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Identifying and Prioritizing Risks Related to Time Delays in Oil and Gas Projects

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Highlights

- In addition to considering the background of contractors and partner companies in the past, managers should pay attention to other criteria such as the political relations of the country with Iran, the contractor promptitude or company, and the diversification of partners in modulating oil contracts.
- Contractors need to prepare the equipment and raw materials needed for the next phases much sooner so that they will not be shocked or hurt in case of rising the prices.
- It is very important to use domestic and foreign legal advisors, pay more attention to the transparency of the contract, and explain to foreign contractors about working conditions in Iran.

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Abstract

A delay is an event that increases the completion time of a part of a project, which is one of the main problems in the executive projects of the country and causes an increase in project costs and damages. Project delays pose significant risks that are dangerous for the project's continuation. These risks are of particular importance in oil and gas projects. Thus, this study aims to identify and rank the risks related to delays in oil and gas projects. The present study is applied in terms of orientation and quantitative in terms of methodology. The study's statistical population is managers and experts on risk and delay in oil and gas projects in the country. Among these people, 15 were selected as the sample by judgmental sampling. Two questionnaires of expertise and prioritization were used for data collection, both of which had validity and reliability. The present study was conducted in several sections. In the first step, the risks associated with project delays were extracted by reviewing works on project risk and delay. In this section, 19 risks were identified. In the next step, these risks were screened using the binominal test, and 11 with a significance coefficient higher than 5% were excluded from the calculations. The remaining eight risks were prioritized using the Codas distance technique. According to the relative evaluation matrix data and the scores of each risk, the risks of sanctions, inflation, lawsuits, and complaints had the highest priority, respectively. Finally, research proposals were developed based on significant risks.

Keywords: Delay-related Risk, Project Delay, Project Risk, Risk

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1. Introduction

One of the critical factors that affect the performance of a project is the cost and the amount of delays. Regarding the special importance of oil and gas projects and their role in the country's economic development, the need to pay special attention to these projects and conduct research studies on them has become apparent. Delays in projects are undeniable due to their particular complexity, and studies show that most projects worldwide are delayed by more than 50% (Gholami and Ryanpour, 2016).

In recent years, various projects, including operation platforms, refineries, and petrochemicals, have been put into operation. However, some are the most successful examples in Iran and the world. In some cases, lack of proper management has led to a waste of time and money. Project management is one of the critical methods with much potential to prevent such problems in developed countries.

Project management is the rules and regulations for starting, planning, executing, controlling, and finishing a team to achieve specific goals. Project management is the utilization of knowledge, skills, tools, and techniques to carry out project activities in a way that meets the needs of the project (Carstens and Richardson, 2019). Risk management is one of the main areas of strategic project management, and legal and contractual tools have many capabilities for project risk management (Nejadi, Ehsanifar, and Khodadai, 2020).

One of the most critical challenges of the country's projects is delays, which increase costs for both parties. Further, in addition to the direct financial losses to the employer and contractor, project delays indirectly cause irreparable consequences in other areas, including delays in affiliated projects, reduced workforce efficiency, loss of crucial staff, and corrosion of structure and equipment, which cause a reduction in their lifespan before reaching utilization phase and environmental pollution (Carlier et al., 2006; Rashid, 2020; Fashina, Fakunle, and Omar, 2020).

Project time management and delay prevention are not just management issues; they affect other economic, political, cultural, social, technological, engineering, and executive areas. It also requires macro-management in all regions by considering key risks.

The critical challenge that most large projects face is delays in various stages and at the stage of project completion. Delay is one of the most common phenomena in oil, gas, and petrochemical projects (Amarkhil, Elwakil, and Hubbard, 2021; Gondia, Siam, Dakhakhni, and Nassar, 2020). Delay is an occurrence that prolongs the project schedule and causes stock stagnation, delays in return on investment, growth of current project costs, reduction of budget purchasing power due to rising prices, stagnation of resources, and stakeholder disagreement or dissatisfaction involved in the project due to imposing surplus costs (Tokdemir, Erol and Dikmen, 2019).

In any country, projects are considered national projects that underlie that country's development based on areas such as industrial technology or geographical location. For example, in Iran, which has plenty of oil and gas resources, oil and gas projects are considered national projects, and for a country like Japan, having industries such as automobiles and electronics is a priority. Therefore, delays in projects will cause many losses in terms of time. Moreover, in addition to delays in project completion, related projects and downstream industries will also suffer delays and face irreparable damage (Ojoko et al., 2016).

Reviewing project delays by the employer or contractor can be done to use the experience gained during project implementation in similar projects. In many projects, many implementation factors have changed at different levels, and the executives' knowledge gained during the project in other sectors must be documented and managed. In this way, it is possible to use experience to prevent similar incidents in the future.

Concerning the provided explanations and the competitive atmosphere between Iran and other oil and gas-producing countries, this study seeks to answer the following questions: Which are the most critical and influential risks associated with time delays in oil and gas projects? How should the risks associated with time delays be prioritized?

2. Literature review

Delay may be defined as an event that increases the time to complete all or part of a project (Amouti and Ankrah, 2017). A delay is the length of time that a project is delayed or stopped due to unexpected events. The most common reasons that increase the duration of an activity or the whole project during the implementation process include changes in workshop conditions; changes in designs; adverse weather; lack of materials, labor, and equipment; and employer negligence.

