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Economic Evaluation of the Construction of Several Gas Wells in the Upstream Area of Oil and Gas: a Case Study of a Gas Field in the North-East of Iran

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Highlights

- This study examined the impact of macroeconomic variables such as interest and inflation rates on the economic evaluation of several gas wells in the upstream area of oil and gas.
- The inflation rate was forecasted using the ARIMA model, and an appropriate discount rate was determined.
- The economic evaluation was performed using tools such as NPV, IRR, and payback period, showing positive financial results.
- A sensitivity analysis using COMFAR software assessed the impact of changes in production rates, discount rates, and energy prices.

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Abstract

The economic evaluation of oil and gas projects aims to provide decision-makers with a comprehensive estimate of costs and benefits. This research investigates the impact of macroeconomic variables, including interest rates and inflation, on the economic assessment of constructing several gas wells in the north-east of Iran. The theoretical framework encompasses net present value (NPV), internal rate of return (IRR), and payback period. Initially, the planning of activities and analysis of the construction and operational phases of the project were conducted. The inflation rate was forecasted using the autoregressive integrated moving average (ARIMA) model, and an appropriate discount rate was determined. Additionally, the study examined the pricing of gas and condensates, as well as fixed and variable costs and project revenues. The economic evaluation was performed using COMFAR software and included sensitivity analysis to assess the effects of changes in key assumptions. The results demonstrate that the project's financial metrics are positive across various production rates, discount rates, inflation rates, and energy prices, confirming its economic viability. This evaluation can enhance Iran's position in the global gas market, contribute to local job creation, and stimulate national revenue growth, thereby supporting the country's economic development. Furthermore, the findings are significant for managers and policymakers, enabling better prioritization of investments and assessment of projects under varying economic conditions through improved forecasting models and comprehensive sensitivity analyses.

Keywords: COMFAR software, Economic evaluation, Internal rate of return, Oil and gas fields, Net present value.

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1. Introduction

Financial constraints cause companies to use economic evaluation for prioritizing projects and investments. This evaluation provides various tools to identify projects with high financial value and help optimize investments and reduce the risks associated with costly drilling operations, preventing the wastage of resources. Additionally, by enhancing field productivity and improving Iran's competitive position in the global gas market, they contribute to national revenue growth. Economic studies not only aid in better decision-making for the development of gas projects but also play a crucial role in the optimal management of natural resources, reducing environmental impacts, and creating local employment. Furthermore, they contribute to the country's energy independence and national security (Azizi et al., 2018). Managers in the oil and gas industry face significant challenges of making investment decisions. Fluctuations in production rates and inflation, changes in global energy prices, and uncertainties in predicting costs and revenues are key issues that affect productivity and competitive advantages. These uncertainties make it difficult to develop optimal investment strategies (Popescu et al., 2021). According to the Fortune Global 500 rankings, 5 of the top 10 companies worldwide are in the oil and gas industry. This reflects the importance of the oil and gas sector in the global economy and emphasizes the need for careful research in investment decision-making in this sector. Studies in this field should be conducted with precision due to the large financial sums involved (Fortune Global 500, 2023). The growing demand for oil and dependence on crude oil and gas imports since the beginning of the 21st century have pushed major oil and gas companies toward global expansion strategies and large-scale investments. Therefore, investment evaluation using methods like discounted cash flow, which accounts for risk, is crucial. This approach helps provide a more accurate assessment of the value of investments (Li et al., 2020). Previous researchers have explored similar areas. For example, Ghanbari Maman et al. (2021) conducted an economic evaluation of refinery projects using cost-benefit analysis in the Siraf refinery and showed that despite financial discounts, some projects were not fully financially viable; however, economic justification significantly increases under different scenarios. Hajizadeh et al. (2019) prioritized the economic extraction of oil from the West Karun fields using cost-benefit analysis and showed that carbon capture was economically justified in some fields. Muhsin and Zhang (2019) conducted an economic evaluation of crude oil refining processes and demonstrated a 47% cost reduction when using the hydrotreating method compared to conventional methods. Pazouki and Khalagati (2018) emphasized the benefits of conducting economic evaluations for informed investment choices using pre-drilling economic analysis criteria. Akinwale et al. (2016) evaluated the economics of marginal oil and gas fields in Nigeria, highlighting the impact of various factors on net present value (NPV), such as taxes, crude oil prices, and operating costs, indicating that these projects remained profitable with a positive NPV.

Based on the above discussion, the economic evaluation of developing four gas wells to expand one of the gas fields in the north-east of Iran will be examined. This study will cover all stages, from exploring the target field to drilling multiple wells, starting up the well clusters, building pipelines to the refinery, setting up a gas gathering center, and other related activities needed for the operation and production of these wells. By looking at the gas output from the wells and the resulting revenue, along with the costs from the beginning of the project to the operational phase, we will assess whether this project is economically viable. This project differs from similar projects in several ways. Firstly, unlike many economic evaluations that rely on fixed assumptions for macroeconomic variables, this project specifically forecasts inflation using the autoregressive integrated moving average (ARIMA) model. This approach provides a more accurate and realistic analysis of the effects of inflation on the project's costs and revenues. Secondly, a comprehensive sensitivity analysis is conducted on various parameters such as gas and condensate production rates, gas prices, fixed and variable costs, and inflation rates. This sensitivity analysis allows the project to maintain its feasibility and profitability under different economic scenarios, even in unfavorable conditions. This combined approach is the key distinction of this project compared to others, which are typically conducted with simpler and fixed assumptions. The results of this study show that the project to construct four gas wells in the north-east of Iran is economically justified. Financial indicators such as the net present value and the internal rate of return (IRR) are both positive and exceed the 30% discount rate, indicating the profitability of the project. Sensitivity analysis also reveals that even with changes in production rates, prices, and costs, the project remains financially stable. Notably, gas production, as the main driver of the project's profitability, plays a significant role. Further, this economic evaluation can assist decision-makers in better prioritizing investments in the oil and gas sector, particularly for high-cost and high-risk projects. Additionally, this project can strengthen Iran's position in the global gas market, while contributing to local job creation and increasing national revenue.

2. Literature review

Numerous studies have assessed the economic viability of oil and gas projects using various criteria. Sokolov et al. (2024) reviewed five main criteria: net present value, internal rate of return, profitability index (PI), payback period (PP), and discounted payback period (DPP). They concluded that combining these criteria could improve investment decision-making. Their study showed that NPV, due to its consideration of the time value of money, was a suitable metric for evaluating projects, while IRR was useful for comparing the rates of return on different projects. PI was used to compare projects with different levels of investment and was simple and easy to understand; DPP accounted for the time value of money but was more complex to calculate.

