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COMPARISON OF PERFORMANCE EVALUATION OF IRANIAN BANKS USING FUZZY AHP, FUZZY TOPSIS AND BALANCED SCORECARD (BSC) APPROACH

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ABSTRACT

The purpose of this paper is the selection of the best bank in Iranian bank industry by using Balanced Score card and using F-AHP, F-TOPSIS techniques. In this study, regarding to the different levels of sub-scale used for BSC measuring indexes were ranked in Iranian banking industry by using fuzzy AHP and Fuzzy TOPSIS. The results of the analysis revealed that the financial *dimension was the primary focus of the BSC and ‘‘*Net profit*’’ was the most important evaluation index. The results obtained from both methods indicate that private bank is more significant than semi private bank and State-owned bank in banking.*

Keywords:
Balanced score card (BSC), Performance evaluation, Fuzzy AHP, Fuzzy TOPSIS.

1. Introduction

The extant literature has focused extensively on the determinants of bank performance. In the last two decades, organizations have actively been in search of competitive advantages such as product leadership, cost leadership, and making differentiation from their competitors (Belkhaoui et al., 2014). Performance evaluation is a process used to evaluate the progress in achieving the determined goals, concluded

information about product efficiency, given services and customer satisfaction, achievements and activity effectiveness (Wu et al., 2011). Extensive changes in today's business environment have caused organizations and managers to show more sensitivity concerning their performance which results in increasing consideration towards employees' performance. In this respect, organizations need people who go beyond their defined career duties, tend to develop cooperation, and help colleagues' employers and clients (Shahin *et al.*, 2014). The BSC system considers the traditional financial key performance indicators (KPIs) as well as leading KPIs of future performance. In this way, it provides key information about the activities of the managers (Valmohammadi and Ahmadi, 2015). The relationship between market structure and bank performance is based on the traditional paradigm "structure–conduct–performance" (SCP) of "collusion." Banks are able to extract rent profits "charter value" as the market is becoming more concentrated, given their ability to pay low rates on deposits and receive high rates on loans. Thus, regardless their management style, banks are likely to make abnormally high profits as the market becomes more concentrated (Belkhaoui et al., 2014). The BSC is a PMS theorized by Kaplan and Norton who was first created as a performance measurement tool, then it has evolved in to a PMS, and subsequently becoming a comprehensive strategic management system (Janes, 2013).

On the other hand, deregulation, consolidation and disintermediation are trends that have spurred a broad and long strand of academic research into the competitiveness, stability and efficiency of banks and banking markets (Bos and kool, 2006). The privatization of the banking sectors in the CEE economies, combined with low entrance barriers for foreign investors during the last 15 years, resulted in an extremely high share of foreign banking participation. In some of these countries, foreign banking assets make up more than 90% of total banking assets in 2002 (Haselmann, 2006). As BSC is a comprehensive approach considering an organization's performance criteria both form financial and non-financial perspective. A strong metrics program can quantify efforts of different business units and departments, and then roll them up to show impacts to overall business performance (Valmohammadi and Ahmadi, 2015).It is evident from recent studies of the BSC that the distinctions between different versions of the scorecard are still not being made explicit. This is shown in Taylor and Baines' study (2012), which assessed the reasons why UK universities are increasingly making use of strategic management tools such as the BSC. Whilst they conclude that by using the BSC, universities manage to enhance their competitiveness through following strategies more rigorously, it is not clear which generation of BSC, the universities actually implemented and which is fundamental in understanding the process of adoption. Senior strategic and operational managers in headquarters of large organizations follow management fashions that lead them to use systems and routines thought to be effective for influencing employees' problem-solving and performance (Antonsen, 2014). Such performance measurement system is the BSC. In this survey, because of the comprehensiveness of BSC for evaluating performance and its increasing

use for strategic management topics, its four aspects have been used as a basis for evaluating organizational performance.

AHP provides a measure through the consistency ratio (C.R.) which is an indicator of the reliability of the model (Chang et al., 2015). The main topic of our research is to determine the performance of the business with performance indicators of the balanced scorecard and prioritized the banks, using BSC. The purpose of this paper is the selection of the best bank in Iranian bank industry by using Balanced Score card and using F-AHP, F-TOPSIS techniques .In this study, private bank, semi-private bank and state-owned bank are prioritized according to BSC criteria (meaning financial, customer, internal business process, learning and growth) and financial, customer, internal business process, learning and growth sub-criteria by using fuzzy analytic hierarchy process (F-AHP) and Fuzzy TOPSIS.

2. Literature of the research

This section briefly reviews the underlying concepts adopted by this research, such as the definitions of performance evaluation, and Balanced Score card (BSC).

2.1- Definitions of Performance evaluation

In the real world, performance evaluation different approaches can be applied (Haeri and Rezaie, 2014). Evaluating business performance is one of the most important management agendas; because the ability to continually evaluate organizational performance is the key factor to access continuous improvement. Many organizations have understood the importance of continuous evaluation of performance, and they are applying various approaches of performance evaluation in the organization (Shahin *et al*., 2014). It is also used to measure the business performance in hotel industries (Wu and Lu, 2012). Different countries use different common models of performance evaluation to measure the productivity of their services and executive agencies. Wu (2012) presented a structural evaluation methodology to link key performance indicators (KPIs) into a strategy map of the BSC for banking institutions. Grigoroudis *et al.* (2012) developed a performance measurement system for public health care organizations in the context of BSC methodology. In order to make a performance management system successful, i.e. it is regularly used by managers and the results are used in improving organizational performance (De Waal and Gerritsen-Medema, 2006). Enhancing organizational performance is the focus of every manager in every enterprise. In order to succeed at enhancing organizational performance, it is crucial for an organization to establish a comprehensive measurement index that provides managers and staff with clear directions and goals set by the enterprise (Tseng and Lee, 2014). Performance management is a continuous process of identifying, measuring, and developing the performance of individuals and teams and aligning performance with the strategic goals of the organization (Aguinis and kraiger, 2009). Organizational performance is an indicator which measures how well an organization accomplishes its objectives (Ho, 2008). For all

