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Ranking Tehran Stock Exchange Industries using a Combined FCM-ELECTRE III-LA Method

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Abstract

One of the most complex decision-making issues for stock exchange investors is the evaluation of companies' performance and their ranking in the next step, which can be done based on different approaches. In the paper, the industries of Tehran Stock Exchange (TSE) evaluated during the years 2010 to 2019 and ranked by a combined fuzzy cognitive map (FCM), Electere III and linear assignment (LA) method. To this aim, first based on the literature review, 21 more cited criteria were selected as the main criteria in performance analysis of the TSE. Then, fuzzy cognitive map as a qualitative analytical tool, was applied to rank financial eavaluation criteria based on their intractions. Applying FCM, five criteria were determined as more important criteria for performance evaluation. In the the next step, all of the industries in TSE were evaluated in 10 years from 2011 to 2020 using the ELECTRE III as a powerfull MCDA method. Finally, LA method was applied for integrating the rank of industry in the 10 years period. The results indicate that insurance and pension industries, Industrial multidisciplinary and Food (except sugar), placed at the first to third ranks.

Keywords:
Tehran Stock Exchange
ELECTRE III
Linear Assignment
Ranking the Industries
Fuzzy Cognitive Map

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INTRODUCTION

Financial markets have always been an attractive field for research and offer different types of opportunities for investors and market analysts, however, the lack of financial literacy and basic knowledge of economic principles can have a special impact on investment returns. Thakar and Chadhari, 2021). A stock market is a financial market where shares of companies are sold in the main market (Thakar and Chadhari, 2020). Investors may use social opinions in addition to primary information that is extracted from historical time series data. These opinions are obtained through online surveys, market analysis, forums, etc. (Wong et al., 2017). Investors should make an effective decision to improve the return of their investments and avoid huge financial losses, especially investing in the stock market (Abdul Sattar et al., 2020). Choosing and choosing the stocks of the companies present in the stock exchange and forming the optimal stock portfolio depends on several factors that complicate decision making for analysts and experts.

One of the important reasons why investors are reluctant to invest in the stock market is their inability to predict, evaluate and analyze data and most importantly, the performance of companies. So they prefer to invest in banks and business matters. On the other hand, organizations also need decisions to provide a suitable model for predicting and measuring performance and cause continuous improvement in all fields (Amjadian et al., 2020). With the emergence of modern methods and their use along with traditional financial criteria, the performance evaluation of companies has also changed, so one of the main issues facing investment decision makers is the lack of recognition and prioritization of performance evaluation criteria for companies (Dahimavi et al. 2014).

Due to the increase in performance evaluation criteria and the importance of decision-making in this field, which leads to the realization of organizational goals (Dahimavi et al., 2014), researchers today are looking for multi-criteria models for complex decision-making, because decision-making with Making several criteria, each of which has a special place, is possible only by using multi-criteria decision-making models. Therefore, by using multi-criteria decision-making methods and considering performance evaluation criteria as indicators and stock exchange companies as options, it is possible to evaluate and rank companies (Hatmi and Kongi, 2017).

Today, solutions based on big data analysis and intelligent computing are used to reduce the complexity of processing large amounts of data (Iqbal et al., 2020). The large volume of data alone does not help the managers of organizations and investors in making decisions, but also causes them confusion, so managing raw data and converting external and internal data of the organization into information and knowledge using methods variety has a fundamental and central role (Iqbal Nia et al., 2014).According to the above topics in this research, in the first step, according to the feedback relationships between the BSC perspectives, the theoretical foundations related to the field of performance evaluation, and by using the combination of fuzzy Delphi methods and fuzzy mapping, the various coordinates in the mental background of people to recognize To transform the intertwined elements of performance evaluation into a clear and specific relationship so that by using the central relationships and the degree of influence of these criteria, the decision maker can take more solid steps and create a better future for himself, and to two questions regarding the criteria Respond effectively to performance evaluation and how to rate them. In the second step, after identifying the important criteria for evaluating the performance of companies by presenting an approach based on multi-criteria decision-making methods to evaluate the performance of companies present in the stock exchange, the performance of each of these algorithms has been evaluated using seven indicators. And finally, by using the well-known MCDM techniques and different points of view, the ranking of the existing industries in the country will be discussed in order to invest in them, the results of which can be used for financial decision makers and investors.