Delays increase the project's duration and the cost of completing the project. Identifying these delays appropriately can also ensure project delays and costs. Therefore, identifying delays on time and determining the project's progress in each middle stage seems necessary (Sweet and Schneier, 2013).

The main problem that most large projects face is delays in various phases and eventual project completion. As one of the most critical problems in civil projects in developing countries, the delay is one of the factors causing adverse effects on projects, which can only be minimized when the causes are identified (Poor Rostam, 2012). Project delays are always associated with risks.

Project risk means an unpleasant event that may occur due to delays, additional costs, and undesirable project outcomes for the organization, community, or environment (Hilson and Simon, 2020). Project risk is an uncertainty that will have positive and negative effects on at least one of the project objectives, such as cost, scope, quality, and so on, if it occurs. Every risk has causes that are definite incidents in the project or its environment and lead to uncertainty (Guan, Abbasi, and Ryan, 2020).

From an economic point of view, risk means the condition in which the decision-maker can assign probabilities to different types of possible outcomes. In decision theory, risk is a fact in which decisions are made under known probabilistic conditions regarding natural conditions. In the project management area, the risk is an undesirable incident or condition that has a positive or negative effect on project objectives if it occurs (Wang et al., 2018).

Risks can affect the activities or organization processes; risks also affect projects. The intensity of risk efficacy is different in each project. The most common risks in the oil and gas industry include market risks, such as changes in oil prices, interest rates, and exchange rates; credit risks; operational risks, such as damages in equipment; geological risks, such as dry wells; environmental risks, such as pollution; political risks such as change of governments, war, and terrorism; and legal risks such as lawsuits, complaints, and compensation. The following is the research background regarding risk and project delay.

Dalvand et al. (2021) identified and prioritized investment risks in sports projects in Iran. In the first phase, the investment risks in sports projects were identified through a literature review and interviews with experts. These risks were 15, and 6 factors were excluded after sieving with a binominal test. The remaining nine factors were evaluated in terms of the degree of impact of the DEMATEL technique.

Five factors, such as market, economic, legal, financing, and stakeholder conflict risks in terms of net effect index, were chosen as the most effective risks.

Finally, these five risks were ranked by ARAS decision-making technique, and the three economic, market, and financing risks had the highest priority, respectively. Karami, Samimi, and Jafari (2020) examined the need for risk management in oil projects in their research. Every year, many large projects are facing operational difficulties. Risk management can be essential in this area's identification and preventive proceedings. Since oil and gas industry projects have many complexities and uncertainties, investing in these projects is associated with high risk.

However, today, risk assessment methods and techniques have become widespread due to advances in hardware and software. Due to the importance of these projects in the Iranian economy and the need for significant investments in the upstream oil and gas sector of the country, it is necessary to identify, evaluate, and prioritize the risks of the upstream oil and gas sector. Risk is one of their inherent and natural features in implementing large projects. Identifying and evaluating these risks helps project managers with better planning.

Von et al. (2019) studied the most important causes of risk in Vietnam oil projects and methods of managing these risks in their research. Their findings indicated that the bureaucratic system of the government and the lengthy procedures of project approval, poor design, project team weaknesses, improper tender, and delay in obtaining approval from legal institutions are the main risks. Managers proposed various strategies to reduce the identified risks, including reforming government structures, effective partnerships with foreign partners, training project managers, evaluating the contractor using multi-criteria decision-making techniques, and increasing the authority of project individuals. These findings have several practical implications. The improvement proceedings presented in this study improve the possibility of oil projects' success in Vietnam.

From the employer's perspective, Hatmoko and Khasani (2019) examined the reasons for the delay of oil and gas projects. The results of their research indicated that the most critically recognized reasons for project delays from the contractor's point of view include delays in payments by the employer, delays in reviewing and approving designed documents by the consultant, errors and defects in designed documents, and late equipment supply by the contractor.

Suppramaniam, Ismail, and Suppramaniam (2018) identified the most important causes of delays in Egyptian oil projects. Their results portrayed that the most important reasons for delays are contractor liquidity problems, changes in project scope by the employer, interventions made by the employer, and lack of proper project financing. According to Ruqaishi and Bashir (2015), various research studies have been done on delay causes. This study examined the causes of delays in construction projects at oil and gas processing facilities in Oman. The survey results of oil and gas project managers showed a high consensus among project stakeholders, customers, contractors, and consultants about the reasons for project delays, and research evidence showed that the reasons for project delays vary according to the size or organization ownership. In addition, seven factors were identified as the main reasons for the project delay. Although six of these identified factors are general and can be addressed in any industry, one of them (poor interaction with vendors in the engineering and procurement stages) is unique to construction projects in the oil and gas industry.

Regarding the background of multiple attribute decision-making (MADM) methods, it should be noted that these methods are divided into two categories: weight and interval methods. In the weight methods, the desirability of each option is the criterion, and in the interval methods, the distance from the ideals is. Using the Euclidean method, the TOPSIS method is one of the first interval methods to calculate the distance between positive and negative ideals. The TOPSIS method is widely used for risk assessment

(Nazam et al., 2015; Jena and Pradhan, 2020; Koulinas et al., 2021). This method is sometimes combined with other methods, such as AHP, ANP, and FMEA analysis (Honari Choobar et al., 2012; Taylan et al., 2014; Liu et al., 2018). The non-deterministic approach of MADM methods for risk assessment has been used in more research. ELECTRE and EDAS techniques are other interval methods developed after TOPSIS. In EDAS, the decision criterion is the distance from the positive and negative averages (Kahraman et al., 2017). CODAS is one of the most advanced interval methods using taxi cab distance and Euclidean distance to evaluate options. This method has also been widely used to assess options in various research (Keshavarz Ghorabaee et al., 2016; Keshavarz Ghorabaee et al., 2017; Li et al., 2021).

