Providing a Model for Optimal Capital Structure in Gas Refining Companies and Determining Parameters Using the AHP Method

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ABSTRACT

Companies have access to various financial resources to implement available profitable investment projects, settle overdue debts, increase working capital, and pay dividends to shareholders. Correct decision-making and the ability of companies to determine the appropriate financial resources are the main factors in company success. The effects of financing on the company's return and risk are the most important goals that management should consider when choosing a financing method and selecting resources that minimize financing costs. In this research, the fuzzy Delphi method was first used to identify financing methods and the criteria for selecting the appropriate financing method. Then, the AHP method was used to prioritize the parameters. This study showed that efficiency, cost, sustainability, operationality, fairness, and transparency are the most important criteria for selecting financing methods in gas companies. Forming subsidiary consortia, receiving facilities, issuing participation bonds, creating an investing company, presence in the stock market, creating a shareholder plan have also been identified as financing methods.

1. Introduction

The considerable volume of oil and gas reserves and Iran's unique geographical and geopolitical position in achieving the world's major consumer markets have made Iran one of the most critical countries in the world, enjoying hydrocarbon reserves. In addition to the importance of these reserves globally, the Iranian oil industry is the most important economic sector and is the mainstay of the country's economic development. In this respect, the oil industry plays a dual role in Iran (Abolfathi, 2019).

This industry and its capitals are the primary support for the growth, development, and continuation of its economic development. Continuing the country's economic development requires special attention to this industry as the driving force of the economy and the supplier of the main requirements of the country's economic development. The oil industry is the leading supplier of foreign currency resources for other

economic sectors and the most critical sector needing investment. This industry is also the maximum economic advantage of the country in attracting financial resources (Bhardwaj, 2018).

At the same time, upstream oil and gas projects have two features. On the one hand, they generally have high economic returns, and on the other hand, due to the risk and uncertainty in the technical and economic parameters affecting the project efficiency, they have a high risk. The simultaneous existence of these features and the variety of investment opportunities and limited financial resources necessitate the management of financial resources and their optimal allocation (Gao, 2017).

The development of the oil industry requires heavy financial resources, and this need doubly indicates its effects in the context of international sanctions. In planning and the strategy of creating and developing production capacities from hydrocarbon resources in the upstream sector, creating and developing refining and distribution capacities, and creating added value in the downstream sectors, paying attention to the optimal amount of resources required in this sector is very important. Of course, this does not mean strengthening the economy's dependence on oil. Instead, it is a good ground for a gradual and targeted reduction of dependence on oil through the development of all economic sectors, including the oil industry as the leading economic advantage through the resources of oil revenues (Hanna, 2017).

On the other hand, the issue of joint oil and gas resources and fields between Iran and the countries of the southern Persian Gulf is of great importance (Mu, Wang, Yang, 2017).

Restrictions on access to domestic and international financial resources (mainly due to international sanctions and pressures), the increase in the capital costs of oil industry projects due to the sharp rise in the world prices in recent years, the reduction of the revenue share of the National Iranian Oil Company from the value of crude oil production and consequently the impossibility of using it in its development projects, and the legal issues in the country in the oil and gas sector have all made it possible to use only financing and cross-selling methods to use foreign capitals, highlighting the necessity of innovation in the field of oil and gas financing (Barison, 2020).

The Bank for International Settlement introduced three changes and innovations in the financial markets as the most influential factors influencing the market. These three innovations increase liquidity, transfer risk (price and credit), and generate revenue (from credits and stocks). Marketability, transferability, and liquidity increase liquidity by increasing the options available to market participants. Financial derivatives make markets more complete, increase social benefits, and reduce the transaction costs in the capital market. Financial development and innovations will positively impact economic growth in the long run (Kutzker, 2017; Salim, 2019).

The secondary markets in the Islamic financial system have not yet been developed. The lack of efficient secondary markets and liquidity in Islamic financial markets indirectly limit investors in choosing the complete structures. Due to the lack of liquidity, Islamic bankers cannot quickly expand their portfolio in the capital market and suffice with few opportunities to diversify the portfolio. Therefore, there is a fundamental need for fast cash instruments to meet the needs of investors looking for floating portfolios with minimal cost and those looking for long-term and medium-term maturity structures (Alan, 2018).

