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Case study

Development of a New SWOT-MCDM Model to Create Marketing and Financial Strategies in Conditions of Uncertain (Case Study of Iralco Company)

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ABSTRACT

The most basic step in managing an organization is to develop appropriate and practical strategies . Developing a detailed and complete plan that will determine the long-term direction of the organization and guarantee the profitability and survival of the organization . In this research, using multi-criteria decision-making techniques, a new SWOT model has been created to formulate organizational strategies (financial, commercial, production and similar). The upcoming research method is of a mixed type (qualitative-quantitative) which will be used in the qualitative part of the method (descriptive-survey) and in the quantitative part of the fuzzy Delphi technique and multi-criteria decision making. In order to target more the results of this research and its output model, Iralco Company (Iran Aluminium) has been selected as a strategic and widely used global product manufacturer to study and implement the mentioned models and techniques.

1 Introduction

The concept of strategy is one of the important and valuable categories that are raised in the field of macro social issues in economy, politics, social, financial and economic micro communication and other issues of life and if we look at it properly, most of the economic problems and failures. The country's production and industry and even personal issues have their roots in the lack of attention in this sector. Superficial perception and not paying attention to the category of marketing has caused the bitter tragedy of the failure of industries to continue in the markets. On the other hand, it must be acknowledged that decision-making, planning, and strategizing in environments full of peace, tranquility, and complete certainty, if not completely meaningless, are certainly unrealistic. In making a decision and presenting an organizational strategy, since instead of a "definite future" one is faced with a spectrum of "probable or believable futures", "uncertainty" casts a shadow on the issue and should be considered in the formulation of the strategy. Although sometimes along with terms and concepts such as decision making and planning, restrictions such as "under conditions of uncertainty" are added but it must be acknowledged that decision-making and planning in environments full of calmness, stillness,

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and absolute certainty, if not completely meaningless, is certainly unrealistic [1]. In making a decision and presenting an organizational strategy, since instead of a "probable future" one is faced with a spectrum of "believable futures", "uncertainty" casts a shadow on the problem. The results of the research conducted in the field of strategy show that organizations gradually realized that if strategy is used properly, they will achieve a sustainable competitive advantage when the necessity of this became more evident when the survival of companies depended on choosing the right strategy and it was appropriate and this incident has always appeared during environmental turbulence [2]. SWOT analysis is an efficient tool for identifying the environmental conditions and internal capabilities of the organization. The basis of this efficient tool in strategic and marketing management is knowing the internal and external environment of the organization. Fred. R. David provides the following method for constructing a four-dimensional matrix of strategies using the combination of four factors. Internal factors (strength and weakness) including factors: finance, marketing, sales, production, management, Staff and the like) and External factors (opportunity and threat) including factors: economic, political, competitive, social, legal and the like) suggests:Strategies of strengths-threats (ST): By implementing these strategies, companies try to use their strengths to reduce or eliminate the effects of existing threats.Strengths-Opportunities Strategies (SO): in the form of these strategies, efforts are made to make the organization take advantage of external opportunities in the best way and maximize the opportunities.Weaknesses-Threats Strategies (WT): The aim of this strategy is to reduce internal weaknesses and avoid threats from the external environment.Weakness-Opportunity Strategies (WO): The purpose of these strategies is for the organization to improve internal weaknesses by exploiting the opportunities in the internal environment [3].

Traditional four-dimensional SWOT matrix	**Strength (S)**	**Weakness (W)**
Opportunity (O)	SO	WO
Threat (T)	ST	WT

Fig.1: Traditional model (four dimensions), [14] strategic management

The advantages and disadvantages of this research are as follows ,The SWOT model is one of the simplest and most practical models in determining marketing strategies and decision-making strategies in many industries and services, which, while being useful, also has some flaws and ambiguities. In this research, it has been tried to use the traditional SWOT four-facet model (Igor Ancef) and by fixing its basic defects and then expanding and developing this model, a flexible six-facet model for SWOT has been extracted. The advantages and disadvantages of this model can be as follows:

a) All traditional SWOT analyses are done with regard to the certainty of the internal and external conditions of organizations, which is practically impossible for future strategies. In this research, the views and opinions related to the uncertainty in creating strategies have been used. Because the future conditions of every organization are predicted in the form of uncertainty in many cases, and almost no expert can state the future conditions of the organization in a definite manner .In this research, using uncertainty techniques, an attempt has been made to solve this shortcoming

b) The methods of weighting and ranking factors in SWOT are very descriptive and lack verifiable criteria, which is also addressed in this research.

c) In the SWOT table, all the aspects for combining internal and external factors (strength, weakness, threat, and opportunity) are not used and only four categories of strategies are created in it. In the present

research, by expanding this model, a more flexible model based on six categories of strategy is available to managers and decision makers which creates a bigger space for decision making. The numerical values used in this research have been obtained according to the opinions of experts regarding the environmental conditions (economic, political, managerial and similar) of the aluminium industry and Iralco company, in the period from May 2022 to May 2023, and this is possible with Paying attention to severe environmental fluctuations in the future will cause the practical results of the research to suffer a decrease in effectiveness. The innovation of this research is as follows, *-In the created model, the use of network analytical process (ANP) in weighting the sub-criteria and strategies causes a more reliable ranking in the model and makes strategies to be created by combining the most important criteria (with the highest weight). Expanding and developing the four-sided strategic SWOT matrix and creating a six-sided SWOT matrix that creates more flexibility and efficiency to provide different strategies. New strategies have been added in the new matrix. Many of these strategies exist in the decision-making of many organizations, but they cannot be explained and placed in the four-dimensional matrix. Therefore, the new design of this matrix and the inclusion of new dimensions will make this matrix more flexible and closer to reality. It can be said that the added dimensions are a kind of reverse engineering. It means transferring several types of strategies that are currently being implemented in many organizations from the application environment to the new matrix. The dimensions added are:

a) The fifth dimension, called OT, means strategies during which it is tried to use the available environmental opportunities to avoid or reduce environmental threats .Which also has a lot of practical history (helping fellow allies to repel existing or common enemies)

b) The sixth dimension called WS strategies, during these strategies, internal strengths are tried to be used to overcome the existing weaknesses. This type of strategy can be one of the most useful strategies in times such as economic sanctions or blockades. Of course, this type of strategy is also very applicable (using strong sectors to help weak sectors in order to maintain or improve them)

Using the MABAC method increases the validity and reliability of the model for the following reasons: A) It has a simple mathematical device and stable results B) Perfect results can be easily obtained with this method because it takes possible values into account C) It is possible to combine this method with other approaches. Hence, the MABAC method has the ability to meet the needs of a valid prioritization tool.

According to the nature of the UTA STAR method (deduction of cumulative utility functions from past decision-making data), using this method ensures the results of the previous ranking .The formulation of strategies is always done according to the analysis of environmental factors and in order to apply them in the far or near future of the organization, therefore, due to the changeable environmental conditions in the future, the use of certainty will reduce the effectiveness of the current strategies in the future. The use of uncertainty (FUZZY) in this research has reduced this shortcoming

<table>
<tr><td colspan="2">WS</td><td colspan="2" rowspan="2">The six-dimensional flexible SWOT matrix</td></tr>
<tr><td>Weakness
(W)</td><td>Strength
(S)</td></tr>
<tr><td>WO</td><td>SO</td><td>Opportunity
(O)</td><td rowspan="2">OT</td></tr>
<tr><td>WT</td><td>ST</td><td>Threat
(T)</td></tr>
</table>

Fig. 2: Innovative and Six-Dimensional Research Model

2 Theoretical Fundamentals and Research Background

In this section, we will study the aluminium industry and analyse it first and then we will examine the conditions of Iralco Company so that we can use it to identify, explain and classify the current internal and external conditions of the company properly and by using them, we can formulate correct criteria, sub-criteria and strategies during the research. In the next step, we will find out the problems of this model by using different researches related to SWOT and identify the results obtained in different methods of analysing this matrix. Knowing the strengths and weaknesses of these methods, a suitable analytical method with the least error and the most effective should be chosen, which we will discuss separately below. Evaluation and understanding of environmental factors of aluminium industries.The value chain of aluminium materials and products from mining to final products includes six main links in the upstream (mining, alumina and smelting of aluminium waste) and downstream (semi-finished products and recycling) but the present research is written with the focus on the upstream area of primary aluminium, focusing on aluminium metal.

