Developing the optimized marketing strategy in the oil and gas industry using a combined technique of Fuzzy Analytic Hierarchy Process (FAHP) and SWOT analysis

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Abstract

The main objective of this strategy is to develop the optimized strategy of oil and gas industry by using the SWOT analysis technique and combining it with Fuzzy Analytic Hierarchy Process (FAHP). In this regard, different analytical levels are determined based on the Fuzzy Analytic Hierarchy Process (FAHP). The first level or the purpose includes the selection of best strategy; the second level or the criteria consists of four factors including S, W, O and T; and the third level or the options includes the overall marketing strategies: Offensive, defensive, conservative and competitive. Therefore, the second level binary comparison is initially performed by FAHP method, and then the binary comparison of sub-criteria is separately calculated, and the strategic region of oil and gas industry is determined at the end. The questionnaire is the data collection tool in this study. Based on the results of research, the local oil and gas industry has been faced with more opportunities in terms of external factors, and more strength in terms of internal factors; and the development strategy should be adopted for this group of indices.

Keywords: Marketing strategy, oil and gas industry, SWOT Matrix, Fuzzy Analytic Hierarchy Process (FAHP)
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1- Introduction

Marketing has various definitions. Kotler has defined marketing as a social and managerial process by which the individuals and groups fulfill their needs and demands through production, distribution and exchange of useful and valuable goods with others (Kotler and Armstrong, 2000). Jobber considers marketing as the achievement of corporate goals through fulfilling the customers' needs (Jobber, David, 2001).

The oil and gas sector has various economic, social and political effects in Iranian society and covers an extensive geographical range. The effect of this sector ranges from the national dimensions to neighboring countries and even the international dimensions. This sector of Iran can have the significant impact on increasing the efficiency of national security, the effectiveness of country on the oil and gas market, diversification of non-oil exports, stabilization of currency market and environmental effects in addition to generating the income for government and raising the budget revenues.

According to the twenty-year perspective program of our country, the mission of National Iranian Oil Company is to become pioneer among the oil producing companies in the world by a business and integrated performance in superior operations, marketing and international trading of oil and gas. According to the draft of 20-Year Perspective Document for oil industry of the Islamic Republic of Iran in 1404 Solar Hejri, this country will have a situation as follows:

- The first producer of petrochemical materials and goods in terms of value;
- The second OPEC's largest producer with a capacity of 7% of global market demand;
- The third largest gas producer in the world with a ten-percent portion of the world gas trade

The Ministry of Petroleum in Iran has had the measures for reorganizing different sectors of this common industry in line with new policies and programs based on the change in the management of activities based on the creation of new enterprises and for more efficiency and effectiveness of companies and different sectors of this industry and clarifying the costs of production and service and creation of appropriate fields for taking the advantage of new technologies. Developing, explaining and implementing the integrated system of strategic marketing management are among the contexts which make the achievement of this position possible.

The appropriate and coordinated allocation of marketing resources to ensure the operational objectives of company in terms of a particular product market is the main focus of marketing strategy. Therefore, the identification of threats to prevent them and also the opportunities to take the advantage of them are the bases for strategic planning at all levels. Therefore, according to the importance of oil and gas sector in Iran, this paper seeks to investigate the possible marketing strategies by identifying the strengths, weaknesses, opportunities and threats facing the oil and gas market.

2- Research literature

Numerous studies have been conducted on the research subject. Some of them are mentioned as follows. However, the researcher's studies on the development of marketing strategy in the oil and gas industry indicate that despite the several studies on this field, there is no conducted comprehensive study in this regard:

A research entitled "A Fuzzy approach for supplier evaluation and selection in supply chain management", the fuzzy decision model is presented to select the best supplier of raw materials (Chena, Chen-Tung, Lin, Ching-Torng, Huang, Sue-Fn, 2004). Using fuzzy TOPSIS model, this study provides the decision making model. The research methodology of this study is designed based on the proposed methodology by Chena.

Another study entitled "System Dynamic-Based Tool for International Market Selection" introduces a model for selection of target export markets in Egypt according to planning the dynamic systems (Azim, 2004). The objective function of this research is defined by three main criteria of price, revenue and market share. A model is provided for evaluating the capacity (potential) of target markets through the defined objective function and criteria for selection of target markets.

In this study, the researcher evaluates the influence each variable on each other and on the market selection after identifying the variables affecting the target market. The obtained results of this study indicate that:

A. The macroeconomic variables have the greatest impact on the selection of export target markets in Egypt.
B. The political risk has the minimal effect on the selection of target markets.
C. Per capita income has been the most important target market selection variable.

D. The growth rate of per capita income is among the most important factors in choosing the target export markets of Egypt. The growth of this index means the existence of appropriate opportunities in target market.
E. The population size and rate of population growth are other important factors which should be taken into account (Azim, 2004)

Another study entitled "Selection of international market and choice of foreign entry mode" provides a model for selection of export target market and the way of optimized entry into each market (Backlund, 2005). The indices, which are studies in this research for identifying the target markets, are as follows: Geographical proximity, cultural proximity, psychological proximity, environmental macro factors, market factors, intra-organizational factors, and the corporate potential.

A research entitled "Developing the strategic planning of exports in car industry of Iran" investigates five socioeconomic factors (including the economic, demographic, geographic and social factors), technology, providers (including the energy, raw materials, capital, labor and machines), competitors (at the regional and international levels) and finally the role of government. A section for investigating the factors of strategic advantages according to the inter-organizational attitudes, investigates the marketing and distribution factors, engineering research and development, management and operation manufacturing, human resources and manpower, and accounting and financial sectors. This section compares the car capacities (Sudan, Turkmenistan and Iraq) as well as considering the part manufacturing (The United Arab Emirates, Russia, and Europe Union). The research result indicates that there is no enough capacity for complete exports of the vehicle (CBU) (Gummesson, 2005).