Risk management products for Islamic financial markets are still foreign, which does not mean that Islam does not recognize the need for risk management, but this is due to the little research done in this field. Indeed, Islam has a heavier duty for carefully identifying and sharing risk. The further growth of Islamic financial markets depends mainly on developing secondary markets and introducing innovative products to increase liquidity and risk management (Klasa et al., 2018).

One of the tools used to investigate, analyze, and evaluate financial instruments and contracts is agency theory. The opportunities and problems in the studied Sukuk can be extracted and evaluated using this theory. In recent years, many articles have addressed the issue of agency costs in various areas of the economy, including finance, and have made it operational (Ramalho, Rita, da Silva, 2018; Devereux, Maffini, Xing, 2018; Levine, Wu, 2020).

Financing is the application of economic principles and concepts in the decision-making of corporate management and solving their problems. This knowledge can be divided into three main parts: financial management, investment, and financial institutions. Project financing is a long-term borrowing method used in large projects based on financial engineering and borrowing against the cash flow generated by the project. It depends on a thorough and detailed evaluation of the

risks of construction, operation, and revenue of the project, and how they are distributed among investors, lenders, and other partners through contracts between them or other arrangements between stakeholders (Williams, 2015).

It is necessary to know the capital structure of National Gas Company, including gas refining companies, to determine its financing methods. According to the general financing pattern, the company has attracted the necessary financial resources through two financing channels from inside and outside the company. As the National Iranian Gas Company is a state-owned company, a part of its resources are provided through the government budget and revenues from the sale of gas. Hence, out-of-company financing with different financing methods through debt (bank facilities and capital market debt securities) should achieve the minimum possible cost of capital to achieve a suitable combination of the capital structure apart from the company's internal resources (Antonczyk, Salzmann, 2014).

However, the equity sector of this company is not very flexible, and financing through shares (capital increase) will not be possible. As it is clear from the titles, no research has been done on providing a suitable model for the optimal structure of capital using the domestic financial markets, and in this regard, this research has a high level of innovation and knowledge. Further, due to the insufficiency of financial resources used by the National Gas Company in meeting the financial needs of the company, including energy efficiency projects, it should look for other financing methods through domestic financial markets, taking into account its costs, and the necessary solutions should be provided.

Prioritizing the provision of resources to optimize the capital structure includes internal and external resources. Therefore, according to the specific conditions of the industry, priority is given to attracting domestic resources, including bank loans and the use of financial derivatives.

The internal research done so far in the field of capital structure has been designed based on the existing methods and using the conditions and capacities of the stock market. The present research in this field primarily considers the capital structure and does not provide a comprehensive understanding of the innovative methods and patterns of financing from the internal resources. Therefore, the present study tries to provide a basis for the optimal identification of new investment methods by comparing comprehensive features based on the domestic markets and existing vacancies to attract investors.

2. Background of the study

Mollanazeri et al. (2017) conducted a study entitled "Success and failure of companies accepted in the Tehran Stock Exchange with a financing approach". The research results indicate that the success and failure of companies are affected by the financing methods, and the increase in the capital more than the bank loans affects the success of companies (Malanzari, Hejazi, 2019).

In a study of the revenue structure of the municipalities in developing countries, Di Angelo et al. (2015) show that property tax is the essential type of local tax, and more than 130 countries in the world receive some types of it. This tax can serve the broader goals of the local accountability and provide an effective relationship between the municipal services and their financial resources closer together (DeAngel, Stulz, 2015).

Cummins et al. (2016) investigated the long-term profitability of the Taiwanese banks and concluded that profitability and gaining profit are affected by the banking services, banks' employees, and other essential factors in increasing the banks' profitability (Cummins, Weiss, 2016).

Hardwave et al. (2018) conducted a study entitled "Electricity project financing mainly construction project structure (BOT) and long-term contracts" and considered only one infrastructure part: energy. Structurally, the financing of the electricity project mainly includes the structure of the construction project (BOT) and long-term contracts. The result of this research is that the tendency of the companies to use project financing is very high and statistically significant (Bhardwaj, 2018).