Table 1: Some of the Studies and Researches Are Described in the Following Table

A researcher or scholars	Tools and methods used	The purpose or result of the research
Adelkhani and Haqshenas Kashani 2019[6].	QSPM-SPSS	Designing practical strategies in Sepah Bank
Aghasafari hana 2020[7].	SWOT	Compilation of organic agriculture development strategies
Ahmed 2021[8].	SWOT-IPA	Determining performance priority in university planning to increase student satisfaction
Ehsanifar and Hosseinzadeh Lotfi 2016[9].	UTA STAR- MADM	Placement and optimization of the place
Gülçin et al. 2021[10].	SWOT-AHP-MABAC	Determining the best health tourism strategy
Hosseini and Qurbani Ghahfarokhi 2018[11].	SWOT-ANP	Selection of strategies for the production of sports goods
Hosseinzadeh robab 2016[12].	MABAC-SHANNON ENTROPY	Determining the competitive position of health care in Iran's provinces
Lestari and Yunita 2020[13].	SWOT	Determining the best marketing strategy of the organization
Mehrmanesh and Ghasemi 2016[14].	SPSS	Prioritizing marketing strategies
Muzahidu et al. 2020[15].	SWOT-ANP	Formulating a strategy in the pottery industry
Nezir 2022[16].	MABAC-BWM-FMEA	Providing a risk assessment framework using risk parameters
Riyanto 2020[17].	SWOT	Compilation of business support strategy
Sanela Arsi 2017[18].	SWOT-ANP-FANP	Prioritizing ecotourism strategies
Solangi et al. 2019[19].	FUZZY-TOPSIS- SWOT-AHP	Sustainable energy planning
Weizhang et al. 2019[20].	MABAC-FUZZY	Ranking of explosion risk levels in stone mines
Yuksel 2007[21].	SWOT-ANP-FUZZY	Ranking criteria and sub-criteria

Today, aluminium with its special and different properties is used in various strategic industries such as construction industry, aerospace industry, transportation, automobile manufacturing, packaging, electrical industry and their subordinate industries and as a strategic metal, it is one of the most important metals in the global metal and products market [4]. Iran is one of the first producers of aluminium ingots in the Middle East. Aluminium production in Iran started in 1351 with the establishment of Arak Aluminium Factory (Iralco) with a production capacity of 100 thousand tons per year. Then Al-

Mahdi and Hormazal Aluminium factories were added to the country's production complex. In the 80s and 90s, the country's aluminium ingot production progressed based on these three factories with a total nominal capacity of about 450,000 tons. Currently, with the construction of several other production units, the production capacity in Iran has reached more than 600,000 tons. Iralco's production has now increased to 200,000 tons with the expansion of the production line [5].

3 Proposed Methodology and Research Questions

The questions that have been tried to be answered during the current research are as follows:

1) What are the strengths, weaknesses, opportunities, and threats for developing a flexible strategic marketing plan for Iralco in the current situation?

2) What is the significance of the criteria used to develop a flexible strategic marketing plan for Iralco using the ANP method in conditions of uncertainty?

3) What are the existing potential strategies to be used in Iralco Company in the current situation using the traditional (four aspects) and new (six aspects) SWOT matrix?

4) What is the priority of implementing the mentioned company's strategies with a developed ANP-MABAC combined approach in the conditions of uncertainty to reach flexible marketing strategies?

5) What is the desirability measurement of the implementation of the flexible marketing strategies of the mentioned company with the developed combined approach-ANP-MABAC UTASTAR in conditions of uncertainty?

6) Reviewing and ranking strategies according to the traditional framework (four aspects) of the SWOT matrix, and determining the flexible and potential alternative strategies in the new flexible model of SWOT (six aspects) can happen?

According to the objective, the present research is in the field of applied research. For this reason, it deals with solving a problem and providing a related solution for managers and stakeholders in the real world of the aluminium industry and Iralco. Also, in terms of the nature and method of data collection, the upcoming research has a mixed research method, which is created by combining qualitative and quantitative research methods. In the qualitative part of this research, it is in the form of (descriptive-survey) and in the beginning, the indicators needed for the SWOT matrix have been extracted through articles, books, magazines and internet sites and then it is based on the mentioned matrix framework and based on internal and external factors (strength, weakness, opportunity, threat) of Iralco and Aluminium Industry, a semi-open questionnaire is designed [22].The semi-open questionnaire has been given to selected expert experts in the initial stage for survey and they were asked to express their opinions about the above factors in a descriptive and separate manner in Iralco factory and aluminium industry, Then the primary theories were collected .In the second stage, all the collected theories with the name of the expert providing the opinion were made available to all experts and they are asked to reevaluate their opinions by studying the opinions and reasons of other experts and some of them and rewrite the most important internal (weakness and strength) and external (threat and opportunity) factors. In the next step, using the final theories, the most converging factors are evaluated and screened by the Delphi technique in uncertainty conditions [23-24]. Screening and importance measurement is done by a closed questionnaire with a spectrum of 5 options in the conditions of uncertainty .In the next step, using the screened factors of the 9-choice questionnaire, a quantitative part is extracted to analyse the pairwise comparisons [25]. In the quantitative section, factors were identified and then the identified factors were analysed and classified in the qualitative part by a combination of Analytical Network Process (ANP) and Multi-Attributive Border Approximation Area Comparison (MABAC) and Star Additive Utility Method (UTASTAR) method under uncertainty conditions. And finally, the innovative

and flexible model of the research will be developed, tested and presented [26-27-28-29].
The statistical community of this research is Iralco Company, which employs about 4500 human resources, of which 221 people are graduates (204 postgraduates and 17 PhDs). But since drafting a strategy and preparing a list of strengths and weaknesses, opportunities and threats in its most effective part requires an expert view and needs high experience and expertise Therefore, among these people, the people(Bachelor's degree, more than 10 years of work experience and more than 5 years of management experience at the middle and high levels of the organization) who have the conditions of the compilation were considered in order to identify and select the internal and external agents of Iralco and to form the expert team. During the initial selection, 62 managers had the condition ,among these managers, 27 people expressed their desire and knowledge about the proposed and desired issues, and based on judgmental sampling, 25 ten people were selected from among the 27 mentioned people and formed the expert team. One of the most important and sensitive stages of research is information gathering. The method of gathering information is influenced by the nature of the subject and the variables under study. Studying libraries is one of the usual ways to obtain findings and one of the most basic steps in collecting information for research .The main data collection methods and tools are documents, observations, interviews and questionnaires . 3 types of questionnaires are used in this research, which are given below:
Type 1. Semi-open questionnaire presented to the expert team to identify and extract internal and external factors and indices
Type 2. Closed questionnaires based on the Likert scale of 1 to 5 and converting them into fuzzy values to confirm and screen the indicators.
Type 3. Paired comparison package questionnaire based on the spectrum of 1 to 9 to examine the importance of the criteria. The validity of this research is done in two parts
A- Face validity B- Criterion-related Validity
Face validity in this research, the fuzzy Delphi technique was first used according to the opinions of selected experts in the aluminium industry in Iralco and finally, due to the fact that the mentioned factors have been confirmed and re-reviewed by the expert team and convergent factors were extracted, its validity is confirmed.In the criterion-related validity section, first, a 5-choice closed questionnaire obtained from the summation of convergent factors in the semi-open Delphi questionnaire was given to the experts and then, the values of the received answers are converted into fuzzy values. In the next step, the fuzzy mean was taken from the created fuzzy value and then the obtained average is converted into a definitive average .In this research, the acceptance threshold value for the absolute mean of each criterion was considered 0.7 and criteria that get a definite average of less than 0.7 will be removed and they will not be used in the 9-option questionnaire (pairwise comparisons). In this research, due to the uncertainty of the data and considering the conditions of uncertainty, inconsistency rate has been used to check reliability. Inconsistency rate is one of the important parameters in pairwise comparisons . This rate indicates whether the comparisons can be trusted or not, or whether the pairwise comparisons have adequate validity. This rate should always be less than 0.1. If the deterministic medium becomes fuzzy, the inconsistency rate can be calculated by using the Goss and Butcher algorithm that they presented in 1998. This index is designed in such a way that if the answers of the experts are inconsistent and contradictory, this problem will show and that's how we realize the inappropriateness of the questionnaire and answers and in the case that the inconsistency is greater than the declared quorum (ten percent), it is necessary to re-evaluate [23]. ANP algorithm for SWOT used in the research can be expressed as follows ,SWOT analysis is a suitable analytical tool for determining the importance of the

identified factors. Although SWOT determines the factors accurately and successfully, but it was not able to quantify the weights and effects of strategic factors in the options .This research shows a process for quantitative SWOT analysis for situations where there is an internal dependence between strategic factors. The proposed algorithm uses the network analytical process (ANP) and allows the measurement to be done in the conditions where there is a dependency between strategic factors. The network model presented in this research for the purpose of SWOT analysis is composed of four levels, the goal (best strategy) at the first level, SWOT factors and SWOT sub-criteria at the second, third and last level, respectively, of strategy options [30-31].

