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Investigating the Reasons behind the Failure of Iran's Gas Export through LNG Employing the Fuzzy Delphi Method

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Highlights

- This article investigates the most important reasons behind the failure of the LNG export projects of Iranincluding 'Iran LNG', 'Pars LNG', and 'Persian LNG' at a macroscale
- The most important reasons for these projects' failure ,include the effects of the factors, such as the role of financing, international sanctions, constraints of the domestic rules and regulations.
- Fuzzy Delphi method has been used to collect experts' opinions on this issue.

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Abstract

In the 2000s, some projects were defined to export Liquefied Natural Gas (LNG) in order to increase Iran's presence in gas export markets.

However, despite the initial planning until 2020, when this research was conducted, none led to a result, and Iran could not play a role in this market. Delay in executing these plans will lead to losing the opportunity to use the joint South Pars field and billions of dollars of foreign exchange earnings. The purpose of this study, which was conducted 2019 to 2020, is to identify the factors leading to the failure of Iran's LNG projects. In order to identify and prioritize these factors, the opinion of experts and the Fuzzy Delphi technique is employed .

Investigating the condition at the national and international level indicates that some factors have prevented all of these projects from being successful, including political issues, international sanctions on Iran, lack of domestic capital, lack of appropriate foundation for attracting foreign investors, constraints of domestic rules and regulations, especially in the upstream sector for choosing the contract format, not having access to the liquefaction technology, and the issues pertinent to marketing, and the most important one, lack of suitable commercial structural design. Identifying these factors and planning for tackling them is the key to escaping this current situation and a guide for prospering in future projects of the country.

Keywords: Foreign investment, Fuzzy delphi, Liquefaction technology, Sanctions, Upstream and downstream rules,

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1. Introduction

An increase in the rate of utilizing natural gas at the outlook of world energy has been confirmed by various reports, including BP Statistical Review of World Energy, and annual reports of International Global Union (IGU). With 16.1% of the natural gas resources, Iran is the second country with enormous gas reservoirs worldwide. However, with less than 1% of global gas exports, it lacks an appropriate place in the market. (BP Statistical Review of World Energy, 2020:34)

There are two common gas export procedures: 1- Exporting through pipelines and 2- conversion gas by liquefaction to LNG and Exporting by special ships. In the 2000s, as the exploitation of the South Pars field started, some plans were defined for production and annual export of more than 70-billion-ton LNG. These plans must have led to the annual exploitation and production of 35.5-billion-ton LNG through three plans, including 'Iran LNG', 'Pars LNG', and 'Persian LNG' by 2014. So far, nevertheless, none of these plans has led to the production of LNG. Their facility constructions have not also significantly proceeded. Unfortunately, Iran does not play a part in this market, and considering the current outlook, none of these plans will result in success at least a few years from now.

Around the world, various countries, such as Australia, the United States, Russia, are launching massive programs to produce LNG at great expense. (IGU Report, 2018). So that, global gas trade is increasing not only in terms of volume but also in terms of new suppliers and importers, mainly due to developments in LNG markets and low gas prices. and at least 260 (MTPA) of new liquefaction capacity between 2020 and 2030 are still expected to be available online, indicating confidence in the growth of medium-term LNG demand. The current situation and outlook for the gas market to 2025 are facing negative natural gas demand due to the arrival of 40 (BCM) of new LNG supply capacity and reduced demand in 2019; this resulted in unprecedented low price and production shut-ins. (Opedal,2020,23)

The importance of launching LNG projects in Iran will become apparent when we know that increasing the supply of LNG from large projects in other countries will saturate the global market and reduce the price of LNG. This can hurt the economy of Iranian projects. On the one hand, new competitors entering as LNG suppliers limit the target market and reduce the expected selling prices. On the other hand, the cost of building and operating these facilities has increased over time in recent years. (Songhurst, 2014). As an illustration, if the Iran LNG project had been exploited based on the plan in 2010, it would have made a profit of approximately $70B for the country during the last ten years. However, more than $10B should be paid as an extra cost for its construction due to increased costs.

Iran has a vast potential to emerge as an LNG supplier by the early 2040s and by 2050 will be among the top ten LNG producers worldwide. But first, the lifting of sanctions against the country and the attraction of foreign investment and technology must be considered. (GECF Global Gas Outlook 2050, 2020,83)

According to the GECF2020 forecast, Iran will not enter the LNG market earlier than the 2040s. If this prediction is correct, Iran will be recognized as an LNG exporter 40 years after the first LNG projects were defined in the 2000s. It also depends on solving problems such as lifting sanctions, attracting foreign investors, accessing technology, and other issues, which we will discuss in full in this study.

This article investigates the most important reasons behind the failure of the LNG export projects of Iran at a macroscale. As the central question of this research, we are to answer the question: what are the influential factors leading to the failure of the defined projects for gas export through LNG, including 'Iran LNG,' 'Pars LNG,' and 'Persian LNG'? To answer this, we accurately examine the conditions of the projects and gather the opinions of experts in the oil and gas industry to explore the influential criteria and sub-criteria by employing the Fuzzy Delphi technique.

Reviewing past projects and understanding their failure, move towards success in future projects. The need for a careful analysis of previous projects to remove future barriers is an undeniable necessity, which indicates the need for this research. The results can be used for policymakers in the country's energy sector, especially decision-makers in LNG contracts in the oil ministry.