Barrison et al. (2020) conclude in a theoretical analysis that variable return schemes such as partnership contracts contrast to the conventional contracts with a fixed return of optimal beam. Of course, Khan also points out that this result depends very much on the availability of information in the economy, and therefore, when there are costs to information symmetry, the second optimal partnership agreement will be the beam (Barison, 2020). Ramalho et al. (2018) present an evaluation of financing through the Mudaraba contract using scenario analysis assuming information asymmetry and conclude that for a borrower, financing with a Mudaraba contract is preferable to financing

through debt or stock in a risk-return analysis framework. For the investor facing three options, the Mudaraba contract is the most unfavorable (Ramalho, Rita, da Silva, 2018).

According to the presented research background indicating the lack of existing studies and an optimal model for financing gas refining companies, this work is knowledge-based and, in this regard, is innovative.

3. Methodology

The research method is mixed and quantitative, and qualitative methods have been used simultaneously. In this research, the status of each variable in the statistical

population is stated. Therefore, this research is descriptive. Due to the use of the questionnaire, the research can be considered a survey, and as this research is applicable, it is applied research.

3.1. Research execution algorithm

This research uses the Delphi method to identify financing methods. Then, the hierarchical analysis is used to determine the priorities, and after determining these weights, we prioritize the proposed options through the AHP method. Figure 1 shows the stages of doing the research and the Delphi method.
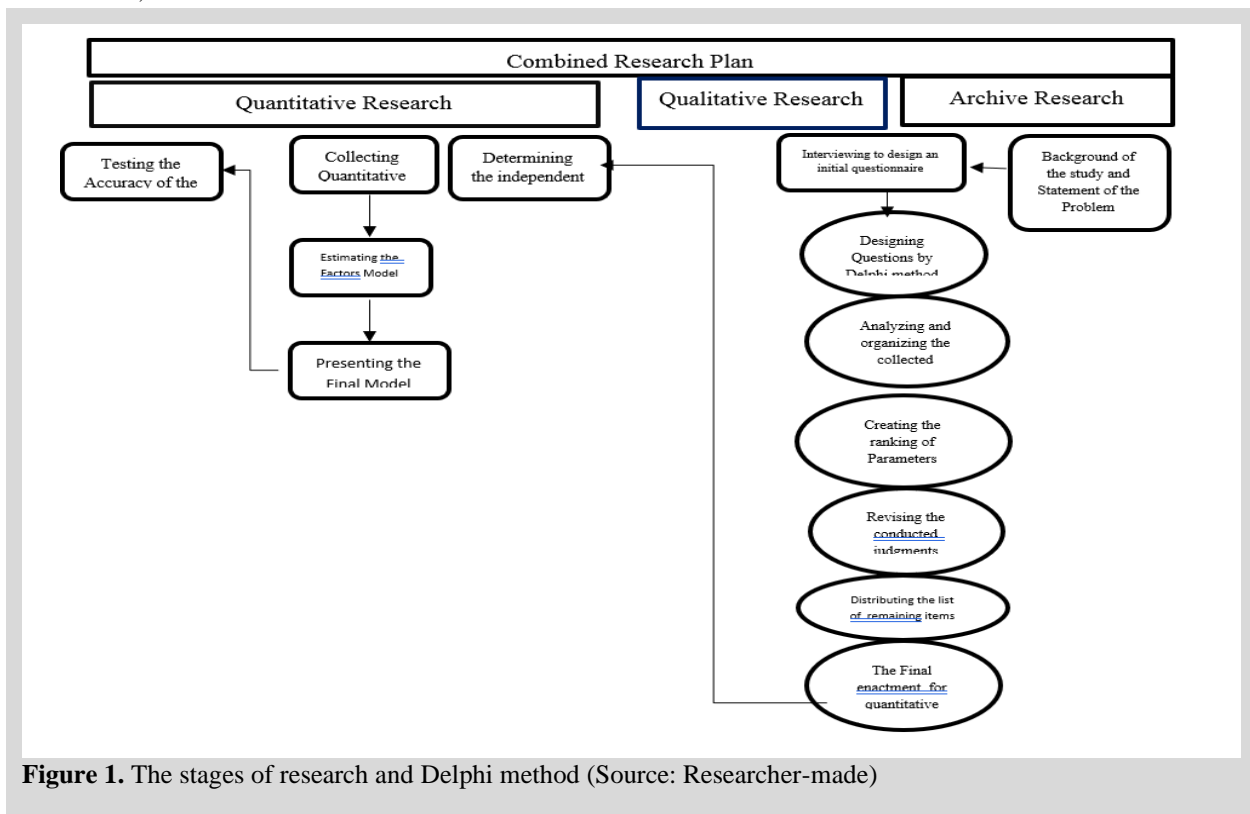