organizations the question of the management of the organization depends on the ability to measure performance and then evaluate and report upon that performance (Crowther and Aras, 2008). Between 1850 and 1975, organizations had evaluated performance solely according to financial criteria, and they have therefore been criticized because of some reasons such as, it encourages a short-term viewpoint, it lacks strategic concentration and lacks the ability to provide data about quality, responsiveness, and flexibility and it fails to provide information about what customers want and the quality of competitors' performance. Research on performance management systems has shown that how exclusive focus on financial success may hinder organizational growth. The BSC is therefore constructed to balance long-term and short-term objectives, financial and non-financial measures, and internal and external factors that contribute to enhanced performance (Antonsen, 2014). At present, the four models of Deming, Baldrige, European Quality Award and Balanced Score Card are the most widely applied ones. Although every performance evaluation system aims to lead the managers and employees toward the successful implementation of the strategies of the organization, the organizations which are able to translate their strategies into the performance evaluation system do far better in implementing their strategies; because they communicate their aim to all the organization's personnel. However, BSC is a card in which the strategy is connected to an integrated set of financial and non-financial indices (Kaplan,1994).

2.2- Definitions of Balanced Score-Card (BSC)

The BSC is a popular tool that is applied by many businesses to assess their performance in diverse aspects of their organization (Hashemkhani-Zolfani and Safaei-Ghadikolaei, 2012). However, the BSC technique ignores environmental and social aspects as essential pillars of a sustainable business; so new methods were developed to cure the problem. Rabbani et al. believed that BSC can help to take all aspects relevant for achieving sustainability into account simultaneously and in a balanced manner (Rabbani *et al*., 2014). While providing executives' information from the four different perspectives, the BSC considers various organizational practices and simultaneously minimizes information overload by limiting the number of measures used. Since then, many companies have already adopted the BSC for measuring their organizational performance (Wu and Chen, 2014). The BSC was first developed and proposed by Robert Kaplan and David Norton in 1992 and aimed to combine the use of financial and non-financial measures and provide managers with richer, more detailed information than financial measures alone. The scorecard concept has evolved over a number of years through a series of papers and books by Kaplan and Norton transforming the scorecard concept from an innovative, but relatively simple performance measurement tool, through to a complex PMS (Perkins *et al*., 2014). The BSC was designed as a managerial tool to help individual companies that have overemphasized short-term financial performance. This managerial tool enables the companies to develop a more comprehensive view of their operations and provides a clear prescription of what companies should measure to evaluate the implications arising

out of the strategic intent (Cunha-Callado and Jack, 2015). The BSC seeks to measure both productivity and learning in the organization. The system gathers data from a wide range of work processes rather than just a single financial measurement of performance. Managers regard various measurements as especially helpful in revealing factors that relate to cause-effect relationships in the organization (Antonsen, 2014). BSC provides a comprehensive framework for managers to modify the strategy of the enterprise in to a coherent set of performance criteria (Kaplan and Norton, 1992). BSC, in contrast to the traditional evaluation system which only included financial criteria, has been designed in such a way that it improves managers' decision making through leading their attention towards wider dimensions of the operations of the enterprise (Shahin *et al*., 2014).

The BSC includes four perspectives to operationalize organizational strategy:

1. **Financial:** The Financial perspective measures the financial status and change of the organization.

2**. Customer:** The Customer perspective measures customer outcomes such as market share, customer retention, customer acquisition, customer satisfaction, and customer profitability.

3**. Internal business process:** The perspective of Internal Business Processes identifies important internal processes in the organization, and measures i.e. quality, response time, cost and the introduction of new products.