Bozbura et al have offered a FAHP methodology (Fuzzy Analytic Hierarchy Process) to improve the quality of prioritizing the human capital measurement indices under the conditions of ambiguity (fuzzy) (Bozbura, F.T. et al, 2006). Through an analytic network process (ANP) and BSC approach, Ravi et al analyzed the alternative methods in reverse logistics for end of life computers. The structure of analytic network process (ANP) hierarchically structures the reverse logistics, and then the dimensions of reverse logistics are extracted from perspectives (Ravi, V. et al, 2005). Wu et al have sought to develop the scorecard model by applying one of the methods for multi-criteria decision making (MCDM) in order to evaluate the performance of major research centers in Taiwan. They have utilized the VIKOR model to prioritize the options in four fields of BSC model. According to the ranked areas, they have concluded that the growth and learning areas have the most important roles and highest coefficient in evaluating the performance of research centers and then the financial sector (Wu, H.Y. et al, 2011). García-Valderrama et al have designed a model for evaluating the performance and investigating the correlation between four dimensions of BSC method by applying the data envelopment analysis (DEA) in research and development companies (García-Valderrama, T. et al, 2009). Hung-Yi W. et al have designed a model for evaluating the performance of banking system by application of Fuzzy Multiple Criteria Decision Making (FMCDM) method in BSC. They have utilized the FAHP method to rank 23 selected indices of four BSC dimensions and ranked three selected banks as the case studies by three SAW, TOPSIS, and VIKOR models and based on the designed model and have concluded that the designed model has a good performance to evaluate the performance of banks (Hung-Yi, W. et al, 2010). Lee et al (2008) have designed a model for evaluating the performance of IT in Taiwanese manufacturing companies by integrating the BSC and FAHP models (Lee, A.H.I. et al, 2008).

3- Research Methodology

This research is descriptive in terms of method, deductive according to the logic, and applied in terms of results. The whole research process provides a model for identifying the target export markets and adopting the optimized strategies in that market. The experts' views are utilized at each stage of research in order to identify the effective factors and weight the required factors and finally the optimized strategy for oil and gas exports.

3-1- Statistical population, sample and sampling method

The statistical population of research consists of all managers and experts in units of oil and gas exporting, marketing and strategic planning in Iran.

$$n = \frac{N.Z_{\alpha/2}.\delta^2}{\varepsilon^2(N-1) + Z_{\alpha/2}.\delta^2}$$

340 managers and staff are identified in statistical population and the sample size is estimated equal to 30 according to the equation above.

3-2- Data collection method

Three different questionnaires are designed and distributed among the managers, experts and elites in order to assess the strengths, weaknesses, opportunities and threats of oil and gas market as well as identifying the location matrix and strategic action in this area. Furthermore, another questionnaire is designed for identifying the priorities of target oil and gas export markets based on the pairwise comparisons and then distributed among the experts in this field.

The validity of questionnaires is confirmed by providing the extracted indices for experts and professionals and giving their comments on removing and adding some indices. The reliability of initial questionnaires is approved by applying the Cronbach's Alpha method.

3-3- Research process

In this research, different analytical levels are initially determined in order to extract the best marketing strategy for oil and gas based on the Fuzzy Analytic Hierarchy Process (FAHP). The first level or the purpose includes the selection of best strategy; the second level or criteria includes four factors of S, W, O and T; and the third level or options includes the overall marketing strategies: offensive, defensive, conservative and competitive. Therefore, the second level binary comparison is initially performed by FAHP method, and then the binary comparison of sub-criteria is separately calculated, and the strategic region of oil and gas industry is determined at the end. Finally, the list of regional industry strategies is prepared and the best strategy determined.

FAHP Methodology:

After preparing the fuzzy pairwise comparisons matrix (the respondents' preferences obtained through a questionnaire), the final and relative phase weights should be measured according to different methods introduced by researchers such as Chang's Extent Analysis Method which is utilized in this paper.

First step) The amount of SK, which is a triangular fuzzy number, is calculated for each row of pairwise comparison matrix which is prepared according to what was mentioned.

The coefficients of each pairwise comparison matrix (sk) is measured after filling to the tables of factor preferences by respondents. The amount of sk is a triangular number which is calculated as follows:

$$S_K = \sum_{i=1}^{n} M_{kj} * \left[\sum_{i=1}^{m} \sum_{i=1}^{n} M_{ij} \right]^{-1} \quad (1)$$

Where, K indicates the number of rows, and i and j are the options and criteria, respectively.

Second step) After measuring SKs in EA method, their magnitudes are measured and compared. In general, if M1 and M2 are two triangular fuzzy numbers, the higher degree of M2 then M1, which is shown by V (M1≥M2)V, is defined as follows:

$$V(M_1 \geq M_2) = 1 \qquad m1 \geq m2$$

$$\text{Otherwise} \quad V(M_1 \geq M_2) = hgt(M_1 * M_2) \qquad (2)$$

So we have:

$$hgt(m_1 \cap m_2) = \frac{u_1 - l_2}{(u_1 - l_2) + (m_2 - m_1)} \qquad (3)$$

The higher amount of a triangular fuzzy number than another k triangular fuzzy number is also obtained according to the following equation.

$$v(m_1 \geq m_2 و ... m و _k) = mi[v(m_1 \geq m_2) و ... v و (m_1 \geq m_k] \qquad (4)$$

Third step) To measure the weights of indexes in pairwise comparison matrix, the following equation is measured according to EA method.

$$w'(x_i) = \min \{v(s_i \geq s_k\}, k = 1,2,...,n, k \neq i \qquad (5)$$

Thus, the index weight vector will be as follows.

$$w' = [w'(c_1), w'(c_2) و ... و w'(cn)]^t \qquad (6)$$

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It is the vector of non-normalized coefficients for Fuzzy AHP.