Methods related to MADM have been placed in existing domains in the history of use. The most important function of these methods in the research literature is analyzing and prioritizing factors and options. The selected subjects are selected in several stages using prioritization, review, and evaluation methods (Govindan et al., 2015; Agarwal et al., 2011; Tahriri et al., 2008). In the early years, simple methods such as AHP were the focus of researchers. Next, in addition to pairwise comparison methods such as AHP, decision matrix-based methods with uncertainty-based approaches such as fuzzy were considered by researchers. A wide range of other topics such as choosing the right location for the factory, choosing the right strategy, purchasing and procurement, marketing, selecting the right educational institution, finance and accounting, the right stock portfolio, future research, performance evaluation, banking, and insurance have used these methods (Asheghi-Oskooee et al., 2021; Tang et al., 2022; Fathi et al., 2019; Saini and Khanduja, 2019; Bahrami and Maleki, 2016; Dedania et al., 2015).

In this research, a wide range of MADM methods have been combined. For example, methods such as Shannon entropy and ANP have been employed to weigh factors, and techniques such as TOPSIS and similarity have been utilized for prioritization. These methods are constantly being developed, and their scope of application is increasing rapidly. EDAS, CODAS, SECA, and MARCOS methods are techniques developed in recent years (Keshavarz Ghorabaee et al., 2018; Keshavarz Ghorabaee et al., 2015).

Risk and risk assessment are fields that have used MADM techniques to a large extent. In these studies, hybrid frameworks based on MADM have been employed to identify, weigh, and prioritize risks. Risk researchers have often used MADM techniques to enhance traditional risk assessment methods such as FMEA (Lo et al., 2020; Lo and Liou, 2018).

Finally, the risks associated with project delays extracted from the literature review are tabulated in Table 1.

Table 1

Risks associated with project delays

Delay-related risk	Description of risks	Resources
Sanction	When a project slows down, sanctions may be imposed to disrupt the project. Sanctions limit the transfer of technology, equipment, capital, and specialized workforce.	Karami, Samimi, and Jafari (2020)

Delay-related risk	Description of risks	Resources
Changes in government policies	Delays in the project may change some government policies and slow project implementation. In Iran, the government accepts commitments incompatible with strategic plans when starting work in a slogan-like and emotional way.	Dalvand et al. (2021)
Changes in the governments and managers	Sometimes, the project is delayed so much that the government and its policies change, which affects the project process. In Iran, the government is less committed to strategic plans, and changes in the government lead to fundamental changes in policies, laws, and strategies. Some projects are often not a priority in the oil and gas industry.	Sanni-Anibire, Zin and Olatunji (2020)
Making complaints and lawsuits	As the project lasts longer, problems and disputes may arise between the employer and the contractor, which leads to difficulties and disruptions throughout the project. Complaints from one of the parties will naturally prolong the project time and lose the focus of the project managers.	Sanni-Anibire, Zin and Olatunji (2020)
Inflation	When the project implementation takes a long time, the whole project is affected by inflation. The internal conditions of the country and its resources are involved, and the project may be stopped. Oil and gas projects are susceptible to exchange rate fluctuations. Fluctuations in exchange rates significantly increase the costs of implementing oil and gas projects.	Dalvand et al. (2021)
Environmental	Abandoned oil and gas projects can do much damage to the environment. Due to the extensive negative consequences, environmental pollution causes widespread sensitivities on the part of society and environmental groups and causes the project managers to lose focus.	Vora, Sunni, and Flage (2021); Adelekem et al. (2020); Silvius (2018)
Exchange rate fluctuations	Since oil and gas projects in Iran depend highly on the dollar, exchange rate fluctuations make supplying equipment and raw materials difficult. Oil and gas projects rely on transferring technology, equipment, and expertise abroad.	Silvius (2018)
Surpassing competitors	In case of delay, competitor countries can gain market share quickly since they do not face Iranian constraints. In recent years, Iran’s competitors in the region, such as Iraq, Saudi Arabia, and the UAE, have surpassed Iran in many oil and gas projects by attracting large amounts of foreign capital from countries such as China.	Salm (2018)