This article will introduce and explain Iran's LNG plans After Literature Review. Afterward, we investigate the most important reasons for these projects' failure at the macroscale and the effects of the factors, such as the role of financing, international sanctions, constraints of the domestic rules and regulations. Then, we examine the results of gathering the experts' opinions in this field by employing the Fuzzy Delphi method. Ultimately, we present the results and proposals.

2 .Literature review

In a study conducted by KPMG GLOBAL ENERGY INSTITUTE in 2014 entitled: "Major LNG projects: Navigating the new terrain." By examining Canada LNG Projects, the United States, East Africa, and Australia Concluded. Successful projects will be those that can deliver on the fundamental value drivers under their control – to convince buyers, financiers, and investors that they can manage risks, deliver on time and be cost-competitive.While each jurisdiction has its challenges, winning projects everywhere can be defined by their ability to deliver on those drivers under their control: Capital efficiency, Timely project delivery, Securing long-term offtake agreements, Disciplined and robust processes, and systems. However, success is often elusive: Sophisticated risk management systems, Comprehensive planning and scheduling, Supply chain management as an integral part of the project, Proactive stakeholder management, Robust and disciplined processes, and procedures. (KPMG Global Energy Institute,2014)

In a 2014 study entitled "Uncertain Future of Australian LNG Projects: (Using Scenario Building in Strategic Management)," Bayzakova examines the possible reasons for the increase in costs and delays in Australian LNG projects. And by identifying common causes that increase costs and delays in projects Provides specific suggestions for minimizing problems. An analysis of six Australian LNG projects showed that the future is inherently uncertain, and even the most experienced and prominent companies may be in trouble. Internal and external factors affect projects' planning, decision-making, and execution stages. Global competition and the high focus on LNG projects have exacerbated existing challenges. It may be the reason for the rise in LNG prices in the future and studies the reasons behind these projects' failure. Though it is impossible to predict the exact cost and start dates of projects, especially in the long term, a scenario planning approach can help minimize cost overruns and delays by making strategic planning more flexible and transparen. (Bayzakova,2014)

In another study conducted by colombo et al., Entitled the Future of Natural Gas. Markets and Geopolitics show that Iran lacks financial resources and technology to develop its export LNG potential due to sanctions imposed by the international community. If these sanctions are removed, there will be increasing attention from the international community to Iran as a potential net gas exporter.

The realization of its vast gas resource potential for exports to international markets, however, depends on a set of factors: firstly, its domestic gas market is heavily subsidized; therefore, there is much

wasteful consumption. And even with vast gas resources, Iran relies on imports, particularly during winter months when residential space-heating demand peaks due to colder weather. Second, the country needs significant financial resources to develop its gas export potential, which is a difficult task, even with the lifting of sanctions.On the other hand, the attraction of foreign financial resources depends on the terms and conditions of the proposed new oil contract, which is an and new unknown structure. (Colombo et al. 2016: 59)

Studies such as "Study of LNG projects in Iran" by Adibi describe and review the projects defined until 2007 and conclude that the slow pace of work is due to lack of proper planning and financial and technical problems, which causes the loss of the opportunity to exploit the common source of South Pars. (Adibi,2003)

In another study entitled "Economic Study of Liquefied Natural Gas (LNG) Production for Iran" conducted by Khalili Iraqi et al. In which the implementation of liquefied natural gas (LNG) production project has been introduced as one of the most suitable ways to export natural gas to Iran. And the results of the research show that the implementation of liquefaction projects in Iran is quite economical and has favorable profitability and a high internal rate of return.

A vast majority of the studies conducted on LNG in the country date back to the 2000s, when defining and designing LNG projects were the center of attention.

The review of previous studies shows that no complete survey of the conditions and problems of Iranian LNG projects has been done, especially using the fuzzy Delphi technique. The innovation of the present study is related to the comprehensive review of all the conditions of LNG projects that have not been studied in the country so far.

2.1 .LNG plans and the condition of Iran at the LNG market

The LNG markets are the combination of different and various activities that mainly include the following steps :

1 -The upstream sector: Including the exploration and extraction operations and development of gas reserves and gas transmission

2 -Liquefaction facilities: These facilities are responsible for the gas conversion to LNG at minus161 degrees Celsius through a unique process, accounting for 25 to 35% of the project’s total costs .

3 -Transmission of LNG to the consumption locations by special ships

4 -LNG receiving and regasification terminal (Wang,Notteboom, 2011: 134)

A successful LNG project involves bringing together a chain of activities to link the gas production to the gas user. The main links in the LNG supply chain are: upstream (gas production), liquefaction, shipping, and the regasification of the LNG for distribution to end-users. Each link in the chain depends on the others since a failure in one connection may halt or impair the delivery of the LNG until the problem is overcome. (Rahimi, Razdan, 2007)

National Iranian Oil Company (NIOC) defined six plans aiming at producing an annual amount of 70-billion-ton LNG until 2015 to enter the LNG market (show in Table 1)

If these plans were executed based on the schedule, Iran would be one of the largest world LNG exporters. Because of the reasons explained in the following, however, the construction of these plans faced failur .