LITERATURE REVIEW

The stock exchange is an organized and official market where accepted securities are traded between buyers and sellers based on certain rules and regulations. The main task of the stock exchange is to provide a transparent market (providing complete information to buyers and sellers) for securities trading. Considering the importance of knowing the background of each phenomenon in a better understanding of its nature and function, a brief history of stock exchanges in the world and Iran has been mentioned below. Forecasting and investigating the behavior of stock prices in the world of economy is a very significant thing. The main reason people invest in the stock market is to gain profit, which requires having the correct information about the stock market and stock changes and forecasts. The nose is the trend of its future. Therefore, the investor needs powerful and reliable tools to predict the stock price and buy shares from the said company (Afshari Rad et al., 2017). Therefore, investors should make an effective decision to improve the return of their investments and Avoid huge financial losses, especially investing in the stock market (Abdul Sattar et al., 2020). Decision makers in the field of investment are often forced to choose among different options. They receive various proposals regarding doing an activity and they should be sufficiently familiar with the principles of comparing different options in terms of profitability in order to be able to choose the best option. choose (Mehrbanpour et al., 2016). The return of the stock exchange is the return that investors generate from the stock market, it can be in the form of profit through transactions or in the form of dividends that the company gives to its shareholders from time to time (Bashar and Maitham, 2016). Stock market returns through dividends declared by companies are applicable in modern financial time series forecasting, stock price forecasting is considered one of the most challenging. Therefore, a number of models have been produced to support investors with more accurate predictions. However, the stock price is affected by various factors and the non-linear relationships between the existing factors in different periods are such that predicting the stock price value or trends is a very difficult task for investors (Mossey and Joshua, 2020).

Keshavarzian et al. (2018) with the aim of providing a model to identify the influencing factors and rank the companies, analyzed the financial performance of 6 petrochemical companies admitted to the Tehran Stock Exchange for the years 2019 to 2018 using the combined AHP and Prameti method. Khanjarpaneh et al. (2017) applied the technical method to predict stock prices with the approach of nonlinear probabilistic models and artificial neural networks. Namazi and Namazi (2015) evaluated the performance of 142 companies during the years 1380 to 1392 using the TOPSIS multi-indicator technique and the comparison of evaluation criteria (evidence from the Tehran Stock Exchange). Taghipourian et al. (2014) evaluated random tree models in predicting the financial performance of companies listed on the Tehran Stock Exchange. In 2014, Khajovi et al. ranked and evaluated the financial performance of selected industrial companies of the Tehran Stock Exchange using the AHP-VICOR fuzzy hybrid model. Hosseini et al. (2014) conducted a research on the fundamental analysis of stocks using two-stage hedging analysis.

In 2020, Abdul Sattar et al presented a stock market classification model using analysis based on HNBC. The presented model produced significant results in the classification of stock market behavior with an accuracy of more than 89%, which enables these investors to adjust their plans based on accurate indicators that reduce the risk of decision making. In 2019, Jiang et al. addressed an improved cumulative framework for stock index forecasting using tree group models and deep learning algorithms. Guchen et al. in 2016 using technical analysis indicators and hybrid artificial neural network based on Based on genetic algorithms and harmony search, they predicted the price index in the Turkish stock market. In 2012, Yalsin et al. ranked Turkey's manufacturing industries using AHP, TOPSIS and VIKOR methods and using traditional financial criteria. Considering the importance of the role of performance evaluation on the

evaluation of companies, it should be noted that despite conducting many researches in this field, so far few researches have been conducted in order to comprehensively and completely identify the key indicators of performance evaluation and also to comprehensively review the performance of companies. is, in table 1 the summary of the conducted research is presented.

Table 1: Summary of research background

Results	Year	Author
In order to evaluate performance by using financial ratios in terms of decision tree algorithm, they attempted to identify the most important financial ratio for the evaluation of firms.	2017	Rezaei and Amir Hosseini
With the aim of selecting the strategic indicators and evaluating the financial performance of companies using the analytical hierarchy of fuzzy and topsis, the chemical industries in tehran stock exchange have been studied, they used financial ratios and value - based measures to assess companies.	2017	Ghaffari Fard and Zahedi
In order to determine the financial performance evaluation indicators and accounting system capabilities to fulfill the responsibility of financial accountability in Tehran municipality, they used fuzzy Delphi method and factor analysis to identify ٢٦ financial indicators.	2017	Babajani and Muharrami
Using the combination of fuzzy Delphi methods, factor analysis and network analysis, they identified and ranked indicators affecting the quality of financial statements of companies.	2019	Bolo et al
In evaluating the financial performance of investment companies in Iran, they used two criteria, Tobin's Q and ROA, and analyzed the obtained information using econometric techniques based on regression.	2020	Nasiri and Soleimani Amiri
By using two prominent techniques, DEA and BSC, they provided a framework for measuring the performance of organizations.	2020	Mehrgan and Moradi
Prediction of stock indices through ANN combined model and genetic algorithm led to the design of the model.	2015	Karimi
Identification of key performance indicators in logistics industries and the relationships between them, which used the combination of BSC and ANP methods.	2016	Cococaltan et al
Identifying and ranking the productivity index of work teams in the hospital using the ANP-BWM approach, case study: Tehran Sajjad Hospital	2017	Karimi
Investigating the financial performance of seven banking companies using the combination of AHP, TOPSIS and PROMATI methods	2018	Sharma et al
Using the combination of ISM-BWM methods, they identified the financial performance evaluation indicators and ranking of Tehran Stock Exchange companies.	2020	Amjadian et al
Selection of three indicators from among 81 performance evaluation indicators of Canadian water centers based on experts' opinion and then by FAHP and FCC methods, the indicators were weighted and the centers were ranked.	2020	Sena Salim et al

