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Ranking of Banks in Terms of Providing Electronic Services Using Two Approaches TOPSIS and VIKOR

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CHRONICLE	Abstract
	The intensification of the competitive environment between financial and credit institutions and the provision of new financial services in order to retain and attract customers, has made the use of more efficient electronic banking tools an inevitable necessity. Therefore, the present study intends to rank banks in terms of the efficiency of electronic services. In order to achieve the objectives of the research, statistical information related to the research was collected from the database of the Central Bank and the financial statements of banks during 2007-2017. Then the banks were ranked using two methods, TOPSIS and VIKOR, and then, using the analysis of variance test, the difference between the intra-group and inter-group means in using two methods was statistically examined. The results of the present study showed that in using the TOPSIS method, Mellat, Keshavarzi and Kar Afarin banks were ranked first, second and third, respectively. Meanwhile, in the ranking, according to Vikor method, Mellat, Kar Afarin and Pasargad banks won the first, second and third ranks. The results of analysis of variance showed that there was a significant difference in the mean of the group ranking of banks in the use of two methods. In other words, the ranking of banks based on two methods is statistically different. Since there is a statistical difference in the mean of the banks' ranking group using the VIKOR method, the results of the VIKOR method are more reliable.

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Introduction

The efficiency of banks and how to calculate it is one of the important issues that in addition to managers and shareholders of banks, is of interest to the banking sector and customers using banking services. Considering the increase in the number of banks and the increase in the diversity of their activities, it is important to evaluate the performance of the banking industry and examine the efficiency of this industry. (Ramezani Farzin et al., 2016) In today's world, the entry of electronic banking into the field of economic activities make it necessary and more complex to study the behavior of economic agents in the presence of this agent. Electronic banking or information technology in general can have a tangible effect on the efficiency of the banking system by reducing costs and innovating in the creation of new credits. Therefore, studying and recognizing these factors for better use and application of them in order to have an economy with more desirable indicators is very important. (Najafinia, Mohammad Ali et al., 2017) In e-banking, banks are knowledge-based, so that agility, creativity and service delivery at any time and everywhere are the characteristics of this type of banks. In order to acquire such characteristics, in addition to educated, specialized and proficient employees in banking and information technology, it must be equipped with modern and up-to-date electronic tools to identify and control the challenges, opportunities and threats ahead. (Rezaei, Farzin 1395) Meanwhile, due to the intensification of competitive environment between banks and financial and credit institutions in order to retain customers and attract their satisfaction, strengthening the provision of electronic services should be at the top of electronic banking programs. Therefore, due to the importance of the subject, the present study intends to rank banks in terms of the efficiency of electronic devices using two methods, TOPSIS and VIKOR. The research framework is such that the second and third sections express theoretical and experimental issues. The third section describes the research method, the fourth section reviews the research results and the fifth section analyzes the research findings and makes suggestions.

Theoretical Foundations

Electronic Banking

In recent years, the advent of e-commerce, especially e-banking, has created opportunities for advanced and innovative solutions in e-government. The Internet and networks, as the backbone of communication today, have turned the world into ubiquitous connections, so that at any time and place, there is always access to digital networks and digital services (Hadi Teymour et al. 1396). In particular, e-banking is growing faster than other sectors of e-commerce in the form of a revolution in banking technology (Lane et al., 2015). E-banking has emerged as a strategic reference for maximum efficiency, operations supervision and cost reduction, which leads to the highest productivity and profitability by replacing paper-based, centralized business methods with automated processes. This is one of the popular services offered by traditional banks to provide faster and more reliable services to users. Thus, the provision of e-banking services has become a necessary issue for banks to continue the competions in global affairs and gain a competitive advantage in the market. (Hadi Teymour et al. 1396).

E-Banking Tools

The most common electronic tools in banking today can be described as follows:

ATM cards: These cards are issued by the bank to the applicants in compliance with the principles of security and are provided to customers as a suitable tool for fast and secure access in exchange and transfer.

Holders of these cards can transfer money, withdrawals, bill payment services, etc. to the funds on their cards at any time of the day or night through ATMs.

ATMs: ATMs, or electronic terminals installed by banks to facilitate the work of bank customers at specific locations are available to customers 24 hours a day.

Sales Terminals (POS): A device that allows the automatic transfer of the amount purchased from the customer's account (cardholder) to the seller's account (card acceptor) through telephone or network connection to the banking system.

Short message banking system (SMS): This system allows banks to provide specific information and services to their customers through this information tool.

Mobile Banking System (M-Banking): When mobile networks got equipped with GPRS, UMTS, etc. systems to provide multimedia services, mobile banking services entered the industry and customers could use this service to bill their bank accounts. Observations, money transference and being informed of large payments and even having complete control over their account are the functions of M-banking (Maleki Mehdi, 1389).

Efficiency

The use of the term efficiency dates back to 1760, when a Frenchman named Jean Brune studied the operation of making a pin to modify its interactions. Even a hundred years before scientific management, French and British industrialists used some form of labor measurement to set performance standards and modify interactions. The simplest and most general definition of performance is provided by Peter Drucker. In his view, efficiency is doing the right thing. Therefore, efficiency is merely a comparison between the resources that are expected to be used to achieve specific goals, objectives and activities and the resources that are actually consumed in this direction (Borhani, 2008). Efficiency in relation to the quantity of services and products provided refers to the financial cost or labor required to provide them (Azar et al., 2007). According to Katz and Kahn (1978), efficiency is the ratio of generated outputs to the data needed to produce these outputs. These two researchers distinguish between potential and actual performance. Potential efficiency indicates how much an organization can produce if it operates optimally. While actual efficiency is the real ratio of the output level to the actual data level. Actual efficiency is usually less than potential efficiency. In another definition, efficiency is defined as the ratio of actual return to standard return, or in fact the ratio of the amount of work done to the amount of work to be done.