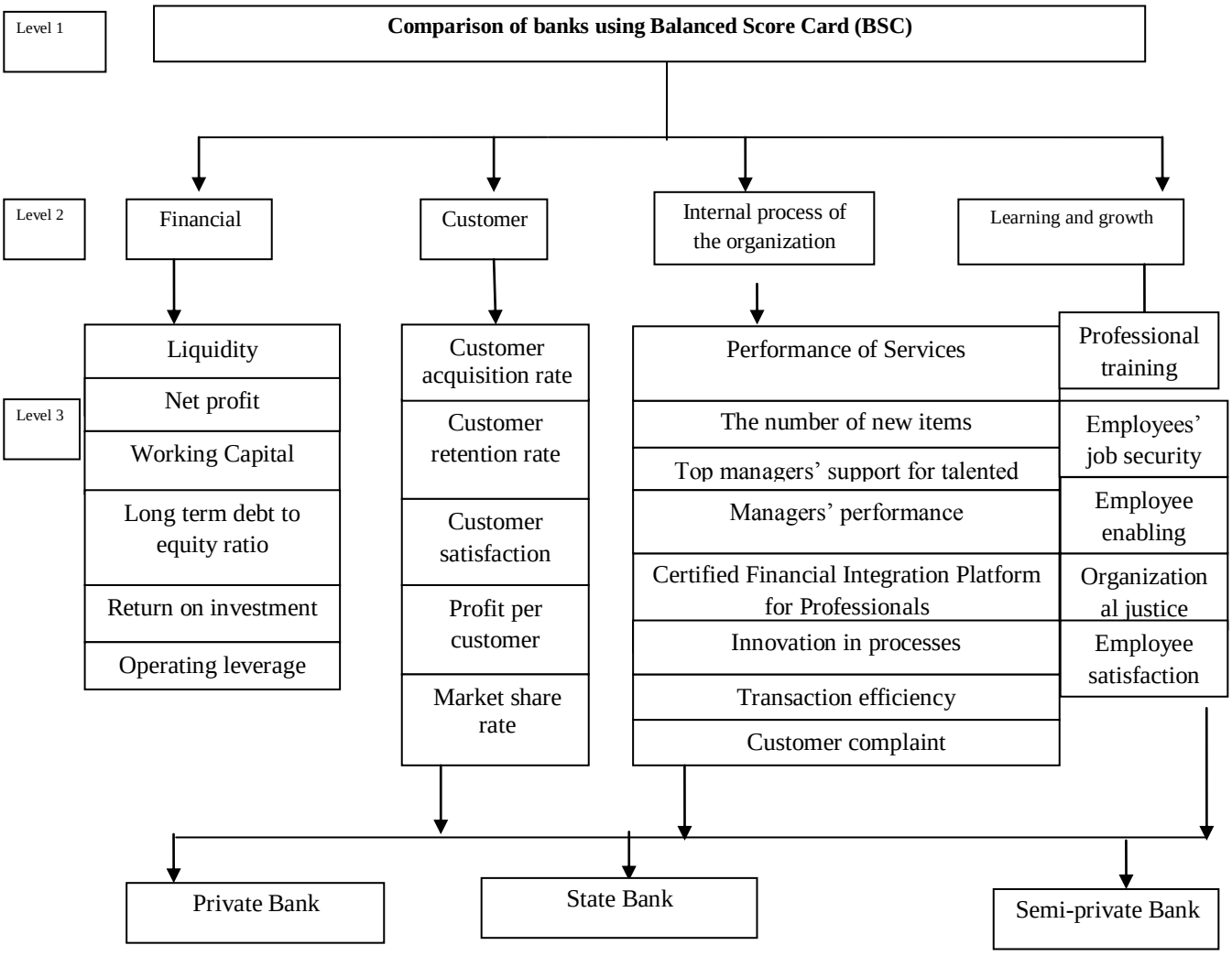
4**. Learning and growth:** The Learning and Growth perspective measures employees' satisfaction and learning, and identifies new systems and organizational procedures that create the requirement and foundation for long-term development and innovation (Antonsen, 2014).

The BSC objectives and measures are determined by organizational visions and strategies and are intended to measure organizational performance using the four perspectives. Since its introduction, BSC has been adopted by many companies as a foundation for strategic management system. It has helped managers to align their businesses to new strategies towards growth opportunities based on more customized, value-adding products and services and away from simply cost reduction (lee *et al*., 2008).

3. Methodology

In present study, conceptual models is presented in figure 1 and the conceptual model of this study is adopted from the studies done by Wu *et al*. (2009), Wu liu (2010), Anvari-Rostami *et al*. (2012) and Lee *et al*.(2011). Level 2 and level 3 in the mentioned figure include criteria and sub-criteria for customer, internal business process, financial and Learning and growth.

Figure1. Hierarchical framework of comparison of banks using Balanced Scorecard (BSC)



Fuzzy TOPSIS and F-AHP methods were used to analyze the data. The Fuzzy Analytic Hierarchy Process (F-AHP) method was used to analyze the obtained data with Chang's (1996) Extent Analysis method. Banking industry experts' opinions about comparison of elements of each level using geometric mean are combined and finally a comparative table to compare elements of each level is obtained. The weight of each element in each level is obtained by using hierarchical analysis method. Banks (state banks, semi-private banks and private banks) were ranked based on Fuzzy TOPSIS method. According to the subjective nature of research model and experts opinion, expert specialists of three Iranian banks in banking industry were selected as expert. Banks in banking industry have been examined in current study included: 1-Melli, 2-Saderat and 3-Sarmaye in Tehran province. Regarding the thematic nature of research model, experts' opinions in Melli Bank (in central branches) as a representative of state banks, Saderat bank (in central branches) as the representative of semi-private banks and Sarmaye Bank (in central branches) as the representative of private banks have been selected. At this stage the importance of

each intended option is determined by expert. Numbers of experts participating in the study were 30 persons who were interested in improving discussion. They were managers with experience of over 20 years in mentioned banks. Questionnaire was used as main research tool.

3.1- Fuzzy analytic hierarchy process

Despite its wide range of application, the conventional AHP approach may not be able to fully reflect the style of human thinking. One reason is that decision makers usually feel more confident to give interval judgments rather than express their judgments in the form of single numeric values. As a result, fuzzy AHP and its extensions are developed to solve alternative selection and justification problems. Although fuzzy AHP requires tedious computations, it is capable of capturing a human's appraisal of ambiguity when complex multi-attribute decision making problems are considered. Chang (1996) developed a fuzzy extent analysis for AHP, which has similar steps to those of Saaty's crisp AHP. However, his approach is relatively easier in computation than the other fuzzy AHP approaches. In this paper, we made use of Chang's fuzzy extent analysis for AHP.