RESEARCH METHODOLOGY

This research is descriptive-survey in terms of method. The data of this research was collected from scientific literature, interviews with professors and experts, and referring to documents. The criteria for measuring the performance of companies have also been identified from scientific literature and interviews with experts. Taking into account the effective criteria on the performance evaluation of the Electr III technique, the existing industries in the country were ranked in order to invest in them. In order to determine effective criteria in evaluating the performance of industries, it was studied from two points of view (investors and research experts). Despite the large number of people who have invested in the stock market in recent years, the number of investors who invest based on the analysis of the performance indicators of companies is limited. Most of the present investors use methods such as: signals provided on social networks, chart reading, recommendations of friends, etc. for investment. Since one of the most important and best methods of investment is the use of performance indicators of companies, and one of the goals of this research is to examine the important indicators of the performance of companies and provide guidance

to investors, naturally we were looking for investors who invest by examining performance indicators. and they are fully familiar with financial indicators, which are few in number, so they are considered expert investors. In this research, investors who have the following conditions:

(1) familiarity with the capital market for at least 5 years

(2) Having a master's degree or higher in accounting and finance fields

(3) Full familiarity with performance evaluation indicators of companies

were selected as respondents. From the point of view of the research experts, the statistical population included university professors in the fields of accounting and finance with the scientific rank of assistant professor and above. According to the selected statistical population (Section 3-3), among the available options, 12 people were selected as expert investors. From the point of view of academic research experts, 10 people were selected as experts.

On another level, in order to test the proposed model of the community studied in this research, there were various industries in the country's capital market. At this level, the 10-year financial information of the companies present in the Tehran Stock Exchange during the years 1390 to 1399 was used to evaluate the performance of the companies. In order to select the companies using the following four criteria, the systematic elimination sampling method was used:

(1) The financial period of the companies should end at the end of March.

(2) The selected company is not one of the holding companies and leasing companies.

(3) The financial information of the companies is available in the studied time period.

(4) The trading of shares of the companies is carried out continuously in the Tehran Stock Exchange and does not stop for more than one month.

Since this research deals with the ranking and evaluation of various industries present in the Tehran Stock Exchange, it is therefore considered a part of quantitative research and the post-event research design was used. MATLAB software was used to analyze the data.

In the current research, among more than 400 criteria related to performance evaluation (Kudhartian and Anwari, 2013 and Memarzadeh et al., 2016 and Pakbaz et al., 2016) with the consensus of the research experts, 21 criteria were used to evaluate the performance of the companies present in Tehran Stock Exchange were selected. Then, in order to determine the importance of these criteria from the point of view of investors, a questionnaire was prepared and given to 12 expert investors selected for the research. present in the Tehran Stock Exchange was extracted from their opinion.

ELECTRE III method

ELECTERE method (in its various forms) is one of the multi-criteria decision-making methods, which was introduced in 1965 by Bernard Roy, the top professor of Dauphin University in Paris, in response to the shortcomings of decision-making methods. In this method, the best choice is made based on maximum advantage and minimum conflict based on a function of different criteria (Gita et al., 2021). Electra includes different versions including Electra I, II, III, IV and TRI. All methods are based on the same basic concepts, but they differ both operationally and according to the type of decision problem. Based on this, Electron I method is used to solve the selection problem, Electron TRI method is used to solve allocation problems, and Electron II, III and IV methods are used to solve ranking problems. The Electra III method outperforms other multi-criteria decision-making methods using its ability to deal with inaccurate, imprecise, and uncertain data. In this method, for j existing criteria, three related thresholds are defined, which are indifference (q), preference (p) and superiority (v). These thresholds create higher relationships with a limit for the data. To use this method, we have the following steps:

Coordination index, for each pair of options $C(a.b)$, a and b is calculated based on the overall comparison of their performance in all criteria. This index has a value between 0 and1, where 0 means the poor performance of option a compared to option b in all criteria. Coordination

index based on the weighted comparison of the performance of each criterion separately $C_j(a.b)$ is calculated using the relation (1) and (2)

$$C(a.b) = \frac{1}{\sum_{j=1}^{n} w_j} \sum_{j=1}^{n} w_j \, C_j(a.b) \quad (1)$$

$$C_j(a.b) = \begin{cases} 1 & g_j(a) + q_j(g_j(a)) \geq g_j(b) \\ 0 & g_j(a) + p_j(g_j(a)) \leq g_j(b) \\ \dfrac{g_j(a) - g_j(b) + p_j(g_j(a))}{p_j\left(g_j(a)\right) - q_j(g_j(a))} & O.W \end{cases} \quad (2)$$

p_j and q_j is the threshold of preference and indifference of criterion j, respectively.