Efficiency in its general sense means the degree and quality of achieving the desired set of goals. Therefore, an enterprise will be efficient if it can achieve all the production goals intended for it. The concept of efficiency is generally used at three different levels, micro level, industry or organization level, and macro level. Efficiency can be defined as the amount of resources needed to produce a unit of product. In this case, they can be calculated in terms of product-to-consumption ratio. In the simplest case, there is only one input and one output, which is the efficiency of the output to input ratio. But in most cases, the units have several inputs and outputs. In this case, efficiency is calculated as the sum of the ratio of outputs to the sum of data (Emami Meybodi, 1999). In the present study, the latter definition of efficiency is used, which is referred to as technical efficiency.

Types of Efficiency

Efficiency can be divided into four categories as follows.

A) Technical efficiency: Technical efficiency indicates the ability of an enterprise to maximize production according to the factors of production. In other words, the ability to convert inputs such as manpower and machinery, etc. into outputs, compared to the best performance, is measured by technical efficiency. Technical efficiency is affected by factors such as management performance, the scale of the organization, or the size of operations.

B) Assignment efficiency: This efficiency indicates the production of the best combination of products using the lowest cost combination of inputs or factors of production. This efficiency is responsible for answering the question of whether the price of the inputs used is such that it minimizes the cost of production. Thus, allocation efficiency requires the selection of a set of production factors that produce a certain level of product at the lowest cost. Allocation efficiency is also called price efficiency. Assignment efficiency is when a decision unit can achieve efficiency by reducing inputs and keeping the output constant.

Structural efficiency: The structural efficiency of an industry is obtained from the weighted average efficiency of firms in that industry. Using the structural efficiency criterion, the efficiency of different industries with different products can be compared.

Scale efficiency: The scale efficiency of an enterprise is obtained from the ratio of the observed efficiency of that firm to the efficiency at the optimal scale. The goal of this efficiency is to produce on an optimal scale.

The Concept of Efficiency in Electronic Banking

One of the important factors in the growth and development of banks' business is to improve efficiency, and this requires the optimal allocation of resources and the use of new and up-to-date services such as electronic banking services. In general, monitoring the performance of a bank according to certain standards is much easier than comparing and analyzing the performance of financial institutions. On the other hand, improving the efficiency of financial markets plays an important role in the country's economy. In today's world, the entry of electronic banking into the field of economic activities makes it necessary and more complex to study the behavior of economic agents in the presence of this factor. Electronic banking or information technology in general can have a tangible effect on the efficiency of the banking system by reducing costs and innovating in the creation of new credits. Therefore, it is very important to study and recognize these factors in order to make better use of them in order to have an economy with more desirable indicators. In the present study, the meaning of efficiency in electronic banking is technical efficiency. Technical efficiency refers to the ability of an enterprise to maximize the production of a product according to a certain amount of production inputs. The concept of technical efficiency is explained using Figures 1 and 2. For example, if an enterprise produces level A of its product using two inputs x1 and x2, and this level of production is equal to level B of production, which is on the same SS production curve. Therefore, this firm can produce the same amount of production with less input than X1 and X2. In fact, by reducing the amount of X1A-X1B from X1 input and X2A-X2B from input, the enterprise can maintain its production level. In fact, by reducing the BA / OA percentage of the two inputs X1 and X2, the firm can reach a point where the minimum factors of production are used to produce the product. Therefore, it can be said that the OB / OA ratio indicates the technical efficiency of this enterprise, which is less than one unit, and naturally, if the enterprise was at point B from the beginning, this ratio was equal to

one unit, and it was said that the firm is technically efficient.

Efficiency= OB/OA
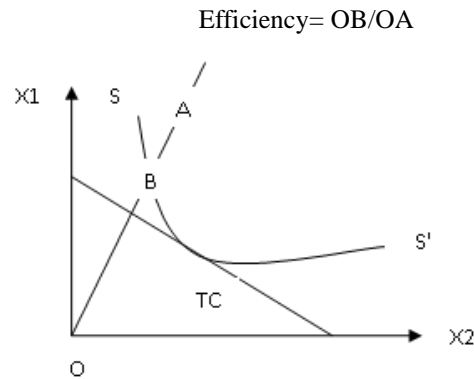
Diagram 1. Produces level
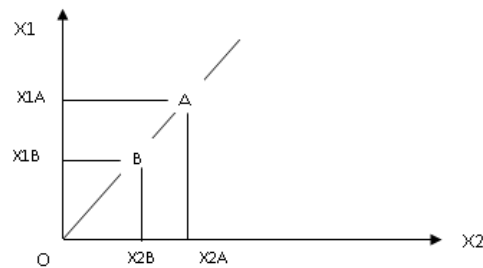
Diagram 2. Produces level

In this research, data related to research variables are collected from the site of the Central Bank. So that the data is the number of transactions resulting from electronic devices such as the number of ATMs, POS, etc. and the amount of transactions from electronic devices is considered as the output.

In this research, the conceptual model defined based on the definition of efficiency in electronic banking is as shown in Figure 1. So far, this model has not been used in ranking the efficiency of banks in previous articles and researches.
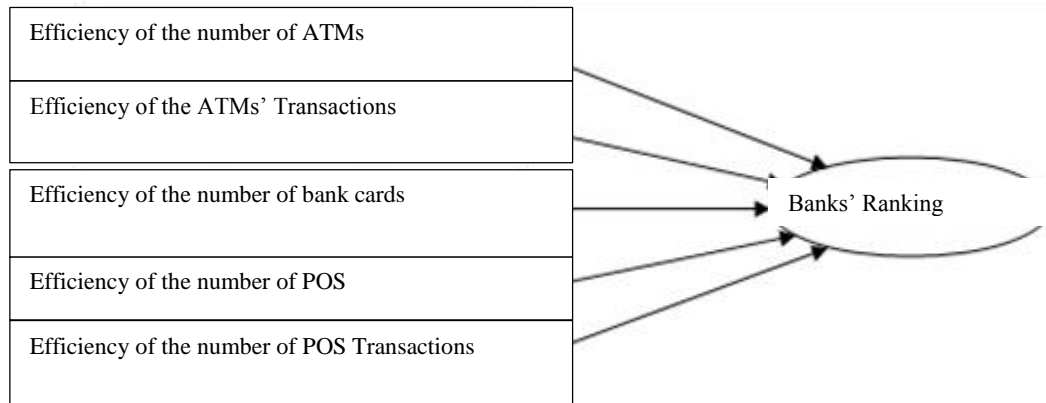
3. Literature Review