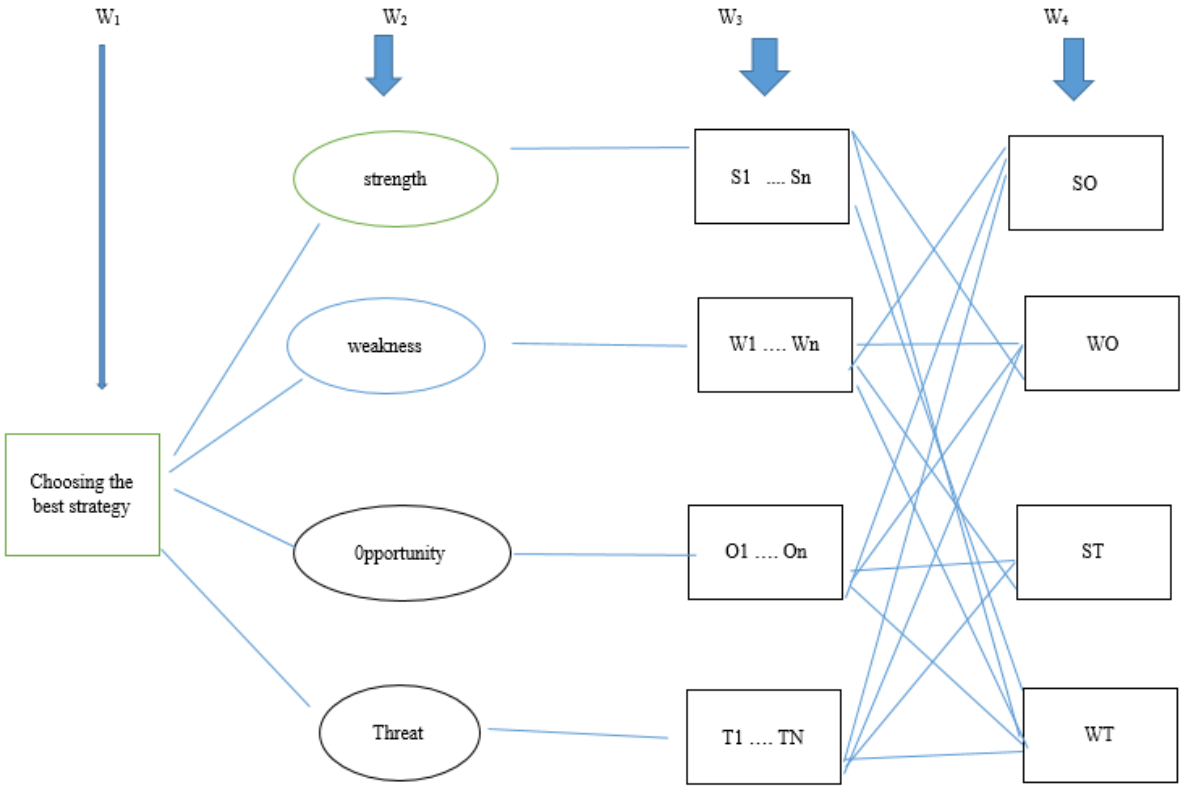


Fig. 3: ANP Algorithm for SWOT

Decision matrix is a swot hierarchy with four levels as follows

$$W = \begin{matrix} \text{Goal} \\ \text{SWOT factor} \\ \text{SWOT sub factor} \\ \text{Alternatives} \end{matrix} \begin{bmatrix} 0 & 0 & 0 & 0 \\ w21 & 0 & 0 & 0 \\ 0 & w32 & 0 & 0 \\ 0 & 0 & w43 & 1 \end{bmatrix}$$

Fig. 4: SWOT Hierarchy

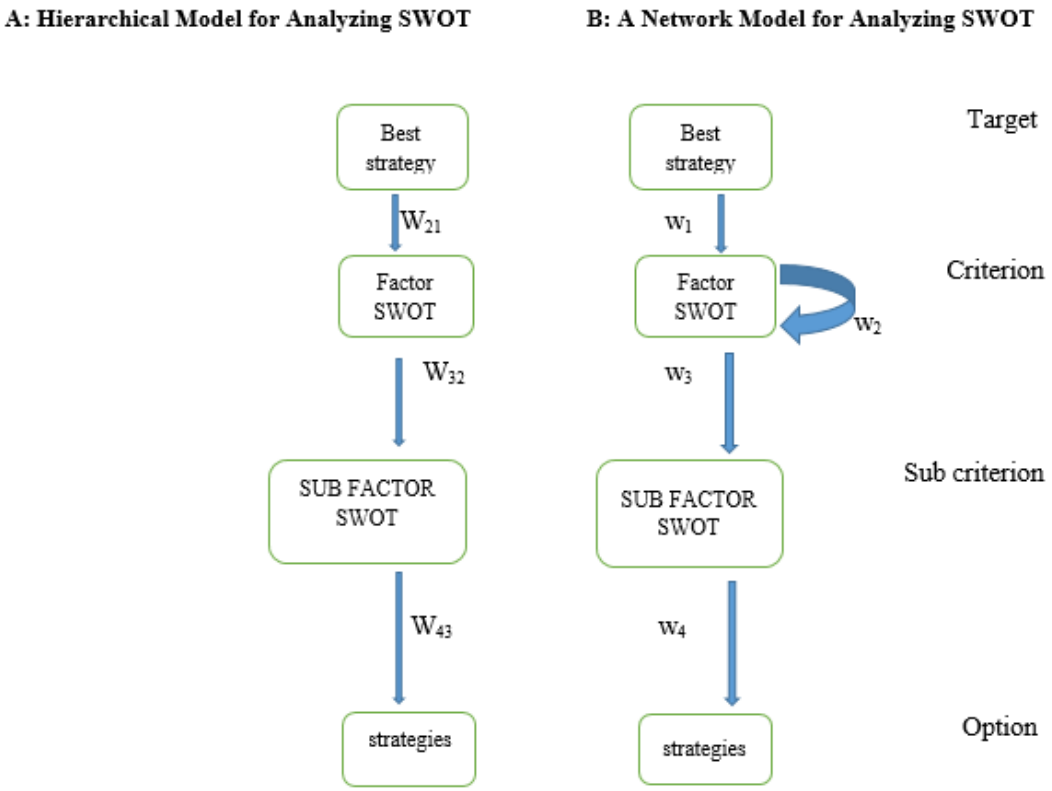


Fig. 5: Hierarchical & Network Model for Analyzing SWOT

W1 is a vector that shows the effect of the goal, including choosing the best strategy according to the SWOT factors, and W2 is a matrix that shows the internal dependence of the SWOT factors. W3 and W4 are also matrices that respectively express the effect of SWOT factors on each of its sub factors and the effect of SWOT sub-factors on the options .In the conditions that w21 is a fuzzy sub matrix expressing the effect of the target on the criteria, w32 is a fuzzy sub matrix expressing the effect of the criteria on each of the sub criteria, w 43 is a fuzzy sub matrix expressing the effect of the sub criteria on each of the options .The importance in each of the above sub matrices is expressed by a triangular number and I is the identity matrix whose components are triangular numbers. In the W matrix, the assumption that the clusters and elements are independent is taken into account but when there is dependence between the clusters, the matrix changes, that is, if the criteria are dependent on themselves, then the W22 index will be non-zero.

Multi-criteria decision-making methods (MCDM) provide the possibility that various criteria can be used simultaneously in determining the best option and the most appropriate conditions. Network analytical process (ANP) is one of the multi-criteria decision-making methods with non-linear structure and two-way relationships. Therefore, the main innovation of ANP is the structure of its networks which enables the researcher to study the relationships between the entry's (components) recognized in different clusters and the dependence between elements in the same cluster.

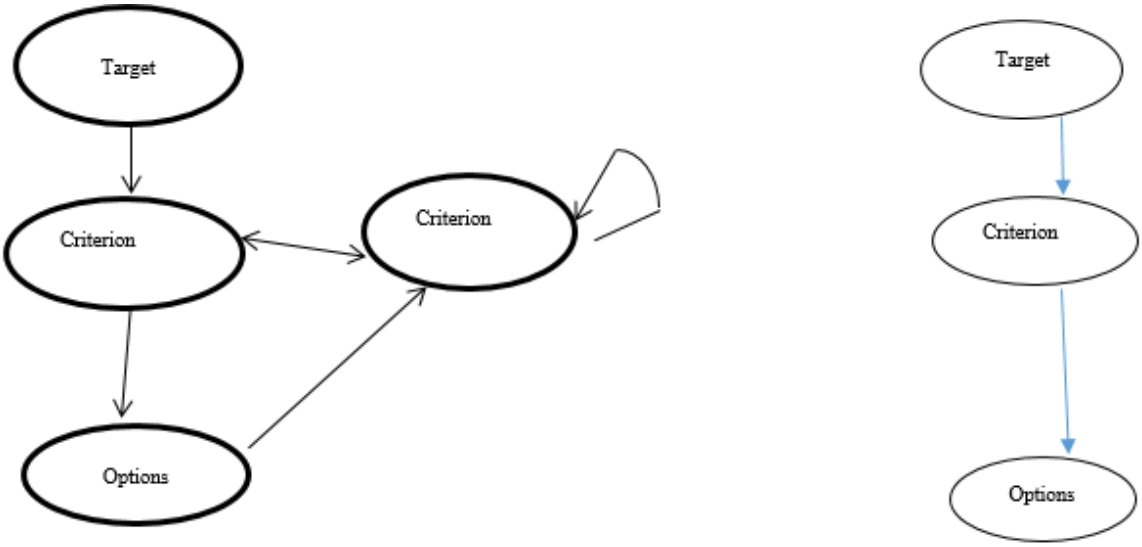


Fig. 6: Differences between a Hierarchical Structure and A Network Structure [21].