Fourth step) The values obtained in the previous phase of non-normalized weight are the criteria of hierarchical analysis table. Therefore, the normalized weights of criteria (indexes) are measured according to the following formula.

$$W_j = \frac{W_i'}{\sum W_i'} \qquad (7)$$

$$w(x, x, x, ...)^t$$

The obtained weights indicate the relative importance coefficient of each index (criterion) based on Fuzzy AHP (by EA) which is the best option of decision making.

A Combined SWOT–FAHP Hierarchical Structure

After conducting the SWOT analysis and obtaining the key priority areas of UMS, the FAHP method could be engaged. This made it possible to rank the priority areas by their relevance, which is essential since not all goals from all areas can be simultaneously achieved, and one cannot deal with all areas at the same time. When performing the FAHP method, experts who knew the UMS area and its limitations could be present during this process and had the chance to take decisions or represent the decision-makers. Here, a particularly important goal was to follow the previously obtained SWOT group criteria under those priority areas obtained from the previous stages of research. On this basis, a hierarchical structure with local fuzzy weights of criteria with respect to the goal, sub-criteria with respect to the criteria, and global fuzzy weights of sub-criteria with respect to the goal arose, as shown in **Figure 1**. Such a construction represents the general structure of the SWOT–FAHP hybrid model as a core part of our research. Weights in **Figure 1** refer to aggregated weights of all decision-makers, either via their reflection for the criteria, or the sub-criteria. When the obtained fuzzy weights were defuzzi fied into the crisp numbers, the KPA of UMS could also be appropriately ranked by their relevance.

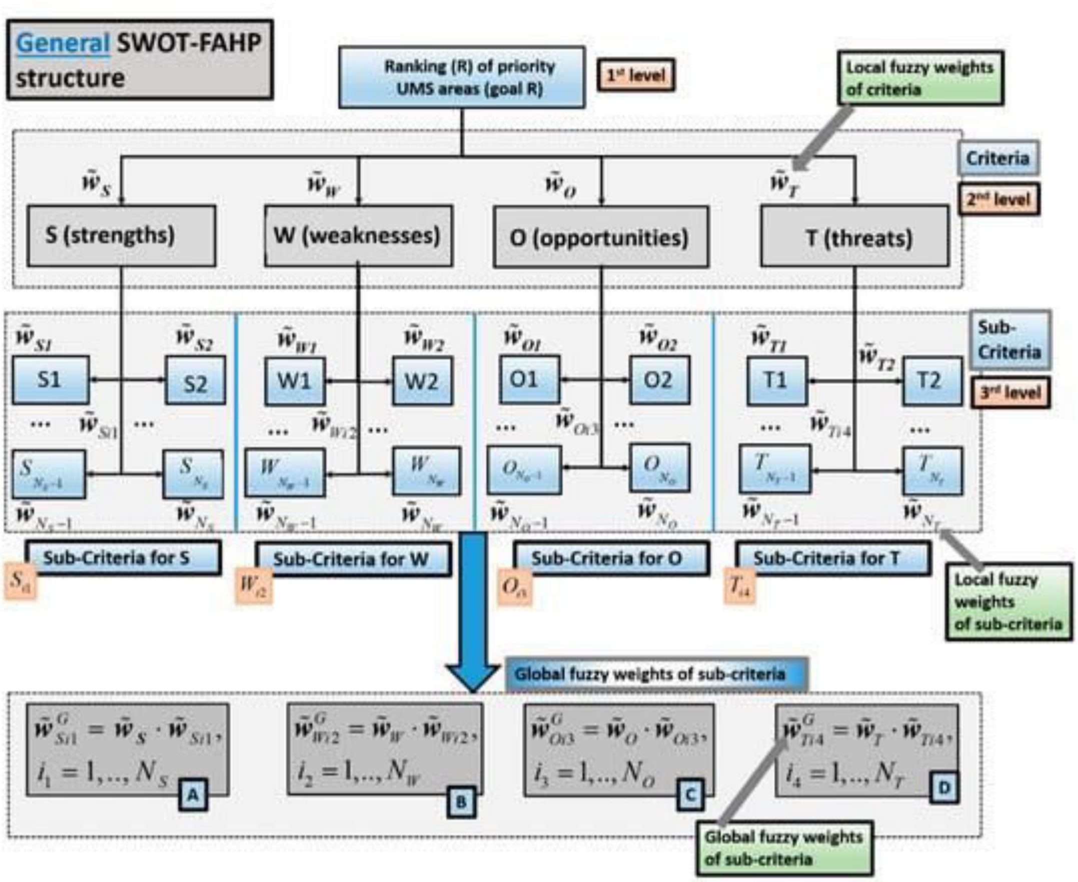

Figure 1. The core part of our research: Hierarchical structure of the SWOT–FAHP (Strengths, Weaknesses, Opportunities, and Threats–fuzzy analytical hierarchical process) hybrid model with aggregated fuzzy weights of all decision-makers.

