raking is obtained from the expert ideal, we use the DEA model. With the DEA model, we combine the expert ideals and mathematical logic, and avoid bias of expert ideals. So we use the ANP ranking to control weights in DEA models. Since the data about doing these strategies are qualitative, we use the fuzzy logic and design Fuzzy DEA model to rank the bank branches.

DEA Models

Let x_{ij} , $i = 1, \dots m$ and Y_{rj} $r = 1, \dots, s$ be the ith input and rth output, respectively, of the jth DMU, j = 1...n. The DEA model for measuring the relative efficiency of DMU_o under an assumption of constant returns to scale is the CCR model [24]:

$$\begin{aligned} &Max \quad \sum_{r=1}^{s} u_r y_{ro} \\ &\text{S.t} \\ &\sum_{i=1}^{m} v_i x_{io} = 1 \\ &\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \le 0 \\ &j = 1, \dots, n \\ &u_r \ge 0 \quad r = 1, \dots, k \\ &v_i \ge 0 \quad i = 1, \dots, m \end{aligned} \tag{1}$$

The following BCC input oriented value-based model, [25] can be used to assess efficiencies.

$$\begin{aligned} &Max \quad \sum_{r=1}^{s} u_r y_{ro} + w \\ &\text{S.t} \\ &\sum_{i=1}^{m} v_i x_{io} = 1 \\ &\sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} + w \le 0 \\ &j = 1, \dots, n \\ &u_r \ge 0 \quad r = 1, \dots, k \\ &v_i \ge 0 \quad i = 1, \dots, m \end{aligned} \tag{2}$$

The standard DEA models have been formulated via the input and output data of DMUs. However, data sets are sometimes given without inputs, so the original input–output data cannot be easily recovered. Let Y_{rj} $r = 1, \dots, s$ be the rth output of the jth DMU, j = 1...n. The DEA model for measuring the relative efficiency of DMU_o is as follows: [38], [39].

$$\begin{aligned} &Min\ u_0 \\ &S.t \\ &\sum_{r=1}^{S} u_r y_{rj} - u_0 \le 0, \\ &j = 1, \dots, n \\ &\sum_{r=1}^{S} u_r y_{r0} = 1 \\ &u_r \ge 0, \quad r = 1, \dots, S \end{aligned} \tag{3}$$

3.1 Fuzzy Numbers

A fuzzy set A in X is a set of ordered pairs:
$A = \{(x \quad \mu_A(x)) | x \in X\}$

$\mu_A(x)$ is called the membership function of X in A. LR-fuzzy number $\tilde{A}$ can be described with the following membership function:

$$\mu_{\tilde{A}}(x) = \begin{cases} L\left(\frac{\underline{m}-x}{\beta}\right) & x \le \underline{m} \\ 1 \quad \underline{m} \le x \le \overline{m} \\ R\left(\frac{x-\overline{m}}{\gamma}\right) & x \ge \overline{m} \end{cases} \tag{8}$$

Where L,R:[0,1] ⟶ [0,1], with L(0)=R(0)=1 and L(1)=R(1)=0, are non-increasing, continuous shape functions. The LR-fuzzy number is denoted by $\tilde{A} = (\underline{m}, \overline{m}, \beta, \gamma)$. The α-cut set of $\tilde{A}$, denoted by $\widetilde{A_\alpha}$, is:

$\widetilde{A_\alpha} = \{x: \mu_{\tilde{A}}(x) \ge \propto\}$

And

$\underline{u}(\alpha) = inf\{x: \mu_{\tilde{A}}(x) \ge \propto\}$
$\overline{u}(\alpha) = sup\{x: \mu_{\tilde{A}}(x) \ge \propto\}$

Hence we have:

$\widetilde{A_\alpha} = [\underline{u}(\alpha) \quad \overline{u}(\alpha)]$

The α-cut sets of a LR-fuzzy number can easily be computed as:

$\widetilde{A_\alpha} = \left[\underline{m} - L^{-1}(\alpha)\beta, \overline{m} + R^{-1}(\alpha)\gamma\right]$;
$\alpha \in (0 \quad 1)$

Theorem 1. Let u be a fuzzy number and $c(u)$ a crisp point, then the function $D(u, c(u))$ with respect to $c(u)$ is

minimum value, if $c(u) = m(u)$ and $m(u)$ is unique and
$m(u) = 1/2 \int_0^1 \left(\underline{u}(\alpha) + \overline{u}(\alpha)\right) d\alpha$

Proof: See [40]
For arbitrary fuzzy numbers u and v
$u \succcurlyeq v \Leftrightarrow m(u) \geqslant m(v)$

And
$u \sim v \Leftrightarrow m(u) \cong m(v)$

So
$u \succcurlyeq v \Leftrightarrow u > v \; or \; u \sim v$

Theorem 2. Let u, v be fuzzy numbers, therefore:
$m(u + v) = m(u) + m(v)$

And
$m(\lambda u) = \lambda m(u)$.