Table 1

NIOC LNG plan projects

	Project Name	Project Objectives MT/y	year	Ownership	Feed & Field
1	'IRAN LNG'	10/8	2010	NIGEC representing NIOC (%49), Investment of Pension Fund, Saving and Welfare of Oil industry staff Co (%1) Pension Fund, Saving and Welfare of Oil industry (%49)	South Pars Phase 12
2	'PARS LNG'	10	2010	NEGEC representing NIOC (%50) Total Co (%40) Petronas (%10)	Phase 11 of South Pars Gas Field
3	'PERSIAN LNG'	16/2	2014	NIGEC representing NIOC (%50) Shell Co (%25) RepsolCo (%25)	Phase 13.14 of south Pars Gas Field
4	North Pars LNG	20		Chinese CINOOK %100 investment	North Pars gas field
5	Golshan & Ferdowsi LNG	10		Malaysian Pertofild %100 investment	Golshan & Ferdowsi gas fields
6	QeshmLNG	3 up3/5		Australian companies	

(Omidvar, 2007: 70), (Adibi,2003,45)

3. Theoretical Foundations

3.1. The most critical factors in the failure of the LNG projects

Due to the particular condition and wide range of activities in LNG projects, various subjects must be taken into account. The essential factors at the macroscale view, including the following issues, will be discussed.

The following subject will fully be explained, including the required technology; financing, political issues, international sanctions, the constraints due to domestic rules and regulation, and the role of structures and their impact on the LNG projects.

3.1.1. Technology and its impact on Iran's LNG projects

The increase in the LNG part in the world's compound of consumed energy has motivated the large European and American countries to cooperate in these projects. However, this technology is merely monopolized by six licensed companies†. Due to the planning for supplying required gas in these

†Companies with liquefaction technology include: 1-Air Product 2-Phillips3-Statoil/Linde4-Shell5-Axens6-Black & Veatch

projects from phases 11, 12 and 13 of South Pars gas field and by considering the extent of huge reserved gas in this field, there is no doubt regarding supplying the volume of gas required for the 'Iran LNG', 'Pars LNG', and 'Persian LNG' projects. The capability and minimum technology required for the development and exploitation of these phases are available despite the financial problems in the country, and there is no limitation for the LNG projects in this regard. Nevertheless, in order to convert gas to a liquid, liquefaction technology must be available, which is not available in the country. Most of the LNG facilities employ the developed technology by the United States' companies that could prevent Iran's advancements (Saxton, 2006). However, three leading un-American technologies for the ''Persian LNG'':Double Mixed Refrigerant Process (DMR) technology by shell company ,for ''Pars LNG'': Liquefine technology by Axens company and for ''Iran LNG'': LNG technology are designed by the Linde company. (Rahimi, 2007).

3.1.2. Financing and its effect on Iran LNG projects

Although financing from domestic resources is more accessible and inexpensive than the others, but forthese projects are not enough. Preparing capital in such projects requires a perspective beyond the national petroleum resources in Iran. Due to the need for the LNG projects for huge investments, most of the financiers do not finance such projects without making sure of a constant revenue flow for return on investment (Ebrahimi, Danaei,2017). Although the financing expression includes a broad spectrum of methods, in most LNG projects, project financing is used as the main choice (Office of the Federal Coordinator, 2013). Such being a case can create different benefits in terms of allocating risk between the lenders and political demands regarding financing for borrowers (Griffin, Boyle, 2008).The mentioned issues are not paid as much attention in designing the 'Iran LNG' project , which were supposed to be implemented with the National Iranian Oil Company's total domestic investment and contribution. Also, financing this project did not take place due to the inappropriate design and significant volume of required investment.‡. In this regard, despite spending more than $2.5 billion and 45% of progress so far, this project has not achieved any results(Iran Liquefied Natural Gas Co, 2016). Under the current circumstance, the initial estimations regarding the project's costs have not been reliable due to being prolonged, resulting in an increase in global prices.§In this case, for the project to proceed, there are much higher costs rather than the time of initial design. In order to proceed, we should definitely get foreign financing for this project. The Persian and 'Pars LNG' projects designed by the contribution of the foreign parties were ceased before the financing steps due to some reasons, such as international sanctions (even though they had a more appropriate financial structure than 'Iran LNG').

3.1.3. International sanctions and their effect on Iran LNG projects

The sanctions against the government are actions violating international law. They are designed to compel the government to obey those laws (Marks, 1999). These sanctions are imposed on Iran in different ways as follows.

- Sanctions of United Nations Security Council: By the condemnation of Iran's nuclear program according to the Security Council resolutions, the nuclear issue of Iran captured international

‡ According to the initial design of the Iran LNG financing, it should have been performed by the National Iranian Oil Company.

§ The cost of constructing liquefaction facilities was between 400-700 dollars per ton from 2005 to 2010. This price has increased to approximately 700-1400 dollars from 2010 to 2015. (Songhurst, 2014)

attention**. In addition to imposing new sanctions, these resolutions provided a new legislative framework to the US and Europe to aggravate their sanctions against Iran (Katzman, 2009).

European Union Sanctions: They include the sanctions on buying oil from Iran, suspending the central bank's properties, and sanctions on SWIFT Banking, prohibition of banking transactions, and prohibition of Iran gas imports and heavy metals exports (Bassiri Tabrizi & Ruth Hanau, 2012). After a while, the other countries joined the sanctions against buying oil from Iran.