The inconsistency index, $D_j(a.b)$, has a value between 0 and 1, which is calculated using the decision matrix and threshold values based on the Eq. 3 for each criterion.

$$C_j(a.b) = \begin{cases} 1 & g_j(b) \geq g_j(a) + v_j\left(g_j(a)\right) \\ 0 & g_j(b) \leq g_j(a) + p_j\left(g_j(a)\right) \\ \dfrac{g_j(b) - g_j(a) - p_j\left(g_j(a)\right)}{v_j\left(g_j(a)\right) - p_j\left(g_j(a)\right)} & O.W \end{cases} \quad (3)$$

The credit score, $S(a.b)$, is calculated based on the coordination and inconsistency indices in the form of the relationship (4).

$$= \begin{cases} C(a.b) & D_j(a.b) \leq C(a.b) \quad \forall j \\ C(a.b) \prod_{j \in \varphi(a.b)} \frac{1 - D_j(a.b)}{1 - C(a.b)} & \forall j \; D_j(a.b) > C(a.b) \end{cases} \quad (4)$$

In relation (2-26), $\varphi(a.b)$ is the set that for each j, $D_j(a.b) > C(a.b)$.

Based on the validity matrix calculated in the previous step, to form the final comparison matrix, the index λ and S(λ) are defined in the form of relations (5) and (6).

$$\lambda = \text{Max}(S) \quad (5)$$

$$S(\lambda) = 0.3 + 0.5\lambda \quad (6)$$

Then the final comparison matrix (T) is calculated using the Eq. 7.

$$T(a.b) = \begin{cases} 1 & S(a.b) > \lambda - S(\lambda) \\ 0 & O.W \end{cases} \quad (7)$$

After forming the final matrix, in order to prioritize the examined options, once the options are ranked from the best to the worst and once again from the worst to the best. Finally, by comparing two decreasing and increasing trends, the final ranking of options is obtained.

Fuzzy Cognitive Map

Fuzzy Cognitive Map (FCM) was first introduced by Axelrod in the 1970s to present in social science knowledge (Axelrod, 2015), which is a network consisting of nodes and arrows as communication lines (a special type of directed graph) and direction The arrow shows the causality relationship considered by the individual, the fuzzy mapping is an extended version of the mapping that is used to model the complex chain of causal relationships and displays the strength of the causal relationships with a number in the range [-1 , 1] (Mustafai et al., 2017). In this method, like normal mapping, positive numbers indicate a direct relationship and negative numbers indicate an inverse relationship between phenomena (Ehsanifar et al., 2016). FCM is one of the research techniques in soft operations in the field of problem structuring (Mustafai et al., 2017), Koso is the first person who added fuzzy logic to cognitive map with the aim of using qualitative knowledge (Koso, 1986). FCM is mainly used to analyze and help the decision-making process by examining random links between related concepts (Amer et al, 2016). In 2007, Rodriguez-Repiso and his colleagues use four matrices with the title, initial success matrix, fuzzy success matrix, success relationship strength matrix and final success matrix to form a fuzzy mapping (Rodriguez-Repiso et al, 2007).

The primary matrix of success (matrix V): The primary matrix of success is an n×m matrix, where n represents the number of factors and m the number of people interviewed to obtain data. O_{ij} are matrix rows that indicate the importance of factor j for person i, elements $O_{i1}.O_{i2}.\ldots.O_{im}$are vector elements V_i related to key success factors belonging to person i (Rodriguez-Repiso et al, 2007).

Fuzzified success matrix (X matrix): Numeric vectors V_i are transferred to fuzzy sets as follows to numeric vectors with values between zero and one (Rodriguez-Repiso et al, 2007).

We find the maximum value in V_i and set its value in X matrix equal to one. And the minimum value in V_i in X matrix becomes zero. Other elements in the V_i vector are placed between zero and one using the Eq. 1.

$$X_i(O_{ij}) = \frac{O_{ij} - \text{Min}(O_{iq})}{\text{Max}(O_{iq}) - \text{Min}(O_{iq})} \quad (8)$$

(8)

where $X_i(O_{ij})$ is the degree of membership of the element O_{ij} in the vector V_i.

Direct estimation of the values in the range [0 , 1] may determine the degree of membership in a way that does not reflect the real world and is not logically justified. In such cases, high or low threshold values should be defined through expert data analysis. Therefore, if V_i is the numerical vector of the element m related to the concept i and O_{ij} (j = 1,2,…,m) consists of the vector V_i , the values of the upper and lower thresholds ($\alpha_u$and α_l, respectively) (Mehrgan et al., 2016).

$$\forall j = 1.2. \dots . m \qquad O_{ij}(O_{ij} \geq \alpha_u) \rightarrow X_i(O_{ij}) = 1 \quad (9)$$

$$\forall j = 1.2. \dots . m \qquad O_{ij}(O_{ij} \leq \alpha_l) \rightarrow X_i(O_{ij}) = 0 \quad (10)$$

Success relationship strength matrix (S matrix): Success strength relationship matrix is an n×n matrix. The rows and columns of this matrix are the key success factors and each element in the matrix indicates the relationship between factor i and factor j. Also, the elements of this matrix S_{ij} can contain values in the range [-1 , 1].