Waqar et al. (2023) analyzed the economic implications of adding heat recovery steam generators to gas and combined cycles. Their findings indicated that while energy efficiency improved, the associated costs could negatively impact NPV and IRR, illustrating the trade-offs inherent in economic evaluations within the industry. Pandit et al. (2023) analyzed the economics of glycerol valorization projects and reported longer payback periods (8.36 years for incineration and 7.13 years for landfill gas), which might be less attractive to investors compared to projects with shorter payback periods. Additionally, Nubi et al. (2022) pointed out that some projects had significantly higher NPVs than others, with one specific project yielding an NPV more than 1.5 times that of comparable projects. Xing et al. (2023) emphasized that the COVID-19 pandemic and geopolitical tensions could have a significant impact on project NPVs. In some cases, project NPVs were estimated to reach as high as $62 million under certain conditions. This underscores the importance of considering external market fluctuations in economic evaluations.

Pheakdey et al. (2023) stated that the energy recovery project from municipal solid waste had an IRR of 31%, indicating the high return potential of this project. In some studies, such as Pandit et al. (2023), the IRR was not specified, which could limit comparisons between projects and more precise evaluations. Obileke et al. (2022) demonstrated that the NPV of a biogas production project was $1783.10, while another project with an NPV of $235 million highlighted the high investment return potential in energy recovery projects. Obileke et al. (2022) noted that the payback period for the biogas project was 2 years, while Martínez et al. (2022) and Nubi et al. (2022) confirmed that energy recovery projects from municipal solid waste had payback periods ranging from 1.6 to 3.2 years, demonstrating a favorable return for investors. Dai et al. (2022) also analyzed three main investment criteria, namely NPV, IRR, and PP, evaluating their advantages and disadvantages. They found that NPV, providing a definitive figure and considering the time value of money, was one of the key metrics for investment evaluation. Meanwhile, IRR, indicating the return on a project without needing a discount rate, was useful for comparing projects. However, IRR might be less accurate in cases involving variable cash flows or projects of different sizes. Both studies emphasized that using a combination of these two criteria could help optimize investment decision-making.

Other studies have analyzed costs and profitability in different projects. Green et al. (2020) discussed how advanced computational techniques, including proxy models, could optimize well controls to maximize the NPV of life-cycle production. Their findings highlighted that precise NPV calculations were essential for informed investment decisions, demonstrating that enhanced optimization could yield improved economic outcomes. Similarly, Lai and Ngu (2020) emphasized the necessity of NPV in evaluating the sustainability of Arctic oil and gas projects. Their bibliometric analysis revealed that integrating economic metrics into sustainability assessments was crucial for balancing socio-economic benefits with environmental risks. This finding reflected a broader trend in the literature where NPV and IRR served as essential tools for measuring project feasibility. Psarras et al. (2020) provided a detailed cost analysis of carbon capture and sequestration from natural gas-fired power plants, showcasing how such assessments could directly influence NPV calculations. The focus on cost efficiencies aligned with the principles of NPV and IRR, reinforcing their importance in evaluating project profitability.

Additionally, Gomes et al. (2021) conducted a cost-benefit analysis of a proposed blockchain system designed to enhance supply chain efficiency in oil and gas projects. Their research quantified potential cost reductions, suggesting that improved operational efficiencies could significantly enhance NPV, thereby making a strong case for the integration of innovative technologies in economic evaluations. Brodziński et al. (2021) and Yao and Cai (2021) did not specify the IRR values for their projects, highlighting a gap in complete financial assessments. This omission could lead to an incomplete understanding of project feasibility, particularly in high-stakes sectors like petroleum. Kitamura et al. (2020) reported that the IRR in their evaluation of a biorefinery exceeded 100%, indicating exceptional profitability for the project. Similarly, Kumar et al. (2020) presented comparable IRR results, attesting to the economic attractiveness of renewable energy projects. León et al. (2020) and Kitamura et al. (2020) both indicated a payback period of approximately five years for their respective projects, implying a relatively short recovery time for their investments.

In a different scenario, Kumar et al. (2020) demonstrated an NPV of $1.4 million for a natural deep eutectic solvent-based biorefinery, emphasizing the economic viability of innovative biorefinery approaches. Additionally, León et al. (2020) reported an NPV of $2,785,624 for a production process of activated carbon, signifying its potential profitability over 10 years. Kiani et al. (2016) assessed the economic feasibility of associated gas recovery projects using NPV and discount rate criteria, demonstrating that certain projects, particularly at high discount rates, had negative NPVs and lacked economic justification. Abdolmaleki et al. (2015) performed a cost-benefit analysis of gas and electricity exports to Iraq, indicating that gas exports might be more cost-effective than electricity under specific conditions. Millington et al. (2014) emphasized the importance of analyzing the monetary implications of pollution on the NPV of a new refinery in Canada, demonstrating that changes in parameters, such as the carbon capture unit, could significantly affect the project’s NPV.

Overall, previous studies show that using various economic evaluation criteria, such as NPV, IRR, PP, and cost-benefit analysis, can help with optimal decision-making for oil and gas investments. These criteria have specific strengths and weaknesses depending on the conditions and type of project, and combining them in evaluations can lead to more accurate results. In countries experiencing high inflation, it is essential to consider the effects of inflation in the financial analysis of projects. While most of the studies reviewed provide valuable insights into the profitability and economic evaluation of investments using metrics like NPV and IRR, they often do not account for inflation as a critical macroeconomic variable. In inflationary environments, failing to include these factors can result in misleading conclusions about a project's financial sustainability. Inflation can significantly affect cost structures, cash flows, and overall economic viability, especially over the long term. Therefore, for a more accurate assessment of a project's potential, particularly in countries with high inflation rates, incorporating the impact of inflation into economic calculations is crucial.