Figure 1. The stages of research and Delphi method (Source: Researcher-made)

In explaining the stages of research implementation, the following issues are raised:

1- Designing a primary questionnaire tool to determine the criteria for comparison with the cooperation and guidance of respected supervisors, advisors, and other experts and collecting information. According to the hierarchical model, a pairwise comparison questionnaire is designed in this section. Each option is compared in pairs in the paired questionnaire based on the components selected in the previous section.

2- Distributing the questionnaire. In this section, according to the purpose of the research, 30

questionnaires are distributed among experts in the statistical population. Before distributing the questionnaire, the researcher tries to give a detailed distribution of the data with the questionnaire matrix. Experts should inform individuals about the exact way of completing the questionnaire.

3.2. Executive research model

The conceptual model of this research is presented in Figure 3. The conceptual model of this research is presented using the control group method with the opinions of 10 experts and thinkers of the National Gas Company using focus groups as one of the methods of qualitative studies. The first series shows the purpose of

the research, and the second series shows the comparative factors; the third series shows the options being evaluated. Capabilities, it will be essential to note that many facts have not yet been revealed to researchers in this field. Now, it appears that the importance and necessity of this study become more evident by recognizing the factors affecting the promotion of dynamic capabilities to achieve a variety of dynamic capabilities following the chain environment and strategic requirements in supply chain management for gaining competitive advantages over competitors.
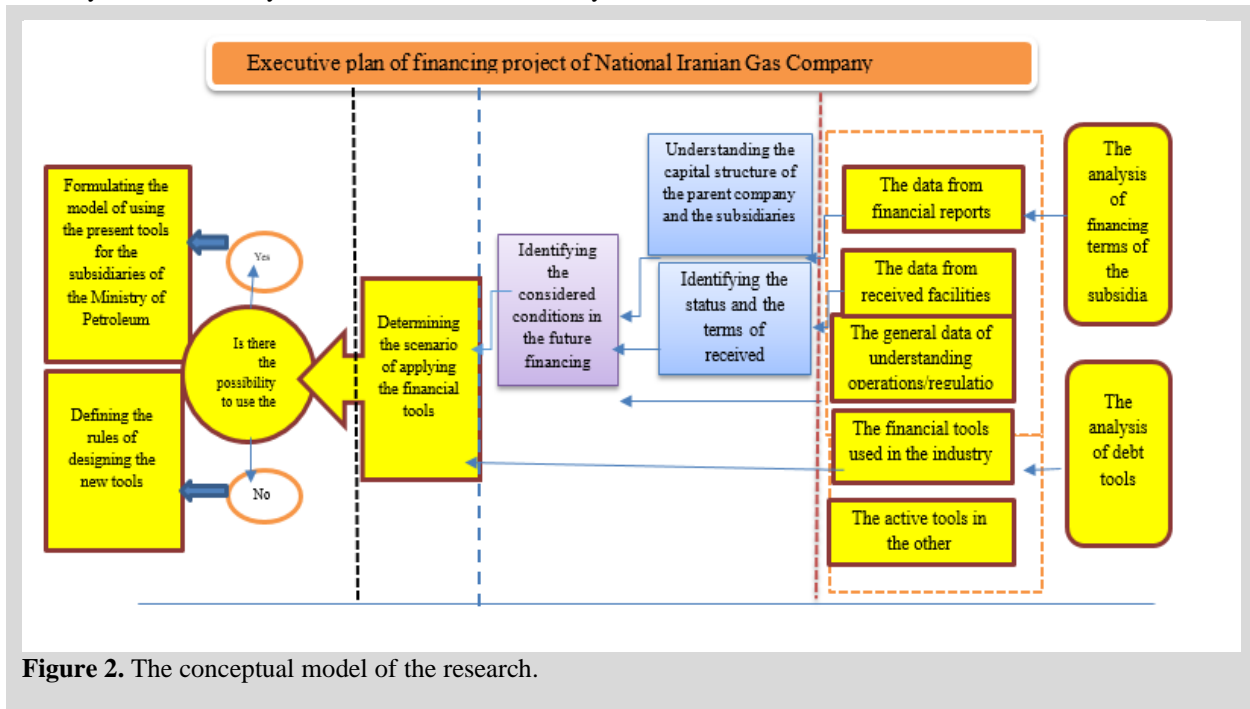

Figure 2. The conceptual model of the research.