Let O = {o_1, o_2. . . on} be an object set, and U = {g_1, g_2, . . ., g_m} be a goal set. According to the Chang's extent analysis, the objects are considered one by one and the analysis is carried out for each of the possible goals (g_i).

Therefore, m extent analysis values for each object is obtained and shown as follows:

$$M_{g_i}^1, M_{g_i}^2, \dots, M_{g_i}^m, \quad i = 1,2,\dots,n$$

Where $M_{g_i}^i \quad (j = 1,2,\dots.m)$ are all triangular fuzzy numbers. The membership function of the triangular fuzzy number is denoted by $M(x)$. The definitions of the triangular fuzzy number and the fuzzy algebraic operations for fuzzy triangular numbers are given in as follows:

The definition of the triangular fuzzy number and the operational laws of triangular fuzzy numbers

The membership function M(X): R→[0,1] of the triangular fuzzy number M= (l,m,u) defined on *R* is equal to

Where $\begin{Bmatrix} \frac{x}{m-l} - \frac{1}{m-l}, & x \in [l,m] \\ \frac{x}{m-u} - \frac{u}{m-u}, & x \in [m,u] \\ 0, & otherwise \end{Bmatrix}$ l≤m≤u and, *l* and *u* are respectively lower and upper values of the support of M[1].

According to Zadeh's extension principle given two triangular fuzzy numbers $M_1=(l_1,m_1,u_1)$and $M_2=(l_2,m_2,u_2)$.

The steps of the Chang's extent analysis can be summarized as follows:

Step 1: The value of fuzzy synthetic extent with respect to the *I* th object is defined as:

$$S_i = \sum_{j=1}^{m} M_{g_i}^i \times [\sum_{i=1}^{n} \sum_{j=1}^{m} M_{g_i}^i]^{-1} \quad (1)$$

Where $\times$ denotes the extended multiplication of two fuzzy numbers. In order to obtain $\sum_{j=1}^{m} M_{g_i}^j$, we perform the addition of m extent analysis values for a particular matrix such that,

$$\sum_{j=1}^{m} M_{g_i}^i = \left(\sum_{j=1}^{m} l_j, \sum_{j=1}^{m} m_j, \sum_{j=1}^{m} u_j\right) \quad (2)$$

And to obtain $[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{g_i}^i]^{-1}$ we perform the fuzzy addition operation of $M_{g_i}^j \quad (i = 1,2, \ldots . m)$ values such that,

$$\sum_{i=1}^{n} \sum_{j=i}^{m} M_{g_i}^i = (\sum_{i=1}^{n} l_i, \sum_{i=1}^{n} m_i, \sum_{i=1}^{n} u_i) \quad (3)$$

Then, the inverse of the vector is computed as,

$$[\sum_{i=1}^{n} \sum_{j=i}^{m} M_{g_i}^i]^{-1} = \left(\frac{1}{\sum_{i=1}^{n} u_i}, \frac{1}{\sum_{i=1}^{n} m_i}, \frac{1}{\sum_{i=1}^{n} l_i}\right)$$

Where $\forall u_i, m_i, l_i > 0 \quad (4)$

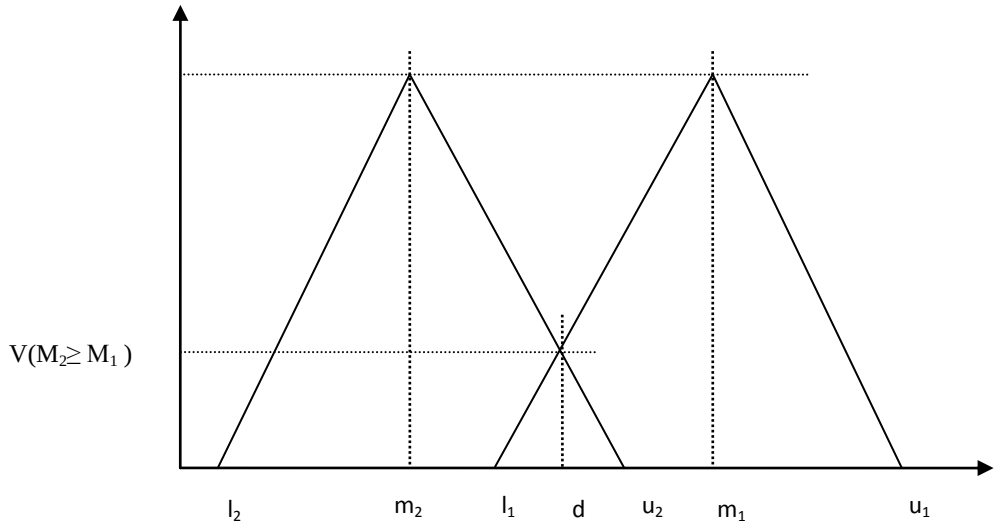
Finally, to obtain the S_j in Eq. (1), we perform the following multiplication:

$$S_i = \sum_{j=1}^{m} M_{g_i}^i \times [\sum_{i=1}^{n} \sum_{j=1}^{m} M_{g_i}^i]^{-1}$$

$$= \left(\sum_{j=1}^{m} l_j \times \sum_{i=1}^{n} l_i, \sum_{j=1}^{m} m_j \times \sum_{i=1}^{n} m_i, \sum_{j=1}^{m} u_j \times \sum_{i=1}^{n} u_i\right) \quad (5)$$

Step 2: The degree of possibility of $M_2 = (l_2, m_2, u_2) \geq M_1 = (l_1, m_1, u_1)$ is defined as