The unilateral sanctions of the US imposed due to different reasons, like the nuclear issue, are indicated in the following (in the Oil and Gas section) (Manzoor, Mostafapour, 2013)

One of the first steps of the US to impose sanctions against the energy section was confining the international companies' investment in the Oil Industry of Iran. In addition to imposing an investment limit on the oil and gas industry, the US deprived Iran of borrowing long-term loans by exerting its influence on World Bank and International Monetary Fund. Besides, the forces on private banks to cease the cooperation with Iran, aiming to prevent allocating governmental credits between the government and Iranian companies, have led to an ambiguous picture of the foreign investment in the oil and gas industry of the country. Such being a case, the foreign companies and international banks stop their collaboration with Iran in financing its energy-related projects. By the aggravation of the sanctions against the oil section and the threats of the US, several companies were forced to quit oil and gas projects in Iran or committed to stopping cooperation in a determined time horizon (Berkashli, Sayadi, 2012).

Although in the initial version of the sanctions by ISA††, there is no direct mention of the LNG projects, in the last amendments of CISADA‡‡, the LNG projects have been particularly emphasized. In this case, investment in these projects, like supplying LNG and the required equipment of this industry, such as liquefaction facilities, LNG transportation ships, and tankers, etc., have been subject to the sanctions (Katzman, 2017). Accordingly, thanks to the sanctions and huge international oil companies' withdrawal, Iran's LNG projects have been restricted. By withdrawal of the foreign parties, the 'Persian' and 'Pars LNG' projects were ceased, 'Iran LNG' was left half-done, and other proposed plans encountered the same destiny.

3.1.4. The national regulation's restrictions and its effect on LNG projects

Regarding the LNG supply chain, one of the important parts is the legal issues and the governing rules over these sectors. Such being a case, in the upstream sector and liquefaction facilities, the country's regulations that owns the reservoir are in force. In the transportation with ships sector, Incoterms' international laws and regulations, and in the country receiving the LNG, the destination rules are in force. The supply chain of LNG can include various contracts, such as those related to the exploration, development, and production from gas fields, the liquefaction facilities construction contracts, transportation contracts, and those of regasification. Our country faces contracts related to the exploration, development, and production from gas fields in the production and preparation of the gas to deliver to the liquefaction facilities. Then, we should deal with the contracts pertinent to the liquefaction facilities.

** These resolutions include: 1696 on June 2006, 1737 on Dec 2006, 1747 on March 2007, 1803 on March 2008, 1835 on Sept 2008, and 1929 on June 2010.

†† Iran Sanctions Acts (ISA)

‡‡Comprehensive Iran Sanctions, Accountability, and Divestment Act (CISADA)

3.1.5. The allowed Iran Petroleum Contracts

Article 3 of the Iranian oil law of 1974 provides in paragraph 3 that regarding the downstream activities, the National Iranian Oil Company is allowed to take any action with the cooperation of each foreign or national individual in order to create refinery and perform oil refining operations. Therefore, the form of productions sharing agreementscan only be carried out in the downstream operations of the oil. Also, foreign contribution and investment were prohibited in the upstream operations. However, using the international companies' services as contracting turned out to be allowed.§§. The allowed contracts are introduced in different sectors, such as the oil law, general policies of article 44, the five-year development plan law, the annual budget law as follows.

According to article 1 of the oil law of 1974, a Contractor Agreement or Service Contractis a contract whereby the contract parties are responsible for executing some petroleum operations in a determined region by the National Iranian Oil Company with its name based on the regulations of this law. The oil law of 1987 has prohibited foreign investment in petroleum operations. However, generally, without mentioning a particular type of petroleum contract, it has allowed concluding any petroleum contract.

According to the third paragraph of Article 3 of general policies of investment law 44, the property right and management in the oil and gas mines are monopolized by the government. According to Article 125 of the fifth development plan, the Ministry of Petroleum can deploy various contract methods to explore, develop, and produce petroleum. In paragraph 3 of Article 125, the Ministry of Petroleum is allowed to accomplish the fifth plan's objectives in producing oil and gas using the Buy-Back agreement method. (Shiravi, 2011).

In most LNG projects worldwide, the related activities to the exploration and production in the gas fields are performed in an integrated structure by using the production sharing contract. However, this method is prohibited in our country, and merely the Buy-Back agreement is acceptable. Nevertheless, the experience of using Buy-Back in the last years has demonstrated that this method is not attractive to international companies enough. Besides, there is a doubt regarding its efficiency in accomplishing the goals of the country. According to the authors of this study, confining the many types of contract by a particular method, such as the Buy-Back method, for a country like Iran enjoying abundant oil and gas resources will not have any accomplishments but losing the development chance and taking advantage of the resources, especially in joint fields. The part in the success of each contract is to increase the domestic knowledge, skills, tools, techniques, and strength for managing the conditions. Suppose a specialized workforce with a scientific and empirical background is trained not only in the technical and engineering fields but also in all required areas. In that case, they can avert any abuse by the contract parties due to the Iranian party's lack of knowledge and inability. In this case, they can also use any contract forms to satisfy the country's demands and obtain the benefits as possible. Therefore, the confinements caused by the national laws for using the methods such as production sharing contract in the upstream sectors has led to the fact that huge international contractors are not attracted to conclude a contract in LNG projects. In addition to the foreign confinements, the restrictions of the national law have also aggravated the project's situation.

4. Methodology

§§ Paragraph (1) of Article 3 of the oil law of 1974 indicates that the oil resources and industry are national and exercising the Iranian people's property rights over the oil resources of Iran in the realm of exploration, development, production, exploitation, and distribution of oil all over the country and the continental shelf is monopolized to National Iranian Oil Company. In this case, it can take action directly or via its representatives and contractors.