Diagram of the 10 Essential Steps of the FAHP Method

A more precise illustration of the consecutive steps of the FAHP method (see also **Figure 1**, third phase) is shown in **Figure 2**. In the first five steps, an ordinary (conventional) AHP is conducted, where decomposition of the problem into a hierarchical structure is applied, by taking into consideration previously obtained SWOT results. In this given structure, a pairwise comparison is then made between the

AHP structural elements (such as criteria and sub-criteria) of individual experts (Felice, Petrillo, 2012). As can be seen from **Figure 2**, the AHP implementation process can be broken down into five crucial steps: (1) defining inputs; (2) design of a hierarchical structure; (3) establishment of pair comparisons; (4) design of a matrix of pair comparisons and calculation of weights; (5) verification of consistency of pair comparisons. The first five steps are needed to check the consistency of individual experts in particular, since the FAHP process cannot proceed in the case of inconsistency.

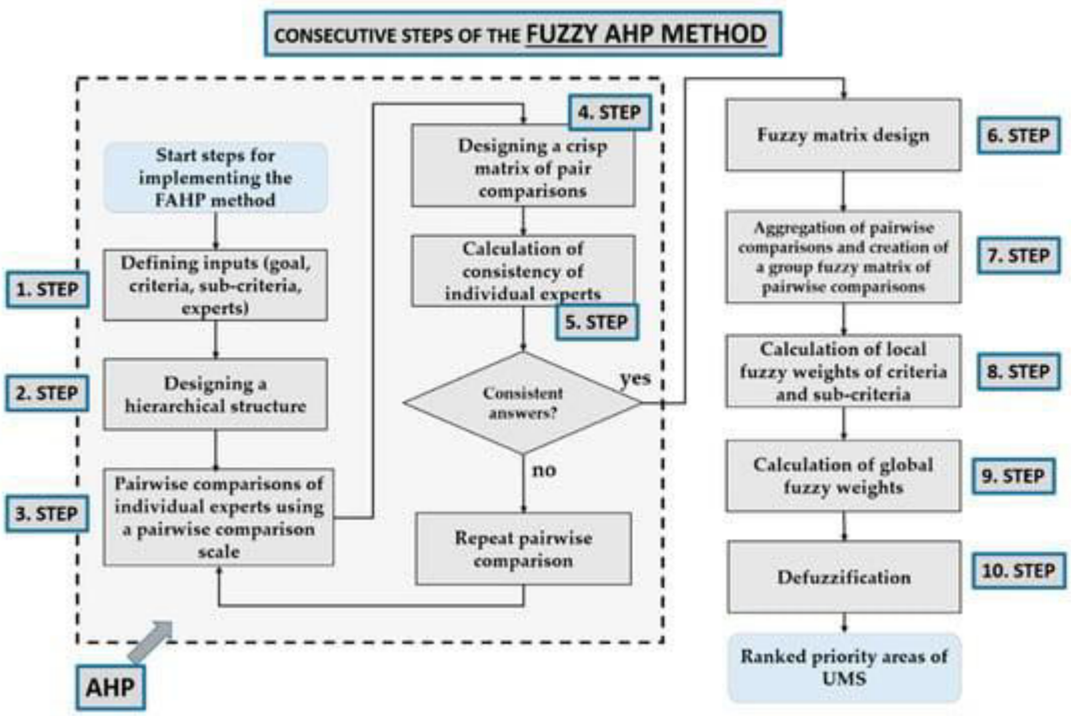

Figure 2. The consecutive steps of the FAHP method.

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In the next section, some details of the consecutive steps of the FAHP method from **Figure 2** will be briefly explained.

The AHP Method and a Brief Explanation of the First Five Steps of FAHP

Let us assume that we have a pairwise comparison matrix of a given decision-maker—expert for $N = 4$ criteria with respect to the goal and $N = 4$ groups of sub-criteria with respect to their criteria (see **Figure 1**). Thus, an individual f-th decision-maker deals with h=1,…,(N+1)=5 groups of criteria/sub-criteria. In addition, they deal with an equal number of the corresponding pairwise comparison matrices (one for criteria and four for sub-criteria), while all f = 1,2,…,m of experts are dealing with Nmax=$m\cdot$ 5max=·5 of such matrices. Accordingly, we can write the following compact form of the given pairwise comparison matrix,

$$A_{fh} = \begin{bmatrix} 1 & a_{12} & \dots & a_{1n} \\ 1/a_{12} & 1 & \dots & a_{2n} \\ \dots & \dots & \ddots & \vdots \\ 1/a_{1n} & 1/a_{2n} & \dots & 1 \end{bmatrix}, f = 1, \dots, m, h = 1, 2, \dots, 5, \quad (8)$$

where *m* is the number of experts, *h* refers to the *h-th* group of criteria/sub-criteria, while Nmax=m·5 is the total number of such matrices.

If estimates are consistent, i.e., $aij \cdot ajk = aik$; i,j,k=1,…,n, the matrix Afh can be written in the form: Afh={$wiwj$/}= {aij} for i, *j*=1,…,nh=} for =1,…,. Thus, individual aii is equal to the ratio of weights $wiwj$/ of compared criteria *i* and *j*. In this case, the vector of weights w(Afh)=(w1,..,wi(Afh)…,wn) h)=(1,.h)…,) can be obtained as a solution of the homogenous system: Afh·w(Afh)=n·w(Afh)h·h)=h), where n=λmax(Afh)=max(h) and the corresponding eigenvector w(λmax)(max) is the principal one. Unfortunately, the pairwise comparison matrix $Afhh$ is often not completely consistent, and consequently, the maximal eigenvalue is λmax(Afh)≥$n$max(h)≥. In order to discover the inconsistency level, the following consistency index of matrix $Afhh$ must be calculated [81]:

$$CI\left(A_{fh}\right) = \frac{\lambda_{\max}\left(A_{fh}\right) - n}{n-1}. \quad (9)$$

The latter can be compared with the random index *RI* (average consistency index), which gives the consistency ratio [81]: 1209

$$CR\left(A_{fh}\right) = \frac{CI\left(A_{fh}\right)}{RI} \quad (10)$$

If CR(Afh)<0.1, the pair comparisons of the given *f-th* decision-maker are treated as being sufficiently consistent; otherwise, the decision-maker needs to repeat the paired comparison.