Beheshtinia, Mohammad Ali and Omidi, Sedigheh (2017), in an article entitled "Presenting a new approach to ranking banks with new global standards after identifying 6 main criteria including financial aspect, social aspect, internal processes, customer criterion, environmental criterion and growth and learning criteria and 25 sub-criteria including capital adequacy, profit margin, return on investment, reduction

of operating cycle time, customer satisfaction, market share, etc., the studied banks were identified in each of the sub-criteria and ranked using fuzzy TOPSIS method. The results showed that the financial aspect is of 22% importance and the social aspect is 16% of the highest and lowest percentages. Among the sub-criteria, return on capital of 0.096, reduction of operating cycle time of 0.094, net profit ratio of 0.079

and lower energy consumption of 0.073 are more important, respectively.
Ahmadi Shadmehr et al. And the received insurance premium with 0.385 and 0.325 percent, respectively, has the highest and the number of claims index with 0.058 percent has the lowest degree of importance among the 5 performance indicators of insurance companies.

| Efficiency of the number of ATMs |
| Efficiency of the ATMs' Transactions |
| Efficiency of the number of bank cards |
| Efficiency of the number of POS |
| Efficiency of the number of POS Transactions |

Banks' Ranking

Figure 1. Article's Conceptual Model

Salimi Mohammad Javad et al. (2016) in an article entitled *Designing a local model for ranking Iranian banks* based on banking health, including the main criteria of capital adequacy, asset quality, management quality, profitability, liquidity and market risk sensitivity by TOPSIS method. The obtained results show that Pasargad, Khavar Mianeh, Kar Afarin, Day and Sina banks had better performance in 1993 than other studied banks, respectively.

Rezaei Farzin et al. In (2016), in an article entitled "Assessing the financial performance of the banking industry by Vikor method", ranked 13 banks in the Tehran Stock Exchange with 12 financial ratios including capital adequacy, asset adequacy, capital expenditure structure, liquidity, Profitability, etc. were evaluated. The results show that Bank Saderat, Tat and Tejarat ranked first to third, respectively,

and Hekmat Iranian Bank ranked thirteenth, and other banks each ranked for themselves.

Yousefi, Mohammad (2017), in an article entitled Ranking the country's banks based on financial indicators and using a combined fuzzy hierarchical approach and TOPSIS, examined 31 banks and 2 financial and credit institutions based on profit and loss statements in their balance sheets. The results indicate that the capital index is one of the most important factors influencing the ranking of banks.

Because efficiency and competition are not directly observable, a variety of indirect scales, either simple or combined, have been used in theoretical and practical models to evaluate performance and analyze performance.

Hasan Dinsar and Emit Hikogulu (2013), in an article entitled Performance

appraisal using VIKOR method and hierarchy based on customer satisfaction in the Turkish banking sector concluded that the results of banks' performance are different in terms of customer satisfaction, the facilities of state-owned banks to meet customer expectations But the performance level of private banks is higher than state-owned banks, state-owned banks have the weakest performance results based on the level of customer satisfaction with negative financial results.

In a 2016 paper entitled Hierarchical Fuzzy Performance Evaluation and TOPSIS Evidence from the Turkish banking sector after the global financial crisis in 2013, Kamal Vatansever et al. Concluded that the financial performance of twelve commercial banks was based on 17 performance indicators Finance including capital ratio, asset quality, liquidity, profitability, etc. Using the two methods show that these two methods rank banks in a similar way.

In a paper entitled Islamic Banking and Its Performance in the ASEAN Banking Industry (Southeast Asia Association) by Peter Wanke et al., on the quality of management, income, liquidity and sensitivity to market risk, etc., it was concluded that the prominent role of Islamic principles in banking efficiency is particularly effective, these beneficial results are found when banks are private.

Research Method

The choice of research method depends on the goals and nature of the research subject and its implementation possibilities. Therefore, the research method can be decided when the nature of the research subject as well as its objectives and scope are clear. In many cases, combined research method is used in research. The nature of the subject in the research is that the researcher seeks to study the consequences of measures to solve social problems or the consequences of common actions, and the purpose of the research is to provide a detailed social study of the consequences of the program implemented for social problems.

TOPSIS ranking method

The TOPSIS algorithm is a very powerful decision-making technique for prioritizing options by simulating the ideal answer, which has very little sensitivity to the type of weighting technique and the resulting responses do not change profoundly. In this method, the selected option must have the shortest distance from the ideal answer and the farthest distance from the most inefficient answer. The advantages of this method include the following:

1. Its output can specify the order of priority of the options and express this priority quantitatively.
2. Considers the contradiction and correspondence between the indicators.
3. The method of work is simple, and its speed is suitable
4. Accepts initial weighting coefficients.
5. The results of this model are completely consistent with experimental methods.

Briefly, in the TOPSIS method, the n * m matrix, which has m options and n criteria, is evaluated. In this algorithm, it is assumed that each index and criterion in the decision matrix has a uniform increase or decrease in desirability, and

in other words, the higher the values that the criteria obtain in this matrix, the higher the value, the higher the desirability. It was the type of cost, it has a lower utility. One of the important advantages of this method is that it is possible to use objective and subjective indicators and criteria at the same time. However, in this model, for mathematical calculations, it is necessary that all the values attributed to the criteria are quantitative and if they are qualitative, they should be converted to small values.