Figure 2. The degree of possibility of $M_1 \geq M_2$



$$V(M_2 \geq M_1) = sup_{y \geq x}[\min\,(M_1(x), M_2(y)] \qquad (6)$$

Which can be equivalently expressed as,

$$V(M_2 \geq M_1) = hgt(M_1 \cap M_2) = M_2(d) = \left\{ \begin{array}{c} 1\ if\ m_2 \geq m_1 \\ 0\ if\ l_1 \geq u_2 \\ \frac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)}, Otherwise \end{array} \right\} \qquad (7)$$

Fig.2 illustrates $V(M_2 \geq M_1)$, for the case $m_2 < l_1 < u_2 < m_1$, where *d* is the abscissa value corresponding to the highest crossover point *D* between M_1 and M_2. To compare $M_1$and M_2, we need both values $V(M_1 \geq M_2)$ and $V(M_2 \geq M_1)$.

Step 3: The degree of possibility for a convex fuzzy number to be greater than k convex fuzzy numbers $M_i(i = 1,2, \ldots, k)$ is defined as

$V(M \geq M_1, M_2, \ldots, M_K)$ = min $V(M \geq M_i)$, *i=1,2,…,k.*

Step4: Finally,$W = (minV(S_1 \geq S_K) minV(S_2 \geq S_K), \ldots, minV(S_n \geq S_k))^T$ is the weight vector for *k=1,…,n* (Erensal *et al*.,2006).

3.2- Aggregation of group decisions

Fuzzy pairwise comparisons can be combined by the use of the following algorithm (Chang *et al*.,

2009):

$$lij = min(lijk), \quad m_{ij} = \left(\prod_{k=1}^{k} mijk\right)^{\frac{1}{k}}, uij = max(uijk) \tag{8}$$

Where (*lijk*, *mijk*, *uijk*) are the fuzzy evaluation of sample members *k* (*k* = 1,2, … ,*K*). However, min and max operations are not appropriate if the sample has a wide range of upper and lower bandwidths, in other words, if evaluations are inhomogeneous. We have to consider that if only one or few decision makers deliver extreme *lijk* and/or *uijk*, the whole span of fuzzy numbers (*lij*, *mij*, *uij*) gets huge. Due to the required number of multiplication and addition operations, the aggregated fuzzy weights can even exceed the 0-1 borders or become irrational (Mikhailov, 2003), which is of course, unsatisfactory. Therefore, we decided to use the geometric mean also for *lij* and *uij* which delivers satisfying fuzzy group weightings. Geometric mean operations are commonly used within the application of the AHP for aggregating group decisions (Davies, 1994):

$$lij = \left(\prod_{k=1}^{k} lijk\right)^{\frac{1}{k}}, mij = \left(\prod_{k=1}^{k} mijk\right)^{\frac{1}{k}}, uij = \left(\prod_{k=1}^{k} uijk\right)^{\frac{1}{k}} \tag{9}$$

3.3- Fuzzy TOPSIS

The TOPSIS method was firstly proposed by Hwang and Yoon (Hwang and Yoon, 1981). The basic concept of this method is that the chosen alternative should have the shortest distance from the positive ideal solution and the farthest distance from negative ideal solution. Positive ideal solution is a solution that maximizes the benefit criteria and minimizes cost criteria, whereas the negative ideal solution maximizes the cost criteria and minimizes the benefit criteria (Wang and Elhag, 2006). In the classical TOPSIS method, the weights of the criteria and the ratings of alternatives are known precisely and crisp values are used in the evaluation process. However, under many conditions crisp data are inadequate to model real-life decision problems. Therefore, the fuzzy TOPSIS method is proposed where the weights of criteria and ratings of alternatives are evaluated by linguistic variables represented by fuzzy numbers to deal with the deficiency in the traditional TOPSIS. In this paper, the extension of TOPSIS method is considered which was proposed by Chen (Chen, 2000) and Chen *et al* (Chen *et al*., 2006). The algorithm of this method can be described as follows:

Step 1: First of all, a committee of decision-makers is formed. In a decision committee that has *K* decision-makers; fuzzy rating of each decision-maker *Dk= (k=1, 2,...K)* can be represented as triangular fuzzy number

$\tilde{R}_k$ = (K=1, 2,… , K) with membership function $\mu_{\tilde{R}_k}$

Step 2: Then evaluation criteria are determined.

Step 3: After that, appropriate linguistic variables are chosen for evaluating criteria and alternatives.

Step 4: Then the weights of criteria are aggregated

If the fuzzy ratings of all decision-makers are described as triangular fuzzy numbers $\tilde{R}_k = (a_k, b_k, c_k)$, $k=1, 2... K.$, then the aggregated fuzzy rating can be determined as $\tilde{R}=(a, b, c)$, $k=1,2,..., K.$ Here; $a= min_{\{a_k\}}$

$B= \frac{1}{k}\sum_{k=1}^{k} b_k$, $c=max\{c_k\}$ (10)

If the fuzzy rating and importance weight of the kth Decision-maker are $\widetilde{x_{ijk}}=(a_{ijk}, b_{ijk}, c_{ijk})$ and $\widetilde{w_{ijk}}=(w_{jk1}, w_{jk2}, w_{jk3})$, $i=1,2,...,m$, $j=1,2,...,n$ respectively, then the aggregated fuzzy ratings $(\tilde{x}_{ij})$ of alternatives with respect to each criterion can be found as $(\tilde{x}_{ij})=(a_{ij}, b_{ij}, c_{ij})$