The statistical population of this research is all knowledgeable managers and employees in finance. The selected experts must meet the following requirements:

- Have a relevant field of activity;
- Have at least one year of work experience;
- Be in direct contact with finance.

The size of the research population is 20 people.

In this research, the researchers, by referring to the professors and experts and using their opinions, have ensured the validity of measuring instruments in measuring the research variables. The compatibility rate of AHP questionnaires is used to confirm the reliability of the AHP questionnaire. If this rate is less than 0.1, the compatibility of the questionnaire is confirmed, and its data is reliable. The compatibility rate of the questionnaire is calculated to be 0.09, which is less than 0.1, indicating that the status of the questionnaire is appropriate.

3- Forming a matrix of pairwise comparisons using the respondents' opinions.

4- Entering the matrix of pairwise comparisons in the form of respondents' opinions in the software environment of hierarchical analysis and software execution.

5- Determining the status of the adaptation rate of research tools.

6- Forming the TOPSIS decision matrix.

7- Scaling the decision matrix using the softening method.

8- Multiplication of weights obtained from the hierarchical analysis stage.

9- Determining distances from ideals.

10- Prioritizing different sections in the form of options.

11- Presenting research results and practical suggestions according to the obtained results.

Considering that the research conducted with AHP is not based on statistical analysis, there is no need to determine the population and statistical sample in a specific sense. Cochran's sampling formula (Equation (1)) was used to determine the number of samples.

$$n = \frac{\frac{z^2 pd}{xd^2}}{1 + \frac{1}{N}(\frac{z^2 pq}{xd^2} - 1)} \qquad (1)$$

According to this formula and the number of 20 persons in the research population, the sample size

equals 20 persons. Therefore, the census method has been used to distribute the research tools. The compatibility rate of AHP questionnaires is used to confirm the reliability of the AHP questionnaire. If this rate is less than 0.1, the compatibility of the questionnaire is confirmed, and its data are reliable.
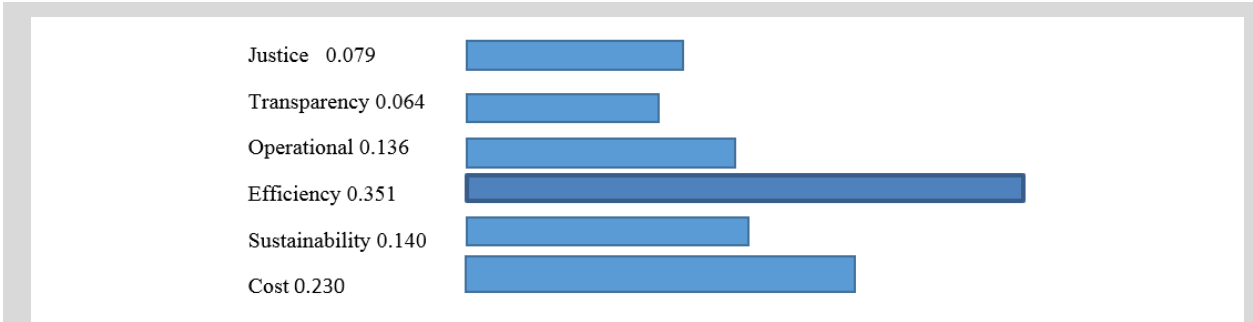

Figure 3. The questionnaire compatibility rate

Figure 3 demonstrates that the compatibility rate of the questionnaire is calculated at 0.09, which is smaller than the criterion of 0.1, indicating that the questionnaire status is appropriate.