The implementation of the Network Analysis Process (ANP) method in the fuzzy environment also overcomes the ambiguities and uncertainties in decision making. In Fuzzy's ANP method, first the internal relationships between the factors are specified to determine the network between the indicators. Then, by making pairwise comparisons, relative weights are calculated. To calculate the weight in fuzzy pairwise comparisons, it is based on the Buckley geometric mean method. This method is known as the improved (expanded) fuzzy AHP .The steps of this method are listed below. Suppose that $\tilde{P}ij$ is a set of decision makers' preferences regarding one index over other indices. The pairwise comparison matrix is formed as follows; [21-30].

$$\tilde{A}=\begin{bmatrix} 1 & \tilde{P}_{12} & \tilde{P}_{1n} \\ \tilde{P}_{21} & 1 & \tilde{P}_{2n} \\ \tilde{P}_{n1} & \tilde{P}_{n2} & 1 \end{bmatrix} \quad (1)$$

$$\tilde{r}_i = \left(\prod_{j=1}^{n} \tilde{P}_{ij}\right)^{1/n}; i = 1,2,3,\dots,n \quad (2)$$

$$W_{crisp}=\frac{L+2M+U}{4} \quad (3)$$

In this research, in order to calculate the weight in pairwise comparisons, verbal expressions and triangular fuzzy numbers listed in the table below have been used. Where n is the number of related elements per row. The fuzzy weights of each pairwise comparison matrix index is obtained by Buckley's geometric mean method. The geometric mean value of the fuzzy comparisons of the index i is obtained for each index:

Then the fuzzy weight of the (i-th) index is shown by a triangular fuzzy number

After calculating the fuzzy weight factors, we de-fuzzy the weights using the formula below and then normalize them

Table 2: Table of Verbal Expressions and Fuzzy Numbers to Weight the Standards [32].

code	Priorities	Fuzzy equivalent of priorities		
		lower limit	Medium limit	Upper limit
1	Equal importance	1	1	1
2	same to relatively more important	1	2	3
3	relatively more important	2	3	4
4	Relatively more important than very important	3	4	5
5	Very important	4	5	6
6	High to very high importance	5	6	7
7	Very important	6	7	8
8	Very much to completely more important	7	8	9
9	Absolutely more important	8	9	10

FUZZY and grey MABAC method used in the research can be expressed as follows**.** In multi-indicator decision making methods, MADM sometimes aims at weighting the research factors and sometimes ranking the research options. The method we will discuss in this article is among the option ranking methods .The MABAC method is one of the latest multi-criteria decision-making techniques used to rank options in multi-criteria decision-making models [27]. Implementation of multi-criteria decision-making methods in fuzzy and grey environments overcomes the uncertainty of decision-making and its ambiguities .So, the results will be more accurate for the model. The MABAC method can also be easily implemented in fuzzy and grey environments. In these environments, the laws related to these methods are used. The MABAC (Multi-Attributive Border Approximation Area Comparison) method is one of the new multi-criteria decision-making methods. The purpose of this method is to rank the options in a multi-criteria decision-making model .Fuzzy MABAC technique examines this model in a fuzzy environment, which eliminates uncertainties and ambiguities in decision-making and results in more accurate results the steps of this method are given below [33-27].

First step is supposing the decision matrix of people's opinions is as follows:

$$\widetilde{D}=\begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} & \dots & \tilde{x}_{1n} \\ \tilde{x}_{21} & \tilde{X}_{22} & \dots & \tilde{P}_{2n} \\ \dots & \dots & \ddots & \vdots \\ \tilde{x}_{m1} & \tilde{X}_{m2} & \dots & \tilde{X}_{mn} \end{bmatrix} \qquad \text{i=1,2,…,m;} \qquad \text{j=1,2,…,n} \tag{4}$$

Each column represents an index and each row represents an option. Xij indicates the quantity of the (i- th) option in the sub-criterion of the (j-th) Also, the sub-criteria may be negative or positive according to the effect on the options. In this research, verbal expressions and fuzzy numbers from the following table were used to evaluate the options for each criterion.

The second step is normalizing the initial decision matrix (N**)**

Due to the fact that the gender of each of the criteria may be different, in the second step the decision matrix is normalized to neutralize the effect of different scale of the criteria. In order to do this and according to the type of each standard, positive and negative standards are used for normalization.

Table 3: Table of verbal expressions and corresponding fuzzy numbers to evaluate the options [32]

code	Priorities	Fuzzy equivalent of priorities		
		lower limit	Medium limit	Upper limit
1	Very weak	1	1	3
2	Weak	1	3	5
3	Medium	3	5	7
4	Great	5	7	9
5	Very great	7	9	11

The normal decision matrix is represented by N

$$N=\begin{bmatrix} n_{11} & \cdots & n_{1n} \\ \vdots & \ddots & \vdots \\ n_{m1} & \dots & n_{mn} \end{bmatrix} \quad (5)$$

The normalized matrices of N are calculated using the following equation.

$$\tilde{t}_{ij} = \frac{\tilde{x}_{ij} - x_i^-}{x_i^+ - x_i^-} \text{ For positive equation} \quad (6)$$

$$\tilde{t}_{ij} = \frac{\tilde{x}_{ij} - x_i^+}{x_i^- - x_i^+} \text{ For negative equation} \quad (7)$$

In the above equations, the X_{ij}entry of the initial decision matrix are (X) and X_i^- and $X_i^+$are defined as below.

X_i^+= max ($x1$, $x2$, …., xm) Indicates the highest value of the fuzzy upper limit, which has been observed among the options in a specific criterion.

X_i^- = min ($x1$, $x2$, ..., xm) Indicates the lowest value of the lower limit of the fuzzy, which is observed among the options in a certain criterion.the third step is forming the normal weighted matrix (Vij)

Since the criteria have different weight in the evaluation process; in this case, the entry of the balanced normal matrix should be calculated according to the following equation. In this equation, t_{ij} is the entry of normal matrix and w_j is the weight of the i-th Criterion. Also, v_{ij} form the entry of the balanced matrix v.

$$\tilde{\upsilon}_{ij} = w_i * (\tilde{t}_{ij} + 1) \quad (8)$$

The Fourth Step is Specifying the Boundary Matrix of the Estimation of the Region (G)

In the fourth step, the border matrix of the estimation area (G) is calculated based on the following equation. In other words, the geometric mean of the entry of each standard column in the weighted matrix should be calculated

$$\widetilde{g_J} = \left(\prod_{i=1}^{m} \tilde{v}_{ij}\right)^{\frac{1}{m}} \quad (9)$$

the fifth step calculating the Distance of the Options from The Boundary of the Estimation of the Area (Q)

The distance of the options from the border of the area estimation is determined according to the following equation, equal to the difference between the weighted matrix (V) and the value of the area estimation border (G).

$$\tilde{Q} = \tilde{V} - \tilde{G} = \begin{bmatrix} v_{11} & \cdots & v_{1n} \\ \vdots & \ddots & \vdots \\ v_{m1} & \cdots & v_{mn} \end{bmatrix} - \begin{bmatrix} g_{11} & \cdots & g_{1n} \\ \vdots & \ddots & \vdots \\ g_{m1} & \cdots & g_{mn} \end{bmatrix} \quad (10)$$

sixth step is ranking the options In the last step of the MABAC method, the value of the criteria functions is calculated based on the total distance of the options from the area estimation vector (qi) for each, according to the following equation. By calculating the sum of the entries of the Q matrix in a row, the final value of the standard functions is determined for each option and the basis of the ranking of the options is set.

$$\widetilde{S_i} = \sum_{j=1}^{n} \tilde{q}_{ij} \quad (11)$$

The following equation is also used to de-fuzzy the final scores. In this equation, L is the lower limit of fuzzy number, M is the middle limit and u is the upper limit of fuzzy number.

$$S = \frac{L+m+u}{3} \quad (12)$$

the developed model of additive utility function of star (UTA STAR) in fuzzy mode used in the research can be expressed as follows

Additive utility star method (UTA STAR) is among the techniques that evaluate and analyse the utility

function of decision making. This technique was first proposed by in Siskos and Jacquet 1982