Here, $aij= min\{a_{ijk}\}$ $Bij= \frac{1}{k}\sum_{k=1}^{k} b_{ijk}$ $c= max\{c_{ijk}\}$ (11)

Then the aggregated fuzzy weights $(\tilde{w}_{ij})$ of each criterion are calculated as:

$(\tilde{w}_j)=(w_{j1}, w_{j2}, w_{j3})$

Here, $W_{j1}= min\{w_{jk1}\}$, $w_{j2}=\frac{1}{k}\sum_{k=1}^{k} w_{jk2}$, $w_{j3}= \max\{w_{jk3}\}$ (12)

Step 5: Then the fuzzy decision matrix is constructed as:

$$\tilde{D}=\begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} & \cdots & \tilde{x}_{1n} \\ \tilde{x}_{21} & \tilde{x}_{22} & \cdots & \tilde{x}_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ \tilde{x}_{m1} & \tilde{x}_{m2} & \cdots & \tilde{x}_{mn} \end{bmatrix}, \quad \tilde{w}=(\tilde{w}_1, \tilde{w}_2, \ldots, \tilde{w}_n)$$

Here $(\tilde{x}_{ij})=(a_{ij}, b_{ij}, c_{ij})$ and $(\tilde{w}_j)=(w_{j1}, w_{j2}, w_{j3})$; $i=1, 2,...m$, $j=1, 2,...n$ can be approximated by positive triangular fuzzy numbers.

Step 6: After constructing the fuzzy decision matrix, it is normalized. Instead of using complicated normalization formula of classical TOPSIS, the linear scale transformation can be used to transform the various criteria scales into a comparable scale. Therefore, we can obtain the normalized fuzzy decision matrix **:**

$\tilde{R}_{:}[\tilde{r}_{ij}]_{m\times n}$, $i=1, 2,..., m$; $j=1,2,...,n$

Where:

$$\left.\begin{array}{l} \tilde{r}_{ij} = \left(\frac{a_{ij}}{c_j^*}, \frac{b_{ij}}{c_j^*}, \frac{c_{ij}}{c_j^*}\right) \quad \text{and} \\ c_j^* = \max_i c_{ij} \quad \text{(benefit criteria)} \end{array}\right\}$$

$$\left.\begin{array}{l} \tilde{r}_{ij} = \left(\frac{a_j^-}{c_{ij}}, \frac{a_j^-}{b_{ij}}, \frac{a_j^-}{a_{ij}}\right) \quad \text{and} \\ a_j^- = \min_i a_{ij} \quad \text{(cost criteria)} \end{array}\right\} \quad (13)$$

Step 7: Considering the different weight of each criterion, the weighted normalized decision matrix is computed by multiplying the importance weights of evaluation criteria and the values in the normalized fuzzy decision matrix. The weighted normalized decision matrix $\tilde{V}$ is defined as: =

$$\tilde{V}=[\tilde{V}_{ij}]_{m\times n}, \quad i=1, 2,..., m; \quad j=1,2,...,n, \quad \tilde{V}_{ij}=\tilde{r}_{ij}(.)\tilde{W}_{ij} \quad (14)$$

Here $\tilde{W}_j$ represents the importance weight of criterion Cj. According to the weighted normalized fuzzy decision matrix, normalized positive triangular fuzzy numbers can also approximate the elements $\tilde{V}_{ij}, \forall i, j$.

Step 8: Then, the fuzzy positive ideal solution (FPIS, A^+) and fuzzy negative ideal solution (FNIS, A^-) are determined as

$$A^+=(\tilde{V}_1^+, \tilde{V}_2^+,...,\tilde{V}_n^+) \quad (15)$$

$$A^-=(\tilde{V}_1^-, \tilde{V}_2^-,...,\tilde{V}_n^-) \quad (16)$$

Where $Vj^+ = \max_i\{\tilde{v}_{ij3}\}$ and $Vj^- = \min_i\{\tilde{v}_{ij1}\}$, $i=1, 2,..., m;\ j=1,2,...,n$

Step 9: Then the distance of each alternative from FPIS and FNIS are calculated as:

$$d_i^+ = \sqrt{1/3\sum_{j=1}^n(\tilde{V}_{ij} - V_j^+)^2} \quad \textbf{(17)}$$

$$d_i^- = \sqrt{1/3\sum_{j=1}^n(\tilde{V}_{ij} - V_j^-)^2} \quad (18)$$

Step 10: A closeness coefficient of each alternative (CCi) is defined to rank all possible alternatives. The closeness coefficient represents the distances to the fuzzy positive ideal solution (A^+) and fuzzy negative ideal solution (A^-) simultaneously. The closeness coefficient of each alternative is calculated as:

$$CC_i = \frac{d^-}{d^-+d^+}, \quad i=1, 2,.., m \quad (19)$$

Step 11: According to the closeness coefficient, the ranking of the alternatives can be determined. Obviously, according to Eq. (17) an alternative A_i would be closer to FPIS and farther from FNIS as CCi approaches to 1 **(**Alavi and Alinejad-Rokny, 2011).

4. Research findings

In order to compare the inserted factors in Balanced Score Card(financial, customer, internal business process, learning and growth), weight of each of these elements is shown in table 1.