Delay-related risk	Description of risks	Resources
Loss of trust and social capital	Delays, especially in national oil and gas projects, undermine public confidence in government managers, employers, and contractors. The lost trust will weaken the position of many companies and contractors among the stakeholders, which will take much work to compensate.	Ebrat and Ghodsi (2014)
Loss of employer and contractor validation	If the project time is extended, the credibility of the employer and the contractor will be reduced. In such cases, funding and attracting domestic and foreign funds will be challenging, possibly even stopping the project.	Koulinas et al. (2020)
Changes in supply and demand	Increasing project implementation time may undermine the economic viability of the project. Technological changes, competitor activities, and political developments may effectively neutralize the project's financial benefits, and policymakers may decide to stop the project.	Alsuliman (2019)
Changes in the provisions of the contract by the government	Over time, the government may change the contract's terms. New laws and policies of the government may completely change the terms of the agreement, and these changes cause legal disputes between the parties to the contract.	Ruqaishi and Bashir (2015); Tokdemir, Erol, and Dikmen (2019)
Loss of key and expert forces	As the project runs longer, some key experts may leave the project. In recent years, many Iranian experts in the oil and gas industries have migrated from the country due to the attractiveness of working in some countries in the region.	Hilson and Simon (2020); Chen (2013)
Increase in project costs	Prices will naturally increase as the project implementation time increases, increasing project implementation costs. In recent years, the intensification of foreign sanctions and liquidity growth have caused an unprecedented price increase.	Hatmoko, J. U. D. and Khasani (2019); Hilson and Simon (2020)
Workers' strikes and riots	With a delay in the project implementation, the contractor may delay the delivery of the status statement, and the employer may not pay the salaries on time, leading to riots and labor strikes. The severity of this risk has dramatically increased due to the pressures caused by the decrease in people's purchasing power in recent years.	Park et al. (2019); Chen (2013)
Changes in upstream technologies of the oil and gas sector	Sometimes, there may be so much delay that upstream technologies are subject to change. The pace of technological change has increased dramatically in	Kendrick (2015); Liu, Meng, and Fellows (2015)

Delay-related risk	Description of risks	Resources
	recent years. These changes are more evident in soft technologies such as artificial intelligence.	
Financing	Excessive increases in project implementation time and delays will cause the loss of reputation of the company, employer, and contractor, as well as investor distrust. In such a situation, financial institutions like banks will be very pessimistic about these projects, and financing will be complex.	Guan, Abbasi, and Ryan (2020)
HSE	Project delays can lead to non-compliance with safety standards, especially in oil and gas projects where safety standards may need to be carefully monitored and checked. Based on the literature, the risk of safety incidents increases significantly, mainly when a project is delayed.	Adeleke et al. (2021); Wu et al. (2020)
Loss of economic justification of the project	Sometimes, the project is delayed so much that it loses its economic justification. The development of alternative energies in the future threatens the profitability and financial viability of many oil and gas projects.	Zhang (2016); Kendrick (2015)

3. Research methodology

The present study is positive from a philosophical point of view, exploratory in terms of purpose, and practical in terms of orientation. Further, the present study is a survey study regarding data collection and its quantitative methodology, and it uses the binomial statistical test and the CODAS method. The study's statistical population includes countries' managers and Shahid Tondgooyan Petrochemical Company experts in oil and gas project delays and risks. Moreover, the sampling method is judgmental and refers to experts. The sample size in this study is 15 people, which is desirable for expert techniques such as CODAS. A sample size of 10 to 20 people is acceptable in decision-making techniques.

For data collection, two questionnaires on informatics and prioritization were used. Initially, an expertise questionnaire was used to sieve research risks. The expertise questionnaire collects experts' opinions on the importance of risks in a range of five. A non-parametric binominal test analyzed the data of these questionnaires. The reason for applying the binominal test was that the data from the expert questionnaire needed to be revised.

All the risks were excluded from the analysis with a significance coefficient higher than 5%. Other risks were included in the CODAS method prioritization questionnaire. Experts' opinions were collected in a range of 100. Experts commented on the importance of sieving factors in this range. In decision-making methods, the wider the range of data collection, the greater the validity of the results. The expertise questionnaire had validity because the research risks were obtained from an extensive review of reliable articles related to project risk and delay.

The Lawshe method was used to evaluate the validity of the obtained concepts. This method often assesses questionnaires and checks qualitative studies' content validity. In this tool, a questionnaire is provided to the group of experts, and they are asked to select one of the *necessary*, *essential*, *but unnecessary*, *non-essential* options for the extraction factors in the questionnaire. Then, the answers given to the questionnaire are quantified by the content validity ratio (CVR) formula. Any identified factor, the CVR of which is outside the range of CVR coefficients, is not validated (Lawshe, 1975).

$$CVR = \frac{n_e - \frac{N}{2}}{\frac{N}{2}} \tag{1}$$

where n_e is the number of experts who have given the necessary answer to the desired factor, and N indicates the number of expert group members.

An expert panel group of 15 members was formed to measure the CVR coefficient. The value of the CVR coefficient for all factors of the questionnaire was above 0.5, which is a good value for the panel of 15 experts.

On the other hand, a nonparametric Wilcoxon test was used to assess the reliability of the expertise questionnaire. The questionnaires were distributed in two stages, and the results of these two stages were evaluated using the Wilcoxon statistical test. Since at the 95% confidence level, the significance coefficient of the test was less than 5%, the reliability of the expertise questionnaire was confirmed. Furthermore, because the factors were sieved and, more importantly, the expertise questionnaire entered the prioritization questionnaire, the prioritization questionnaire had validity.

The number of research factors and experts was controlled to increase the reliability and consistency of the prioritization questionnaire. The large number of experts and the excessive increase of factors in final decision-making and prioritization will reduce reliability. The number of final risks in the prioritization questionnaire was 8, and the number of experts was 15, which are acceptable values, so the prioritization questionnaire in this study is reliable. The present study includes the following stages:

1. Reviewing the literature related to project risk and delay to extract research risks;

2. Screening research risks by using a statistical test;

3. Prioritizing the screened risks by using the CODAS technique.

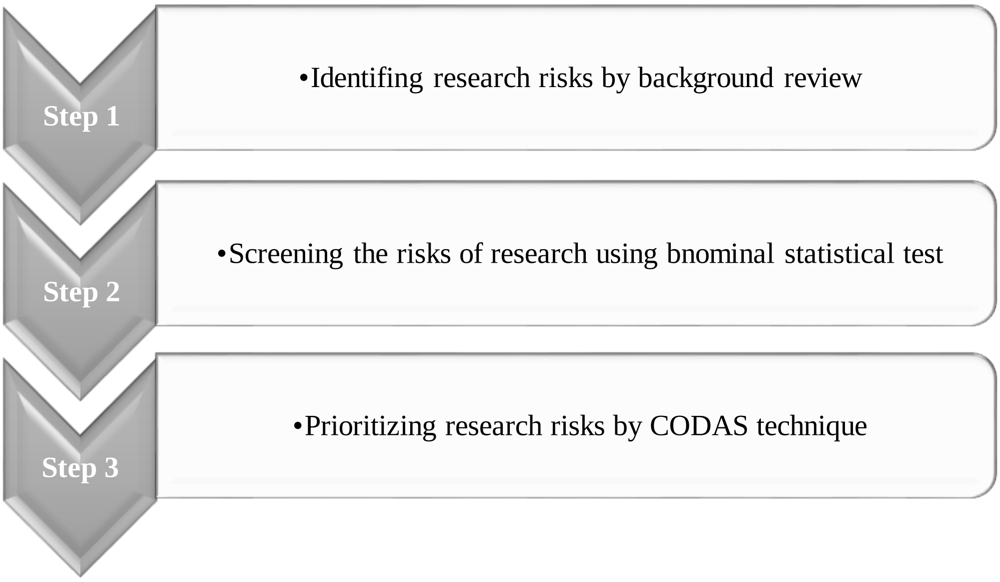

Figure 1

The research stages

A binominal statistical test was used to sieve factors. Decision-making methods are sensitive to many factors, so their best-case scenario is less than 10 factors. This is because increasing the number of factors improves the consistency and validity of the results. In such cases, the number of factors should be reduced as much as possible using tests and sieving techniques such as binominal, Fuzzy Delphi, or deductive analysis. In this study, a binominal statistical test was used, and it is not sensitive to the normality of the data.

The CODAS method has been proposed by Keshavarz Ghorabaee and Zavadskas (2016). This study uses the CODAS method to prioritize the final risks. This method uses the Euclidean distance as the primary criterion and the taxi cab distance as the secondary criterion to identify the desirability of the options. These distances are obtained based on the distance from the negative ideal point. The steps of this method are as follows:

Step 1: The decision-making matrix is formed according to the options and criteria. The data related to the requirements for all problem possibilities are collected at this stage based on experts' opinions.

$$X = \left[x_{ij}\right]_{n\times m} = \begin{bmatrix} x_{11} & \cdots & x_{1m} \\ \vdots & \ddots & \vdots \\ x_{n1} & \cdots & x_{nm} \end{bmatrix} \qquad (2)$$

Step 2: The weight and degree of importance of the criteria are determined using weighting methods.

Since there was no significant difference in the level of expertise of the samples, the weight of the experts was considered the same. The weight of each expert's opinion was obtained by dividing the number of one by the number of experts, equal to 15. In this article, the expertise of Shahid Tondgooyan Petrochemical Company experts was evaluated according to their level of education, organizational position, and work experience in the field of oil and gas.

$$W = \left[w_{1j}\right]_{1\times m} \qquad (3)$$

Step 3: This step is related to normalizing the decision-making matrix. This method uses linear normalization. In the linear normalization method, each option is divided by the maximum value of each column for utility options. For cost-related options, the minimum value of each column is divided by each value. The corresponding equation is given below:

$$n_{ij} = \begin{cases} \dfrac{x_{ij}}{\max\limits_{i} x_{ij}}\ , & if\ \ j\epsilon N_b \\ \dfrac{\min\limits_{i} x_{ij}}{x_{ij}}, & if\ \ \ j\epsilon N_c \end{cases} \qquad (4)$$

Step 4: In this step, a normal rhythmic matrix is obtained. For this purpose, the weights of each criterion are multiplied by the normal matrix data. The equation is given below:

$$r_{ij} = w_j n_{ij}$$

Here: (5)

$\sum_{j=1}^{m} w_j = 1$ and $w_j\ (0 < w_j < 1)\ \exists$

Step 5: This step is to identify the negative ideal point as a basis for calculating the distance from each option. For this purpose, each criterion's minimum value is considered a negative perfect point. The corresponding equation is given below:

$$ns = [ns_j]_{1\times m}$$
$$ns_j = \min_i r_{ij} \quad (6)$$

Step 6: Each option's Euclidean distance and the taxi cap distance from the negative ideal point are calculated in this step. Equations 7 and 8 are used for this purpose:

$$E_i = \sqrt{\sum_{j=1}^{m} (r_{ij} - ns_j)^2} \quad (7)$$

$$T_i = \sum_{j=1}^{m} |r_{ij} - ns_j| \quad (8)$$

Step 7: The relative evaluation matrix for each option is obtained in this step. This is why a threshold is used. Suppose the absolute value difference of the Euclidean distance between the two options is less than the threshold. In that case, the coefficient of zero is considered for the taxi cab difference. Suppose the absolute value difference between the Euclidean distance between the two options is more than the threshold. In that case, the coefficient of one is applied to the difference between the two distances. The equations for this step are as follows:

$$Ra = [h_{ik}]_{n\times n} \quad (10)$$

$$h_{ik} = (E_i - E_k) + (\psi(E_i - E_k) \times (T_i - T_k)) \quad (11)$$

The function ψ is related to the threshold and is defined by Equation 12:

$$\psi(x) = \begin{cases} 1 \ , & if \ |x| \geq \tau \\ 0 \ , & if \ |x| < \tau \end{cases} \quad (12)$$

At this stage, the parameter τ can be between 0.05 and 0.01, depending on the decision-maker's opinion.