TOPSIS algorithm

1- Formation of data matrix based on n alternative and k index:

$$A_{ij} = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ a_{m1} & a_{m2} & \cdots & a_{mn} \end{bmatrix}$$

2- Standardizing the data and forming a standard matrix through the following relation:

$$r_{ij} = \frac{a_{ij}}{\sqrt{\sum_{k=1}^{m} a_{kj}^2}}$$

$$R_{ij} = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix}$$

1- Determining the weight of each of the indicators (WI): In this regard, the indicators that are more important have a higher weight.

$$V_{ij} = \begin{bmatrix} w_1 r_{11} & w_2 r_{12} & \cdots & w_n r_{1n} \\ w_1 r_{21} & w_2 r_{22} & \cdots & w_n r_{2n} \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ w_1 r_{m1} & w_2 r_{m2} & \cdots & w_n r_{mn} \end{bmatrix}$$

4. Determining the distance i of the alternative from the ideal alternative (highest performance of each index): This index is denoted by (A^*).

$$A^* = \left\{ (\max_i v_{ij} | j \in J), (\min_i v_{ij} | j \in J') \right\}$$
$$A^* = \left\{ v_1^*, v_2^*, ..., v_n^* \right\}$$

5- Determining the minimum alternative i distance (lowest performance of each index): This index is denoted by (A⁻).

$$A^- = \left\{ (\min_i v_{ij} | j \in J), (\max_i v_{ij} | j \in J') \right\}$$
$$A^- = \left\{ v_1^-, v_2^-, ..., v_n^- \right\}$$

6- Determining the distance criterion for the ideal alternative (S_i^*) and the minimum alternative (S_i^-):

$$S_i^* = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^*)^2}$$

$$S_i^- = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^-)^2}$$

7- Determining the coefficient (C_i^*): This coefficient is equal to the minimum alternative distance (S_i^-) divided by the set of minimum alternative distance (S_i^-) and the ideal alternative distance (S_i^*) which is denoted by (C_i^*) and the is calculated by the following relation:

$$C_i^* = \frac{S_i^-}{S_i^- + S_i^*}$$

8- Ranking of alternatives based on the amount (C_i^*): The above amount fluctuates between zero and $1 \geq C_i^* \geq 0$. In this regard, $C_i^* = 1$ indicates the highest rank and $C_i^* = 0$ also indicates the lowest rank.

VIKOR Rating Method

VIKOR method is one of the most widely used models in decision making and choosing the best option. This model is based on the method of collective agreement and has conflicting criteria and is generally used to solve discrete problems. This method is developed for multi-criteria optimization of complex systems and also focuses on categorizing and selecting from a set of options and determines adaptive solutions to a problem with conflicting criteria, so that it can help decision makers to reach a final decision. This method focuses on ranking and selecting from a set of options and determines compromising answers to a problem with conflicting criteria, as well as the ability for decision makers to reach a final decision. Compromise answer is a possible answer to the closest ideal answer and compromise is an agreement in the direction of bilateral exchanges (Opricovic S and Tzeng GH. 2007).

VIKOR Algorithm

1. Forming a decision matrix

The decision matrix or the scoring option matrix is formed based on criteria. The decision matrix is denoted by X and each element is denoted by xij.

2. Data normalization

The next step is to normalize the decision matrix using the following formula:

$$X = \begin{bmatrix} x_{11} & x_{12} & . & x_{1j} \\ x_{21} & x_{22} & . & x_{2j} \\ . & . & . & . \\ x_{j1} & x_{j2} & . & x_{ij} \end{bmatrix}$$

$$n_{ij} = \frac{x_{ij}}{\sum_1^m x_{ij}}$$

Note that the linear normalization method is different from the vector method. In Vickor technique, linear method is used and in TOPSIS technique, vector method is used.

Each Xij is the value of each criterion for each option, after enabling the numbers and summing each column and taking the square root of each column, the numbers are displayed as a new table.

3. Determining the ideal and positive point

For each criterion, we determine the best and worst of each of all the options and call them f + and f -, respectively. If the criterion is of utility type, we will have:

$f + = \text{Max } f_{ij}$

$f - = \text{Min } f_{ij}$

4. Determining usefulness and regret

Two basic concepts of utility (S) and regret (R) are introduced in VIKOR calculations. The value of utility (S)

indicates the relative distance of option i from the ideal point and the value of regret (R) indicates the maximum inconvenience of option i from distance from the ideal point.

$$S_i = \sum_{j=1}^n W_j \cdot \frac{f_j^* - f_{ij}}{f_j^* - f_j^-}$$

$$R_i = max \left[w_j \cdot \frac{f_j^* - f_{ij}}{f_j^* - f_j^-} \right]$$

5. Calculating the VIKOR index

The next step is to calculate the VIKOR index (Q) for each option:

$$Q_i = v \left[\frac{S_i - S^*}{S^- - S^*} \right] + (1 - v) \left[\frac{R_i - R^*}{R^- - R^*} \right]$$

$$S^* = MinS_i \; ; \; S^- = MaxS_i$$

$$R^* = MinR_i \; ; \; R^- = MaxR_i$$

6. The two final conditions of decision making with VIKOR technique

In the final step of the VIKOR technique, the options are sorted into three groups

from small to large, based on the values of Q, R, and S. The best option is to have the smallest Q provided the following two conditions are met:

$$Q(A_2) - Q(A_1) \geq \frac{1}{m-1}$$

Condition two: Option A1 must be recognized as the top rank in at least one of the groups R and S. If the first condition is not met, both options will be the best option. If the second condition is not met, options A1 and A2 are both selected as the top option.

Differences between TOPSIS and VIKOR models

The advantage of VIKOR model over TOPSIS is that in this model, it is not necessary to use the opinions of experts to evaluate the options based on criteria, but raw data can be used. This is the main difference between the VIKOR model and the TOPSIS model, which was designed based on pairwise comparisons of criteria and options, while in this model, pairwise comparisons between criteria and options are not made, but each option is evaluated independently based on each criterion. This assessment can be based on raw data or expert opinion. Therefore, the main purpose of this model is to determine the weight and value of each option and rank them. The VIKOR method ranks the options based on one ideal solution, while the TOPSIS method performs the optimal option based on the two ideal and anti-ideal solutions.

Both methods are based on a summation function that indicates proximity to the ideal solution. The VIKOR method is based on linear normalization, while TOPSIS uses the vector normalization method to eliminate the units of standard functions. The solution obtained from the TOPSIS method is the shortest distance from the ideal and the farthest from the negative ideal solution. VIKOR method helps to determine a compromise solution that helps the maximum ability of the group for more frequency and the minimum for less frequency. This article mainly focuses on comparing multi-criteria decision making methods such as TOPSIS and VIKOR methods for selecting electronic banking tools.