Table 1.Normalized final weight of Balanced Score Card factors sub-scales

	Learning/growth	Customer	Internal process of the Organization	Financial
W	0.206	0.298	0.167	0.328

According to the responses provided by the decision makers and displayed in table (1), the final arrangement of BSC's aspects or criteria by importance has been acquired with the financial criterion overweighing the other aspects. The customer criterion came second, followed by the learning/growth criterion, while the internal process has proved the least significant of the four.

At the third level, that include: financial., customer, internal business process, learning and growth sub-criteria level, we proposed four double comparison tables that were weighed and compared according to financial., customer, internal business process, learning and growth, respectively. The results attained from spillover weights of each factor are presented in tables (2) through (5).

Table 2.Final weight of BSC's sub-criteria regarding financial criterion

	liquidity	Net profit	working capital	Long term debt to equity ratio	Return on investment	Operating leverage
W	0.074	0.317	0.140	0.011	0.174	0.284

Table 3.Final weight of BSC's sub-criteria regarding customer criterion

	Customer acquisition rate	Customer retention rate	Customer satisfaction	Profit per customer	Market share rate
W	0.032	0.180	0.184	0.294	0.311

Table 4.Final weight of BSC aspects sub-criteria regarding organization internal process criteria

	The number of new items	Performance of Services	Management performance	top managers' support for talented employees	Certified Financial Integration Platform for Professionals	Innovation in processes	Transaction efficiency	Customer complaint
W	0.022	0.111	0.175	0.172	0.110	0.097	0.146	0.168

Table 5.Final weight of BSC aspects sub-criteria regarding learning/growth

	Professional training	Employees' job security	Employee enabling program	Organizational justice	Employee satisfaction
W	0.028	0.265	0.156	0.263	0.288

Comparing the measures regarding financial, as presented in table 2, we can conclude that pure profit is first and operating leverage is second in the ranking of the most important sub-criteria of the financial aspect. The other sub-criteria in order of importance are return on investment, working capital, liquidity ratio and ratio of long term debt to equity. According to the ranking of the sub-criteria of the customer aspect, as shown in table 3, market share rate and profit per customer sub-criteria hold the first and second ranks, respectively. Following these two sub-criteria in the ranking list, customer satisfaction, customer retention rate and customer acquisition rate are posed. As for the ranking of the sub-criteria of the internal process aspect based on their level of significance, as you can see in table 4, manager's performance, immediately followed by the sub-criterion of top managers' support for talented employees, stands at the top of the ranking list. Customer complaint, efficiency of interactions, performance of services, organizational coordinated processes, innovation in processes and the number of new items are the other sub-criteria in order of appearance in the ranking table. As far as the ranking of the learning/growth aspect's sub-criteria is concerned, as shown in table 5, employee satisfaction and employees' job security are, respectively, the first and two sub-criteria in the ranking list. The next sub-criteria in the list are organizational justice, employee enabling program and professional training.

In the last row of table 6, banks are compared by experts with respect to their net profit, operating leverage, working capital, return on investment, cash deposit, market share rate, profit per customer, customer satisfaction, customer retention rate, customer *acquisition* rate, managers' performance, top managers' support for talented employees, customer complaint, transaction efficiency, performance of services, certified financial integration platform for professionals, innovation in processes and the number of new items, employees' satisfaction, employees' job security, organizational justice, employee enabling programs and professional training. The total weight of each sub-criterion of the four aspects or criteria in the banking industry has been calculated and tabulated in table 6.

Table 6. Final weight of banks are compared by experts regarding sub-criteria

	Sub-criteria	Overall weight of sub-criteria	State-owned bank	Semi-private bank	private bank
Financial	liquidity	0.074	0.201	0.382	0.418
	net profit	0.317	0.065	0.430	0.505
	working capital	0.140	0.260	0.308	0.432
	Long term debt to equity ratio	0.011	0.105	0.406	0.489
	Return on investment (ROE)	0.174	0.062	0.391	0.547
	Operating leverage	0.284	0.088	0.296	0.616
Customer	Customer acquisition rate	0.032	0.071	0.390	0.540
	Customer retention rate	0.180	0.047	0.350	0.603
	Customer satisfaction	0.184	0.020	0.409	0.571
	Profit per customer	0.294	0.020	0.363	0.617
	Market share rate	0.311	0.054	0.190	0.756
Internal process of the organization	The number of new items	0.022	0.075	0.427	0.498
	Performance of Services	0.111	0.177	0.249	0.574
	Manager's performance	0.175	0.067	0.356	0.577
	(Top managers' support for talented employees)	0.172	0.127	0.291	0.581
	(Certified Financial Integration Platform for Professionals)	0.110	0.098	0.280	0.622
	Innovation in processes	0.097	0.084	0.372	0.544
	Transaction efficiency	0.146	0.064	0.272	0.664
	Customer complaint	0.168	0.085	0.388	0.527
Learning/growth	Professional training	*0.028*	0.358	0.085	0,557
	Employees' job security	*0.265*	0.402	0.046	0,552
	Employee enabling program	*0.156*	0.353	0.053	0,593
	Organizational justice	*0.263*	0.339	0.109	0,552
	Employee satisfaction	*0.288*	0.364	0.125	0,511

According to the weights of the sub-criteria for each of the three types of bank, i.e. the private, semi-private and state banks (table 7), we have gained the total weight of each bank.