Cumulative utility method is a method for inferring cumulative utility functions from a set of past decision-making data. (In this research, FUZZY MABAC method). Cumulative utility methods simultaneously use points assigned by decision makers to a selected set of options (decision data), which is called the reference set, as well as the ranking of options from the best to the worst option or from the option with the most to the least preferred as data and or receive input. After receiving inputs, cumulative utility methods employ linear programming techniques to derive a specific decision model in the form of a utility function for the decision maker that recreates the given ranking of options as completely and accurately as possible. The obtained utility function is a real multivariate, polynomial function with a range equal to (0,1) where each variable represents the points that have been given to the options in relation to a specific criterion. The purpose of cumulative utility method is to derive or evaluate decision models from preference data or past decisions in the form of a list of ranked options. In the literature, this approach is called preference separation. This process initially defines, determines and models the problem related to decision-making as a set of criteria by using non-decreasing, comprehensive and independent utility functions. Then, using special linear programming techniques, from among the ranked options. The reference set is a comprehensive and general cumulative utility function and several relative and limited utility functions. It infers a collective. This model is able to solve the problem of dependence of indicators on each other while estimating the utility function.Marginal utility (value) functions are finally obtained by using the above relations and linear programming, with an objective function that depends on the $\sum_{k=1}^{m}[\tilde{\sigma}^{+}(a_k) + \tilde{\sigma}^{-}(a_k)]$ and indicates the total amount of deviation. As stated by " Siskos and Jacquet ", if the optimal answer is obtained if the objective function is equal to zero, (z*=0) then the number of acceptable answers for the

$$\sum_{i=1}^{n}\sum_{j=1}^{\alpha_1-1} w_{ij}^{c} \tag{13}$$

is not zero and it leads to many desirable answers that maintain the [k] conditions. Descending has become a problem [9-28]. First step is calculating the value of the marginal (border) value Expressing the Additive desirability of the options $\widetilde{U}[g(a_k)]\,, k = 1,2,\dots,m$ based on the desirability values of the margins (border) . The value of the marginal (boundary) value of each option (a) belonging to the domain $g_{i(a)} \in [g_i^j\ ,\ g_i^{i+1}]$can be calculated by linear extrapolation using the following equation:

$$\tilde{u}_i[g_i(a)] = u_i\left(g_i^j\right) + \frac{\tilde{g}_i(a) - \tilde{g}_i^j}{g_i^{j+1} - g_i^j}\left[u_i\left(g_i^{j+1}\right) - u_i\left(g_i^j\right)\right] \tag{14}$$

The above step is executed for all the options and the values of the border margins are stated for all the options.

second step is expression of marginal utility values based on (w_{ij}) variables

$$\begin{cases} u_i\left(g_i^j\right) = 0 & \forall \quad i = 1,2,\dots,n \\ u_i\left(g_i^j\right) = \sum_{i=1}^{j-1} w_{it} & \forall \quad i = 1,2,\dots.n \ \ and\ j = 2,3,\dots,\alpha_i - 1 \end{cases} \tag{15}$$

In the developed star Additive utility method, similar to the classical method, a double positive error function is proposed according to the under equation

$$\tilde{u}_i'[g(a)] = \sum_{i=1}^{n} \tilde{u}_i\,[g_i(a)] - \sigma^+(a) + \sigma^-(a) \quad \forall \ \ a \in A_R \tag{16}$$

While $\sigma_{(a)}$ is an error potential related to $u'[g(a)]$

Third step is calculating the difference between consecutive $\Delta(a_k, a_{k+1})$

Equation:

$$\tilde{\Delta}(a_k, a_{k+1}) = \tilde{u}[g(a_k)] - \sigma^+(a_k) + \sigma^-(a_k) - \tilde{u}[g(a_{k+1})] + \sigma^+(a_{k+1}) - \sigma^-(a_{k+1}) \tag{17}$$

Fourth step is fuzzy linear programming model

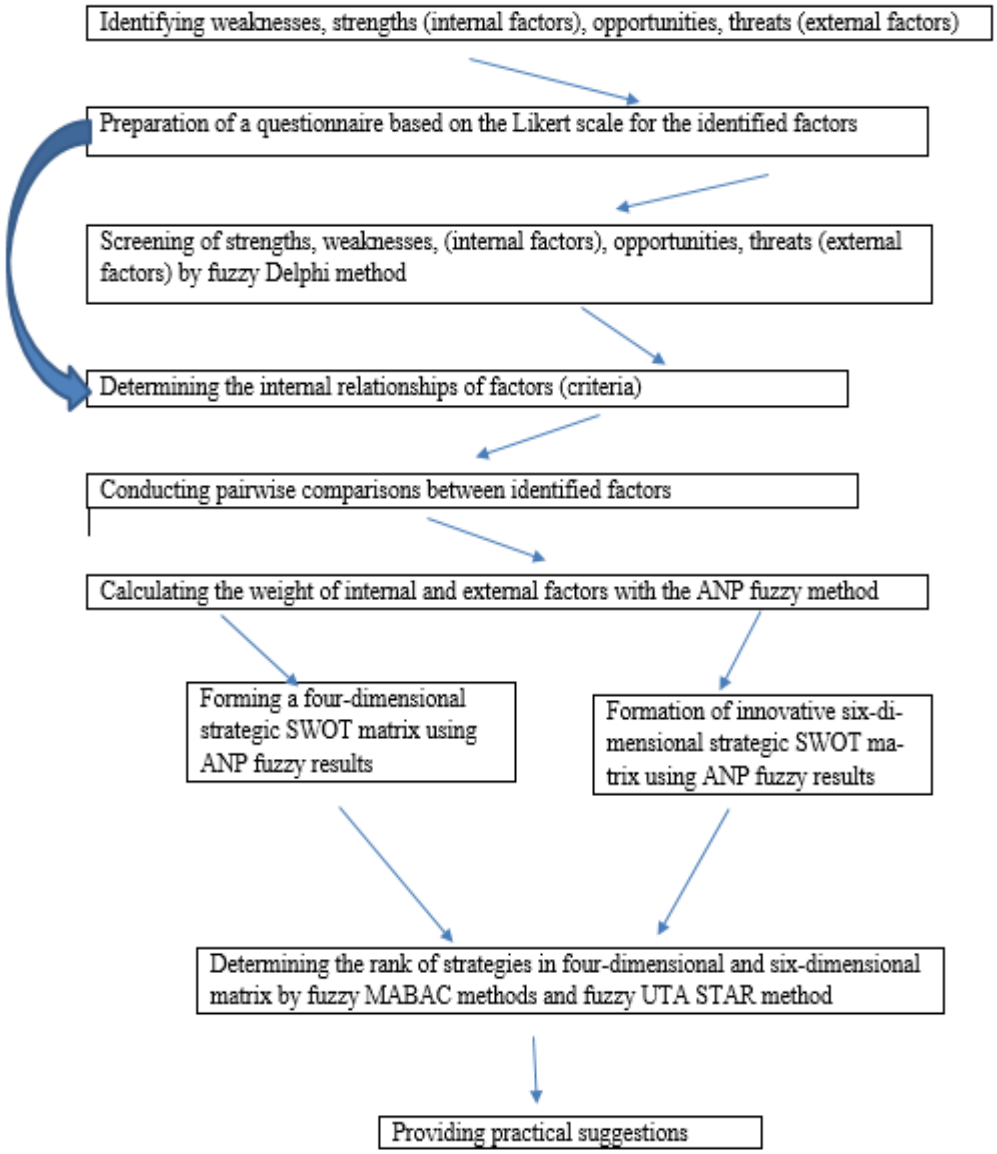
$$[min]\tilde{z} = \sum_{k=1}^{m}[\tilde{\sigma}^+(a_k) + \tilde{\sigma}^-(a_k)] \tag{18}$$

$$\left.\begin{array}{l} \tilde{\Delta}(a_k, a_{k+1}) \geq \tilde{\delta} \ \ if\ \ a_k \geq a_{k+1} \\ \tilde{\Delta}(a_k, a_{k+1}) = 0 \quad if\ a_k \sim a_{k+1} \end{array}\right\} \ \forall \ \ k$$

$$\sum_{i=1}^{n}\sum_{j=1}^{\alpha_1-1} w_{ij}^{c} = 1$$

$$w_{ij} \geq \tilde{0} \quad , \quad \tilde{\sigma}^+(a_k) \geq \tilde{0} \quad , \quad \tilde{\sigma}^-(a_k) \geq \tilde{0} \qquad \forall \quad i,j\ and\ lk$$

$$\tilde{\delta} = (0.05\,, 0.05\,, 0.05\,)$$



Flow chart 1. Research Steps

4 Analysis and Finding

The results of the fuzzy Delphi method (identification, refinement and prioritization of criteria and sub-criteria to extract feasible strategies) . At this stage, first, a semi-open questionnaire was given to selected experts and they were asked to express their opinions on the following in a detailed and separate manner .a) Internal environment (weakness and strength) b) external environment (opportunity and threat). Then these initial theories were collected. In the second stage, all the theories collected without the name of the expert providing the opinion were available to all the experts. They were asked to revise their opinions by studying the opinions and reasons of other experts and rewrite the most important factors again. Then, the questionnaires of the second stage of collection and comments were categorized and numbered, which included 48 items. Then, the expert team was asked to express their opinion about each criterion in the form of verbal variables listed in the mentioned questionnaire. In the next

step, the fuzzy fixation of the values obtained from the experts' responses was done. To fuzzy the numbers, first, we convert the values into fuzzy numbers according to the spectrum of the table 2-3, then based on the equations 3-9 to 3-11, the fuzzy average of the points is obtained. And then by the equation 3-12, the fuzzy average is converted into a definite number. In this research, a threshold number of 0.7 is considered for the fuzzy mean for validity measurement below the criteria, the results of which are given in Table 4.