Final index of success: When the strength matrix of success relationships is completed, some of the data included in it can be misleading data. Not all key success factors presented in the matrix are related and there is not always a causal relationship between them. In order to analyze the data and convert the power matrix of success relationships into the final success matrix, according to an expert, it is necessary that the power matrix includes only those fuzzy elements that represent the causal relationships between the key factors of success (Jamali and Mohammadi, 2018). Therefore, with the help of experts, the data were analyzed and the strength of relationship matrix (SRMS) was converted into the final matrix (FMS) (Mehrgan et al., 2016).

Graphical Representation of Fuzzy Cognitive Mapping (FCM): The graphical representation of the final matrix draws a targeted fuzzy map for key success factors. In the final representation, each arrow connects the factors, and has a weight ($\pm w_{ij}$) that indicates the intensity or strength of the direct or inverse causal relationship between the two factors (Rodriguez-Repiso et al, 2007 and Gerogiannis et al. et al., 2012).

FINDINGS

In this stage, in order to check the relationships between the selected criteria of the previous stage and to calculate the power of the 21 criteria extracted by the fuzzy Delphi method, the fuzzy mapping technique is used, in this way that initially based on the answers of12 experts Investing a 12x21 matrix was prepared to form the initial matrix. The rows of the initial matrix, respectively, include 21 performance evaluation criteria of companies as follows: working capital ratio, current debt to equity ratio, gross profit to sales ratio, operating profit to sales ratio, operating profit growth, total asset return ratio, return on equity, income per share, dividend per share, price-earnings ratio per share, sales growth rate, sales volume, domestic sales volume, foreign sales volume, export amount to total sales, inventory ratio of goods in progress to production, the ratio of inventory to production, research cost and labor productivity to production, money flow index, demand index and purchasing power of shares to sales and matrix columns including the answer of each of the12 investors regarding the score of each of This is the criteria. In the next step, the fuzzy matrix of the criteria and the strength matrix of the relationships were calculated

At the end, with the benefit of the opinion of 10 selected research experts, the data were analyzed and the relationship strength matrix (SRMS) was converted into the final matrix (FMS), based on their opinion, meaningless relationships between the research factors were removed and the causal direction of the relationships was also determined. Became its results are shown in Table 1 and the phase mapping diagram drawn using graph theory and Ucinet6 software is shown in fig 1.

Table: 1 the final matrix (FMS)

C70	C69	C68	C58	C49	C48	C46	C44	C43	C42	C29	C21	C20	C19	C17	C15	C14	C13	C12	C9	C7	Criteria
•	•	•	•	•	•	•	•	•	•	•	0.88	•	•	•	•	•	•	0.92	•	•	C7
•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	C9
•	•	•	•	•	•	•	•	•	•	0.98	0.92	•	•	•	•	0.96	0.96	•	•	0.92	C12
•	•	•	•	•	•	•	0.92	•	•	0.94	0.92	•	•	•	•	0.96	•	•	•	0.92	C13
0.83	•	•	•	•	•	•	•	•	•	•	0.92	•	•	•	•	•	0.96	0.96	•	0.92	C14
•	•	•	•	•	•	•	•	•	•	•	•	0.79	•	0.83	•	•	•	•	•	•	C15
0.69	•	•	•	•	•	•	•	•	•	•	•	0.79	•	•	0.83	•	•	•	•	•	C17
0.78	0.69	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	C19
0.77	•	•	•	•	•	•	•	•	•	•	•	•	•	•	0.79	•	•	•	•	•	C20
•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	0.92	0.92	0.92	•	0.88	C21
•	•	•	•	•	•	•	•	0.9	0.88	•	0.9	•	•	•	•	0.98	0.94	0.98	•	0.9	C29
0.85	•	•	•	•	•	•	•	•	•	0.88	0.85	•	•	•	•	0.85	0.9	0.9	•	•	C42
•	•	•	•	•	•	•	•	•	0.98	0.9	0.88	•	•	0.73	•	0.88	0.92	0.92	•	•	C43
0.92	•	•	•	•	•	0.96	•	0.88	•	0.9	0.88	0.73	•	0.69	•	0.92	0.92	0.88	•	•	C44
0.88	•	•	•	•	•	•	•	0.88	•	0.9	•	0.77	•	•	•	0.92	0.92	0.88	•	•	C46
•	•	•	•	•	•	•	•	0.83	•	•	0.88	•	•	•	•	•	•	•	•	•	C48
•	•	•	•	•	0.98	•	0.85	•	•	•	0.85	•	•	•	•	•	•	•	•	•	C49
•	•	•	•	•	•	•	•	•	0.79	•	•	•	•	•	•	•	•	•	•	•	C58
0.85	0.86	•	•	•	•	•	•	•	•	•	•	•	0.72	•	•	•	•	•	•	•	C68
0.83	•	0.86	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	C69
•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	0.83	•	•	•	•	C70

One of the outputs of the static analysis of the fuzzy cognitive map was the identification of the effectiveness, effectiveness and centrality of the criteria, the summary of this information is available in Table 2, where the criteria are ranked based on the centrality index. According to graph theory, this research (map) has a total of 21 nodes (criteria), of which 2 nodes are only senders (influencer), 1 node is neither sender nor receiver (influencer), and20 nodes are central.