3. Methodology

In the economic evaluation of oil and gas projects, specific theoretical frameworks are used to ensure that the analysis and assessment of these projects are conducted accurately and scientifically. The most important of these indicators are the following:

Net present value

The net present value of a project represents the present value of the project's revenues minus the present value of its costs. If the NPV of a project is positive, the project is considered economically viable (Abolhasani, 2013).

$$NPV = \sum_{t=0}^{n} \frac{(R_t - C_t)}{(1 + i_d)^t} \tag{1}$$

Internal rate of return

The internal rate of return is essentially the rate of return on an investment. It is the discount rate that makes the net present value of a project equal to zero. In other words, if the revenues and costs of a project are discounted at the IRR rate, the NPV of the project becomes zero.

$$\sum_{t=0}^{n} \frac{(R_t - C_t)}{(1 + IRR)^t} = 0 \tag{2}$$

In this method, the internal rate of return should be compared with the discount rate. As long as the IRR exceeds the discount rate, the project is considered economically viable and worth implementing.

Payback period

The payback period is the number of years required to recover the initial investment. According to this criterion, a project with a shorter payback period is more economically efficient. The payback period is determined by dividing the initial investment cost by the annual cash flow.

$$PBP=I/NCF \tag{3}$$

where PBP is the payback period, I is the investment cost, and NCF is the annual cash flow. This method is suitable for risk-averse investors who prefer to recover their investment periodically.

Dynamic payback period

The dynamic payback period involves calculating the payback period while accounting for the time value of money, with calculations based on discounted cash flow data.

Net present value ratio (NPVR)

This ratio refers to the net present value of a project relative to its initial investment. It indicates how many units of NPV are generated for each unit of investment over the project's lifespan. Generally, if the NPVR is greater than 1.0, it indicates that the project is profitable and implies a suitable investment (Zahedi and Moallemi, 2017).

This research utilizes a theoretical framework based on key economic indicators, including net present value, internal rate of return, payback period, dynamic payback period, and net present value ratio which are widely recognized in previous studies for evaluating oil and gas projects. By calculating these indicators from project financial data, we aim to enhance understanding of the economic potential of these projects and improve investment decision-making, while facilitating comparisons with other studies.

Iran holds a significant global position in the natural gas trade. According to the British Petroleum (BP) Statistical Review of World Energy at the end of 2020, Iran is ranked second in the world in terms of gas reserves, with 31.9 trillion cubic meters, following Russia holding 37.4 trillion cubic meters. Iran accounts for approximately 17.1% of global gas reserves. With an annual production of 250.8 billion cubic meters, Iran is the third-largest gas producer globally, following the United States and Russia, with a 6.5% share of global production.

The report also stated that Iran's gas exports via pipelines amounted to 16 billion cubic meters in 2020, while the total global gas exports were 755.8 billion cubic meters, giving Iran a market share of about 2.11%. However, given its vast gas reserves and strategic location, Iran has the potential to increase its share in regional and international gas markets. In 2020, Iran's gas was exported to countries such as Turkey, the European Union, Middle Eastern countries like Iraq, and some Commonwealth of Independent States (CIS) member countries, including Azerbaijan (BP Report, 2021).

3.1. Macroeconomic variables affecting economic evaluation

In today's economic environment, macroeconomic variables such as interest rates and inflation rates significantly impact the assessment and forecasting of economic performance. This study examines the influence of these variables on the economic evaluation of developing several gas wells in one of the gas fields in the east of Iran. Interest rates affect investment decisions and economic productivity, while inflation rates influence financial decisions and the value of money. Accurate forecasting of these variables helps managers and policymakers make better economic policy decisions. This research analyzes these variables in detail to explore their crucial role in the economic evaluation of the project.

Interest rate

From the perspective of economic entities, the interest rate is the price paid for borrowing credit or money. It also represents the opportunity cost of using money or the cost of renting money. The interest rate signals producers about where to allocate their financial resources for investment (Abolhasani and Bahraminia, 2018).

Inflation rate and its trend forecasting

Inflation is defined as a continuous and sustained increase in the general price level. Various economic and non-economic factors can cause this increase, affecting the general price level from either the demand or supply side. From a demand perspective, inflation occurs when there is increased demand for goods and services, while the supply remains constant. Several factors can increase demand; for example, a higher supply of money than the economic needs of the country or the volume of produced goods can cause a demand increase, and so can excessive issuance of banknotes and increased credit in society. People's expectations about the future can also influence demand. On the supply side, factors that raise production costs or reduce output levels lead to an increase in the general price level. These factors include higher costs for raw materials, increased costs of production inputs, and rising prices of various energy carriers. Natural disasters such as floods, earthquakes, storms, and droughts also contribute to higher production costs, reduced output, and, consequently, increased general price levels (Abolhasani and Bahraminia, 2018).

3.2. Description of the gas field

This gas field was confirmed following geological studies and seismic operations, and a single exploratory well was drilled thereafter. The dimensions of the gas structure are 4 × 13 kilometers. Drilling well number one began on May 25, 2009, aiming primarily to evaluate the hydrocarbon potential of the Shurijeh and Mozdouran formations, with the Kashf-Roud formation as a secondary target. After testing these formations, the rig was demobilized on July 4, 2010. Through nine formation tests conducted in well 1 and reservoir logging, the presence of gas in the Shurijeh, Mozdouran, and Kashf-Roud formations was confirmed. Gas production was established in the Mozdouran formation during the tests, while only minor amounts of gas surfaced from the Shurijeh and Kashf-Roud formations. This project was put on hold until early 2024; however, from 2024 onward, the National Iranian Oil Company has prioritized the repair and completion of well 1, along with drilling three additional wells.

The gas pricing determination method follows a rule of thumb for natural gas pricing: In the United States, these rules are based on fixed ratios between the prices of gas and crude oil (Brown et al., 2007).

The following are some examples:

10-to-1 rule: The gas price is set at one-tenth of the crude oil price (e.g., if the oil price is $60, the gas price would be $6 per million BTU).

1-to-6 rule: The gas price is set at one-sixth of the crude oil price, considering the thermal content, but this may overestimate the actual price.

Burner tip rule: This rule determines the gas price based on the complex relationship between gas and oil prices, taking into account various market factors:

$$P_{\mathrm{HH}} = 0.1511 \times P_{\mathrm{WTI}}$$

Simple regression: Another method introduced by Brown and Russell uses weekly price data:

$$P_{\mathrm{HH}} = 0.1104 + 0.1393 \times P_{\mathrm{WTI}}$$

Gas pricing based on a netback method: This method, commonly used in the European market, determines the gas price based on the weighted average price of substitute fuels, such as fuel oil and diesel, and adjusts it for transportation, storage, and taxation costs. The study of Ram et al. (2021) examined the retroactive pricing method for Iranian gas exports to Europe. They calculated the market value of gas for major gas-consuming countries and estimated the transportation and transit costs from Iran to these countries. Based on their findings, the market value of gas was estimated at $985, $875, $740, and $674 per thousand cubic meters for Italy, France, Spain, and Germany, respectively. The transit fees and transportation costs for Italy and Germany were estimated at $157 and $367 per thousand cubic meters, respectively, resulting in an export gas price of around $307 per thousand cubic meters at the Iranian border for Germany (Ram et al., 2021).