Proof: See [40]
Proposed Fuzzy DEA Models
Consider the set of the DMUs including with fuzzy outputs. In fact, assume that we have a set of DMUs with fuzzy output vectors. So the fuzzy model with only outputs is:

$$\begin{aligned} &Min\ u_0 \\ &\text{s.t} \\ &\textstyle\sum_{r=1}^{S} u_r \tilde{y}_{rj} - u_0 \preccurlyeq \tilde{0}, \\ &j = 1, \dots, n \\ &\textstyle\sum_{r=1}^{S} u_r \tilde{y}_{r0} \cong \tilde{1} \\ &u_r \geq 0, \quad r = 1, \dots, S \end{aligned} \tag{4}$$

By using theorem 1 and theorem 2 we have:

$$\begin{aligned} &Min\ u_0 \\ &\text{s.t} \\ &\textstyle\sum_{r=1}^{S} u_r m(\tilde{y}_{rj}) - m(u_0) \preccurlyeq \tilde{0}, \\ &j = 1, \dots, n \\ &\textstyle\sum_{r=1}^{S} u_r m(\tilde{y}_{r0}) \cong \tilde{1} \\ &u_r \geq 0, \quad r = 1, \dots, S \end{aligned} \tag{5}$$

So we have:

$$\begin{aligned} &Min\ u_0 \\ &\text{s.t} \\ &\textstyle\sum_{r=1}^{S} u_r \int_0^1 \left(\underline{y}_{rj}(\alpha) + \overline{y}_{rj}(\alpha)\right) d\alpha - \\ &u_0 \leq 0, \quad j = 1, \dots, n \\ &\textstyle\sum_{r=1}^{S} u_r \int_0^1 \left(\underline{y}_{r0}(\alpha) + \overline{y}_{r0}(\alpha)\right) d\alpha = 1 \\ &u_r \geq 0, \quad r = 1, \dots, S \end{aligned} \tag{6}$$

Consider the following changes of variable
$\hat{y}_{rj} = \int_0^1 \left(\underline{y}_{rj}(\alpha) + \overline{y}_{rj}(\alpha)\right) d\alpha$

Therefore, we have

$$\begin{aligned} &Min\ u_0 \\ &\text{s.t} \\ &\textstyle\sum_{r=1}^{S} u_r \hat{y}_{rj} - u_0 \leq 0, \\ &j = 1, \dots, n \\ &\textstyle\sum_{r=1}^{S} u_r \hat{y}_{r0} = 1 \\ &u_r \geq 0, \quad r = 1, \dots, S \end{aligned} \tag{7}$$

4. Finding

In accordance with the proposed performance evaluation model shown in Fig. 1, this study conducts an empirical analysis by taking six branches of Iranian Eghtesade Novin bank. By reviewing the related backgrounds of efficient indices on an internal and external bank's environment, 43 and 26 efficient indices about the bank's internal and external environment have been acquired respectively. By making further inquiries, key indices were recognized and we request from supervisors and bank staff that they determine the degrees of significance of all previously mentioned indices (5 shows high important indices and 1 means low significant indices). Then, as illustrated in Tables 2 and 3, once an index has a mean upper than 2.5 degrees of significance, it was chosen as an efficient index and all of these indices were categorized into BSC perspectives. In the following tables' BSC column, the letters P, L, C and F are brought into play as four BSC perspectives (internal process, learning and growth, customers and

(15)

(16)

financial) respectively. The summary of calculations is as follows.