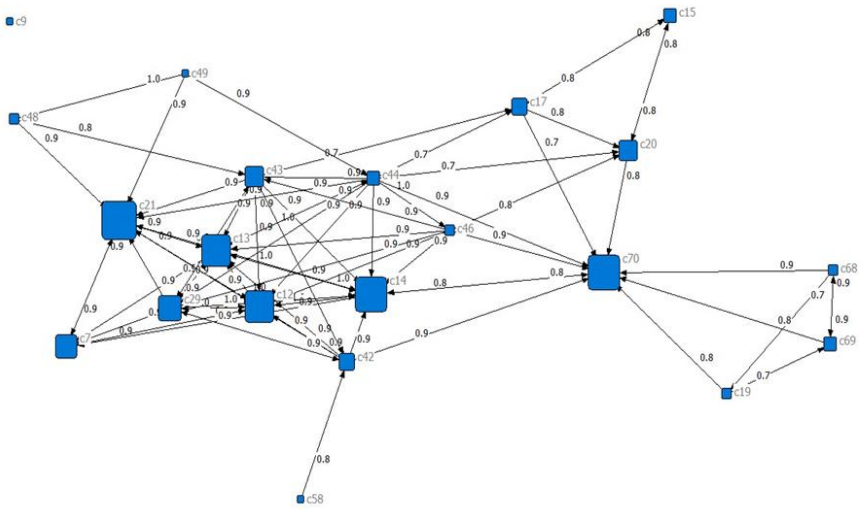

Fig. 1. Fuzzy mapping related to company evaluation criteria

Table 2: ranking of fuzzy mapping criteria based on centrality index

Centerality	Influencing	Affecting	Criterion	Criteria code	Rank
12.791	8.208	4.583	Operating profit growth (OPG)	C14	1
12.479	8.854	3.625	Price/earnings ratio per share (P/E)	C21	2
12.063	7.417	4.646	Operating profit to sales ratio	C13	3
12.062	7.333	4.729	Gross profit to sales ratio	C12	4
11.937	5.479	6.458	The company's sales growth rate	C29	5
40.417	1.771	8.646	Foreign sales volume (exports)	C44	6
9.667	3.479	6.188	Domestic sales volume	C43	7
8.236	7.403	0.833	The power of shares to sale	C70	8
7.875	2.646	5.229	Sales volume	C42	9
7.083	0.958	7.125	The amount of exports to total sales	C46	10
6.313	4.521	1.792	Working capital ratio	C7	11
4.646	3.083	1.563	Dividend per share (DPS)	C20	12
4.563	2.25	2.313	Return on equity (ROE)	C17	13
3.299	0.861	2.438	Money flow index (MFI)	C68	14
3.25	1.625	1.625	Return on Assets (ROA)	C15	15
3.244	1.556	1.688	demand index (DI)	C69	16
2.688	۰	2.688	The inventory to sales ratio in manufacturing	C49	17
2.687	0.979	1.708	The ratio of goods in process to production	C48	18
2.201	0.722	1.479	Earnings per share (EPS)	C19	19
0.792	۰	0.792	Cost of research and labor productivity to production	C58	20
۰	۰	۰	debt-to-equity ratio	C9	21

Although in Figure1, the influence of each criterion on other criteria is specified. But as mentioned, the criterion for identifying the most important criteria is according to the degree of centrality of the criteria. Therefore, operating profit growth (OPG), price-to-earnings-per-share ratio (P/E), operating profit-to-sales ratio, gross profit-to-sales ratio, and the company's sales growth rate, which have the highest degree of centrality, are considered five important measures of were selected, that all five selected important criteria examine companies from a financial perspective. In this research, the judgment method was used to determine the final weight of each of the criteria.

Table 3: Weight each criterion by ANP method

Weight	Indicator	Row
0.20	Operating profit growth (OPG)	1
0.35	Price/earnings ratio per share (P/E)	2
0.30	Operating profit to sales ratio	3
0.05	Gross profit to sales ratio	4
0.10	The company's sales growth rate	5

After determining the performance evaluation criteria of the companies and their respective weight of the companies present in the Tehran Stock Exchange during the years 2010 to 2019 based on 5 operating profit growth criteria (OPG), price to earnings per share ratio (P/E) , the ratio of operating profit to sales, the ratio of gross profit to sales and the company's sales growth rate were evaluated based on the ELECTRE III method. The table below shows a summary of the ranking.