Step 8: This step is related to calculating the evaluation score of each option, which is obtained by adding the previous evaluations in a row according to Equation 13.

$$H_i = \sum_{k=1}^{n} h_{ik} \quad (13)$$

Step 9: Finally, the rank of each option is determined by using the evaluation score calculated in the previous step. The choice with the highest score in the last step is ranked first, and the other options are ranked in descending order.

4. Research findings and discussion

Research risks were assessed by reviewing articles related to the risk and oil and gas project delays. Nineteen risks were obtained from the literature review. A binominal statistical test sieved these 19 risks, and risks with a significance coefficient higher than 5% were excluded from the final analysis.

To reduce the number of risks, they should be sieved before the final rating with the CODAS technique. Decreasing the number of final risks increases the reliability of the results in the final decision-making and prioritization phase. Table 2 tabulates the results of the binominal test.

The results of the binominal test illustrated that eight risks have a significance coefficient of less than 5% and were selected for final prioritization by the CODAS technique. These risks were the risk of losing economic justification, risk of losing expertise, risk of sanctions, risk of changing governments and managers, risk of filing lawsuits and complaints, risk of losing the credibility of employer and contractor, risk of overtaking competitors, and inflation risk.

Table 2

The binominal test

		Hypotheses	**Sample size**	**Observed ratio**	**Test ratio**	**Significance level**
Sanction	Group 1	<= 3	1	0.07	0.50	0.001
	Group 2	> 3	14	0.93		
	Total		15	1.00		
Changes in government policies	Group 1	<= 3	8	0.53	0.50	1.000
	Group 2	> 3	7	0.47		
	Total		15	1.00		
Changes in governments and managers	Group 1	<= 3	2	0.13	0.50	0.007
	Group 2	> 3	13	0.87		
	Total		15	1.00		
Making complaints and lawsuits	Group 1	<= 3	3	0.20	0.50	0.035
	Group 2	> 3	12	0.80		
	Total		15	1.00		
Inflation	Group 1	<= 3	3	0.20	0.50	0.035
	Group 2	> 3	12	0.80		
	Total		15	1.00		
Environmental risk	Group 1	<= 3	8	0.53	0.50	1.000
	Group 2	> 3	7	0.47		
	Total		15	1.00		
Exchange rate fluctuations	Group 1	<= 3	8	0.53	0.50	1.000
	Group 2	> 3	7	0.47		
	Total		15	1.00		
Surpassing competitors	Group 1	<= 3	2	0.13	0.50	0.007
	Group 2	> 3	13	0.87		

		Hypotheses	Sample size	Observed ratio	Test ratio	Significance level
	Total		15	1.00		
	Group 1	<= 3	5	0.33	0.50	0.302
Loss of trust and social capital	Group 2	> 3	10	0.67		
	Total		15	1.00		
	Group 1	<= 3	3	0.20	0.50	0.035
Loss of employer and contractor validation	Group 2	> 3	12	0.80		
	Total		15	1.00		
	Group 1	<= 3	10	0.67	0.50	0.302
Changes in supply and demand	Group 2	> 3	5	0.33		
	Total		15	1.00		
	Group 1	<= 3	8	0.53	0.50	1.000
Changes in the provisions of the contract by the government	Group 2	> 3	7	0.47		
	Total		15	1.00		
	Group 1	<= 3	2	0.13	0.50	0.007
Loss of key and expert forces	Group 2	> 3	13	0.87		
	Total		15	1.00		
	Group 1	<= 3	7	0.47	0.50	1.000
Increase in project costs	Group 2	> 3	8	0.53		
	Total		15	1.00		
	Group 1	<= 3	9	0.60	0.50	0.607
Workers' strikes and riots	Group 2	> 3	6	0.40		
	Total		15	1.00		
	Group 1	<= 3	10	0.67	0.50	0.302
Changes in upstream technologies of the oil and gas sector	Group 2	> 3	5	0.33		
	Total		15	1.00		
	Group 1	<= 3	10	0.67	0.50	0.302
Financing	Group 2	> 3	5	0.33		
	Total		15	1.00		
	Group 1	<= 3	8	0.53	0.50	1.000
HSE	Group 2	> 3	7	0.47		
	Total		15	1.00		

		Hypotheses	Sample size	Observed ratio	Test ratio	Significance level
Loss of economic justification of the project	Group 1	<= 3	3	0.20	0.50	0.035
	Group 2	> 3	12	0.80		
	Total		15	1.00		

These risks are then prioritized using the CODAS technique. Fifteen research experts expressed their views on the importance of delay risks within a spectrum of 100. Table 3 lists the decision-making matrix of research risks.