Table 2. The bank efficient weakness and strengths indices classified in BSC

Wi	Weakness	Score	BSC	Si	Strengths	Score	BSC
W1	Non development of e banking	3.48	P	S1	Keeping customers information secretly	4.42	L
W2	Bank's small effort for personnel education	3.39	L	S2	Suitable behavior with customers	4.26	C
W3	No marketing	3.30	P	S3	Suitable work hours for customers	4.12	C
W4	No royal customers	3.27	C	S4	Utilizing new banking methods	3.96	P
W5	Non of reward as a basis for organizational growth	3.25	L	S5	Decreased customers waiting time	3.84	C
W6	None of innovation in customer service	3.22	C	S6	Customers' trust to the bank	3.83	C
W7	none of exclusive services in the bank	3.20	C	S7	Bank's proper popularity	3.78	L
W8	the banks poor tasks for personnel	3.19	P	S8	Bank's appropriate capitals	3.67	F
W9	Insufficient number of the bank current loyal customers	3.15	C	S9	Bank's correct work Surrounding	3.64	P
W10	Non of personnel motivation system	3.14	L	S10	Specialized staffs for fine service	3.57	P
W11	Personnel inappropriate work hours	3.12	P	S11	Skilled manpower	3.54	P
W12	No utilizing the banks' potential in market changes	3.05	F	S12	Pursuit of customer complaints	3.54	C
W13	New branches Inappropriate extension along the city.	3.00	P	S13	Proper number of the bank staffs	3.50	P

Table 3. The bank efficient threats and opportunities indices classified in BSC

Ti	Threats	Score	BSC	Oi	Opportunities	Score	BSC
T1	Economic sanction	4.32	F	O1	Highly reputed customers	4.38	C
T2	Country's economic condition	4.18	F	O2	Increased demand deposit profit rate	3.92	F
T3	Bank's inactivity in international markets	3.84	P	O3	regulating bank and economic systems	3.85	P
T4	Governmental influence via central banks	3.84	P	O4	Assigning banks monetary resources to feasible plans	3.80	F
T5	Increased governmental liabilities to the bank	3.83	F	O5	Privatizing	3.62	P
T6	Increased inflation rate	3.56	F	O6	Customer awareness of other bank's services	3.56	C
T7	The banks' increased liabilities	3.56	F	O7	Decreasing bank's liabilities to central bank	3.52	F
T8	Disappointed customers on future economic conditions	3.42	C	O8	Governmental banks sanction from the west	3.40	F

T9	No use of IT for marketing	3.40	P	O9	Liquidity flow improvement	3.27	F
T10	Aided subsidence	3.15	F	O10	Increased governmental capitals in banks	3.24	F
T11	Privatizing governmental banks	3.13	P	O11	Utilizing financial resources to face with environmental changes	3.21	F
T12	Establishing new private banks	3.10	P	O12	The ability of the bank in recognizing positive changes	3.02	P

By determining these threats, opportunities, weakness and strengths, we can design the SWOT matrix. The managers and experts of the organizations can determine the strategies with this matrix. With regard to SWOT analysis, (SO, ST, WO and WT) strategies can be combined as in Table 4. After defining the strategies of the bank with the SWOT matrix, these strategies are divided into four perspectives of BSC. We can see this in Table 4.

Table 4. The bank strategies classified in BSC

NO	**SO Strategies**	**Description**	**BSC Perspective**
S1	S8,O4	Assigning the banks' financial resources to feasible economic plans.	F
S2	S2,S3,S4,S5,S6,S7,O1,O6	Value creating for customers	C
NO	ST Strategies	Description	BSC Perspective
S3	S1,S2,S3,S5,S6,S7,T1,T8,T11,T12	Keeping current customers and attempting for gaining new customers	C
S4	S10,S11,S4,T9.T3	Increasing number of active personnel in IT	P
NO	WO Strategies	Description	BSC Perspective
S5	W11,W13,O1,O6	Decreasing the amount of branches and focus on giving services to rich customers	C
S6	W3,W9,O1,O2,O6	Appropriate and efficient advertising	P
S7	W1,W6,W7,O1.O6,O8,O12	Innovation in services and exclusive services	L
S8	O11,O12,W12,W13	Concurrent changing with capital market changes	F
S9	W2,W8.W10.O3	endeavor for personnel education and designing motivation and reward system and creating loadstone jobs	L
NO	WT Strategies	Description	BSC Perspective
S10	W13,W11,T1,T3,T11.T12	Expanding the number of branches and adjusting banks' work hours	P
S11	W1.T9,T11.T12	Developing electronic banking	P

At continue, relationships among BSC's perspectives are determined by employing the DEMATEL technique. After putting BSC's perspectives across the bank, a propos 18 checklists were distributed among specialists and the bank managers, and they were requested to distinguish the effect of each of the four BSC's perspectives to BSC's other perspectives.