The maximal eigenvalue needed in Equation (2) can be calculated in the following way

$$\lambda_{\max}\left(A_{fh}\right) = \frac{1}{n}\sum_{i=1}^{n}\frac{\left(A_{fh}\cdot w\left(A_{fh}\right)\right)_i}{w_i\left(A_{fh}\right)}, i = 1, 2, \dots, n, \quad (11)$$

where the calculation of corresponding weights can be in the simplified form obtained by using the geometric mean method (Brunelli, 2015):

$$w_i\left(A_{fh}\right) = \sqrt[n]{\prod_{j=1}^{n} a_{ij}} \Bigg/ \sum_{i=1}^{n}\sqrt[n]{\prod_{j=1}^{n} a_{ij}}, \quad i = 1, 2, \dots, n. \quad (12)$$

A Brief Explanation of the Last Five Steps of FAHP

After calculating the consistency and completing the AHP calculation process carried out by participating (*m*) experts, fuzzy matrices of pairwise comparisons are formed in the next, sixth step (see **Figure 2**). For this purpose, the AHP crisp numbers are first transformed into fuzzy numbers on the basis of linguistic statements of *m* decision-makers. In our case, the triangular fuzzy numbers were used, while the pairs chosen by the individual decision-makers/experts were compared based on the pair-based comparison scales (Ayhan, 2013).

Fuzzy matrices of pair comparisons (for criteria and sub-criteria) were formed on the basis of the Buckley's "geometric mean method" approach conducted for triangular fuzzy numbers $a\tilde{}ij$, where the following form of the fuzzy matrix can be created by a given decision-maker (derived from crisp matrix (1)) (Emrouznejad, 2018):

$$\bar{A}_{fh} = \begin{bmatrix} (1,1,1) & \bar{a}_{12} & \dots & \bar{a}_{1n} \\ \bar{a}_{21} & (1,1,1) & \dots & \bar{a}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \bar{a}_{n1} & \bar{a}_{n2} & \dots & (1,1,1) \end{bmatrix} \in \left\{ \left(a_{ij,f\,h}, b_{ij,f\,h}, c_{ij,f\,h} \right) \right\}, \quad (13)$$

$$for\ i,j = 1,\dots,n, \quad f = 1,\dots,m, \quad h = 1,\dots,5$$

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where *m* is the number of experts, *h* refers to the *h*-th group of criteria/sub-criteria, while Nmax=m·5 max=·5 is the total number of such matrices (see Equation (13)).

Here, each element $a\tilde{}ij,fh$=(aij,fh,bij,fh,cij,fh) of the matrix $A\tilde{}fh$ represents the lower, middle, and upper values, respectively, of the triangular fuzzy numbers inside the matrix (6). The same logic stands for all other triangular numbers presented in this paper.

The next, seventh, step from **Figure 2** encompasses the aggregation of the decision-makers using the geometric mean of their fuzzy pairwise comparisons. After obtaining all pairwise comparisons of all decision-makers and designing fuzzy matrices of pairwise comparisons, their geometric means can be calculated. Moreover, *N* + 1 = 5 joint (group) fuzzy matrices $U\tilde{}h$,h=1,…,5$\tilde{}h$,h=1,…,5 of pairwise comparisons of all *m* decision-makers can also be formed (one for criteria: $U\tilde{}1$=$U\tilde{}1,N\times N$, and four for sub-criteria: $U\tilde{}2$=$U\tilde{}2,NS\times NS$, $U\tilde{}3$=$U\tilde{}3,NW\times NW$, $U\tilde{}4$=$U\tilde{}4,NO\times NOU\tilde{}5$=$U\tilde{}5,NT\times NT$), where the dimensions of these matrices are as follows:

$$d\,(h) \in \{N, N_S, N_W, N_O, N_T\}, h = 1,..,5. \quad (14)$$

While performing the seventh step, the geometric mean of the fuzzy pair comparisons to aggregate the *m* decision-makers was expressed in the form of triangular fuzzy numbers, as follows (Emrouznejad, 2018):

$$\bar{u}_{ijh} = \left(\prod_{f=1}^{m} \bar{a}_{ij,fh} \right)^{1/m} \in \left(a_{\bar{u}_{ijh}}, b_{\bar{u}_{ijh}}, c_{\bar{u}_{ijh}} \right), h = 1,\dots,5, \quad (15)$$

where $u˜ijh∈U˜h,h∈\{1,2,...,5\}$ $˜h,h∈\{1,2,...,5\}$ are the fuzzy pair comparisons of the *h-th* group of criteria/sub-criteria, while *m* is the number of decision-makers. For the sake of simplicity of explanation, the calculated $u˜ijhh$ values symbolize either the elements of the joint fuzzy matrix $U˜1=U˜1,N×N$ of pairwise comparisons of all *m* decision-makers for *N* = 4 criteria (S, W, O, T) or the elements of the *N* joint fuzzy matrices $U˜h,h=2,...,5∈\{U˜2,NS×NS,U˜3,NW×NW,U˜4,NO×NO,U˜5,NT×NT\}˜h,h=2,...,5∈$ for the corresponding *M* sub-criteria (where $M=NS+NW+NO+NT$).