Table 7. Combining the weights of three levels and computing the final weight *banks*

banks	fuzzy
State bank	0.083 (3)
Semi-private bank	0.342 (2)
Private bank	0.576 (1)

As it is evident from table 7, results show that, from the viewpoint of the managers of the banking industry, the order of the banks in terms of importance and in line with maximizing their performance (Balanced Scorecard) is that the private bank has the highest priority among the banks under study while the semi-private bank got the second rank and the state bank is the last among the three in priority. By using Fuzzy TOPSIS, the banks including private bank, state-owned bank, and semi-private bank are ranked with respect to the legal resources sub-scale, human resource, organizational resources, financial resources and relationship resources sub-scale and their corresponding weights.

The distance of each alternative from FPIS and FNIS with respect to each criterion is calculated. The results of all alternatives' distances from FPIS and FNIS are shown in Table 9. di^{+} and di^{-} of alternatives are shown in table 9 and then closeness coefficients alternatives are calculated as shown in table 10.

Table 9.Distance between each option and positive and negative ideal amount

Private bank	$d1+=$	0.402	$d1-=$	0.484
State bank	$d2+=$	0.445	$d2-=$	0.468
Semi-private bank	$d3+=$	0.424	$d3-=$	0.469

Table 10.Determining the relative distance of each option to its ideal price

	cli	
Private bank	$cl1=$	0.547
State bank	$cl2=$	0.512
Semi-private bank	$cl3=$	0.525

Each bank (Private bank, State-owned bank, Semi-private bank) which has larger CLI is a better choice. According to the table 10, private bank is at the first rank and semi-private bank and State-owned bank are at the next priorities, respectively.

5. Conclusion

The purpose of this paper is the selection of the best bank in Iranian bank industry by using Balanced Score card and using F-AHP, F-TOPSIS techniques. In this study, private bank, semi-private bank and state-owned bank are prioritized according to BSC criteria (financial, customer, internal business process, learning and growth) and financial, customer, internal business process, learning and growth sub-criteria using fuzzy Analytic hierarchy process (F-AHP) and Fuzzy TOPSIS. The results of the F-AHP analysis revealed that the financial dimension was the primary focus of the BSC and *''*Net profit*''* was the most important evaluation index. This is because banking is a service industry, and banking performance is strongly related to earning profit. Therefore, in addition to paying attention to the financial indices, such as operating leverage, return on investment, which are ranked as the second and third important indices to sustain a high banking performance, banks also must ensure that their customers remain loyal to them and must develop new markets to attract new customers. The obtained results indicated that the private banks had a higher level of performance than the semi-private and state banks. Indeed, the private banks had done much better in obtaining higher performance in the banking industry than the semi-private and state banks. Moreover, although in this study, the order of the criteria from the most to the least important were : financial, customer, learning/growth and, finally, internal process. However, in the study done by Wu, Tzeng and Chen (2009), the order turned out to be: customer, financial, internal process and learning/growth. The results of the present study are nearly consistent with those of Wu, Lin and Tsa (2010), in that among the sub-criteria of the financial criterion, pure profit outweighs the others. The financial performance of banks has a key role in evaluating their other performances since the efficiency of each of their activities is reflected in their main financial statement. Moreover, the level of profit-making is considered to be highly important for banks as financial organizations. As regards the prioritization of the sub-criteria of the customer criterion, in the study done by Wu, Tzeng and Chen (2009), customer satisfaction was determined to be paramount, followed by the sub-criteria of customer retention rate, profit per customer, market share and attraction rate, respectively, Whereas in the present paper the sub-criterion of market share rate ranked first, with profit per customer, customer satisfaction, customer retention rate and customer acquisition rate, coming next, respectively. Concerning the organization's internal process criterion, Wu, Tzeng and Chen (2009)found the ranking of the sub-criteria from the most to the least important one to be as: the number of new items, organizational coordinated processes, efficiency of interactions, customer complaint, managers' performance and Performance of services and also in the study done by Wu, Lin and Tsa (2010*)*, top managers' support for talented employees and innovation in processes ranked second and last, respectively, while in this research, the order in which the sub-criteria were recorded was: managers' performance, top managers' support for talented employees, customer complaint, transaction efficiency, performance of services, certified financial integration platform for professionals, innovation in processes and the number of new items. As for the learning/ growth criterion, according to Wu, Tzeng and Chen (2009), the list of the sub-criteria

arranged from the most to theleast significant indices as: professional training, organizational justice, employee satisfaction, employees' job security and existing employee enabling program, while in the current research, the corresponding list were as: employee satisfaction, employees' job security, existing organizational justice, existing employee enabling program and professional training.

5.1 - Management implications

Based on the results of this study, we present the following management implications for the bank directors. The implementation created different opinions on the evaluation mechanism. Most people advocated the functions of bank evaluation; the government organized a wide bank Evaluation program, which denoted the characteristics, advantages and disadvantages of each bank. While the evaluation indices of the performance of each aspect tended to be different, the evaluation committee had to grade the evaluation indices to set up a fair evaluation system. Hence, this research established the weighted evaluation indices, the sequence of the evaluation indices through the F-AHP structure and an expert questionnaire. Thus, the purpose was to provide the banks and relevant education branches with an evaluation system as an important reference point for implementing performance evaluation systems in the future.

5.2- Limitations and Suggestions for future research

Because the globalization creates competition among banks, future research is recommended taking other Iranian banks into consideration. Due to the importance of performance evaluation in continuous improvement, the following suggestions seem to be useful in this context:

• Proposing other restricted DEA ranking model, ANP and ELECTERE techniques integrated by BSC and comparing the results with this study.

• Implementing the proposed approach in different scopes of industry and service and compare the results with this study

• Determining the importance weights of BSC aspects in other banking centers and considering them as a base for restricting weights in other similar researches in this area.

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