Table 4: ranking of industries by method ELECTRE III

2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	Industry code	industry
22	3	5	5	4	4	6	3	9	29	1	Aggregation of real estate
26	35	29	5	4	30	30	26	3	3	2	Coal mining
3	25	13	12	8	13	22	2	19	7	3	Mining of metal ores
9	18	23	7	6	19	15	26	3	24	4	Extraction of oil and gas except for exploration
7	28	9	30	27	1	1	24	9	27	5	Banks and credit institutions
3	7	18	20	17	11	28	13	15	1	6	Insurance and pension
5	31	18	14	1	23	18	15	26	26	7	Industrial contracting
2	14	16	3	7	16	8	13	5	28	8	Industrial multidisciplinary
1	10	3	21	13	8	3	11	14	10	9	Transportation, storage and communication
13	2	7	28	14	16	15	4	19	22	10	Cars and auto parts
29	12	11	16	20	11	17	20	11	19	11	Drugs
16	14	13	19	32	2	13	1	25	6	12	Electrical devices
29	18	25	2	1	6	31	7	2	12	13	Computers
19	26	1	8	14	5	9	6	1	16	14	Agriculture and related services
13	3	12	25	24	28	10	29	13	21	15	Lime cement, gypsum
20	16	20	17	3	3	25	10	5	8	16	Chemicals
6	28	6	10	11	11	7	5	19	23	17	Supply of electricity, gas, steam and hot water

10	6	16	1	19	6	21	13	7	4	18	Food except sugar
18	11	10	10	24	23	1	22	27	18	19	Oil products
31	7	32	28	21	16	13	15	17	17	20	Basic metals
27	32	30	14	17	29	23	23	11	2	22	Sugar
24	28	26	22	11	26	19	8	23	5	23	Ceramic Tile
31	23	2	4	28	14	4	18	7	13	24	Non metallic mineral
7	20	8	25	22	8	20	8	15	14	25	Rubber and plastic
16	23	3	28	8	25	4	18	23	9	26	Equipment and machinery
28	1	30	24	29	20	11	25	23	15	27	Metal products
23	9	24	22	17	27	26	28	19	25	28	Paper products
27	17	20	32	11	22	28	20	۲۵	20	29	Telecommunications
13	30	28	33	30	21	24	18	4	11	30	Hotel and restaurant

Based on the results obtained in 2010, electre3 method, the real estate massification industry, in 2011 the chemical industry, in 2012 the computer industry, in 2013 the insurance and pension industry, in 2014 the insurance and pension industry, in 2015 the industry In2016, he considers lime-gypsum cement, basic metals industry, in 2017, lime-gypsum cement industry, in 2018, machinery and equipment industry, and in 2019, automobile and parts industry as the best industry. Since the volume, value and number of transactions are different in each year, the value of the industry ranking in each year cannot have the same importance. Therefore, in order to calculate the importance of each year, three indicators of volume of transactions, value of transactions and number of transactions carried out in each year were extracted, the results of which are shown in Table 5.

Table 5: the volume, value and number of transactions between 1390 to 1399
(Source of Tehran Stock Exchange website)

Transactions quantity	**Transactions value**	**Transactions volume**	**Year**
4,400,470	227,736,454,114	73,631,744,197	2011
5,235,174	219,615,000,000,000	68,856,000,000	2012
17,083,767	692,738,000,000,000	163,247,000,000	2013
12,916,249	377,118,997,800,000	144,645,618,300	2014
13,967,014	561,607,155,302,401	228,063,040,412	2014
15,746,777	638,540,031,595,715	256,771,884,054	2015
15,563,922	643,119,579,004,103	262,998,758,638	2016
33,575,652	1,606,104,000,000,000	520,333,000,000	2017
113,329,796	5,126,411,458,327,900	1,911,557,712,495	2018
363,204,160	27,014,917,042,371,000	2,328,613,338,685	2019
595,022,681	37,107,908,043,855,200	5,166,718,126,187	**Sum**

The results show the annual growth especially in 2018 and 2019. In order to continue the path and calculate the importance of each year, based on the conducted surveys and the opinion of research experts, the ratio of the volume of transactions carried out in each year was used. The importance (weight) of each year is given in Table 6.

Table 6: Importance (weight) of each year based on the volume of transactions made in each year

2020	2019	2018	2017	2016	2015	2014	2013	2012	2011	Year
0.45	0.217	0.101	0.051	0.05	0.044	0.028	0.032	0.013	0.014	Weight

Now, in order to obtain the final rank of industries by linear allocation method, each year was considered as an index and industries as available options. After the calculations, the results and the final rank of each industry were obtained, which is shown in Table 7.