4. Data analysis

4.1. Descriptive statistics

Most of the subjects are men, and 85% of the total sample are examined in this group. Women make up only 15% of the sample population, and 50% of the subjects are in the master's group. Further, 40% have a bachelor's degree, and 10% have a doctoral degree. Moreover, 45% of the people who make up the majority

of the sample group are middle-aged people between 30 to 50 years old, and 35% of people are under 30 years old; finally, 20% are over 50 years old. This age group is the lowest in the age component.

4.2. Fuzzy Delphi

Step 1: distributing the initial questionnaire

As the different characteristics of people affect their mental interpretations of the qualitative variables, the experts have answered the questions with the same mentality by defining the range of qualitative variables.

These variables are defined as fuzzy triangular numbers according to Table 1 and Figure 4.

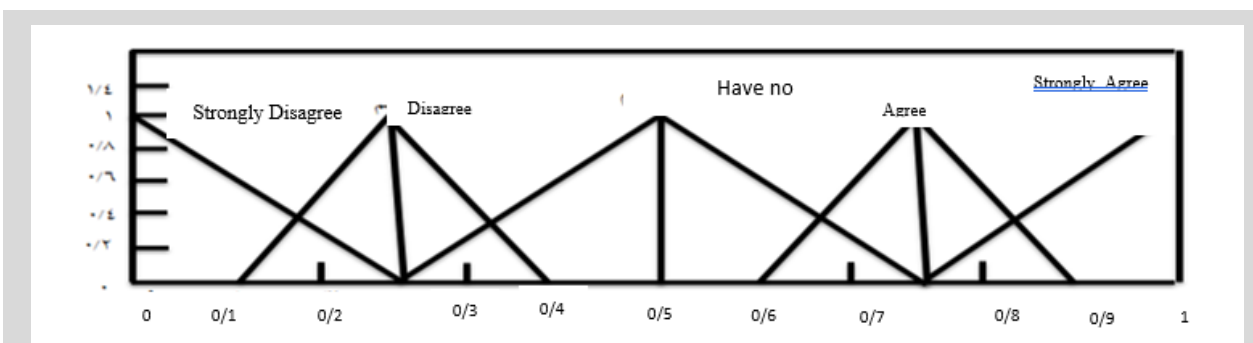**Figure 4**. The definition of language variables.

Table 1. Triangular fuzzy numbers of verbal variables.

Verbal variables	Triangular fuzzy number	Defined fuzzy number
Strongly agree	(0,0.25,1)	(0.9375)
Agree	(0.15,0.15,0.75)	(0.75)
Have no opinion	(0.25,0.25,0.5)	(0.5)
Disagree	(0.15,0.15,0.25)	(0.25)
Strongly disagree	(0.25,0,0)	(0.0625)

In the table above, the actual fuzzy numbers are calculated using the Minkowski formula as follows:

$$X = m + (B - a)/4 \qquad (1)$$

According to the results of this table, the fuzzy mean of each component is calculated according to the following equations:

$$A_i = \left(a_1^i, a_2^i, a_3^i\right) \qquad (2)$$

$$i = 1, 2, 3, \ldots, n$$

$$A_{ave} = (m_1, m_2, m_3)$$
$$= \left(\frac{1}{n}\sum_{i=1}^{n} a_1^i, \frac{1}{n}\sum_{i=1}^{n} a_2^i, \frac{1}{n}\sum_{i=1}^{n} a_3^i\right) \qquad (3)$$

In this regard, A_i represents the expert viewpoint of i and A_{ave} is the average viewpoint of the experts. The results of these calculations are presented in Table 5:

Table 2. Calculating the average opinion of experts obtained from the first survey.

Factor	m	α	β	De-fuzzy mean
Financing criteria				
Financing cost	0.89	0.21	0.07	0.85
The stability of financing method	0.83	0.20	0.10	0.80
The efficiency of financing method	0.80	0.23	0.11	0.77
Operational financing method	0.76	0.23	0.13	0.74
Financing transparency	0.85	0.21	0.09	0.82
Justice in the distribution of financial resources	0.88	0.22	0.07	0.84
The methods of financing				
Receiving facilities	0.84	0.20	0.10	0.81
The formation of sub-consortia	0.75	0.23	0.03	0.72
Creating a project as a project shareholder	0.95	0.23	0.03	0.90
Creating investment companies	0.61	0.23	0.20	0.61
The issuance of participation bonds	0.95	0.24	0.03	0.90
Attracting foreign capital	0.96	0.24	0.02	091
Presence in the securities market	0.88	0.23	0.07	0.83

In the table above, the triangular fuzzy mean is calculated using Equation (2) and is de-fuzzed using the Minkowski formula (Equation (1)). The obtained actual mean indicates the intensity of experts' agreement with each component of the conceptual research model.