Calculations of the local fuzzy weights for *N* criteria and *M* sub-criteria are carried out in the eighth step, where we used Buckley's approach once again. Firstly, the calculation of the geometric mean $r˜ih$ should be derived as follows (see Equations (14) and (15)) (Emrouznejad, 2018)::

$$\begin{aligned}\tilde{r}_{ih} &= \left(\prod_{j=1}^{d(h)} \tilde{u}_{ijh}\right)^{1/d(h)} = \left(\tilde{u}_{i1h}\cdot\tilde{u}_{i2h}\cdot\ldots\cdot\tilde{u}_{id(h)h}\right)^{1/d(h)} \in \left(a_{\tilde{r}_{ih}}, b_{\tilde{r}_{ih}}, c_{\tilde{r}_{ih}}\right),\ \text{where} \\ i &= 1,\ldots,\ d(h) \in \{N, N_S, N_W, N_O, N_T\}\ for\ h = 1,..,5.\end{aligned} \quad (16)$$

The local fuzzy weights for *N* = 4 criteria and *M* sub-criteria are computed in the eighth step (see **Figure 1** and **Figure 2**, and Equation (16)), as follows (Wang,Chen, 2021):

$$\begin{aligned}\tilde{w}_{ih} &= \frac{\tilde{r}_{ih}}{\tilde{r}_{1h}+\tilde{r}_{2h}+\ldots+\tilde{r}_{ih}\ldots+\tilde{r}_{d(h)h}} = \frac{\tilde{r}_{ih}}{\sum_{i=1}^{d(h)}\tilde{r}_{ih}} = \left(a_{\tilde{w}_{ih}}, b_{\tilde{w}_{ih}}, c_{\tilde{w}_{ih}}\right),\quad where \\ i &= 1,\ldots,\ d(h) \in \{N, N_S, N_W, N_O, N_T\}\ for\ h = 1,\ldots,5.\end{aligned} \quad (17)$$

According to **Figure 1**, we can split the weights in (10) into the weights for the criteria, and the weights for sub-criteria. For the criteria, the local weights can be denoted more simply: $w˜crit∈\{w˜S,w˜W,w˜O,w˜T\}$ while for the sub-criteria, they include the following weights: $w˜sub−crit∈\{w˜Si1,w˜Wi2,w˜Oi3,w˜Ti4\}$whose indices $(i1,i2,i3,i4)$ 1211

Within the ninth step from **Figure 1**, the calculation of global (collective) fuzzy weights is also carried out for the sub-criteria, by means of multiplying the local fuzzy weights of criteria with the ones of the sub-criteria (see **Figure 1**, blocks A, B, C, D below). This way, the following global weights are obtained,

$$\tilde{w}^{C}_{sub-crit} \in \left\{\tilde{w}^{C}_{Si1}, \tilde{w}^{C}_{Wi2}, \tilde{w}^{C}_{Oi3}, \tilde{w}^{C}_{Ti4}\right\}\ for\ (i_1, i_2, i_3, i_4). \quad (18)$$

In the last, tenth step, the fuzzy weights are defuzzified, wherein the fuzzy numbers (weights) are transformed into the crisp numbers for the needs of ranking and comparison of priority areas. Many authors (Husain et al, 2017) claim that the most frequent among all the suggested defuzzification methods is the so-called centre of gravity (COG) method, also known as "centroid". It is useful due to its simplicity (Tzeng, Huang, 2011) and the reliability of the results. By using the COG method, the crisp weights of criteria and sub-criteria are calculated as follows :

$$w_C \in \{w_{C1}, w_{C2}, w_{C2}^G\} = COG[\bar{w}_C] = COG\left[\left(a_{\bar{w}_C}, b_{\bar{w}_C}, c_{\bar{w}_C}\right)\right] = \frac{a_{\bar{w}_C}+b_{\bar{w}_C}+c_{\bar{w}_C}}{3}, \text{ where}$$
$$\bar{w}_C \in \left\{\bar{w}_{C1}, \bar{w}_{C2}, \bar{w}_{C2}^G\right\} = \left\{\bar{w}_{crit}, \bar{w}_{sub-crit}, \bar{w}^G_{sub-crit}\right\}, \text{ and} \quad (19)$$
$$\bar{w}_{crit} \in \{\bar{w}_S, \bar{w}_W, \bar{w}_O, \bar{w}_T\}, \bar{w}_{sub-crit} \in \{\bar{w}_{St1}, \bar{w}_{Wt2}, \bar{w}_{Ot3}, \bar{w}_{Tt4}\}, \bar{w}^G_{sub-crit} \in \left\{\bar{w}^G_{St1}, \bar{w}^G_{Wt2}, \bar{w}^G_{Ot3}, \bar{w}^G_{Tt4}\right\}.$$

The formed crisp numbers (weights) offer an important insight into the individual priority areas and present a basis to construct a comprehensive UMS development strategy.