For recognizing relationships among BSC's perspectives some steps are mandatory.

Step 1: Defining elements and determining relations. Specialists and the banks managers' ideas are gathered in this stage and proficient indices of each BSC's perspectives are determined as illustrated in Tables 5, 6, 7 and 8. Then, DEMATEL is used to develop a total-relation matrix of the four evaluations.

Step 2: Establishing a direct relation matrix X. Ideas gathered from step1 are abridged in a (4×4) matrix, that is to say, the Z (4×4) matrix as shown in Table 5. The numbers inside the matrix demonstrate the influential degrees between one perspective and the others.

Step 3: Calculating direct normalized relation matrix. By means of equation (2) normalized direct matrix is created as in Table 6.

Step 4: Computing total-relation (direct/indirect) matrix. By introducing normalized matrix T and utilizing Eqs. (3), (4) and (5) total-relation matrix T is obtained as presented in Table 7.

Table 5. Direct relation matrix X between perspectives

	Financial(F)	Customers(C)	Learning and growth(L)	Internal Process(P)
Financial(F)	0.0000	2.8889	3.1111	3.2222
Customers(C)	2.7222	0.0000	2.9444	2.8889
Learning and growth(L)	2.7222	2.4444	0.0000	3.4444
Internal Process(P)	2.7778	2.8889	3.2778	0.0000

Table 6. Normalized direct relation matrix X

	Financial(F)	Customers(C)	Learning and growth(L)	Internal Process(P)
Financial(F)	0.0000	0.3133	0.3373	0.3494
Customers(C)	0.2952	0.0000	0.3193	0.3133
Learning and growth(L)	0.2952	0.2651	0.0000	0.3735
Internal Process(P)	0.3012	0.3133	0.3554	0.0000

Table 7. Total-relation (direct/indirect) matrix T

	Financial(F)	Customers(C)	Learning and growth(L)	Internal Process(P)
Financial(F)	5.3570	5.5892	6.1580	6.2722
Customers(C)	5.2850	5.0510	5.8169	5.9150
Learning and growth(L)	5.3170	5.2936	5.6109	5.9854
Internal Process(P)	5.4602	5.4606	6.0267	5.8696
Ri	21.4192	21.3944	23.6125	24.0422

Note: Numbers in bold are the perspectives which reach the threshold (5.6001). In order to find the influential relation between the evaluation perspectives, the median (5.6001) is put as the threshold in this research. As the value reaches or exceeds the threshold, the perspective is then considered to be more influential than the others. In this case, the value reaches or goes over the threshold in the total-relation matrix T (Table 7) is shown in bold. The construction of an ANP networked level framework is based on the total-relation matrix T. By using Eqs. (6) and (7) as shown in Table 8, the total amount of each row is presented by D_i and the total amount of each column is presented by R_j. The horizontal axis (D_i+R_j) presents the influential degrees of relations between elements, but vertical axis (D_i-R_j) represents the influential degrees of relations between one element and the other elements in the proposed BSC framework as illustrated in Figure 2. Concerning Table 8, it is observed that the biggest influential value (1.9572) is selected from one of the perspectives toward "Financial'' that has the highest value of (D_i-R_j).

Step 5: Drawing causal diagram. As shown in Table 8, (D + R) is X-axis and (D - R) is Y-axis. Taking Financial, Customer, Internal process and Learning and growth, the relation of these four perspectives reaches the Threshold. Drawing a causal diagram as in Fig. 3, it is clear that financial and learning (growth) perspectives are the main and trivial perspectives respectively. Based on the above cause & effect diagram, the relation among the four BSCs' perspectives is as shown in Fig 3.

These relationships organize an ANP structure. This structure is shown in Fig 3.