Statistical population and data collection method

The statistical population of the present study is selected governmental and non-governmental commercial banks including Bank Melli, Tejarat, Mellat, Eghtesad-e-Novin, Parsian, Saman, Pasargad, Entrepreneur, and Export and specialized government-owned specialized banks including Keshavarzi Bank. Based on the availability of statistical information were selected. Also, the time domain of the research is April 2007 to July 2017 and the necessary statistical information is extracted from the Central Bank. In this research, library study method, internet search and valid scientific journals have been used to collect information related to theoretical and experimental foundations. In addition, the present study is applied in terms of purpose and in terms of data collection and analysis is of survey and descriptive-analytical type.

Research Findings

The ranking of banks for the ratio of the scale of cards to the number of cards by

TOPSIS and VIKOR methods led to the following result.

Table 1. Ranking of banks for the ratio of card scale to the number of cards by TOPSIS and VIKOR methods

TOPSIS Method			VIKOR Method		
Bank	**Results**	**Ranking**	**Bank**	**Results**	**Ranking**
Mellat	0.6931639330	1	Eghtesad Novin	0.0000000000	1
Melli	0.6195770890	2	Parsian	0.2003328160	2
Saderat	0.6064403120	3	Pasargad	0.2003328160	3
Keshavarzi	0.5441956710	4	Tejarat	0.2003328160	4
Tejarat	0.4369611110	5	Mellat	0.2469542678	5
Eghtesad Novin	0.2506005550	6	Saderat	0.2836996744	6
Parsian	0.2245086110	7	Kar Afarin	0.4584354042	7
Saman	0.1237875250	8	Saman	0.4781559357	8
Pasargad	0.0816877200	9	Melli	0.5715952444	9
Kar Afarin	0.0591450290	10	Keshavarzi	1.0000000000	10

In terms of the number of cards issued by banks, in the TOPSIS method, Bank Mellat was ranked first, and Melli and Saderat banks were ranked second and third, respectively. At the bottom of the ranking are Pasargad and Kar Afarin banks. Also, in VIKOR method, Bank Eghtesad Novin took the first place and Parsian and Pasargad banks took the second and third places. According to the mentioned method, at the bottom of the ranking are national and agricultural banks.

The ranking of banks for the ratio of the amount of the number of ATMs to the number of machines by TOPSIS and VIKOR methods led to the following result.

Table 2. Ranking of banks for the ratio of the number of ATMs to the number of machines using TOPSIS and VIKOR methods

TOPSIS Method			VIKOR Method		
Bank Name	Result	Bank Ranking	Bank Name	Result	Bank Ranking
Keshavarzi	5.3026423970	1	Keshavarzi	0.0000000000	1
Kar Afarin	4.9872250330	2	Kar Afarin	0.2070623628	2
Parsian	4.5746055390	3	Tejarat	0.4778399915	3
Saman	3.9168431160	4	Parsian	0.4894300492	4
Eghtesad Novin	3.7968222490	5	Eghtesad Novin	0.5277646606	5
Tejarat	3.7189821570	6	Saman	0.5487412962	6
Pasargad	2.2194260430	7	Pasargad	0.7639788154	7
Mellat	2.0077266320	8	Mellat	0.7898481488	8
Saderat	1.7350599180	9	Saderat	0.9023235466	9
Melli	1.6048517380	10	Melli	0.9746327914	10

In the efficiency of the number of ATMs by banks, in the TOPSIS method, Keshavarzi Bank is ranked first, Kar Afarin Bank is ranked second, and Parsian Bank is ranked third. At the bottom of the ranking are Bank Saderat and Bank Melli. Also in VIKOR method, Keshavarzi Bank is in the first rank and Kar Afarin Bank is in the second rank and Tejarat Bank is in the third rank. At the bottom of the ranking are Bank Saderat and Bank Melli.

Banks' ranking of the ratio of the number of ATM transactions to the number of TOPSIS and VIKOR transactions resulted in the following result.

Table 3. Ranking of banks for the ratio of the number of ATM transactions to the number of transactions by TOPSIS and VIKOR methods

TOPSIS Method			VIKOR Method		
Bank Name	Result	Bank Ranking	Bank Name	Result	Bank Ranking
Mellat	66.0539767300	1	Keshavarzi	0.0000000000	1
Keshavarzi	46.8033979000	2	Kar Afarin	0.7040944416	2
Kar Afarin	22.5352174400	3	Saman	0.7449362090	3
Pasargad	13.2453260700	4	Parsian	0.7528688549	4
Parsian	12.3927949600	5	Saderat	0.7649524132	5
Saderat	10.8430667800	6	Eghtesad Novin	0.7986905432	6
Saman	6.1698998350	7	Tejarat	0.8740082156	7
Eghtesad Novin	1.3946610800	8	Mellat	0.9239269151	8
Melli	1.2100454140	9	Melli	0.9414264847	9
Tejarat	1.0365746140	10	Pasargad	0.9995721703	10

In the efficiency of the number of ATM transactions by banks, in the TOPSIS method, Bank Mellat ranks first, Agricultural Bank ranks second, and Karafarin Bank ranks third. At the bottom of the ranking are Bank Melli and Bank Tejarat. Also, in VIKOR method, Keshavarzi Bank is the first rank and Kar Afarin Bank is the second rank and Saman Bank is the third rank. At the bottom of the ranking are Bank Melli and Bank Pasargad.

The ranking of banks for the ratio of the number of POS terminals to the number of terminals by TOPSIS and VIKOR methods led to the following result.