Due to the lack of precise data on the export gas price in Iran, this study uses the average price of Henry Hub gas in the United States for 2023, which is $2.5 per million BTU or approximately 9 cents per cubic meter. This value is rounded to about 10 cents, and a sensitivity analysis will be conducted on it. Additionally, in May 2023, the price of gas condensates on the Iranian Energy Exchange was $45 per barrel, while the global oil price was around $80, indicating a $35 price difference.

The gas production rate of the field is forecasted in this study using the MBAL software. The details of this forecast are presented in Table 1.

Table 1

The forecast results

Year	Gas production rate (MMScf/day)	Gas condensate rate (STB/day)
2027	106.00	10.60
2028	106.00	10.60
2029	106.00	10.60
2030	106.00	10.60
2031	106.00	10.60
2032	106.00	10.60
2033	106.00	10.60
2034	103.09	10.30
2035	87.87	8.78
2036	75.39	7.53
2037	65.02	6.50
2038	56.32	5.63
2039	48.95	4.89
2040	42.69	4.26
2041	37.33	3.73
2042	32.71	3.27
2043	28.72	2.87
2044	25.26	2.52
2045	22.25	2.22
2046	18.35	1.85

The method used for the project feasibility analysis involves the COMFAR III software, developed by the United Nations Industrial Development Organization (UNIDO). This software assists in cash flow analysis, identifying opportunities, strategic planning, and analyzing external financial resources. COMFAR III can also calculate the internal rate of return and net present value and provide results in tables and charts.

The project planning outlines that the construction period will last from the beginning of 2024 to the end of 2026. This period mainly includes the repair and completion of well 1, drilling three additional gas wells, installation of equipment, testing, and commissioning, as well as the construction of necessary infrastructure such as roads, buildings, power and telecommunications lines, and gas transmission lines. Drilling each well, along with the associated tests and equipment installation, will take approximately six months, with one drilling rig responsible for drilling all four wells.

The operational lifespan of each well is projected to be 20 years based on simulations. During the first 7 years, the production rate will remain steady, after which the production of gas and condensates will gradually decline and cease by the 20^{th} year.

3.3. Inflation rate forecast using ARIMA

To forecast the inflation rate until 2031, we employed the autoregressive integrated moving average model, which involved the following steps:

1. Stationarity Test: Using monthly inflation rate data from April 2006 to March 2023, the augmented Dickey–Fuller (ADF) test was conducted. The results indicated that the inflation rate was nonstationary and became stationary after two differences.

2. Auto-Regressiveness Test: Examining the autocorrelation (AC) and partial autocorrelation (PAC) plots confirmed that the inflation variable was auto-regressive. The autoregressive (AR) (1) and moving average (MA) (1), MA(2), and MA(3) lags were selected for the ARIMA model.

3. ARIMA Model: The forecasting model was determined to be ARIMA(1,2,3) and confirmed that all lags were significant at a confidence level of 99%.

4. In-sample forecasting: The model was estimated for data from April 2006 to December 2020 and then forecasted for January 2021 to December 2022. The mean percentage error was 13.7%.

5. Out-of-sample forecasting: Using all available data, the inflation rate was forecasted until 2031. The results indicated that the predicted inflation rate would be around 49%.

These forecasts were conducted using EViews software, and the results were used in conjunction with COMFAR software for evaluating oil and gas projects.

The discount rate in this study was set to 30%, which was equivalent to the interest rate on participation bonds as announced by the Central Bank in February 2024.

3.4. Economic evaluation

The identification and quantification of costs in this section involve a precise numerical breakdown of various project expenses, including both foreign and domestic costs, as detailed in Table 2.

Table 2

The cost estimation for field development project

Description of costs for upstream facilities	Cost in Iranian Rials (Billion Rials)	Cost in foreign currency (Million Dollars)
Preparation of the site for drilling three new wells (200 × 200 m^2)	1600	
Land acquisition for drilling three new wells (200 × 200 m^2)	360	
Drilling three new wells	5390	32.68
Repair and completion of well 1	880.4	3.8
Purchase and installation of surface facilities for four wells	1670	9

Description of costs for upstream facilities	**Cost in Iranian Rials (Billion Rials)**	**Cost in foreign currency (Million Dollars)**
Land acquisition for the construction of approximately 15 kilometers of access road for the 3 new wells	680	
Construction of 15 kilometers of access road for the 3 new wells	410	
Land acquisition for the construction of approximately 20 kilometers of flow pipelines, 40 kilometers of transmission pipelines, and the establishment of a gathering center	1730	
Construction of approximately 20 kilometers of 6-inch flow pipelines from the wells to the gathering center	434	2.6
Construction of approximately 40 kilometers of 16-inch pipeline from the gathering center to the refinery	2168	8.3
Preparation of the site for a new gathering center	785	
Construction of a new gathering center	1274	3.25
Purchase and installation of a precise flow measurement system on the 16-inch gas pipeline exiting the gathering center	0	5.5
Purchase and installation of three flow shut-off valves for the sour gas system	88	0.45
Purchase and installation of five pig-launcher and pig-receiver systems for flow and transmission pipelines	138,2	0.63
Flow testing, sampling, and PVT analysis	0	7
Core analysis	0	1.5
Field studies	0	3
Construction of an electrical substation	600	
Purchase of a 1 MW electricity subscription	24	
Construction of electrical lines for four new wells	300	
Development of telecommunications and SCADA systems for four wells	420	
Preliminary/basic and detailed engineering studies for upstream sections	185	
Obtaining necessary environmental permits, establishing green spaces, and nonstructural safety measures	110	1.5
Support, service, welfare, workshop, and administrative needs	652	1.2
Contingency costs	2325.2	6.4

The identification of revenues and quantitative analysis show that drilling four gas wells in this area, as an important project, will contribute to energy supply and generate significant revenues. These wells will produce both natural gas and condensates, each representing a separate revenue stream. Natural gas, with high demand in domestic and international markets, will be the primary source of income, while gas condensates will be used in petrochemical industries and liquid fuel production, contributing to a portion of the revenue. The wells will remain operational for 20 years, with a constant production rate of 106 million cubic feet per day and 10.6 barrels per day of condensate during the first 7 years, followed by a gradual decline until production ceases at the end of the 20-year period. A quantitative revenue analysis will be performed based on these figures using COMFAR software.