4.1. Using the fuzzy delphi method to examine the reasons for LNG projects failure

This research is applied in terms of purpose classification and mixed approach. Mixed research is a method in which a researcher or a team of researchers combines quantitative and qualitative components and approaches to reveal the existing obstacles in research and a profound understanding of the phenomenon.(Burke Johnson & Onwuegbuzie, 2007). Concerning the simultaneous use of the qualitative and quantitative collection techniques and data analysis methods, this research is conducted using the mixed method.

The researcher's mental paradigm is the constructivist paradigm because the information available on the research subject was not so that a theory could be presented at the beginning. The theory is given after the study, and the results are based on the participants' mental opinions.

To choose the decision-making criteria, there is no specific method, and generally, the subject literature is used in different researches. These criteria are determined based on the subject of the research and the researcher's viewpoint. Concerning the explanations indicated in the previous section, five main criteria and 25 sub-criteria were identified. These items are the basis of preparing the Fuzzy Delphi questionnaire, screened based on the participants' viewpoint. (Table 2)

4.2. Data analysis method

The Fuzzy Delphi method became popular due to determining the decision-making criteria in the early 1950s to examine experts' viewpoints. In the 1960s, this method was confirmed as a scientific method, and day by day, the Delphi method's applications increased for the expert's judgment. This method is a process leading to the solution of complex problems without a face to face communication by collective unanimity, not personal. This important issue becomes feasible by a set of questionnaires along with controlled feedback(Manoliadis, Pantouvakis, & Christodoulou, 2009). The oral statements and expressions, like "higher," might have different meanings for any individual. Therefore, using fuzzy logic can overcome such linguistic constraints and ambiguous interpretations and statements (Habibi, Firouzi Jahantigh, & Sarafrazi, 2015). The single-level Fuzzy Delphi has been utilized in various investigations. Ishikava (1993) demonstrated that using the minimum-maximum technique and also fuzzy aggregation can eliminate the Delphi steps, achieving a desired and valid result. (Duru, Bulut, & Yoshida, 2012)

Regarding the advantages of the Fuzzy Delphi compared to the conventional Delphi method, Kamarulzaman states that by employing the fuzzy numbers and Delphi technique, the Delphi steps are decreased. In one step, the expected results are obtained(Kamarulzaman, Jomhari, Raus, & Mohd Yusof, 2015).

Since in fuzzy Delphi method, the dimensions of components and criteria are determined based on the judgment and opinions of experts, Therefore, the less critical criteria are removed from the model, and the essential criteria remain in the model; In other words, in this method, reliability as done in quantitative research will not be significant.

The validity of the results in fuzzy Delphi methods depends on the competence and expertise of the participants in studying and answering the questionnaires.(Carlucci, Schiuma,2009)

And on the other hand, the results obtained by using the technique of getting accurate parallel information do not contradict similar cases, so the validity of the results is confirmed.

The fuzzy Delphi used in this investigation includes the steps as follows. Identifying a suitable spectrum for fuzzification of the participants' statements: the fuzzy triangular numbers with five scales and the triangular membership function are employed in this section. (Equation 1)

Fuzzy values' fuzzy aggregation: After collecting the participants' viewpoints, these comments must be fuzzy and aggregated in the next step. Out of 39 submitted questionnaires, 16 were completed by the experts of the petroleum industry and academia. According to the participants' responses and choosing the importance degree of each linguistic variable, these variables have been demonstrated by corresponding fuzzy numbers.

Defuzzification: After the fuzzy aggregation of the participants' viewpoints, the obtained values must be defuzzy. There are various methods for defuzzification, including a simple average of fuzzy triangular numbers, the center of gravity (COG), the center of the area (COA), and the average of the maximum. (Habibi, FirouziJahantigh, & Sarafrazi, 2015)

In this article, the method below is used for fuzzification (Equation 2):

$$l_i = min(l_{ij})$$
$$m_j = \sqrt[n]{\prod_{i=1,j=1}^{n.m} m_{ij}} \quad (1)$$
$$u_j = max(u_{ij})$$

$$Df_i = \frac{l_j + 2m_j + u_j}{4} \quad (2)$$

Choosing the threshold and the screening criteria: After choosing the suitable method and defuzzification from the values, a threshold (α) should be considered for screening factors to accept or decline the criterion (iS). In such screening:

If α ≤ iS, then the criterion is accepted. If α > iS, then the criterion is declined (eliminated).

This threshold is determined by the mental inference of the researcher, affecting the number of selected criteria. There is not any general rule for determining the threshold value. According to Pareto's 20-80 rule, most researchers consider the threshold 80 percent (Chen & Wang, 2010). In this study, by modeling the recent investigations and according to Pareto's rule, the threshold is considered 80%; it means that the number 7 is considered as a threshold for rejecting or accepting the criteria. Accordingly, a number of criteria with values below the threshold are eliminated.