Table 4. Ranking of banks for the ratio of the number of POS terminals to the number of terminals by TOPSIS and VIKOR methods

TOPSIS Method			VIKOR Method		
Bank Name	**Result**	**Bank Ranking**	**Bank Name**	**Result**	**Bank Ranking**
Kar Afarin	30.307	1	Kar Afarin	0.0000000000	1
Parsian	7.613	2	Parsian	0.5410397265	2
Saman	5.306	3	Eghtesad Novin	0.5639956547	3
Eghtesad Novin	5.0159447810	4	Saman	0.6096390710	4
Mellat	3.6344403410	5	Mellat	0.6971401794	5
Tejarat	3.3418082430	6	Tejarat	0.7369993015	6
Keshavarzi	2.4371105110	7	Keshavarzi	0.8041875889	7
Pasargad	2.0018390200	8	Pasargad	0.9250718226	8
Saderat	1.8786830940	9	Saderat	0.9630418507	9
Melli	1.7692429470	10	Melli	1.0000000000	10

In the efficiency of the number of POS terminals by banks, Karafarin Bank is ranked first and Parsian Bank is ranked second and Saman Bank is ranked third. At the bottom of the ranking are Bank Saderat and Bank Melli. Also, in VIKOR method, KarafKar Afarinarin Bank is in the first rank and Parsian Bank is in the second rank and Bank Eghtesad Novin is in the third rank. At the bottom of the ranking are Bank Saderat and Bank Melli.

The ranking of banks for the ratio of the transaction amount of POS terminals to the number of transactions of TAPS and VIKOR terminals led to the following result.

Table 5. Ranking of banks for the ratio of transaction amount of POS terminals to the number of transactions of terminals by TOPSIS and VIKOR methods

TOPSIS Method			VIKOR Method		
Bank Name	Result	Bank Ranking	Bank Name	Result	Bank Ranking
Kar Afarin	29.5630938200	1	Kar Afarin	0.0000000000	1
Keshavarzi	3.6177112480	2	Keshavarzi	0.3210209269	2
Pasargad	3.1880278060	3	Pasargad	0.7144193519	3
Saman	3.0597051820	4	Saman	0.7541529984	4
Eghtesad Novin	2.4974604940	5	Eghtesad Novin	0.7971635322	5
Saderat	2.3868990050	6	Melli	0.8383119727	6
Melli	2.3570956120	7	Saderat	0.8478972139	7
Parsian	2.1861551880	8	Parsian	0.9042899407	8
Mellat	1.9174245850	9	Mellat	0.9867858144	9
Tejarat	1.9054826600	10	Tejarat	0.9994506592	10

In terms of the number of POS terminal transactions by banks, Karafarin Bank ranks first and Keshavarzi Bank ranks second and Pasargad Bank ranks third. At the bottom of the ranking are Bank Mellat and Bank Tejarat. Also, in VIKOR method, Kar Afarin Bank is the first rank and Keshavarzi Bank is the second rank and Pasargad Bank is the third rank. At the bottom of the ranking are Bank Mellat and Bank Tejarat.

Analysis of variance of bank rankings in TOPSIS method
To analyze the analysis of variance, we must first examine the condition of homogeneity of variances, then first perform this test with the F Levene's test and then analyze the analysis of variance of banks in the TOPSIS method.
Homogeneity test of variance of different banks in TOPSIS method
To evaluate the homogeneity of variance, F-Levene's test was used, the results of which are given below.

Table 6. Descriptive information of TOPSIS method for different banks

Bank	E Tools' Number	Mean	Standard Deviation	Standard deviation error	95% confidence interval for the Mean	
					Lower Bound	Upper Bound
Melli	5	7.60	3.362	1.503	3.43	11.77
Mellat	5	4.80	3.768	1.685	.12	9.48
Tejarat	5	7.40	2.408	1.077	4.41	10.39
Saderat	5	6.60	2.510	1.122	3.48	9.72
Keshavarzi	5	3.20	2.387	1.068	.24	6.16
Kar Afarin	5	3.40	3.782	1.691	-1.30	8.10
Pasargad	5	6.20	2.588	1.158	2.99	9.41
Parsian	5	5.00	2.550	1.140	1.83	8.17
Eghtesad Novin	5	5.60	1.517	.678	3.72	7.48
Saman	5	5.20	2.168	.970	2.51	7.89

Table 7. F Levene's homogeneity test for variance homogeneity of TOPSIS method for different banks

	F Levene's homogeneity test for variance homogeneity in TOPSIS method for banks		
Sig	Denominator Degrees of Freedom	Nominator Degrees of Freedom	Levene's Statistics
0.687	40	9	0.721

Given that the significance level is greater than 0.05, we conclude that the variance of the TOPSIS method is equal in the samples taken from electronic devices, in other words, there is no variance inequality. Now, considering the equality of variances, we are allowed to test the mean for the groups, which we will examine below.

Furthermore, considering that in previous researches in the field of electronic banking and regarding the use of decision-making techniques, the assumption of normal society has been confirmed. Therefore, the average comparison has been done.

Table 8. Analysis of variance of the mean of the TOPSIS method in different banks

|	Total Squares	Degrees of Freedom	Squares Mean	F	Sig
	Analysis of variance of bank rank in TOPSIS method				
Intragroup	101.300	9	11.256	1.447	0.201
Intergroup	311.200	40	7.780		
Total	412.500	49			

According to the table above, especially the sig column, which is greater than 0.05 (the reported value is 0.201), then

we conclude that in general, the average of the TOPSIS method is not

significantly different in all different banks.
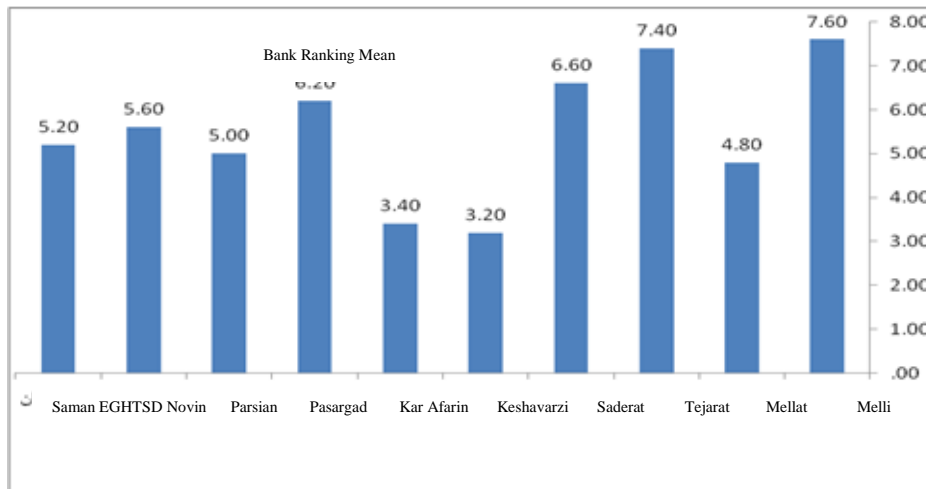
Diagram 3. Average of electronic banking tools in TOPSIS method

As can be seen in the table, Bank Melli with an average of 7.60 has the highest average rating and Keshavarzi Bank with an average of 3.20 has the lowest average rating in the efficiency of electronic devices using the TOPSIS method.