4. Results

The COMFAR software output was obtained after entering the data and evaluating them with a discount rate of 30% and an inflation rate of 49% (forecasted using the ARIMA model). For comparison, an inflation rate of 3% was considered for the United States. The gas selling price of 10 cents per cubic meter and the condensate price of $45 per barrel were applied in the COMFAR calculations.

Following the calculations, the net present value with inflation accounted for was found to be 5110 trillion Iranian Rials (equivalent to $8.5 billion with an exchange rate of 600,000 Iranian Rials per dollar). Since this number is positive, the project is economically viable. The chart indicates that the NPV is negative from 2024 to 2026 but turns positive starting from 2027 when production begins. The cumulative net present value is negative until the beginning of 2028 but thereafter becomes positive and increases to 5110 trillion Iranian Rials by 2046.

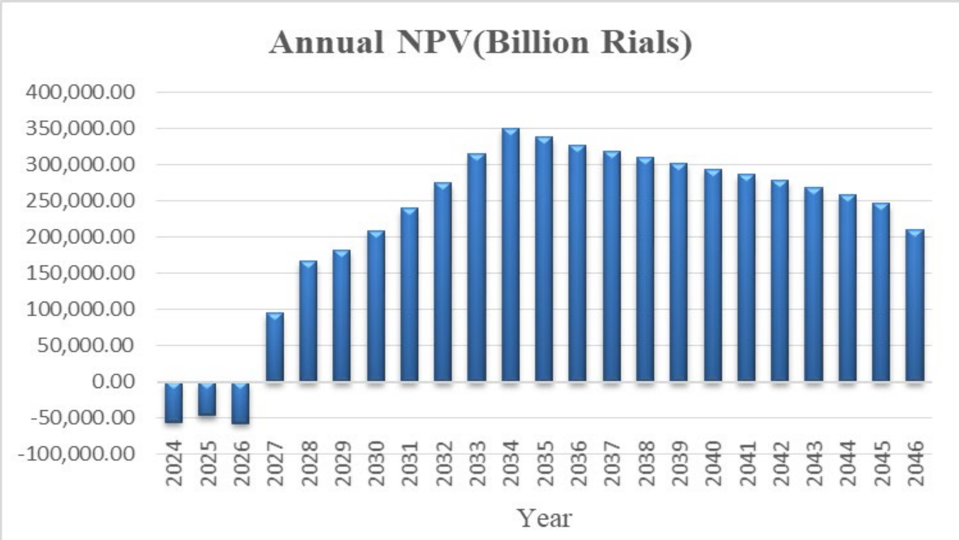

Figure 1

Annual NPV variation over the construction and operation periods, adjusted for inflation

Table 3

Changes in NPV during the construction and operation periods

Year	Cumulative NPV at an inflation rate of 49% (billion Iranian Rials)
2024	–56,149.19
2025	–102,787.03
2026	–159,885.30
2027	–65,113.25
2028	101,923.30
2029	284,452.15
2030	493,630.08
2031	733,380.17
2032	1,008,170.65

Year	Cumulative NPV at an inflation rate of 49% (billion Iranian Rials)
2033	1,323,122.83
2034	1,673,475.18
2035	2,011,304.65
2036	2,338,615.98
2037	2,656,725.56
2038	2,966,479.31
2039	3,268,249.86
2040	3,562,279.82
2041	3,848,404.86
2042	4,126,084.57
2043	4,394,593.33
2044	4,652,893.05
2045	4,899,636.61
2046	5,109,224.43

The internal rate of return for the gas well drilling project is 41.22% without considering inflation and 107.54% when inflation is taken into account. These figures indicate that the project is viable and offers a satisfactory return in both scenarios, as the IRR exceeds the discount rate of 30% in both cases.

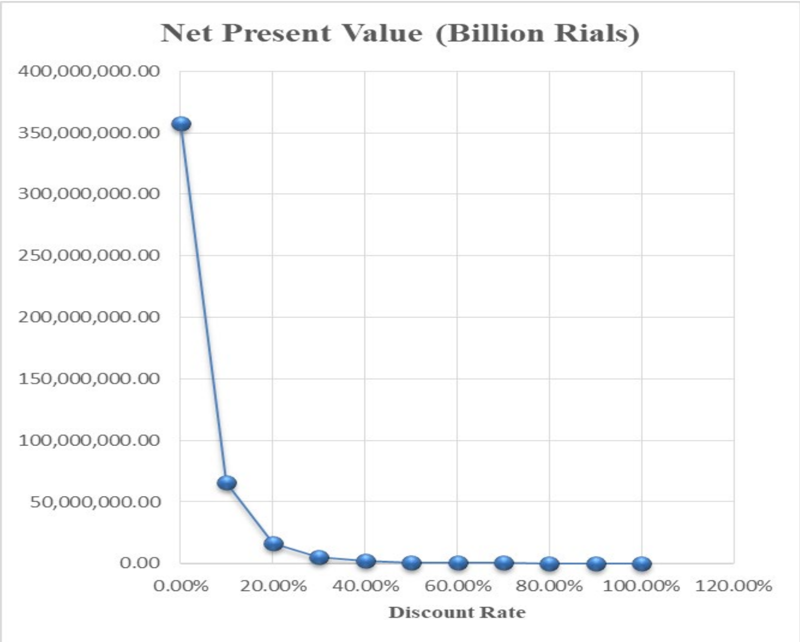

Figure 2

The net present value at different discount rates

Table 4

Net present values at different discount rates

Discount rate	Net present value (billion Iranian Rials)
0.00%	357,740,810.62

Discount rate	Net present value (billion Iranian Rials)
10.00%	65,690,853.66
20.00%	16,089,205.44
30.00%	5,110,917.91
40.00%	2,011,101.16
50.00%	925,634.03
60.00%	470,897.79
70.00%	251,440.57
80.00%	133,452.50
90.00%	64,634.40
100.00%	21,943.13

The chart illustrates the trend of cumulative net cash flows and the normal payback period over the construction and operation phases of the project. During the construction phase and the first year of operation, the net cash flows are negative. Starting from the fifth year, which is four years after the beginning of the project, the cumulative net cash flows turn positive and continue to increase steadily. This steady increase indicates the project's long-term stability and profitability. In other words, one year after the start of operation, the project not only covers the initial costs but also begins to generate continuous profit.