Table 2

The screening results of the criteria and sub-criteria in the fuzzy Delphi (findings)

Rate	Result	Defuzzification	Fuzzy average	criteria and sub-criteria	Row	
5	Accept	7.7	(5,7.8,10)	liquefaction technology	C1	1
7	Accept	7.4	(5,5.7,10)	inaccessibility to the liquefaction technology	C11	2
20	Reject	4.7	(5,5.7,10)	impossibility of transferring the technology to the domestic companies	C12	3
2	Accept	7.7	(5,7.8,10)	financial and economic issues	C2	4
21	Reject	4.7	(0,5,9)	the need for higher investment for LNG	C21	5
9	Accept	7.4	(5,7.4,10)	not providing the required capital for the projects	C22	6
18	Reject	5.2	(0,5.8,9)	the lack of national resources for the LNG projects	C23	7

29	Reject	3.2	(0,3,7)	the constraints of the global conditions in gaining capital from foreign resources	C24	8
13	Accept	7.3	(5,7.2,10)	Inappropriate methods of financing available for projects	C25	9
8	Accept	7.4	(5,7.4,10)	higher investment risk in Iran	C26	10
1	Accept	7.9	(5,8.3,10)	political issues and sanctions	C3	11
16	Accept	7	(3,7.6,10)	constraints caused by the sanctions in attracting the technology	C31	12
3	Accept	7.7	(5,7.8,10)	constraints caused by the sanctions in attracting foreign investors	C32	13
10	Accept	7.4	(5,7.4,10)	constraints caused by the sanctions for the presence foreign companies	C33	14
22	Reject	4.5	(0,4.5,9)	constraints caused by the sanctions in marine transportation	C34	15
30	Reject	3.2	(0,3,7)	regional negotiations and competition with other producers	C35	16
4	Accept	7.9	(5,8.3,10)	national laws and regulations	C4	17
17	Accept	7	(3,7.6,10)	legislative constraints in the upstream sectors	C41	18
11	Accept	7.4	(5,7.4,10)	legislative constraints in the integrated structure	C42	19
6	Accept	7.5	(5,7.6,10)	legislative restrictions of the production sharing in the upstream sector,	C43	20
27	Reject	3.8	(1,3,7)	legislative constraints in the downstream sectors	C44	21
12	Accept	7.4	(5,7.4,10)	legislative constraints in attracting foreign investors	C45	22
28	Reject	3.4	(0,7.6,10)	legislative constraints in attracting specialized foreign workforce	C46	23
15	Accept	7	(3,7.6,10)	structure and marketing	C5	24
14	Accept	7.3	(5,7.2,10)	legislative constraints in the integrated structure for use the liquefaction technology	C51	25
25	Reject	3.9	(1,3.8,7)	not paying attention to the importance and position of the LNG	C52	26
19	Reject	4.7	(1,4.5,9)	not being acquainted with these contracts	C53	27
24	Reject	4.1	(1,4.3,7)	not being specified responsible of the LNG projects	C54	28
23	Reject	4.1	(1,4.3,7)	higher gas consumption rate in the country	C55	29
26	Reject	3.9	(1,3.8,7)	Restrictions on finding foreign customers	C56	30

With respect to the obtained results from the fuzzy Delphi method, it can be seen that the indicated points in the following have the most influence in the failure of the LNG projects, respectively.

1- political issues and sanctions

2- financial and economic issues for financing and the related problems

3- the national laws and regulations and the constraints in using the production sharing method

4- problems in providing technology

5- structure and marketing

Regarding the sub-criteria, some of the options like constraints caused by the sanctions in attracting foreign investors, legislative restrictions of the production sharing in the upstream sector, inaccessibility to the liquefaction technology, higher investment risk in Iran, not providing the required capital for the projects, and the constraints caused by the sanctions are of paramount importance for foreign companies presence. The sub-criteria of the impossibility of transferring the technology to the domestic companies, the need for higher investment for LNG, the lack of national resources for the LNG projects, the constraints of the global conditions in gaining capital from foreign resources, the constraints caused by the sanctions in marine transportation, regional negotiations and competition with other producers, legislative constraints in the downstream sectors, legislative constraints in attracting specialized foreign workforce, not paying attention to the importance and position of the LNG projects, not being acquainted with these contracts, not being specified responsible of the LNG projects, , higher gas consumption rate in the country has been recognized to lack the sufficient impact on the failure of the projects.

5. Strategies for diminishing the existing constraints

According to the authors, in order to overcome the existing problems, we can take the actions in the following. In order to provide the technology, we can choose credible foreign companies taking advantage of liquefaction technology as partners. Also, we can make them the main shareholders in a huge part of the project in addition to the liquefaction facilities, like upstream sectors. In this case, by a more expected profit, an incentive is provided for them to be convinced to participate in this project.

For the investors' contribution to these projects, the most important factor is making sure of the return on capital and stability of the investable country in terms of political and economic issues and related laws. One of the ways to ensure the foreign investors about maintaining their capital is choosing some of contracting methods providing the possibility of long-term contribution, being shareholders in the upstream sectors for the investors. In this case, it would ensure return of investment and their expected profit. Regarding our country, we should use the contracting methods capable of compensating for the required stability of the investors. Using the methods such as production sharing for the upstream sector and integrated structures would be beneficial.

One of the important reasons for projects' failure is the sanctions. The western countries, especially the US, make drastic efforts to prevent Iran from achieving the LNG projects. Because in case Iran becomes a member of the LNG exporters club, in addition to the oil export in the global markets, it accomplishes another vital part of the energy export. However, if these facilities are not constructed, Iran will be deprived of further influence on the energy export markets. Accordingly, the LNG facilities construction should not be considered a single-faceted project for exporting the gas, because in terms of geopolitical situations, prosperity in such plans can enhance Iran's influence over the global energy markets and more participation there. In order to mitigate the effect of the sanctions, we can create more attractive conditions for the technology owners and the LNG industry investors. By making changes in the structure of the projects, they will be encouraged to neglect the constraints due to the sanctions.