4- Research results and findings

4-1- Determining the final matrix of fuzzy pairwise comparisons for main factors by FAHP method

We initially integrate the collected questionnaires using the geometric mean method and then identify the relative importance of SWOT matrix factors:

Table (1): Determining the relative importance of factors

Factors	Strengths	Weaknesses	Opportunities	Threats
Strengths	1	1.8	4.4	1.23
Weaknesses	-	1	1.44	1
Opportunities	-	-	1	0.28
Threats	-	-	-	1

Then we convert the numbers and entries of matrix above into the corresponding fuzzy numbers to preferences:

Table (2): Fuzzy pairwise comparison matrix of main factors

criteria	S	W	O	T
S	(1,1,1)	(1,1.18,3)	(2,2.44,4)	(0.33,1.23,4)
W	(0.33,0.85,1)	(1,1,1)	(1,1.44,3)	(0.5,1,2)
O	(0.25,0.41,0.33)	(0.33,0.69,1)	(1,1,1)	(0.14,0.28,0.5)
T	(0.25,0.81,3)	(0.5,1,2)	(2,3.57,7.14)	(1,1,1)

Afterwards, we determine the coefficients of each pairwise comparison matrix (Si vector). This vector is calculated by multiplying two vectors as follows:

We add the components of fuzzy numbers in each row to obtain the first vector.

The second vector is the sum of triangular numbers in the matrix above and it is reversed. This vector is the same in calculation of all SIs.

Measuring the reverse of a triangular number is as follows:

If a_{ij}=(L, m, u) is a triangular fuzzy number, its reverse will be as follows:

$$a_{ij}^{-1} = (1/u, 1/m, 1/l)$$

According to the above cases, the Si vectors will be calculated as follows:

$$S_1 = (2.66, 4.23, 6) \otimes \left(\frac{1}{31.06}, \frac{1}{12.16}, \frac{1}{11.03}\right) = (0.09, 0.35, 0.54)$$

$$S_2 = (2.70, 4.00, 6) \otimes \left(\frac{1}{31.06}, \frac{1}{12.16}, \frac{1}{11.03}\right) = (0.09, 0.33, 0.54)$$

$$S_3 = (2.33, 3.39, 8.03) \otimes \left(\frac{1}{31.06}, \frac{1}{12.16}, \frac{1}{11.03}\right) = (0.08, 0.28, 0.73)$$

$$S_4 = (3.33, 4.77, 11.03) \otimes \left(\frac{1}{31.06}, \frac{1}{12.16}, \frac{1}{11.03}\right) = (0.011, 0.39, 0.1)$$

Afterwards, the possibility degree of vectors is calculated:
Comparison of Si vectors in Fuzzy Analytic Hierarchy Process (FAHP) algorithm will be done according to the following formula:

$$V(S_1 \geq S_2) = 1 \text{.........} if S_1 \geq S_2$$

$$V(S_1 \geq S_2) = \frac{l_2 - u_1}{(m_1 - u_1) - (m_2 - u_2)} \text{...........} if S_2 \geq S_1$$

Where,

$$S_1 = (l_1, m_1, u_1)$$

$$S_2 = (l_2, m_2, u_2)$$

Therefore, according to the above formula, the vectors S1 to S7 will be compared as follows:

$$V(S_1 \geq S_2) = 1 \qquad V(S_2 \geq S1) = 0.96$$
$$V(S_1 \geq S_3) = 1 \qquad V(S_2 \geq S_3) = 1$$
$$V(S_1 \geq S_4) = 091 \qquad V(S_2 \geq S_4) = 0.87$$

$$V(S3 \geq S1) = 0.90 \qquad V(S4 \geq S1) = 1$$
$$V(S3 \geq S2) = 0.93 \qquad V(S4 \geq S2) = 1$$
$$V(S3 \geq S4) = 0.85 \qquad V(S4 \geq S3) = 1$$

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In the next step, we write the values of d (I) according to the following order:

$$d'(I1) = MIN(S_1 \geq S_2, S_3, S_4) = 0.91$$
$$d'(I2) = MIN(S_2 \geq S_1, S_3, S_4) = 0.87$$
$$d'(I3) = MIN(S_3 \geq S_1, S_2, S_4) = 0.85$$
$$d'(I4) = MIN(S_4 \geq S_1, S_2, S_3) = 1$$

The d(I) values make up our final matrix:

$$W' = (0.91, 0.87, 0.85, 1)^T$$

$$W = (0.25, 0.24, 0.23, 0.28)$$

Therefore, on the basis of FAHP method, the prioritization of criteria will be as follows:

Table (3): Final matrix for prioritization of criteria using the FAHP method

Indices	Weights of criteria (row mean)

S	0.25
W	0.24
O	0.23
T	0.28

4-2- Calculating the weights of sub-factors

Like the steps above, the results of binary comparison for each criterion are presented along with their options.

Table (4): Comparing the strengths with relevant options using the FAHP method

Index (criterion)	Weight	Priority
Local experts' relative self-sufficiency in the study of reservoirs and application of software for simulation of local reservoirs	0.318	1
Developing and implementing a comprehensive system of research and technology in the Ministry of Petroleum	0.287	2
Developing and implementing the short-term policies of energy efficiency including energy labeling and coding	0.199	3
Technical facilities to recover the gas injected into the oil reservoirs after completion of Enhanced Oil Recovery (EOR)	0.196	4

Table (5): Comparing the weaknesses with relevant options using the FAHP method

Index (criterion)	Weight	Priority
Inattention to protective production from oil reservoirs and EOR studies	0.649	1
Non optimized allocation of gas resources to different uses such as the gas injection despite the conducted studies in this field	0.351	2

Table (6): Comparing the opportunities with relevant options using the FAHP method

Index (criterion)	Weight	Priority
The existence of significant oil and gas reserves in the Caspian Sea and Zagros area	0.319	2
Geopolitical situation of Iran in the Persian Gulf region	0.266	3
Sustainable increase in demand for oil and gas in the world	0.310	1
Entering the peak oil period	0.105	4

Table (7): Comparing the threats with relevant options using the FAHP method

Index (criterion)	Weight	Priority
Applying the international sanctions and pressures by Western powerful countries	0.257	3
The absence of foreign investors in the oil and gas sector of Iran due to the international political pressures	0.389	1
The increased speed of oil and gas exploration and recovery by neighboring countries from common reservoirs especially in South Pars gas field	0.354	2

The calculated incompatibility rate index (I.R.) is from zero to 0.01 for all criteria and it indicates the significance of whole model and verified calculations.