Table 4: The Results of the Fuzzy Delphi Method

Criterion		**Sub Criterion**	**Fuzzy average**	**Non-Fuzzy average**	**Condition**
Strength	1	Private dock in the port of Imam	0.575, 0.825, 0.95	(0.783)	Accept
	2	Proximity to most of the subordinate industries and domestic suppliers due to being in the centre of the country	0.375, 0.625, 0.85	0.617	Reject
	3	Easy access to the best semi-heavy and heavy industries of the country in the central province due to the presence of most of these industries in Arak and the province.	0.5, 0.75, 0.875	(0.708)	Accept
	4	The first and the largest aluminium ingot producer in Iran	0.5, 0.725, 0.875	(0.700)	Accept
	5	The presence of some elite and experienced people in the company	0.525, 0.775, 0.9	(0.733)	Accept
	6	The long-term contract between Iralco and the country of Guinea is based on the permission to extract from the rich bauxite mine of this country (Conakry)	0.575, 0.825, 0.95	(0.783)	Accept
weakness	7	High costs of electricity consumption (about 20% of the production cost)	0.475, 0.725, 0.875	(0.692).	Reject
	8	High costs of energy, overhead and wages due to non-advanced production technology	0.525, 0.775, 0.925	(0.742)	Accept
	9	Lack of liquidity needed for development	0.525, 0.775, 0.925	(0.742)	Accept
	10	Lack of application of specialized management in most departments.	0.3, 0.525, 0.75	(0.525).	Reject
	11	Lack of effective communication and lack of employment of domestic and foreign specialists and elites of the aluminium industry in production and research	0.575, 0.825, 0.975	(0.792).	Accept
	12	Lack of implementation of privatization in the real sense.	0.2, 0.375, 0.625	(0.400).	Reject
	13	Failure to use modern aluminium production technology.	0.15, 0.325, 0.575	(0.350)	Reject

Table 4: Continue

		Sub Criterion	Fuzzy average	Non-Fuzzy average	Condition
	14	Inefficient recruitment, administrative, financial and executive structure confirmation	0.5, 0.75, 0.95	(0.733).	Accept
	15	Absence of active and effective R&D department in the factory.	0.375, 0.625, 0.825	(0.608)	Reject
	16	Substitution of relationships instead of criteria for recruiting, promoting and transferring organizational jobs.	0.325, 0.575, 0.8	(0.567).	Reject
	17	Very weak connection with international and academic research.	0.25,0.5,0.75	(0.500)	Reject
	18	Absence of active diplomacy with countries with primary resources	0.5, 0.75, 0.925	(0.725)	Accept
	19	Weak and unstable profit due to the sale of bullion (raw sale)	0.3, 0.55, 0.8	(0.550)	Reject
	20	Absence of a transparent system of salaries and wages, related to the productivity of the human force	0.325, 0.575, 0.825	(0.575)	Reject
	21	Lack of ownership or easy access to rich domestic bauxite resources for production	0.35, 0.525, 0.775	(0.550).	Reject
	22	Non-participation in aluminium recycling industries, which have high profit and low cost, and relying only on raw sales (bullion sale)	0.575, 0.825, 0.95	(0.783).	Accept
Opportunity	23	About 41% of the world's bauxite reserves are in Asia and Pacific. (Asia 18 percent and Oceania 23 percent)	0.4, 0.65, 0.8	(0.617).	Reject
	24	The largest producer of bauxite in the world is China, which has a good commercial and political relationship with Iran.	0.375, 0.6, 0.825	(0.600)	Reject
	25	Aluminium is the third most abundant element in the earth's crust after oxygen and silicon	0.35, 0.6, 0.85	0.600	Reject
	26	Aluminium is the most used metal in the world after iron.	0.592, 0.35, 0.6, 0.825	(0.592)	Reject
	27	The presence of many aluminium recycling industries in Iran.	0.558, 0.325, 0.55, 0.8	(0.558)	Reject
	28	The growing trend of global aluminium consumption	0.525, 0.775, 0.925	(0.742)	Accept
	29	Most of the world's aluminium consumption is in Asia.	0.375, 0.6, 0.8	(0.592)	Reject

Table 4: Continue

	30	Huge resources of gas in Iran that can replace electricity energy to produce	0.55, 0.8, 0.975	(0.775)	Accept
		Sub Criterion	**Fuzzy average**	**Non-Fuzzy average**	**Condition**
	31	Aluminium is considered a national strategic and leading industry	0.5, 0.75, 0.9	(0.717)	Accept
	32	The special feature of aluminium such as its density is one third of steel and high resistance to pressure and stress before breaking, high strength of aluminium alloys.	0.325, 0.55, 0.75	(0.542)	Reject
	33	Low recycling costs (5% of the cost of aluminium production from raw materials)	0.375, 0.575, 0.75	0.567	Reject
	34	The presence of educated people and elites with high academic and experimental technical knowledge in the central province and the country	0.5, 0.75, 0.925	(0.725)	Accept
	35	The presence of leading universities and research institutes in the province, the country and the world	0.5, 0.75, 0.9	(0.717)	Accept
	36	The announcement of the government's strong support for production and employment	0.525, 0.775, 0.9	(0.733),	Accept
	37	Existence of low-grade bauxite mines in Iran that are not noticed by competitors and are not significantly exploited	0.35, 0.6, 0.825	(0.592)	Reject
	38	Considerable profit in the subordinate industries of the aluminium industry	0.325, 0.55, 0.75	(0.542),	Reject
	39	The lack of special and rich bauxite mines in Iran	0.475, 0.725, 0.9	(0.700),	
Threat	40	Subsidy of energy price in China for production as a competitor.	0.4, 0.65, 0.85	(0.633)	Accept
	41	Strict environmental laws of regulatory bodies.	0.3, 0.525, 0.75	(0.525)	Reject
	42	The growth of aluminium industries in neighbouring countries, especially in the Persian Gulf	0.55, 0.8, 0.95	(0.767),	Accept
	43	The high-risk factor of foreign investment in Iran	0.225, 0.475, 0.725	(0.475)	Reject
	44	Disruption of rival countries in the Persian Gulf area in raw material safety	0.425, 0.675, 0.875	(0.658)	Reject
	45	The opinion of the people of the region to the factory as a big source of environmental pollution	0.5, 0.75, 0.9	(0.717)	Accept
	46	The country's economic sanctions	0.525, 0.775, 0.9	(0.733),	Accept
	47	The lack of stability of the exchange rate	0.575, 0.825, 0.95.	(0.783),	Accept
	48	48. The presence of strong competitors in the field of alumina resource extraction in the world	0.6, 0.85, 0.975	(0.808)	Accept

According to the results of the fuzzy Delphi method listed in the above table, the number of 25 non-fuzzy criteria have obtained less than 0.7, so they are removed and 23 indicators are confirmed as the final ones, which are specified in the above table which are indicated in the table.

The steps of fuzzy ANP analysis in this research are as follows these steps are as follows method First Step is Calculation of Fuzzy and Normal Weights, in this part, we calculate the fuzzy and normal weights of the main criteria by using pairwise comparisons of the criteria, and the results are included in the table below.

Table 5: Fuzzy and Non-Fuzzy Weight of the Main Criteria

Criterion name	Geometric mean $\left(\prod_{j=1}^{n} \widetilde{p_{ij}}\right)^{\frac{1}{n}}$	Fuzzy weight $\widetilde{w}_i$	Non-fuzzy weight	Normal weight
S	(0.509, 0.607, 0.744)	(0.096, 0.136, 0.202)	0.143	0.138
W	(1.661, 2.03, 2.404)	(0.312, 0.456, 0.653)	0.469	0.454
O	(0.834, 1.008, 1.201)	(0.157, 0.226, 0.326)	0.234	0.226
T	(0.675, 0.805, 0.977)	(0.127, 0.181, 0.265)	0.189	0.182
$\sum(\prod_{j=1}^{n} \tilde{p}_{ij})^{\frac{1}{n}}$	5/326, 4/45, 3/68			

Second step is final weight of the main criteria, in this part .The main criteria have internal relationships, and to calculate the final weight, it is enough to use the equation $W_{final} = W_{21} + W_{22}$ that in this equation, $W_{21}$is the weight of the main criteria without considering the internal relationships, and W_{22} is the final matrix of internal relationship weights. The final weight results of the main criteria are given below:

$$\text{Final weight of criteria} = \begin{matrix} \\ S \\ W \\ O \\ T \end{matrix} \begin{vmatrix} \text{S} & \text{W} & \text{O} & \text{T} \\ 0 & 0.144 & 0.234 & 0.238 \\ 0.583 & 0 & 0.766 & 0.762 \\ 0.223 & 0.526 & 0 & 0 \\ 0.194 & 0.330 & 0 & 0 \end{vmatrix} \times \begin{vmatrix} \text{weight criteria} \\ 0.138 \\ 0.454 \\ 0.226 \\ 0.182 \end{vmatrix} = \begin{vmatrix} \text{final weight} \\ 0.162 \\ 0.392 \\ 0.269 \\ 0.176 \end{vmatrix} \quad (19)$$

$$\text{Final weight of criteria} = \begin{matrix} \\ S \\ W \\ O \\ T \end{matrix} \begin{vmatrix} \text{S} & \text{W} & \text{O} & \text{T} \\ 0 & 0.144 & 0.234 & 0.238 \\ 0.583 & 0 & 0.766 & 0.762 \\ 0.223 & 0.526 & 0 & 0 \\ 0.194 & 0.330 & 0 & 0 \end{vmatrix} \times \begin{vmatrix} \text{weight criteria} \\ 0.138 \\ 0.454 \\ 0.226 \\ 0.182 \end{vmatrix} = \begin{vmatrix} \text{final weight} \\ 0.162 \\ 0.392 \\ 0.269 \\ 0.176 \end{vmatrix}$$

According to the results, the weaknesses with a weight of 0.392 have won the first place. Opportunity points with a weight of 0.269 ranked second, threat with a weight of 0.176 ranked third and strength with a weight of 0.162 ranked fourth. The third step is determination of the final weight and ranking of the sub-criteria, in this part, the final weight of the sub-criteria is obtained by multiplying the relative weight of the sub-criteria by the weight of the main criteria as given in the Table 6.