Step 2: distributing the second version of the questionnaire

In this stage, after showing the results of the first questionnaire for each person, the elites were informed about the initial results of each question and the general answers of the people. Then, the second questionnaire was presented to the people. The fuzzy results of the studied options are also listed in Table 3:

Table 3. Calculating the average of experts' responses.

Factor	m	α	β	De-fuzzy mean
Financing criteria				
Financing cost	0.96	0.24	0.02	0.91
The stability of financing method	0.94	0.24	0.04	0.89
The efficiency of financing method	0.93	0.24	0.04	0.88
Operational financing method	0.94	0.24	0.04	0.89
Financing transparency	0.95	0.24	0.03	0.9
Justice in the distribution of financial resources	0.93	0.23	0.04	0.88

Factor	m	α	β	De-fuzzy mean
The methods of financing				
Receiving facilities	0.96	0.25	0.02	0.91
The formation of sub-consortia	0.98	0.24	0.02	0.92
Creating a project as a project shareholder	0.98	0.24	0.02	0.92
Creating investment companies	0.94	0.24	0.04	0.89
The issuance of participation bonds	0.99	0.25	0.01	0.093
Attracting foreign capital	0.99	0.25	0.01	0.93
Presence in the securities market	0.95	0.24	0.03	0.9

According to the views presented in the first stage and its comparison with the results of this stage, if the difference between the two stages is less than the too-small threshold, then the poll process stops.

$$S(A_{m2}, A_{m1}) = \frac{1}{3}[(a_{m21} + a_{m22} + a_{m23}) - (a_{m11} + a_{m12} + a_{m13})]$$

(4)

The average difference between experts' opinions in the first and second groups can be calculated by considering the above formula. The difference between the first and second stages is presented in Table 4:

Table 4. The difference in the de-fuzzy mean.

Factors	The de-fuzzy mean of the first stage	The de-fuzzy mean of the second stage	The difference between the mean of the two populations
Financing criteria			
Financing cost	0.91	0.85	0.06
The stability of financing method	0.89	0.80	0.09
The efficiency of financing method	0.88	0.77	0.11
Operational financing method	0.89	0.74	0.15
Financing transparency	0.90	0.82	0.08
Justice in the distribution of financial resources	0.88	0.84	0.04
The methods of financing			
Receiving facilities	0.91	0.81	0.10
The formation of sub-consortia	0.92	0.90	0.02
Creating a project as a project shareholder	0.92	0.90	0.02
Creating investment companies	0.89	0.61	0.28
The issuance of participation bonds	0.93	0.90	0.03
Attracting foreign capital	0.93	0.91	0.02
Presence in the securities market	0.90	0.83	0.07

As the table above shows, the expert group members have reached a consensus in most components, and the rate of disagreement in the first and second steps has been less than the low threshold (0.1). Thus, the survey on the above components has stopped. Moreover, in the third survey, the remaining variables are examined.

Step 3: Distributing the Third Version Questionnaire

The fuzzy results of the studied options are also presented in Table 5.

According to Equation (4), the difference between the experts' average opinions in the first and second groups can be calculated. The difference between the first and second stages is presented in Table 6.

Table 5. Calculating the average response of experts.

Factors	m	α	β	De-fuzzy mean
Financing criteria				
The efficiency of financing method	0.80	0.23	0.11	0.87
Operational financing method	0.76	0.23	0.13	0.85
The methods of financing				
Receiving facilities	0.84	0.20	0.10	0.84
Creating investment companies	0.61	0.23	0.20	0.84

Table 6. The difference in the de-fuzzy mean.