Table 8. Total-relation matrix with (Di + Ri) and (Di-Ri)

RANK	Y-axis, $D_i - R_j$	X-axis, $D_i + R_j$	RANK	
1	1.9572	44.7956	3	**Financial(F)**
2	0.6735	43.4623	4	**Customers(C)**
4	-1.4056	45.8194	2	**Learning and growth(L)**
3	-1.2251	46.8593	1	**Internal Process(P)**

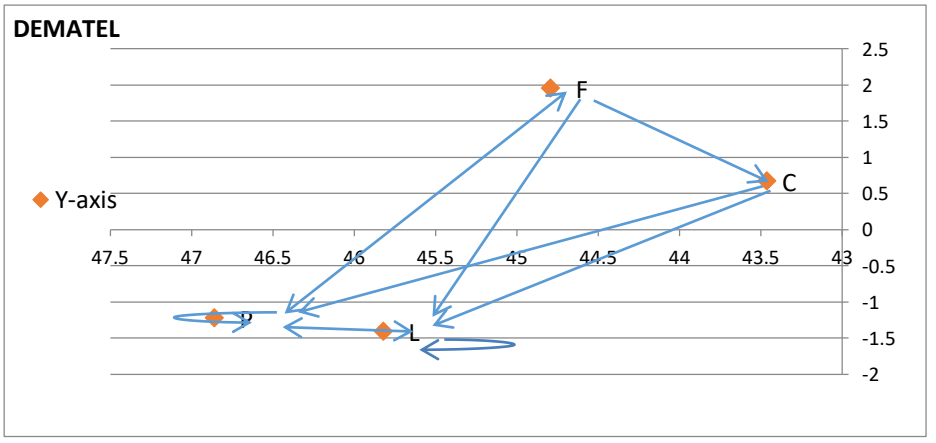

Fig 2. Total-relation matrix with (Di + Ri) and (Di-Ri)

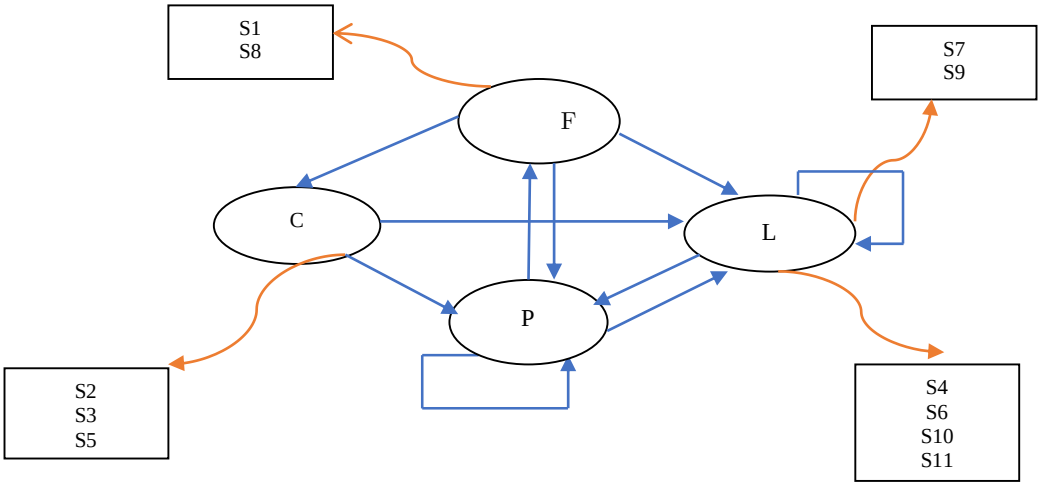

Figure 3. ANP networked evaluation structure

After applying of DEMATEL to analyze the mutual influential of BSC perspectives, we use the ANP questionnaire. In this study we use the opinions of experts. Data about expert ideals were collected and then entered into ANP software of Super Decision to obtain strategies ranking.

With regard to SWOT analysis, four (SO, ST, WO and WT) strategies can be combined as in Table 4. After defining the strategies of the bank (Table 4), the relation between elements is judged by professionals subjectively. The checklist is based on comparing strategies from each pair of strategies and it is represented by numbers from 1 to 9 to present ‘‘equal importance’’ to ‘‘very high importance’’ Geometric mean of specialists and the bank managers’ opinions about the importance of each strategy in comparison to other strategies through pair-wise comparison is illustrated in Table 9.

After normalizing the aforementioned gathered specialists and the bank managers’ opinions, we ranked the strategies based on ANP method. These strategies ranks are shown in Table 10.