6.2 Analysis of variance of bank rankings in VIKOR method

To analyze the analysis of variance, we must first examine the condition of homogeneity of variances with the F Levene's test, then first perform this test and then analyze the analysis of variance of banks in the VIKOR method.

6.2.1 Homogeneity test of different banks in VIKOR method

Table 9. Descriptive information of VIKOR method for different banks

Bank	E Tools' Number	Mean	Standard Deviation	SD Error	95% confidence interval for the Mean	
					Lower Bound	Upper Bound
Melli	5	8.80	1.64	.73	6.76	10.84
Mellat	5	7.00	1.87	.84	4.68	9.32
Tejarat	5	6.00	2.74	1.22	2.60	9.40
Saderat	5	7.20	1.79	.80	4.98	9.42
Keshavarzi	5	4.20	4.09	1.83	-.87	9.27
Kar Afarin	5	2.60	2.51	1.12	-.52	5.72
Pasargad	5	6.20	3.11	1.39	2.33	10.07
Parsian	5	4.00	2.45	1.10	.96	7.04
Eghtesad Novin	5	4.00	2.00	.89	1.52	6.48
Saman	5	5.00	2.00	.89	2.52	7.48

Table 10. F Levene's homogeneity test for homogeneity of variance of VIKOR method for different banks

F Levene's homogeneity test for variance homogeneity in TOPSIS method for banks			
Sig	Denominator Degree of Freedom	Nominator Degree of Freedom	Levene's Statistics
0.179	40	9	1.506

Given that the significance level in is greater than 0.05 (the reported value is 0.179), we conclude that the variance of the VIKOR method is equal in the samples taken from electronic devices. Now, considering the equality of variances, we are allowed to test the mean for banks, which we will examine

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below According to the table above, especially the sig column, which is less than 0.05 (the reported value is 0.013), then we conclude that in general, the average VIKOR method is significantly different in all different banks.

Table 11. Analysis of variance of the average VIKOR method in different banks

			Analysis of variance of bank rank in VIKOR method		
	Total Squares	Degree of Freedom	Squares Mean	F	Sig
Intragroup	158.100	9	17.567	2.762	0.013
Intergroup	254.400	40	6.360		
Total	412.500	49			
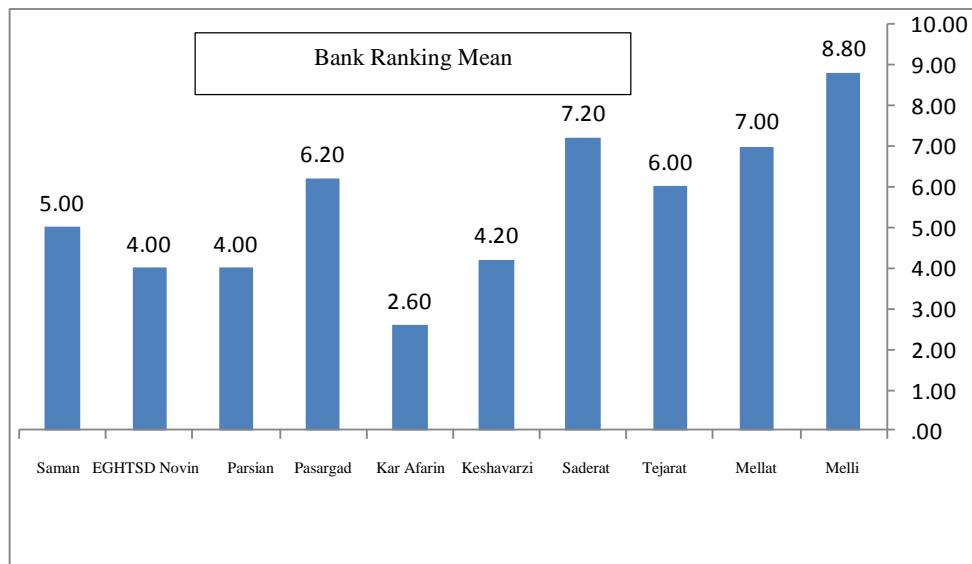
Diagram 4. Average of electronic banking tools in Vikor method

As can be seen in the table, Bank Melli with an average of 8.80 has the highest average rating and Bank Karafarin with an average of 2.60 has the lowest average

rating in the efficiency of electronic devices.

Conclusion and Suggestions

Evaluating and ranking banks based on the efficiency of electronic devices is very important in a country's economy. Because with the development of electronic devices in the world, banks are forced to use these tools to stay on the path of competition and meet the needs of their customers. So far, in various studies, banks have been ranked based on different criteria, which often cannot lead to satisfactory results, because the use of different performance indicators changes the ranking. In this study, banks were ranked based on the efficiency of identified electronic devices using two methods, TOPSIS and VIKOR. Electronic devices include the number of bank cards, the number of ATMs, the number of ATM transactions, the number of POS terminals and the number of terminal transactions as input and the transaction amount of the number of cards, transaction amount, the number of ATMs and POS machines were used as output. Then, the efficiency of electronic devices in banks was ranked by two methods, TOPSIS and VIKOR. In terms of tool efficiency, the number of bank cards in TOPSIS method, Mellat Bank and in VIKOR method, Eghtesad-e-Novin Bank took the first place. In terms of tool efficiency, the number of ATMs in both TOPSIS and VIKOR Agricultural Bank methods is ranked first. Also, in the efficiency of the tool, the number of ATM transactions in the TOPSIS method of Mellat Bank and in the VIKOR method of Keshavarzi Bank were ranked first.