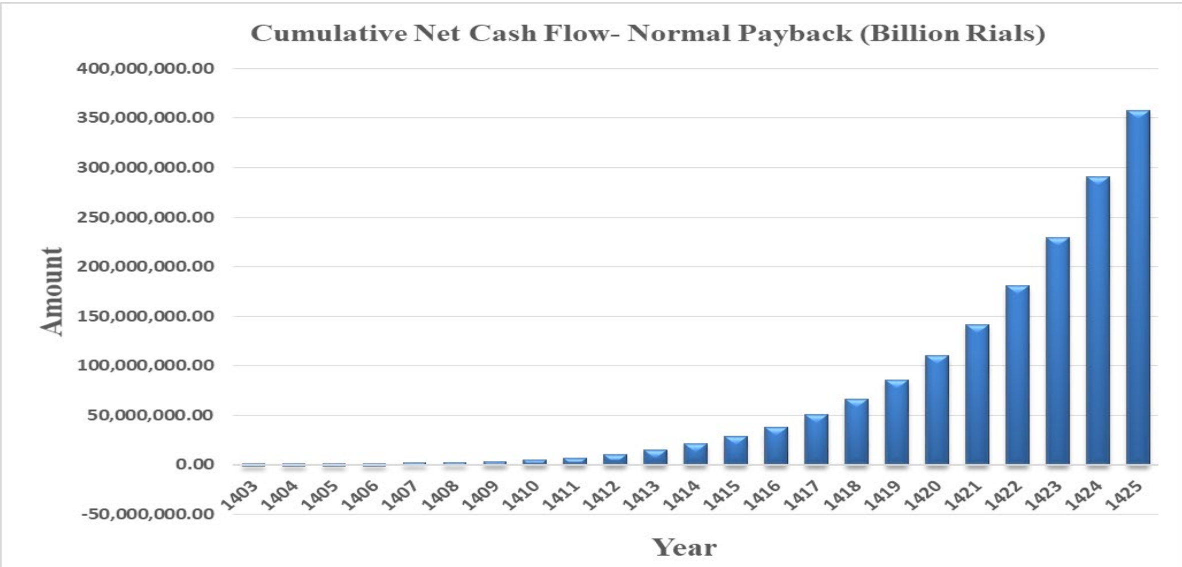

Figure 3

The normal payback period

Figure 4 delineates the cumulative net present value and the dynamic payback period at a discount rate of 30%. The dynamic payback period, considering the time value of money, indicates that it takes 4.39 years from the start of the project to recover the initial investment and 1.39 years from the beginning of the operation for the cumulative net cash flows to become positive.

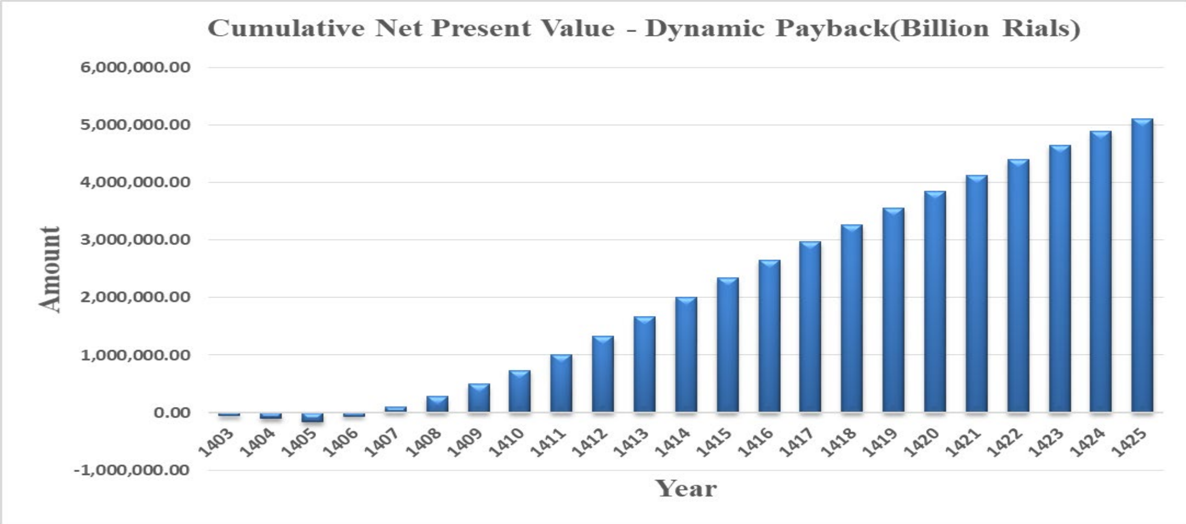

Figure 4

The dynamic payback period

Figure 5 illustrates the ratio of the net profit margin to total sales during the operation phase. This ratio fluctuates between 61% and 93% throughout the operation, reflecting increases or decreases in the net profit according to changes in gas production. This high ratio provides a desirable net profit margin, indicating that the project is economically efficient and has strong profit-generating capabilities.