Table 3

The decision-making matrix of the research risks

Research risks	Ex 1	Ex 2	Ex 3	Ex 4	Ex 5	Ex 6	Ex 7	Ex 8	Ex 9	Ex 10	Ex 11	Ex 12	Ex 13	Ex 14	Ex 15
Risk of losing economic justification	30	50	20	50	25	35	40	50	55	45	35	30	50	40	45
Risk of losing expert staff	40	60	50	40	50	40	60	65	55	50	40	50	60	50	45
Sanction risk	90	100	95	85	88	90	100	90	98	85	88	92	100	100	95
Risk of changing governments and managers	70	60	70	80	75	80	80	60	65	75	60	75	70	70	80
Risk of lawsuits and complaints	80	55	75	70	80	70	85	80	85	95	90	80	70	60	75
Risk of loss of credibility of the employer and the contractor	50	50	25	30	20	25	40	60	55	50	30	25	15	10	20
Risk of overtaking competitors	75	70	80	90	80	85	75	90	65	70	60	70	70	65	80
Inflation risk	85	90	95	100	92	90	88	90	100	90	80	85	90	95	95

Then, the values of the decision-making matrix become normal. Due to the large volume of calculations, the results are given for the first five experts. The normal matrix data of the first five experts are presented in Table 4. The linear method was used to normalize the matrix data.

Table 4

The normal matrix of the research risks

Research risks	Ex 1	Ex 2	Ex 3	Ex 4	Ex 5
Risk of losing economic justification	0.33	0.5	0.21	0.5	0.27
Risk of losing expert staff	0.44	0.6	0.53	0.4	0.54
Sanction risk	1.0	1.0	1.0	0.85	0.96
Risk of changing governments and managers	0.78	0.6	0.74	0.8	0.82
Risk of lawsuits and complaints	0.89	0.55	0.79	0.7	0.87
Risk of loss of credibility of the employer and the contractor	0.55	0.5	0.26	0.3	0.22

Research risks	Ex 1	Ex 2	Ex 3	Ex 4	Ex 5
Risk of overtaking competitors	0.83	0.7	0.84	0.9	0.87
Inflation risk	0.94	0.9	1.0	1.0	1.0

Then, the weighted normal matrix and the negative ideal points were determined by multiplying the normal matrix data by the weight of the expert's opinions. The research experts were examined according to the criteria of Islam et al. (2019). The evaluation criteria of experts were organizational position, education level, work experience related to oil and gas projects, and unrelated work experiences. Considering that there is no significant difference between the research experts in terms of the evaluation criteria of Islam et al. (2019), their weight is deemed the same. To calculate the weight of the expert's opinions, the number of 1/15 divided by the number of experts is 0.066.

Table 5

The normal rhythmic matrix

Research risks	Ex 1	Ex 2	Ex 3	Ex 4	Ex 5
Risk of losing economic justification	0.022	0.033	0.014	0.033	0.018
Risk of losing expert staff	0.029	0.04	0.035	0.07	0.036
Sanction risk	0.067	0.067	0.067	0.057	0.064
Risk of changing governments and managers	0.052	0.04	0.049	0.0536	0.054
Risk of lawsuits and complaints	0.059	0.03	0.053	0.046	0.058
Risk of loss of credibility of the employer and the contractor	0.037	0.033	0.017	0.02	0.014
Risk of overtaking competitors	0.056	0.046	0.056	0.06	0.058
Inflation risk	0.063	0.06	0.067	0.067	0.067
Negative ideal points	0.022	0.033	0.014	0.02	0.014

In the next step, it is time to calculate the distance matrix. The data of this matrix are listed in Table 6. In the CODAS technique, the taxi cab distance is also calculated in addition to the Euclidean distance. In classical distance methods, only the Euclidean distance is emphasized.

Table 6

The Euclidean distance and the taxi cab matrix

Research risks	E_i	T_i
Losing economic justification risk	0.039	0.093
Losing expert staff risk	0.062	0.203
Sanction risk	0.17	0.655
Changing governments and manager's risk	0.12	0.427
Lawsuits and complaints risk	0.13	0.485

Research risks	E_i	T_i
Loss of credibility of the employer and the contractor risk	0.017	0.029
Overtaking competitor's risk	0.128	0.487
Inflation risk	0.168	0.633

Finally, the score and rank of each risk are obtained by calculating the relative evaluation matrix.

Table 7

The relative evaluation matrix

Project risks	**Loss of economic justification risk**	**Loss of expertise risk**	**Sanctions risk**	**Change of governments and manager' s risk**	**Lawsuits and complaints risk**	**Loss of credibility of employer and contractor risk**	**Overtaking competitor' s risk**	**Inflation risk**
Losing economic justification	0	0.133	0.696	0.414	0.484	–0.085	0.463	0.669
Losing expert staff	–0.13	0	0.563	0.281	0.351	–0.218	0.329	0.536
Sanction risk	–0.696	–0.563	0	–0.281	–0.211	–0.782	–0.233	–0.005
Changing governments and managers	–0.415	–0.281	0.281	0	0.011	–0.499	0.008	0.254
Lawsuits and complaints	–0.484	–0.351	0.212	–0.011	0	–0.57	–0.003	0.184
Loss of credibility of the employer and the contractor	0.085	0.218	0.781	0.499	0.57	0	0.548	0.754
Overtaking competitors	–0.463	–0.329	0.234	–0.008	0.003	–0.548	0	0.206
Inflation risk	–0.669	–0.536	0.005	–0.254	–0.18	–0.754	–0.206	0
Risk score	–2.755	–1.71	2.77	0.64	1.025	–3.458	0.906	2.598
Risk rank	7	6	1	5	3	8	4	2

Finally, the score and rating of each risk are obtained by calculating the relative evaluation matrix. According to the relative evaluation matrix data, the risks of sanctions, inflation, lawsuits and complaints, and overtaking competitors have the highest score and rank, respectively. Each risk score is obtained from the column sum of the values of the relative evaluation matrix. The higher the factor score is, the higher the rank becomes.