4-3- Determining the strategic marketing region

Two tables should be calculated for evaluating the internal and external factors in order to determine the strategic area. The strengths and weaknesses are evaluated in the table of internal factors, and the opportunities and threats evaluated in the table of external factors. If the total score of organization is more than 2.5 in this matrix, the opportunity of organization will overcome the threats, and if this score is less than 2.5, it indicates that the opportunities are overcome by threats. The table for sample combination of internal and external factors is presented in the following table:

Table (8): Calculating the internal and external factors

Priorities			Relative importance factor	Rank	Importance factor * Rank
Internal factors	Strengths	S1	0.159	2	0.318
		S2	0.144	3	0.432
		S3	0.99	4	0.396
		S4	0.98	4	0.254
	Weaknesses	W1	0.324	2	0.648
		W2	0.176	3	0.528
	Total		Σ = 1	2.576	
External factors	Opportunities	O1	0.160	4	0.640
		O2	0.133	3	0.399
		O3	0.155	3	0.465
		O4	0.53	3	0.159
	Threats	T1	0.129	4	0.516
		T2	0.195	2	0.390
		T3	0.177	2	0.354
	Total		Σ=1	2.918	

Table 8 shows that the external factors are superior to internal factors. Therefore, the development of marketing strategy, and environmental opportunities and threats is the main challenge of oil and gas industry.

Final score of evaluating the internal factors=2.576

1 2 3 4

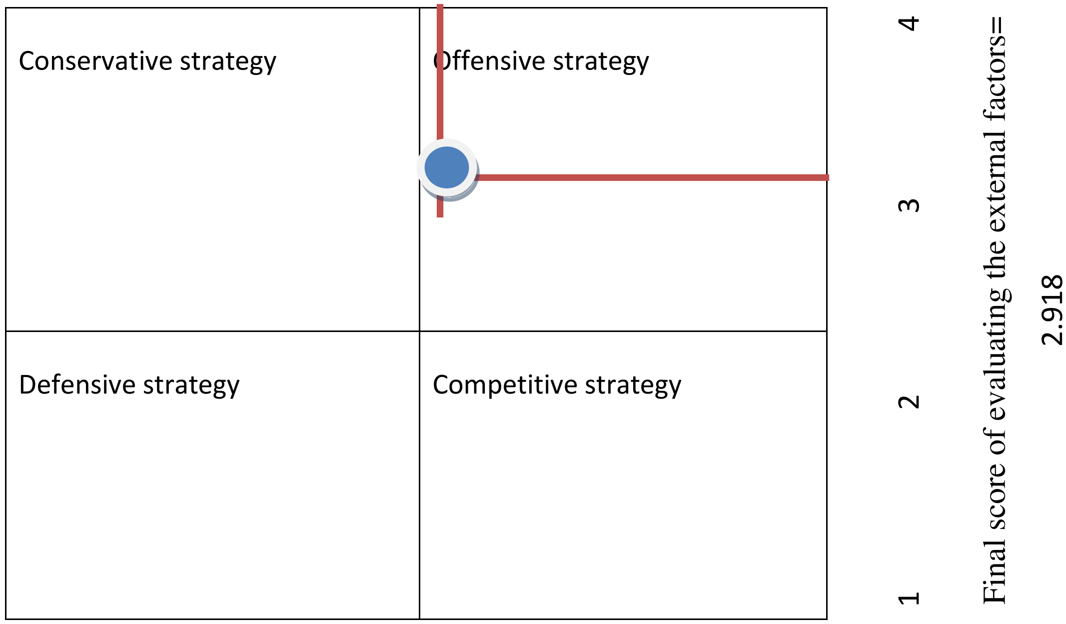

Figure 3: Matrix for evaluating the internal and external factors (IE)

Since the intersection of internal and external factors is located in Square 1 in terms of strategic situation, this group of indices is faced with more opportunities in terms of external factors; and with more strength in terms of internal factors; and the development strategy should be adopted for this group of indices.

According to this strategy, due to the geopolitical position of Iran in the Persian Gulf region and the existence of good reserves of oil and gas, this country can have less dependence on the high-technological countries in exploration and extraction of oil and gas fields because of its local experts' self-sufficiency in the study of reservoirs and application of simulation software of local reservoirs as well as providing the comprehensive system of research and technology in the utilization of existing technical capabilities.

5- Conclusion

Since providing the optimized executive systems in line with the long-term local objectives is one of the macro national objectives in presenting the national documents, it is essential to pay attention to these policies in executive sector of our country. However, according to the results of SWOT fuzzy analysis, we should prioritize the overall presented policies for oil and gas sector according to the today's conditions. Therefore, the investment in inferior and superior areas through the optimized allocation of local resources is considered as one of the main priorities. Furthermore, the special attention to technology in the oil industry, and localization of required technologies, and finally the simultaneous management of supply and demand in the oil and gas sector are among the other strategic priorities as the bases for strategic policies in this sector.

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