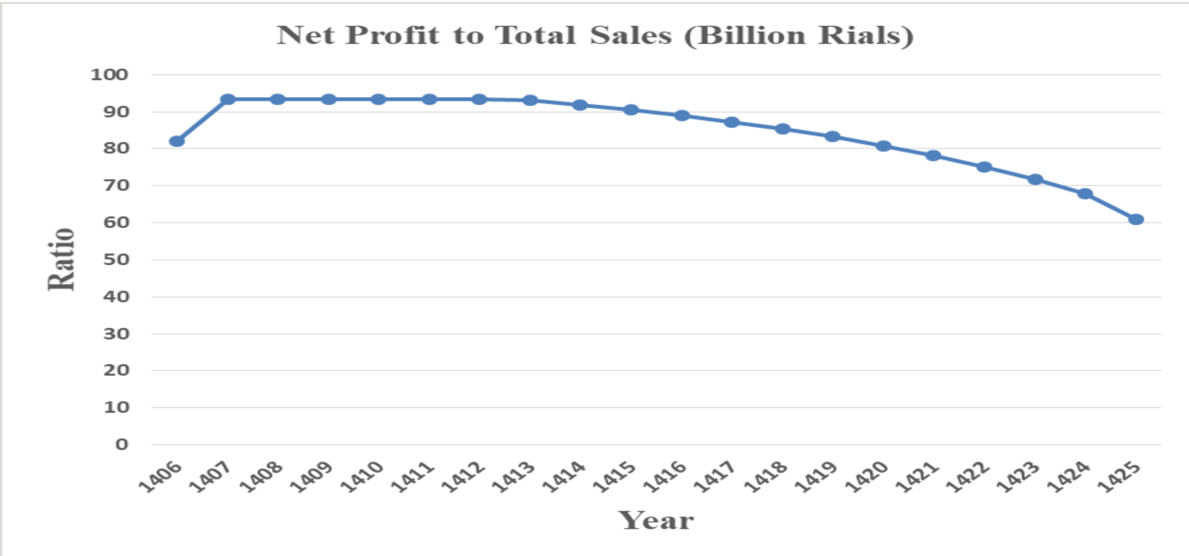

Figure 5

The ratio of the net profit margin to total sales during project operation

In 2027, since the production capacity does not reach its maximum, the ratio of the net profit margin to total sales is 82%. In the following year, as production capacity reaches its peak, this ratio increases; nevertheless, from 2024 onward, with a decrease in the production, it drops to 61% by the final year of operation.

Typically, an NPVR greater than 1.0 indicates project profitability. The NPVR for this project is 12.4, implying that each dollar invested generates approximately $12 in the net present value. This demonstrates that investment in this project is reasonably justified in terms of the net present value.

5. Discussion

This analysis was conducted on sales revenue and fixed and variable costs. The results indicate that a 20% change in sales revenue, fixed investment costs, and operating expenses will not reduce the internal rate of return of the project below 30%. This result signifies that the project remains financially acceptable and justifiable even in the face of significant changes in the key project parameters.

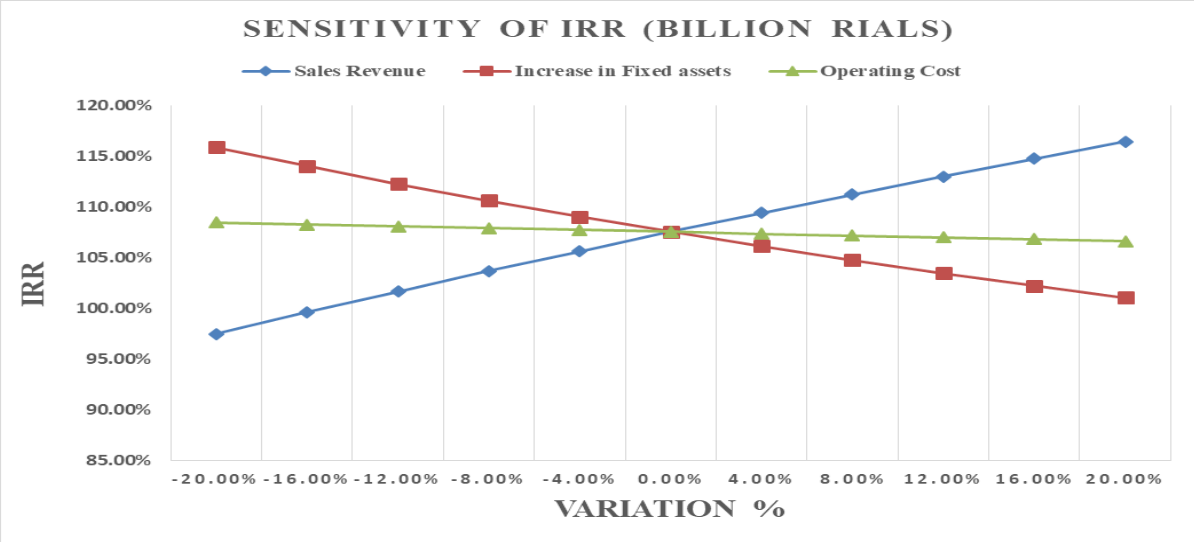

Figure 6

The sensitivity analysis of IRR with respect to changes in sales revenue, fixed investment costs, and operating expenses

The results of this analysis show that even with a 20% decrease in the production rate, the project's IRR remains above 97%. Conversely, a 20% increase in the production rate raises the IRR to 116%.

Table 5

The IRR sensitivity analysis with respect to the production rate

		Gas production rate				
Condensate production rate	٪	–20	–10	Selected scenario	+10	+20
	–20	97.48%	102.67%	107.53%	112.10%	116.43%
	–10	97.49%	102.68%	107.54%	112.11%	116.44%
	Selected scenario	97.50%	102.69%	107.54%	112.12%	116.45%
	+10	97.51%	102.69%	107.55%	112.13%	116.46%
	+20	97.52%	102.70%	107.56%	112.14%	116.46%

The analysis also highlights the different impacts of gas and condensate production rates on the IRR. Due to the smaller volume of condensate production, changes in this rate have little effect on the IRR. In contrast, changes in the gas production rate significantly impact the IRR, indicating that the profitability of the project is heavily dependent on gas production.

The impact of changes in the gas and condensate production rates on the net present value of the project is also examined. In this analysis, the production rate is adjusted by plus or minus 20% to assess the effects on NPV.

The results indicate that even in the worst-case scenario, with a 20% decrease in the production rate, the project's NPV remains positive, demonstrating its financial resilience even under reduced production conditions. On the other hand, in the best-case scenario, with a 20% increase in production rate, the project's NPV significantly rises, indicating high profitability potential if production increases.

Table 6

The NPV sensitivity analysis with respect to production rate (Billion IRR)

Condensate production rate	Gas production rate					
	%	–20	–10	Selected Scenario	+10	+20
	–20	3,859,549	4,484,210	5,108,956	5,733,702	6,358,630
	–10	3,860,465	4,485,152	5,109,937	5,734,658	6,359,520
	Selected Scenario	3,861,426	4,486,172	5,110,917	5,735,663	6,360,409
	+10	3,862,402	4,487,183	5,111,898	5,736,459	6,361,393
	+20	3,863,387	4,488,133	5,112,879	5,737,396	6,362,370

Changes in the gas production rate have a substantial impact on the NPV. These findings confirm that the economic performance of the project is highly dependent on the gas production rate, which plays a crucial role in determining the project's net present value.

The primary goal of this analysis is to evaluate the impact of price changes for two products on the project's net present value. In this assessment, the gas price is considered within a range of 5 to 25 cents per cubic meter, and the condensate price is assumed within a range of $30 to $60 per barrel. The NPV of the project remains positive across all scenarios, even with lower prices for gas and condensate, indicating the project's resilience to price fluctuations of these products.