Table 6: Final Weight and Ranking of the Sub-Criteria

Criterion	weight Criterion	Sub Criterion	Relative weight Substand-ard	final weight substand-ard	final rank substand-ard
Strength	0.162	Private dock In the port of Imam	0.067	0.0109	23
		Easy access to the best semi-heavy and heavy industries of the country in the central province due to the presence of most of these industries in Arak and the province.	0.111	0.0180	21
		The first and the largest aluminium ingot producer in Iran	0.374	0.0606	5
		The presence of some elite and experienced people in the company	0.300	0.0486	8
		The long-term contract between Iralco and the country of Guinea is based on the permission to extract from the rich bauxite mine of this country (Conakry)	0.149	0.0241	16
Weakness	0.392	High costs of energy, overhead and wages due to non-advanced production technology	0.402	0.1576	1
		Lack of liquidity needed for development	0.059	0.0231	17
		Lack of effective communication and lack of employment of domestic and foreign specialists and elites of the aluminium industry in production and research	0.105	0.0412	10
		Inefficient recruitment, administrative, financial and executive structure confirmation	0.623	0.159	4
		Absence of active diplomacy with countries with primary resources	0.104	0.0408	11
		Non-participation in aluminium recycling industries, which have high profit and low cost, and relying only on raw sales (bullion sale)	0.0670	0.171	3

Table 6: Continue

Criterion	weight Criterion	Sub Criterion	Relative weight Substand-ard	final weight substand-ard	final rank substand-ard
Oppor-tunity	0.269	The growing trend of global aluminium con-sumption	0.290	0.0780	2
		Huge resources of gas in Iran that can replace electricity energy to produce	0.074	0.0199	20
		Aluminium is considered a national strategic and leading industry	0.103	0.0277	15
		The presence of educated people and elites with high academic and experimental technical knowledge in the central province and the country	0.225	0.0605	6
		The presence of leading universities and re-search institutes in the province, the country and the world	0.186	0.0500	7
		The announcement of the government's strong support for production and employment	0.121	0.0325	13
Threat		The lack of special and rich bauxite mines in Iran	0.165	0.0290	14
		The growth of aluminium industries in neigh-bouring countries, especially in the Persian Gulf	0.089	0.0157	22
		The opinion of the people of the region to the factory as a big source of environmental pollu-tion	0.122	0.0215	19
		The country's economic sanctions	0.273	0.0480	9
		The lack of stability of the exchange rate	0.227	0.0400	12
		48. The presence of strong competitors in the field of alumina resource extraction in the world	0.123	0.0216	18

Formulation of four-dimensional and six-dimensional research strategies according to the important sub-criteria is as follows, after identifying and measuring the importance of the four internal and exter-nal factors in the previous section, taking into account their importance, we tried to compile the most creative potential strategies (WO, WT, SO, ST) as below. The Strategies Used in The Traditional SWOT (Four Dimensions) Matrix Are as Follows:

Strategies of the first to fourth dimensions (WT, ST, WO, SO)

1) W_3T_8 Escaping the trap of lack of raw materials by partnering with the Iranian government in stock-piling and exploring new bauxite mines.

2)$\boldsymbol{W_{2.8}T_4}$ Amending the structure of the human resource recruitment system and removing the paralyzing, unexpert and political laws of the process of human resources entering the ranks and headquarters of Iralco Company as the best solution to increase the power of the company's most important production department.

3) $\boldsymbol{W_2T_7}$ Optimizing the current production line and replacing new technology in this production line in order to increase productivity and reduce environmental pollution.

4)$\boldsymbol{S_6T_{10}}$ Using the bauxite mines of the countries that are under the contract between Iran and Iralco, but have not been exploited due to high transportation and mining costs (Bauxite in Guinea, Conakry) through an active diplomatic partnership with foreign companies that use mines adjacent to this mine or neighbouring Guinea.

5) $\boldsymbol{S_{1.3}T_4}$ Moving towards the production and sale of aluminum final products in the raw markets, especially in the Persian Gulf region.

6) $\boldsymbol{W_{5.8}O_{12.13}}$ Reforming the structure of the human force at the levels of middle, executive and operational and upper managers by using educated and elite people of Arak city and the country in the relevant fields of operational departments for optimal decision making.

7) $\boldsymbol{W_{8.5}O_{12.13}}$ Creating a powerful system of performance appraisal and methodology in a practical and measurable way to improve the salary system and the organizational chart by using university specialists and companies specializing in improving processes and methods.

8) $\mathbf{W_{12.5}O_{12.13}}$Strengthening the marketing department and external operations of the company by using: Elites and people fluent in foreign languages and international marketing sciences for continuous interaction with customers, suppliers and representatives of the companies and governments involved through cooperation with universities, specialized institutions, elites and industry specialists of the country.

9) $\boldsymbol{W_2O_8}$ Moving towards the creation of a production line using new and integrated energy technology (gas and electricity) to reduce the cost of production and prevent environmental pollution.

10) $\boldsymbol{S_4O_6}$ Codified planning to enter new markets in the aluminum industry

Strategies Compiled Using Innovative Flexible SWOT (Six Dimensions), Fifth- and Sixth-Dimension Strategies (WS, OT)

The following strategies have been added to the dimensions of the traditional four-dimensional SWOT matrix and created new dimensions and a new six-dimensional matrix

1**)** $\mathbf{W_{5.8}S_5}$ Effective use of the experience and ideas of corporate elites and people with internal experience to correct the current inefficient structure of the organization.

2) $\mathbf{W_{16}S_{3.4}}$ Entering the secondary industries and final products of the aluminum industry as the largest and first producer of raw materials (ingots) and exiting from crude sales and as a result achieving more and more stable profits.

3**)** $\mathbf{O_{9.14}T_{8.9}}$ Attracting the support of the government to receive foreign exchange and subsidy assistance as the largest producer of strategic and leading aluminium industry in the country.

4) $\mathbf{O_{12.13}T_1}$ Production of enriched bauxite from low-grade domestic bauxite sources by using the technical knowledge of leading universities and research institutes of the aluminium industry in the country and the world in order to escape the trap of lack of raw materials.

Steps to Solve the Fuzzy Mabac Method explained as follow ,the first step is to form a decision matrix (D)

This matrix was obtained based on the opinion of experts and using Patil's and Kant's Table

WS		The six-dimensional flexible SWOT matrix	
Weakness W	**Strength** S		
WO	SO	**Opportunity** O	OT
WT	ST	**Threat** T	

Fig.7: Innovative and Six-Dimensional Research Model

Table 7: Matrix (D)

D	S1	S2	S3	…	T4	T5	T6
SO	(4.2,6.2,8.2)	(5,7,9)	(4.8,6.8,8.8)	…	(1.8,3.6,5.6)	(2.2,3.4,5.4)	(1.4,3,5)
ST	(4,5.6,7.6)	(5.2,6.8,8.8)	(5.4,7.2,9.2)	…	(4.8,6.4,8.4)	(4.6,6.2,8.2)	(4.4,6.4,8.4)
WO	(2.6,4.2,6.2)	(2,3.6,5.6)	(2.2,3.6,5.6)	…	(2.2,3.4,5.4)	(2.6,3.8,5.8)	(2.4,3.8,5.8)
WT	(1.4,2.4,4.4)	(1.2,2.4,4.4)	(1,1.8,3.8)	…	(5,7,9)	(4.6,6.2,8.2)	(4.8,6.8,8.8)

The second step is forming the normal matrix (N), For example, for the first cell we will have:

$$t_{ij} = \frac{x_{ij}-x_i^-}{x_i^+-x_i^1} = \frac{x_{11}-x_1^-}{x_1^+-x_1^-} = \frac{(4.2,6.2,8.2)-1.4}{8.2+1.4} = (0.412, 0.706, 1) \quad (20)$$

Table 8: Matrix (N)

N	S1	S2	S3	…	T4	T5	T6
SO	(0.412,0.706,1)	(0.487,0.744,1)	(0.463,0.707,0.951)	…	(0,0.25,0.528)	(0,0.2,0.533)	(0,0.216,0.486)
ST	(0.382,0.618,0.912)	(0.513,0.718,0.974)	(0.537,0.756,1)	…	(0.417,0.639,0.917)	(0.4,0.667,1)	(0.405,0.676,0.946)
WO	(0.176,0.412,0.706)	(0.103,0.308,0.564)	(0.146,0.317,0.561)	…	(0.056,0.222,0.5)	(0.067,0.267,0.6)	(0.135,0.324,0.595)
WT	(0,0.147,0.441)	(0,0.154,0.41)	(0,0.098,0.341)	…	(0.444,0.722,1)	(0.4,0.667,1)	(0.459,0.73,1)