Factors	The me-fuzzy mean of the second stage	The de-fuzzy mean of the third stage	The difference between the mean of the two communities
Financing criteria			
The efficiency of financing method	0.88	0.87	0.01
Operational financing method	0.89	0.85	0.04
The methods of financing			
Receiving facilities	0.91	0.84	0.07
Creating investment companies	0.89	0.84	0.05

As the table above shows, the expert group members have reached a consensus in all components, and the rate of disagreement in the first and second stages has been less than the low threshold (0.1). Thus, the survey on the above components stops.

4.3. Components ranking section with hierarchy

a. Determining the weight of criteria

Firstly, in this section, the matrix table of respondents' opinions about the importance of the

studied variables is presented. The results of the average opinions of the respondents are presented in Table 7.

Then, attempts are made to examine the weight of the first level criteria using EXPERT CHOICE software and the data obtained from the hierarchical analysis questionnaire.

Table 7. Matrix of people's opinions about the criteria under review.

	Justice	Transparency	Operational	Efficiency	Stability	Cost
Justice		3.2	3.1	4.1	2.5	4.3
Transparency			2.2	2.3	3.2	3.2
operational				2.2	1.3	2.2
Efficiency					3.4	3.1
Stability						2.3
Cost						

Table 8. Ranking of criteria according to AHP.

Option	Weight of indicators	Ranking
Receiving facilities	0.87	2
The formation of sub-consortia	0.93	1
Creating a plan as a shareholder	0.22	6
Creating investment companies	0.60	4
The issuance of participation bonds	0.72	3
Attracting foreign capital	0.11	7
Presence in the securities market	0.33	5

According to Table 8, it can be stated that among the methods of financing, the formation of subsidiary consortia (0.93), receiving facilities with weight (0.87), the issuance of participation bonds with weight (0.72), creating investment companies (0.60), presence in the securities market (0.33), creating a shareholder plan (0.22), and finally attracting foreign capital (0.11) had the highest priority in sequence among financing methods.

5. Conclusions

The present study seeks to provide a model for optimal capital structure in the subsidiaries of the gas companies using the domestic financial markets. Based on the research findings, it was found that the factors of efficiency, cost, stability, operational, justice, and transparency have been the most important criteria for selecting financing methods in the subsidiaries of the Ministry of Petroleum. The formation of sub-consortia, receiving facilities, the issuance of participation bonds, creating investment companies, presence in the securities market, and creating a plan as a shareholder have been identified as financing methods. The results of this paper are in line with the research of Spitsin (2020), Codetzker (2017), DiAngelo (2015), Sean (2015), Alan (2018), and Barrison (2020).

As a result of identifying criteria and financing methods, it was found that the factors of efficiency, cost, sustainability, operational, justice, and transparency have been the most important criteria for selecting financing methods. The formation of sub-consortia, receiving facilities, the issuance of participation bonds, creating investment companies, presence in the securities market, creating a plan as a shareholder, and finally attracting foreign capital have been identified as financing methods. The results of this article are in line with the research of Spitsin (2020), Kutzker (2017), DeAngelo (2015), Synn (2015), Alan (2018), and Barison (2020).

The results of the criteria analysis showed that among the factors, the efficiency with a weight of 0.351, the cost with a weight of 0.230, sustainability with a weight of 0.140, operational with a weight of 0.136, justice with a weight of 0.079, and transparency with a weight of 0.064 have the highest and lowest weights in hierarchical analysis respectively. This section found that the efficiency of the financing method has been of great importance for the respondents. This study also showed that the transparency of the financing method in the surveyed companies to identify the appropriate financing

method has the least importance. The results of this article are in line with the research of Bhardwaj (2018), Ramalho (2018), Levine (2020), Cummins (2016), and Spitsin (2020).

The TOPSIS method has also been used to rank financing methods. The results of information analysis in this section showed that among the methods of financing, the formation of sub-consortia with a weight of 0.93, receiving facilities with a weight of 0.87, the issuance of participation bonds with a weight of 0.72, creating investment companies with a weight of 0.60, presence in the securities market with a weight of 0.33, creating a plan as a shareholder with a weight of 0.22, and finally attracting foreign capital with a weight of 0.00001 had the highest and lowest priority among the financing methods respectively. The results of this article are in line with the research of Gao (2017), Barison (2020), Salim (2019), and Sundaresan (2013).

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