6. Conclusion and Suggestions

Despite defining the projects for exporting the gas via LNG in recent years, none of the plans with the export goal of more than 70 million tons per year LNG has achieved any results. The most important factors in the failure of these projects on a macro scale are explained as follows:

Not having access to liquefaction technology has caused all of the LNG projects defined in the country to fail.

Given that all of these projects require huge volume of financial resources, coordination between the financing conditions and the particular situation of each project, and laying the suitable foundation via estimating the needs for the lenders' group are important factors in the development of the general structure of the project. Designing the financing structure of the LNG projects is one of the important and strategic decisions in starting a project. In the case of inaccuracy and improper design, the project will encounter failure.

The effect of international sanctions on the Iran LNG projects includes the following. First, the technology merely belongs to several American and European companies, and due to the sanctions, all of them have been unwilling to provide their technology to Iran's projects. Second, due to the restrictions of the sanctions for the maximum investment in the projects and increase in the investment risk in Iran, none of the investors are interested in financing the project; the international financial institutions also restrict financing. Third, the big international companies refuse to participate in Iran LNG projects concerning the pressures and intimidation. In the constraints due to the national laws, the LNG projects encounter two groups of rules. The first group is the laws related to the upstream sectors. There is no possibility of using the concession contracts or production sharing contracts for exploiting these fields. The only allowed method of the policy-makers is using the service contract methods or Buy-Back domestic procedure.

Regarding the downstream sector comprising liquefaction facilities, they have a great deal of freedom according to the Ministry of Petroleum's laws and the dependent companies. They can get investment licenses or conclude required contracts, and there is no constraint regarding the LNG projects in this case. Despite most LNG projects worldwide using the production sharing contract in upstream, the national laws have prohibited the possibility of using this method. This has led to the fact that the projects are not interesting enough for foreign investors. Many investment limitations in Iran, including political issues, international sanctions, high risks, inappropriate credit rates, and limiting rules and regulations, will discourage the contracts in the form of Buy-Back for the LNG projects requiring a great deal of investment and long term presence. Although the relevant authorities have always emphasized these sanctions as the only reason behind the failure of these projects.

However, our investigations indicate that despite the undeniable role that sanctions play in the failure of the projects, these kinds of assumptions are somehow naiveness and weak explanations that underestimate the weaknesses, including lack of adequate knowledge into these projects and structural design that is suitable for achieving the technology and required financing due to the limiting domestic regulations and rules in executing the LNG projects. With a broader perspective at the macroscale, the major reason behind these problems is misuse and not choosing a suitable commercial structure for the projects, which laid a foundation for strengthening these problems. Indeed, the major reason for the failure of these projects is the limitations imposed by rules that exist in the country for selection of the contractual form, especially in the upstream sector, such that the only option is the Buy-Back contract which does not motivate international energy companies. The most important solution to these problems is employing structures that allow more participation for international companies. Employing an integrated structure and the methodof production sharing for the upstream sector can lay a foundation for attracting the valid international companies for the financing and supply of technology required for these projects along with avoiding tension, the effective connection with the global community, and lifting sanctions for exploiting from the projects. According to the results obtained by the Fuzzy Delphi methods, it can be seen that from the expert’s perspective, the following criteria, respectively, have the greatest impact on the failure of LNG projects:

1-political issues and sanctions. 2-Financial and economic issues in the financing and the relevant problems. 3-Domestic rules and regulations and limitation in employing the participation method in production. 4-The problems in technology supply. 5- The structure and marketing

Finally according to since a great deal of time has passed from concluding the 'Persian LNG' and Pars LNG contracts, it seems that it is not possible to employ them anymore. Therefore, by reforming the structure, we must look for new projects that are lesser subject to the mentioned limitations. In the 'Iran LNG' project, it is essential for the project to continue by reforming the structure, attracting valid international companies with technology, and capturing foreign investors interest.

References

Adibi, S. "An analysis on LNG plans in Iran" Economy of Energy, (2003), No.99, pp. 43-48(in Persian)

BassiriTabrizi, Aniseh; Ruth Hanau Santini (2012), "EU Sanctions against Iran: new wine in old bottles?" ISPI – Analysis, No97

BP Statistical Review of World Energy, 2018: www.bp.com/content/Energy-Outlook-2018-edition-Booklet.pdf.

BP Statistical Review of World Energy, (2020): www.bp.com/content/dam/bp/business sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2020-full-report.pdf

Burke Johnson, R., & Onwuegbuzie, A. (2007). Mixed Methods Research: A Research Paradigm Whose Time Has Come. Educational Researcher .

Bayzakova, Aida, (2014) "The Uncertain Future of Australian LNG Projects: The Use of Scenario Building in Strategic Management" Master's Thesis, EN310E

Carlucci, D., & Schiuma, G. (2009). Applying the Analytic Network Process to Disclose Knowledge Assets Value Creation Dynamics. Expert Systems with Applications, 7687-7694.

Chen, M.-K., & Wang, S.-C. (2010). The use of a hybrid fuzzy-Delphi-AHP approach to develop global business intelligence for information service firms. Expert Systems with Applications, 7394-7407.