The third step is to form the weighted normal matrix (V), This matrix is obtained by Multiply the final weight of sub-criteria in the normal matrix

Table 9: Matrix (V)

V	**S1**	**S2**	**S3**	**…**	**T4**	**T5**	**T6**
SO	(0.015,0.018,0.022)	(0.027,0.031,0.036)	(0.089,0.103,0.118)	…	(0.048,0.06,0.074)	(0.04,0.048,0.061)	(0.022,0.026,0.032)
ST	(0.015,0.017,0.021)	(0.027,0.031,0.035)	(0.093,0.106,0.121)	…	(0.068,0.079,0.092)	(0.056,0.067,0.08)	(0.031,0.036,0.042)
WO	(0.013,0.015,0.018)	(0.02,0.023,0.028)	(0.069,0.08,0.094)	…	(0.051,0.059,0.072)	(0.043,0.051,0.064)	(0.025,0.029,0.035)
V	**S1**	**S2**	**S3**	**…**	**T4**	**T5**	**T6**
WT	(0.011,0.012,0.016)	(0.018,0.021,0.025)	(0.06,0.066,0.081)	…	(0.07,0.083,0.096)	(0.056,0.067,0.08)	(0.032,0.038,0.043)

The fourth step matrix (G), this matrix is obtained by multiplying the geometric mean of the column related to the criteria in the weighted matrix
For example, for the first cell we will have:

$$g_{SO} = ((0.015,0.018,0.022) \times (0.015,0.017,0.021) \times (0.013,0.015,0.018) \times (0.011,0.012,0.016))^{\frac{1}{4}} = (0.013,0.016,0.019)$$

Table 10: Matrix (G)

G	S1	S2	S3	…	T4	T5	T6
SO	(0.013,0.016,0.019)	(0.023,0.026,0.031)	(0.077,0.087,0.102)	…	(0.058,0.069,0.083)	(0.048,0.057,0.071)	(0.027,0.032,0.038)

The fifth step matrix (Q), calculate the distance of each option from the border of the estimation area
For example, for the first cell we will have:

$$\boldsymbol{q_{11}} = (\mathbf{0.015}, \mathbf{0.018}, \mathbf{0.022}) - (\mathbf{0.019}, \mathbf{0.016}, \mathbf{0.013}) = (-\mathbf{0.004}, \mathbf{0.002}, \mathbf{0.009})$$

Table 11: Matrix(Q**)**

Q	S1	S2	S3	…	T4	T5	T6
SO	-0.004,0.002,0.009	-0.004,0.005,0.013	-0.014,0.016,0.041	…	-0.035, -0.009,0.015	-0.031, -0.009,0.013	-0.016, -0.006,0.005
ST	-0.003,0.001,0.007	-0.003,0.004,0.012	-0.009,0.018,0.044	…	-0.014,0.009,0.033	-0.014,0.009,0.031	-0.007,0.004,0.015
WO	-0.006, -0.000,0.005	-0.011, -0.002,0.005	-0.032, -0.007,0.017	…	-0.032, -0.010,0.013	-0.028, -0.006,0.015	-0.013, -0.003,0.007
WT	-0.008, -0.003,0.002	-0.012, -0.005,0.002	-0.041, 0.020,0.004	…	-0.013,0.013,0.037	-0.014,0.009,0.031	-0.006,0.005,0.016

the sixth step is ranking of strategies in the traditional four-dimensional swot matrix using FUZZY MABAC method, in this section, the Fuzzy MABAC method is used to rank 4 categories of strategies: WT, ST, WO, SO. According to the results, WO strategy won the first rank. WT strategy has won the second rank, SO strategy the third rank and ST strategy the fourth rank

Table 12: Score and Final Ranking of Each Option

Option name	fuzzy score	Non-fuzzy score	Rank
SO	(-0.454, -0.033, 0.383)	-0.035	3
ST	(-0.494, -0.08, 0.336)	-0.079	4
WO	(-0.264, 0.19, 0.606)	0.177	1
WT	(-0.38,0.038, 0.455)	0.037	2

Ranking strategies in the innovative six-dimensional swot matrix using the FUZZY MABAC method explained as follow, (All steps of six-dimensional SWOT matrix calculations are similar to four-dimensional matrix)
In this section, Fuzzy MABAC method has been used to rank 6 strategies: OT, WT, ST, WO, SO and WS and according to the results, the WO strategy ranked first, the OT strategy ranked second, the SW strategy ranked third, the WT strategy ranked fourth, the SO strategy ranked fifth, and the ST strategy ranked sixth.

Table 13: Score and Final Ranking of Each Option

Option name	fuzzy score	Non-fuzzy score	Rank
SO	(-0.454, -0.061, 0.354)	-0.061	5
ST	(-0.523, -0.132, 0.283)	-0.124	6
WO	(-0.296, 0.141, 0.557)	0.134	1
WT	(-0.394,0.017, 0.432)	0.018	4
SW	(-0.362,0.074,0.489)	0.067	3
OT	(-0.339,0,1.8,0.523)	0.097	2

Ranking strategies in swot using fuzzy star additive utility method used in the research can be expressed as follows, in this section, we are going to rank the strategies in SWOT by using the fuzzy star Additive utility method and comparing it with the results obtained by the fuzzy MABAC method. First, we will do this ranking in the traditional four-sided matrix and then in the innovative six-sided matrix, and we will compare the results with the Fuzzy MABAC ranking that was done in the previous section.

Ranking strategies in swot using fuzzy star additive utility method in traditional four-dimensional SWOT model explained as follow

The following results were obtained after solving the model in the framework of the star Additive linear model

Table 14: Ranking of Strategies in Traditional Four-Dimensional SWOT Model

Z^*	W_{11}	W_{12}	W_{21}	W_{22}	W_{31}	W_{42}
0	0.3096	0.0067	0.2278	0.3064	0.0979	0.0516

Table 15: The Total Value of Each of the Options and The Comparison of the Initial Rating

Strategy type			Option	Total value in fuzzy star Additive utility model	Rank relative to the corresponding value of fuzzy star's Additive favourability	The initial rank obtained from the MABAC fuzzy method
WO			A_1	0.8121	1	1
WT			A_2	0.7135	2	2
SO			A_3	0.511	3	3
ST			A_4	0.3468	4	4

Ranking of strategies in swot using Fuzzy Star Additive Utility Method in the six- dimensional SWOT model explained as follow

After solving the model in the framework of the star Additive linear model, the following results are obtained.

Table 16: Ranking of Strategies in the Six- Dimensional SWOT Model

Z^*	W_{11}	W_{12}	W_{21}	W_{22}	W_{31}	W_{32}	W_{41}	W_{42}
0	0.0083	0.0583	0.1583	0.1833	0.0583	0.1166	0.0333	0.0084

Table 17: The Total Value of Each of the Options and the Comparison of the Initial Rating

Strategy type	Op-tion	Total value in fuzzy star Additive utility model	Rank relative to the corresponding value of fuzzy star's Additive	The initial rank obtained from the MABAC fuzzy method
WO	A_1	0.7917	1	1
OT	A_2	0.7425	2	2
SW	A_3	0.6925	3	3
WT	A_4	0.6425	4	4
SO	A_5	0.5925	5	5
ST	A_6	0.5425	6	6

5 Discussion and Conclusions

In this research, 48 indicators, including strengths, weaknesses, opportunities, and threats, were given to 10 research experts through the questionnaires in order to compile a flexible strategic marketing model in Iralco. Then, the analysis of this part was done using the fuzzy Delphi method. The results showed that 23 indicators were finally confirmed. Then, using the fuzzy ANP method, the weight and importance of the criteria and sub-criteria were examined. The results showed that among the main criteria, weak points ranked first, opportunity points ranked second, threat ranked third and strengths ranked fourth. Also, among the 23 sub-criteria, high energy, overhead and salary costs due to non-progressive production technology have been ranked first. The growing trend of global aluminium consumption ranks second and the non-participation in aluminium recycling industries, which has high profit and low cost, and relying only on raw sales (bullion sales) has won the third rank. In the next step, using the fuzzy MABAC method, the strategies were ranked in the four-dimensional and six-dimensional innovative matrix. The results showed that in the four-dimensional matrix, the WO strategy was ranked first. The WT strategy has won the second rank, the SO strategy has won the third rank, and the ST strategy has won the fourth rank. Also, in the six-dimensional matrix, the WO strategy has been ranked first. OT strategy is ranked second, SW strategy is ranked third, WT strategy is ranked fourth, SO strategy is ranked fifth and ST strategy is sixth. In the next step, by using the fuzzy star Additive desirability method, the strategies were ranked again in the innovative four-dimensional and six-dimensional matrix. And its results were compared with the fuzzy MABAC ranking results and the results were completely similar. In the last step, according to the results obtained in the previous stages, the six-faceted and innovative SWOT matrix was approved as a matrix that provides more and more flexible strategies with a higher ranking and impact factor

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