Table 7

The sensitivity analysis of net present value with respect to changes in gas and condensate prices (Billion IRR)

Condensate price (USD per barrel)	Gas price (cents per cubic meter)					
		5	Selected Scenario	15	20	25
	30	1,983,919	5,107,648	8,231,377	11,355,106	14,489,504
	40	1,986,099	5,109,828	8,233,556	11,357,285	14,491,684
	Selected Scenario	1,987,189	5,110,917	8,234,646	11,358,375	14,492,774
	50	1,988,278	5,112,007	8,235,736	11,359,465	14,493,865
	60	1,990,458	5,114,187	8,237,915	11,361,644	14,496,045

An increase in the gas price from 5 to 25 cents per cubic meter results in a significant rise in the NPV, implying that the NPV is highly sensitive to the gas price.

While an increase in the condensate price from $30 to $60 per barrel has also a positive effect on the NPV, this effect is not as pronounced as the one caused by the changes in the gas price. This is due to the lower production volume of condensates compared to gas, which causes price fluctuations to have a lesser impact on the project's NPV.

This section examines the changes in the fixed investment costs by ±30%, and the results indicate the following:

- An increase in the investment costs leads to a decrease in the NPV. Specifically, an increase in these costs can extend the payback period to 4.63 years.
- A decrease in the investment costs results in an improved NPV, demonstrating that the project is sensitive to reduction in investment costs and shows improvements in the net present value.

Table 8

The sensitivity analysis of the net present value with respect to the fixed investment costs

	Billion Rials (NPV)	Year (PP)	Year (DPP)
Decrease in fixed investment costs by 30%	5,151,324	3.76	4.15
Initial results	5,110,917	4	4.39
Increase in fixed investment costs by 30%	5,070,511	4.13	4.63

Changes in the operating costs are also examined by ±30%, and the results are as follows:

- An increase in the operating costs results in a decrease in the NPV, which is due to the higher ongoing project costs and reduced profit margins.
- A decrease in the operating costs leads to an improved NPV; reducing these costs contributes to increased project profitability.

Table 9

The sensitivity analysis of the net present value with respect to the operating costs

	NPV(Billion Rials)	PP(Year)	DPP(Year)
Decrease in operating costs by 30%	5,414,415	3.93	4.31
Initial results	5,110,917	4	4.39
Increase in operating costs by 30%	4,807,419	4.07	4.47

The sensitivity analysis shows that the project still maintains a positive net present value under various conditions, even with significant fluctuations in the fixed investment costs and operating costs.

Given the high inflation rate in Iran, the sensitivity analysis of the NPV with respect to the inflation rate is conducted considering scenarios with higher inflation rates. Generally, an increase in the inflation rate leads to a decrease in the NPV. This decrease is due to rising operating and investment costs, as well as a reduction in the real value of future revenues. However, in specific situations like the current project, higher inflation rates might result in an increase in the NPV. This happens when the project's revenues benefit from inflation. For instance, if the project's products are sold in international markets with foreign currencies, and the local currency depreciates due to the high inflation rate, the project's revenues in local currency increase.

Table 10

The sensitivity analysis of the net present value with respect to the inflation rate

Inflation rate	NPV(Billion Rials)	PP(Year)	DPP(Year)
10	132576	4.4	5.66
20	351784	4.24	5.08
30	872570	4.13	4.75
40	2178327	4.06	4.53
Selected scenario	5110917	4	4.39

Furthermore, since the discount rate in the NPV formula is assumed to be constant, an increase in the project revenues relative to its costs, due to rising inflation, can lead to a higher NPV. This is particularly true for projects where products are sold in international markets with stable currencies.

6. Conclusions

The project's economic evaluation shows strong viability, with a net present value of 5110 trillion IRR ($8.5 billion) when accounting for inflation. This positive NPV indicates that the project is economically feasible. Although the annual NPV is initially negative from 2024 to 2026, it turns positive starting in 2027 and reaches 5110 trillion IRR by 2046. Despite a decline in production after 2034, the project remains profitable over time. The internal rate of return is 41.22% without inflation and 107.54% with inflation, both exceeding the 30% discount rate, which confirms the project's financial attractiveness. The payback period analysis shows negative cash flows during the construction phase and the first year of operation, but they become positive from the fifth year, indicating long-term profitability. The project's profit margin ratio remains strong throughout the operation phase, ranging from 61% to 93%, and the net present value ratio of 12.4 signifies a favorable return on investment. Sensitivity analysis reveals that variations in production rates, prices, and costs do not significantly undermine the project's financial stability. Even ay high inflation rates, the NPV can be maintained or increased under certain conditions, such as foreign currency sales. In summary, the project is economically justified with a positive NPV, high IRR, and resilience to financial and operational changes, demonstrating strong long-term profitability and value. However, inflation, global energy market changes, and production rates can impact the final results of the project. Therefore, risk management and precise planning to address these uncertainties are essential.

The limitations and challenges include the variability in production rates and the inflation rate, which can impact both revenues and costs; fluctuations in global energy prices that directly affect project revenues; and the uncertainty in forecasting costs and revenues, particularly in large-scale and long-term projects. For future research, it is recommended that the economic impacts of projects on local and regional economies, such as job creation and economic development, should be explored; the environmental effects, including greenhouse gas emissions and impacts on natural resources, should be assessed; and new technologies in the oil and gas industry to boost efficiency and reduce costs should be investigated. Practical recommendations involve adopting advanced technologies to enhance efficiency and cut costs, implementing strong management systems to control expenses and optimize resources use, and securing long-term sales contracts with reliable customers to minimize economic risks and market volatility.

This study points to several important applications. Firstly, the project can contribute to increasing the domestic energy supply and gas exports, thereby strengthening Iran's position in global gas markets. Additionally, the revenues from gas and condensate exports would boost the country's economic growth and improve foreign exchange income. Secondly, the successful execution of this project can help create local employment opportunities and develop regional infrastructure, playing a key role in enhancing local welfare and reducing unemployment. Lastly, this economic evaluation can assist policymakers in prioritizing investments in the oil and gas sector, leading to better resources management and risk mitigation.

Nomenclature

AC	Auto correlation
AR	Auto regressive
ARIMA	Auto-regressive integrated moving average
DPP	Dynamic payback period
IRR	Internal rate of return
MA	Moving average
NPV	Net present value
NPVR	Net present value ratio
PAC	Partial auto correlation
PI	Profitability index
PP	Payback period

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