Colombo, Silvia, El Harrak, Mohamed, Sartori, Nicolo (2016), "The Future of Natural Gas.Markets and Geopolitics"European Energy Review.Netherlands

Duru, O., Bulut, E., & Yoshida, S. (2012). A fuzzy extended DELPHI method for adjustment of statistical time seriesprediction: An empirical study on dry bulk freight market case. Expert Systems with Applications, 840-848

EbrahimiSeyednasrollah, Danaei Kimia (2017), Review of Effectiveness and Functionality of Take or Pay Clause in LGN Sale Contracts., energy law studies, 2(2), 189-212. (In Persian)

GECF Global Gas Outlook 2050 Synopsis, 2020, Doha-Qatar, https://www.gecf.org/_resources/files/events/gecf-to-unveil-latest-edition-of-flagship-publication-global-gas-outlook-2050/2020-edition-of-the-gecf-global-gas-outlook-2050.pdf

Griffin, Paul, Boyle, Carolyn, (2008), "Liquefied natural gas: the law and business of LNG"; chapter 7: Stuart Salt, Linklaters," Financing LNG projects" London: Globe Business Publishing Ltd, p91-112

Habibi, A., Firouzi Jahantigh, F., & Sarafrazi, A. (2015). Fuzzy Delphi Technique for Forecasting and Screening Items. Asian Journal of Research in Business Economics and Management, 130-143.

IGU World LNG report (2020) https://www.igu.org/wp-content/uploads/2020/04/2020-World-LNG-Report.pdf

IGU World Gas LNG Report, (2018): www.igu.org/sites/IGU_LNG_2018_0.pdf

Iran Liquefied Natural Gas Co., (2016), Iran LNG Project Overview, www. iranlng. ir

Ishikawa, A., Amagasa, M., Shiga, T., Tomizawa, G., Tatsuta, R., &Mieno, H. (1993). The Max‐Min Delphi Method and Fuzzy Delphi Method via Fuzzy Integration. Fuzzy Sets and Systems, 241-253.

Katzman, Kenneth (2009), "Iran Sanctions", Congressional Research Service.

Katzman, Kenneth (2017), "Iran Sanctions", Congressional Research Service .

Kamarulzaman, N., Jomhari, N., Raus, N., MohdYusof, M. (2015). Applying the Fuzzy Delphi Method to Analyze the User Requirement for User Centered Design Prcess in Order to Create Learning Application. Indian Journal of Science and Technology,1-7.

Khalili Araghi, M., Kasraei, Z., Watani,A. & Haji Haidari, A. (2008). Economic study of liquefied natural gas (LNG) production for Iran. Journal of Energy Economics Studies / Fifth (50),19 ,23-49 (in Persian)

KPMG GLOBAL ENERGY INSTITUTE, (2014) "Major LNG projects: Navigating the new terrain Focus on Canada, United States, East Africa and Australia" https://assets.kpmg.com/content/dam/kpmg/pdf/2014/06/major-LNG-projects-navigating-new-terrain.pdf

Marks, Stephan P. (1999), "Economics Sanctions as Human Rights Violations; Reconciling Political and Public Health Imperatives", American Journal of Public Health. No.10.

Manoliadis,O.,Pantouvakis,J.-P.,Christodoulou, S.（2009).Improving Qualifications based Selection by Use of the Fuzzy Delphi Method. Construction Management and Economics, 373-384.

Manzoor, Davood, Mostafapour,Manoochehr', (2013), "Reviewing Unfair Sanctions: Features, Objectives and Fulfilled Measures" Volume 1, Issue 2 (Quarterly Journal of Fiscal and Economic Policies (in Persian)

Mehr News Agency, 17 of September 2013, https://www.mehrnews.com/news/2137496/

Office of the Federal Coordinator, (2013), Financing strategies for LNG export projects, Alaska Natural Gas Transportation Projects.

Omidvar, Hedaiat, (2007), Iran details LNG Liquefaction Plants, Oil & Gas Journal 105(21)70

Opedal Anders,2020," Energy Perspectives2020" Equinor's Global Macro and Market Energy. https://www.equinor.com/content/dam/statoil/image/how-and-why/energy-perspectives/2020/energy-perspectives-report-2020-i.pdf

Rahimi, Gholamali (2007). World LNG Industry Review. Tehran. Institute for International Energy Studies. (In Persian)

Rahimi, Gholam Ali and Razdan, Mahsa, (2007), Evaluation of Developments in LNG Projects Structure,02nd Iranian Petroleum Engineering Congress, Tehran,

Saxton, Jim, IRAN'S OIL AND GAS WEALTH, Joint Economic Committee – 433 Cannon House Office Building, (202) (2006), p. 4.

Berkashli, Fereydoun,Sayadi, Mohammad, (2012), "Short-term and long-term effects of international oil sanctions on Iran's energy sector "Strategic Research Center No.155(in Persian)

Shiravi, Abdolhossein, (2011),'International trade law' - Tehran, SMT Publication. (In Persian)

Songhurst, Brian, (2014), "LNG Plant Cost Escalation", The Oxford Institute for Energy Studies, N. 83.

Wang, Siyuan; Notteboom; Theo, (2011), "World LNG shipping: dynamics in markets, ships and terminal projects", University Press Antwerp. P129-154