The efficiency of Kar Afarin Bank in the two instruments, the number of POS machines and the number of POS machine transactions, has won the first

rank. In total, in using electronic tools among ten banks in TOPSIS method, the efficiency of Keshavarzi Bank with an average of 3.20 is first, the efficiency of Kar Afarin Bank with an average of 3.40 is second and the efficiency of Bank Mellat with an average of 4.80 is third. In VIKOR method in using electronic tools among ten banks, the efficiency of Kar Afarin Bank with an average of 2.60 is in the first rank and the efficiency of Novin Eghtesad and Parsian banks with an average of 4.00 is in the second rank and the efficiency of Keshavarzi Bank with an average of 4.20 is in the third rank. Among the ten selected banks, Bank Melli has the worst ranking in the use of electronic devices, so that it is ranked tenth in the TOPSIS method with an average of 7.60 and in the VIKOR method with an average of 8.80. Due to the fact that the two methods of TOPSIS and VIKOR use a different approach to normalization to eliminate the units of measurement. Analysis of variance and difference of means should be done. In this study, the result of variance homogeneity test indicates the existence of variance homogeneity between banks in the efficiency of electronic devices using two methods, TOPSIS and VIKOR. But there is a significant difference between banks in terms of the average efficiency of electronic devices in using the VIKOR method. Therefore, ranking banks in having the efficiency of electronic devices according to VIKOR method is the criterion for action. And it is suggested that researchers use this method to rank banks.

References

- Azar, Adel, Anvari Rostami, Ali Asghar, Rostami, Mohammad Reza (2007), Measuring the relative efficiency of companies listed on the stock exchange with the approach of data envelopment analysis (information technology indicators), accounting and auditing studies, fourth year , No. 14, pp. 138-119.
- Ahmadi Shadmehri Mohammad Taher, Derakhshani Majid, Grivani Fatemeh and Nouri Mostafa. Ranking of insurance companies in North Khorasan province by TOPSIS method. Monetary Economics, Finance, Volume (24), Issue (13), Year (8-2017), Pages (69-87).

  - Emami Meybodi, Seyed Amir (1999), Measuring Efficiency and Productivity, Tehran: Institute of Business Studies and Research.

- Borhani, Hamid, 2008, Measuring efficiency in Iranian commercial banks and its relationship with organizational dimensions, 9th Islamic Banking Seminar.

-
- Beheshtinia, Mohammad Ali and Omidi, Sedigheh, Presenting a New Approach to Banking Ranking, Quarterly Journal of Strategic and Macro Policies, Volume 5, Number 17, Spring 2017, pp. 27-53.
-
- Salimi Mohammad Javad, Ebrahimi Sarvolia Mohammad Hassan, Ghasempour Shiva, Designing a local model for ranking Iranian banks based on banking health, Financial Research, Volume 18, Number 4, Winter 2016, pp. 653-674.
-

- Rezaei Farzin, Gheybdoost Hamed, A Study of the Financial Performance of the Banking Industry by Vikor Method, Quarterly Journal of Development and Transformation Management, Volume 2016, Special Issue, Winter 2016, Pages 33-43
- Yousefi Mohammad, Ranking of the country's banks based on financial indicators and using the combined approach of fuzzy AHP and TOPSIS, Monetary and Banking Research Quarterly, Eleventh Year, No. 35, spring 1397, pp. 25-54.

- Teymouri Hadi, Goodarzvand Chegini Maryam, A Study of Factors Affecting the Formation Process of Electronic Loyalty with the Mediating Role of Electronic Commitment (Case Study: Electronic Banking Industry in Iran) Journal of Modern Marketing Research, Volume 7, Number 4 - Number 27, Winter 2017 , Pp. 117-144.

- Maleki Mehdi, A Study of the Role of Electronic Banking in Iran, Journal of Banking and Economics, No. 112, March 2011, pp. 19-19.
- Opricovic S and Tzeng GH. (2007). Extended VIKOR method in comparison with outranking methods. European Journal of Operational Research. 178, 514–529.

- Tzeng GH and Opricovic S. (2002). A comparative analysis of the DEA-CCR model and the VIKOR method. Yugoslav Journal of Operations Research. 18, 187–20.

- Huang JJ, Tzeng GH and Liu HH. (2009). A revised VIKOR model for multiple criteria decision making - The Perspective of Regret Theory, Y. Shi et al. (Eds.): MCDM 2009, CCIS 35, pp. 761–768, Springer-Verlag Berlin Heidelberg.

- Yang YPO, Shieh HM and Tzeng GH.(2009). A VIKOR Technique with Applications Based on DEMATEL and ANP, Y. Shi et al. (Eds.): MCDM 2009, CCIS 35, pp. 780–788, 2009. Springer-Verlag Berlin Heidelberg 2009.
- Sayadi MK, Heydari M and Shahanaghi K.(2009). Extension of VIKOR method for decision making problem with interval numbers. Applied Mathematical Modeling. 33, 2257–2262.
- Agage, G., & El-Masry, A. (2016). Understanding the Determinants of Hotel Booking Intentions and Moderating Role of Habit. International Journal of Hospitality Management, 54, 52-67.
- Katz, D., & Kahn, R.L (1966). "The social psychology of organizations", New York: Wiley.
- , Kemal VATANSEVER, Soner AKKO, Fuzzy Performance Evaluation with AHP and Topsis Methods: Evidence from Turkish Banking Sector after the Global Financial Crisis, Eurasian Journal of Business and Economics 2013, 6 (11), 53-74.
- Peter Wanke et all, ISLAMIC BANKING AND PERFORMANCE IN THE ASEAN BANKING INDUSTRY: A TOPSIS APPROACH WITH PROBABILISTIC WEIGHTS, International Journal of Business and Society, Vol. 18 S1, 2017, 129-150.
- Hasan Dincer and Umit Hacioglu, Performance evaluation with fuzzy VIKOR and AHP method based on customer satisfaction in Turkish banking sector, Kybernetes, Vol. 42 No. 7, 2013, pp. 1072-1085.
- Abdul Ghani, K., Jayabalan, V., & Sugumar, M. (2002). Impact of Advanced Manufacturing Technology on Organizational Structure. Journal of High Technology Management Research, 13, 157-175.

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