Si	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
S1	1.0000	1.4339	0.8960	2.8275	1.8852	0.6434	0.1905	0.2313	0.2330	1.2920	0.2367
S2	0.6974	1.0000	0.5674	0.9456	1.5824	0.6376	0.3535	0.4082	0.2503	0.9319	0.2484
S3	1.1161	1.7625	1.0000	0.6555	1.5971	0.3577	0.2570	0.2905	0.2779	1.4016	0.2708
S4	0.3537	1.0576	1.5255	1.0000	1.3994	0.2623	0.1671	0.2514	0.2757	0.3277	0.2500
S5	0.5304	0.6320	0.6261	0.7146	1.0000	0.2891	0.2354	0.2924	0.2894	0.7882	0.2021
S6	1.5543	1.5683	2.7956	3.8120	3.4587	1.0000	0.5849	0.2603	0.3247	1.1822	0.3239
S7	5.2506	2.8287	4.0524	5.9858	4.2480	1.7096	1.0000	0.6757	0.4056	1.3580	0.4144
S8	4.3242	2.4495	3.4418	3.9780	3.4197	3.8415	1.4799	1.0000	0.5315	1.0576	0.7062
S9	4.2911	3.9955	3.5989	3.6267	3.4559	3.0799	2.4653	1.8813	1.0000	1.4656	1.0313

S10	0.7740	1.0731	0.7135	3.0514	1.2687	0.8459	0.7364	0.9456	0.6823	1.0000	0.4274
S11	4.2255	4.0264	3.6934	1.4160	4.9492	3.0876	2.4132	1.4160	0.9696	2.3399	1.0000

Table 9. Geometric mean of the bank managers' opinions

Table10. The banks' strategies ranking with ANP method

Rank	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Strategies	S9	S11	S8	S7	S10	S6	S3	S1	S2	S4	S5

As a final point, a fuzzy questionnaire was designed. It was represented by linguistic variables to present ''very bad'' to ''very good''. To more clearly illustrate the quantity of the banks' strategy accessibilities, it was entreated from the banks' employees to sort the banks' branches. Arithmetic normalized mean of the banks' employee opinions is considered as fuzzy weights as follows:

Now, we apply proposed fuzzy DEA model for strategic efficiency of 6 branches of Iranian banks. We use the strategies rank for weight restrictions of the DEA model. Model (7) with restricted multiplier transformed to the following model:

Table11. Fuzzy Number

Very Bad	0	0	2
Bad	0	2	4
Relatively Bad	2	4	6
Relatively Good	4	6	8
Good	6	8	10
Very Good	8	10	10

Table12. Arithmetic normalized mean of the banks' employee opinions

S5			S4			S3			S2			S1			BRANCH
0.46	0.66	0.86	**0.40**	**0.60**	**0.80**	0.43	0.63	0.82	**0.57**	**0.77**	**0.91**	0.37	0.55	0.74	DMU(1)
0.32	0.49	0.69	**0.31**	**0.49**	**0.66**	0.48	0.68	0.88	**0.60**	**0.80**	**0.92**	0.43	0.63	0.82	DMU(2)
0.36	0.56	0.76	**0.22**	**0.40**	**0.60**	0.40	0.60	0.78	**0.58**	**0.78**	**0.88**	0.32	0.50	0.70	DMU(3)
0.40	0.60	0.80	**0.35**	**0.55**	**0.73**	0.45	0.65	0.83	**0.55**	**0.75**	**0.92**	0.37	0.57	0.77	DMU(4)
0.54	0.74	0.88	**0.50**	**0.70**	**0.90**	0.54	0.74	0.88	**0.58**	**0.78**	**0.98**	0.46	0.66	0.80	DMU(5)
0.28	0.46	0.66	**0.38**	**0.58**	**0.78**	0.38	0.58	0.76	**0.48**	**0.68**	**0.84**	0.40	0.60	0.80	DMU(6)
S10			S9			S8			S7			S6			BRANCH
0.32	0.51	0.71	**0.29**	**0.49**	**0.68**	0.38	0.58	0.78	**0.20**	**0.38**	**0.58**	0.31	0.49	0.68	DMU(1)
0.35	0.54	0.72	**0.35**	**0.54**	**0.74**	0.35	0.55	0.75	**0.31**	**0.51**	**0.69**	0.45	0.65	0.80	DMU(2)
0.26	0.44	0.64	**0.54**	**0.74**	**0.90**	0.34	0.54	0.74	**0.28**	**0.46**	**0.64**	0.32	0.48	0.68	DMU(3)
0.32	0.52	0.70	**0.43**	**0.63**	**0.82**	0.33	0.52	0.72	**0.23**	**0.42**	**0.62**	0.33	0.53	0.73	DMU(4)
0.42	0.62	0.82	**0.44**	**0.64**	**0.82**	0.44	0.64	0.84	**0.40**	**0.60**	**0.78**	0.46	0.66	0.86	DMU(5)
0.24	0.42	0.62	**0.26**	**0.46**	**0.64**	0.26	0.44	0.64	**0.26**	**0.46**	**0.66**	0.32	0.52	0.72	DMU(6)