Sanction risk significantly affects technology transfer, attracting foreign capital, and providing devices and equipment needed for oil and gas projects. On the other hand, the sanctions have changed the priorities and policies of governments and, in this way, led to the slowness and delay of oil and gas projects. Many projects in Iran, especially oil and gas projects, are stopped due to the need for scenario thinking as soon as they face exchange rate fluctuations and price growth. Inflationary changes often cause disputes between the parties. In such a situation, using the scenario approach and considering different conditions and the possibility of threats will lead to inflation risk management. Considering the economic, political, and legal impulses in drafting the contract, using expert legal advisors, and accurately estimating the costs will significantly reduce the number of future disputes in the legal sector.

5. Conclusions

Many projects are delayed for various reasons in different sectors in Iran. This delay has many consequences for the project objectives and carries many risks. The oil and gas sector is one of the critical areas in the country, and delays in these projects have caused much financial damage to the country's economy and have caused the oil industry to perform poorly in competition with other countries. This study aimed to identify the risks associated with delaying oil and gas projects. As a result, 19 risks were identified through an analytical review of the project's risk history and delays.

These risks were then sieved using the nonparametric binominal test. At this stage, 11 risks were eliminated due to a significance coefficient above 5%. The remaining eight risks were assessed using the CODAS distance technique. Risks of sanctions, inflation, lawsuits and complaints, and overtaking competitors had the highest priority, respectively.

Most studies on project risk and delay have examined these two variables separately in different projects. However, the present study considered both variables in oil and gas projects.

In this section, an attempt was made to provide suggestions regarding the most critical risks. The most crucial risk was related to foreign sanctions. Given that in recent years, some foreign companies, especially Western companies, abandoned projects as soon as the sanctions had begun, this should be considered in evaluating partners.

Therefore, in addition to considering the background of contractors and partner companies in the past, attention should be paid to other criteria such as the political relations of the country with Iran, the contractor promptitude or company, and the diversification of partners in modulating oil contracts. Regarding inflation, because the Iranian economy is inflationary and the prices of goods, raw materials, and equipment are constantly rising, a conservative view of the supply of equipment and raw materials is critical. Contractors must prepare the equipment and raw materials required for the subsequent phases much sooner to avoid being shocked or hurt in case of rising prices. This is even more important for imported equipment and raw materials because, in addition to inflation, aggravating sanctions could make access to these equipment and raw materials more challenging. The third risk is legal risk. Unfortunately, this risk is prevalent in many fields besides oil and gas.

Due to the carelessness and ignorance of senior managers about the legal consequences of many contract clauses, much financial damage has been inflicted on the country's industries and economy. In this regard, it is essential to use domestic and foreign legal advisors, pay more attention to the transparency of the contract, and explain working conditions in Iran to foreign contractors. In this regard, cooperation with companies continuously cooperating with the oil industry in recent years has been a higher priority.

Due to their long history of collaboration, these companies have more information about working conditions in Iran and are less affected by changes in different conditions.

Because of inflation and unstable economic conditions in the country, these companies are more accurate in estimating their costs and making the necessary estimates in advance. Another critical risk in delaying oil and gas projects is overtaking competitors like Qatar. Because many oil fields are communal, competitors can quickly use shared resources in case of a project delay.

Regarding this risk, considering issues such as strengthening oil and gas startups in the country, trying to prioritize the transfer of advanced technologies at every opportunity to lift sanctions, developing training and research centers related to the oil and gas industry, and prioritizing field-related projects are mentioned in the communal field. Changing governments and managers in Iran means changing many programs and priorities. Because managers in Iran have not agreed on vital economic and industry issues, projects are delayed as the government changes.

In this regard, developing long-term strategic visions and plans regarding priorities, goals, and policies can significantly reduce oil project delays. In this case, the consensus of key stakeholders should be considered because the approval of long-term plans with the consensus of critical people will solve the problem.

One of the main challenges of oil and gas projects in Iran is the need for scenario thinking. Executors usually need a correct estimate of the costs and resources required to implement the project. Further, they need to correctly predict various economic, political, legal, and technological drivers and threats and their probability of occurrence. In addition to conventional threats, unknown risks known as black swans often significantly affect project performance and delays. Therefore, identifying and analyzing drivers, weak signals, and surprises affecting the future of projects increase the possibility of effective risk management.

Research suggestions can be presented on content, data collection, and method. In content, research can be done in other fields, such as health and tourism. To further diversify and validate the research results, one can also refer to industry experts’ opinions in addition to considering the background in risk extraction. Finally, conducting research with Fuzzy, Gray, and Rough approaches is recommended to assume the uncertainty.

Nomenclature

AHP	Analytic hierarchy process
ANP	Analytic network process
CODAS	Combinative distance-based assessment
CVR	Content validity ratio
EDAS	Decision-making method based on the distance from the average
ELECTRE	Elimination and choice expressing reality
FMEA	Failure mode and effects analysis
MADM	Multiple attribute decision making
MARCOS	Measurement of alternatives and ranking according to the compromise solution
N	The number of expert group members
n_e	The number of experts who have given the necessary answer to the desired factor
SECA	Simultaneous evaluation of criteria and alternatives
TOPSIS	Technique for order of preference by similarity to ideal solution

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