Table 7: Final ranking of industries by linear assignment method

Rank	Industry	Rank	Industry
1	Insurance and pension	22	Hotel and restaurant
2	Industrial multidisciplinary	23	Sugar
3	Food except sugar	24	Telecommunications
4	Cars and auto parts	25	Paper products
5	Mining of metal ores	26	Chemicals
6	Aggregation of real estate	27	Coal mining
7	Lime cement, gypsum	28	textiles
8	Oil products	29	Supply of electricity, gas, steam and hot water
9	Metal products	30	Agriculture and related services
10	Extraction of other mines	31	Engineering
11	Auxiliary activities to intermediary ….	32	Wholesale
12	Equipment and machinery	33	Electrical devices
13	Extraction of oil and gas except exploration	34	Print
14	Drugs	35	Retail
15	Transportation, storage and communication	36	Industrial contracting
16	Rubber and plastic	37	Electronic and optical computer products
17	Banks and credit institutions	38	Communication equipments

18	Computer	39	Leather products
19	Basic metals	40	Wood products
20	Ceramic Tile	41	Other transport
21	Non metallic mineral	42	Information and communication

Based on the results obtained from among the top 42 industries during the years 2010-2019, insurance and pension industries, multi-discipline industries, food except sugar and sugar, automobiles and parts, metal ore extraction, real estate accumulation, lime cement Gypsum, petroleum products, metal products, extraction of other mines were ranked 1 to 10 respectively. Reviewing the 10-year rankings of the insurance and pension industry shows the continued superiority of this industry based on five indicators of operating profit growth (OPG), price-to-earnings ratio (P/E), operating profit-to-sales ratio, gross profit-to-sales ratio and The company's sales growth rate is such that the best rank of this industry was in 2013 and 2019, when it was ranked 1st, and in 2018, it got its weakest rank (9th rank). The multi-discipline industry got the best rank in 2019 (rank 2) and the weakest rank in 2019 (rank 24), and the food industry, except for sugar, got the best rank in 2019 (rank 2) and weak It got the highest rank in 2010 (rank 17).

CONCLUSION

The results of Table 33-4 showed the different performance of industries in different years. In1390, sugar industry, 1391 rubber and plastic industry, 1392 petroleum products industry, 1393 insurance and pension industry, 1394 industrial contracting industry, 1395 metal ore mining industry, 1396 basic metals industry, in 1397, the rubber and plastic industry, in 1398, the oil products industry, and in 1399, the insurance and pension industry have taken the first place. Since the volume, value and number of transactions are different in each year, the value of the industry ranking in each year cannot have the same importance. After extracting and checking the indicators of volume, value and number of transactions made for each year, based on the opinion of research experts, we used the index of transaction volume to calculate the weight (importance) of each year. The results showed that the weight of 1390 equals 0.014, 1391 equals 0.013, 1392 equals 0.032, 1393 equals 0.028, 1394 equals 0.044, year 1395 equals 0.05,2016 equals 0.051, 2017 equals 0.101, 2018 equals 0.217 and the weight of 2019 equals 0.45. Now, having in hand the importance of each year and the ranking of the industries of that year, the linear allocation method was used for the final ranking and presentation of the best industries. In order to modify the classical linear allocation method and with the aim of affecting the performance distance of the options, first intervals are defined and then each option is ranked according to belonging to each of the intervals. In the final ranking of the options, the belonging of each option to each of the defined intervals was the ranking criterion. In this way, not only the weight of the criteria, but also the performance distance of the options was effective in the ranking. In order to check the relationships between the extracted 21 key criteria, a questionnaire was prepared and given to the research experts, based on the answers received and using the fuzzy mapping method, the relationships between the criteria were checked and the criteria were ranked. In this step, five criteria of operating profit growth (OPG), price-to-earnings ratio (P/E), operating profit-to-sales ratio, gross profit-to-sales ratio, and the company's sales growth rate were selected.

Based on the results obtained from among the top 42 industries during the years 2010-2019, insurance and pension industries, multi-discipline industries, food except sugar and sugar, automobiles and parts, metal ore extraction, real estate accumulation, lime cement Gypsum,

petroleum products, metal products, extraction of other mines were ranked 1 to 10 respectively, which are suggested to investors for investment. In line with the study done, it is suggested to capital market investors to use methods that combine the criteria extracted from this research in order to accurately evaluate the performance of companies active in the market, the results of the research to decision makers, analysts It will help researchers and investors in the financial fields to better analyze the investigated companies, because the use of the appropriate model and correct clustering of companies leads to the selection of the optimal investment portfolio.

This research can help the managers and trustees of the capital market in ranking companies so that they can use the index extracted from this research, which is of interest to investors and plays an essential role in showing the financial status of a company, as a supplement to the index. Use conventional ratings. Considering the accuracy and multi-dimensional view of the presented model and its suitability for different users, it is suggested to the industrial management organization to use this model to prepare the list of the top companies in Iran. It is suggested to the stock exchange organization to establish institutions to evaluate the performance and rating of the companies admitted to the stock market using new and combined approaches so that they can evaluate the companies based on the needs of the investors and help the investors. to choose the desired company without worry and according to this information and their level of risk tolerance and profitability.

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