S11			BRANCH
0.29	0.46	0.65	DMU(1)
0.40	0.58	0.78	DMU(2)
0.24	0.44	0.62	DMU(3)
0.32	0.50	0.70	DMU(4)
0.56	0.76	0.94	DMU(5)
0.48	0.68	0.86	DMU(6)

$$
\begin{aligned}
&Min\ u_0 \\
&s.t \\
&\textstyle\sum_{r=1}^{S} u_r \hat{y}_{rj} - u_0 \le 0, \\
&j = 1, \dots, n \\
&\textstyle\sum_{r=1}^{S} u_r \hat{y}_{r0} = 1 \\
&u_r \ge 0, \quad r = 1, \dots, S \\
&u_9 \ge u_{11} \\
&u_{11} \ge u_8 \\
&u_8 \ge u_7 \\
&u_7 \ge u_{10} \\
&u_{10} \ge u_6 \\
&u_6 \ge u_3 \\
&u_3 \ge u_1 \\
&u_1 \ge u_2 \\
&u_2 \ge u_4 \\
&u_4 \ge u_5
\end{aligned}
\qquad (8)
$$

Now we apply this model for strategic performance. Note that in this case, we have no inputs and the proposed model is based on only fuzzy outputs. By applying the model (20), we obtained the results which are shown in Table 13.
As can be seen in Table 13, the strategic performance ranking of DMUs is:
$DMU_6 \gg DMU_1 \gg DMU_2 \gg DMU_4 \gg DMU_3 \gg DMU_5$

A manager can understand the strategic situation with these results. Since understanding the strategies is a major step in applying them, we can say that these results are reliable. On the other hand, using the ANP method or the same subjective methods for strategic ranking is based on managers judgments. So these results may be biased, since the ranking of DMUs with DEA models is based on scientific method. We combine the ANP method with DEA model to determine the correct weights of the indexes. Hence, these results are more reliable.

Table13. Results of strategic performance

No. of DMUs	Performance Evaluation	Performance Ranking
DMU_1	1.2162	2
DMU_2	1.1107	3
DMU_3	1	5
DMU_4	1.0844	4
DMU_5	1	6
DMU_6	1.2301	1

5. Discussion and Conclusions

In this study, we proposed a framework for strategic performance evaluation. Managers can determine and control the performance trend in their organizations with this evaluation framework. There are many studies about efficiency, effectiveness, profitability, marketability and etc. in the literature of performance evaluation. But the studies about strategic performance in organizations are very low. Our proposed model has several steps for

evaluation of performance. In step 1, we determined the weaknesses, strengths, threats and opportunities of organizations. We then divided these measures to four perspectives of the BSC model. It must be mentioned that, organizations must do the strategic management process to obtain their weaknesses, strengths, threats and opportunities. In the next step, the SWOT matrix is used to determine strategies of organization and then these strategies are divided into four perspectives of BSC. In the next step we use the DEMATEL technique to create the relationships among the four perspectives of BSC. We can determine an ANP structure using the DEMATEL technique. In the next step, we use ANP method to rank the strategies and, finally, based on doing these strategies, the DMUs were ranked with fuzzy DEA model. Since we have only outputs in performance evaluation, we use the DEA model with only outputs. We must say that, since the ANP method and the same subjective methods are based on managers and expert ideal; we combine the ANP method with the DEA model to obtain the correct ranking of DMUs, because the DEA model is based on mathematical logic and far from managers and experts bias.

So this framework applies to the strategic performance of 6 bank branches in Iran. The results show that the bank branches ranking is:

$DMU_6 \gg DMU_1 \gg DMU_2 \gg DMU_4 \gg DMU_3 \gg DMU_5$

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