

Unlocking the Value in the Oil and Gas Industry- Techno-Commercial Strategies and New Technologies for Enhanced Profitability

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Abstract

The oil and gasoline corporations had been extensively impacted in the course of COVID-19, leading to a worldwide oil rate drop and also in demand for oil and gasoline as the oil rate hit ancient lows. predominant agencies like ExxonMobil and Baker Hughes slashed budgets and deferred projects, even as offshore systems and far-flung web sites noticed team of workers reductions. To boom the oil price, organizations installation many mixed strategies that balance deliver growth with sustainability and marketplace balance. technology like virtual transformation, internet-zero techniques by using shifting toward renewable, Asset optimisation, and predictive preservation accelerate oil and fuel marketplace. no longer best the ones technical strategies, but additionally a few industrial strategies, via keeping the seller profiles, procurement data and contacts, economic data covered by means of CAPEX and OPEX control, with monetary fashions like NPV, IRR, and payback, which assist sturdy assignment rating and informed funding selections. except this, numerous technical adaptability capabilities like real-time production monitoring with IoT and SCADA, AI/ML-pushed predictive analytics, and improvement in drilling technology, like the deployment of recent downhole sensors, development of smart drilling processes, at the side of a smart and powerful information analytics device, alongside new and advanced seismic technology like complete-waveform imaging (FWI), Seismic while drilling (SWD), dispensed acoustic sensing (DAS) and many others supply a new era in oil field. From the above dialogue, it has been clear that the COVID-19 pandemic acted as a catalyst for technological innovation across the industry of oil and gasoline. advanced population and combustion studies have immediately motivated gas performance, emissions reduction, and alternative strength systems — key factors of price creation in the oil and fuel industry.

Keywords: Oil and gas, Covid-19 impact on oil and gas, strategy adaptation, weighted analysis

2. Introduction

The COVID-19 pandemic severely disrupted global oil and gas operations, causing demand collapse, project delays, and financial strain. However, it accelerated digital transformation through automation, AI, and remote operations, ensuring business continuity. Companies optimised CAPEX, OPEX, and adopted resilience-focused strategies to stabilise performance. The crisis ultimately drove innovation and sustainability, unlocking new value and profitability in the post-pandemic energy landscape. New technologies such as AI, automation, and digital oilfields are creating high-skilled jobs in data analytics, remote operations, and maintenance, driving efficiency and employment growth in the oil and gas industry. The motivation behind this study is to explore how emerging technologies and innovative strategies in the oil and gas industry can enhance efficiency, create skilled employment, and unlock greater economic and sustainable value.

Table 1. Oil Price Trend Before, During & After COVID-19.

Period	Key Events	Price Level
2018–2019 (Pre-COVID)	Balanced demand, OPEC cuts, shale growth	Brent \$60–75
Early 2020 (Pandemic Begins)	Lockdowns, demand collapse	Brent \$20–25
April 2020	Storage overflow, OPEC+ price war	WTI –\$37
2021 (Recovery)	Vaccines, economy reopens, OPEC cuts	Brent \$70–80
2022 (Ukraine War)	Supply fears, sanctions	Brent \$100–130
2023–2024	Weak demand in China, inflation, SPR release	Brent \$70–90

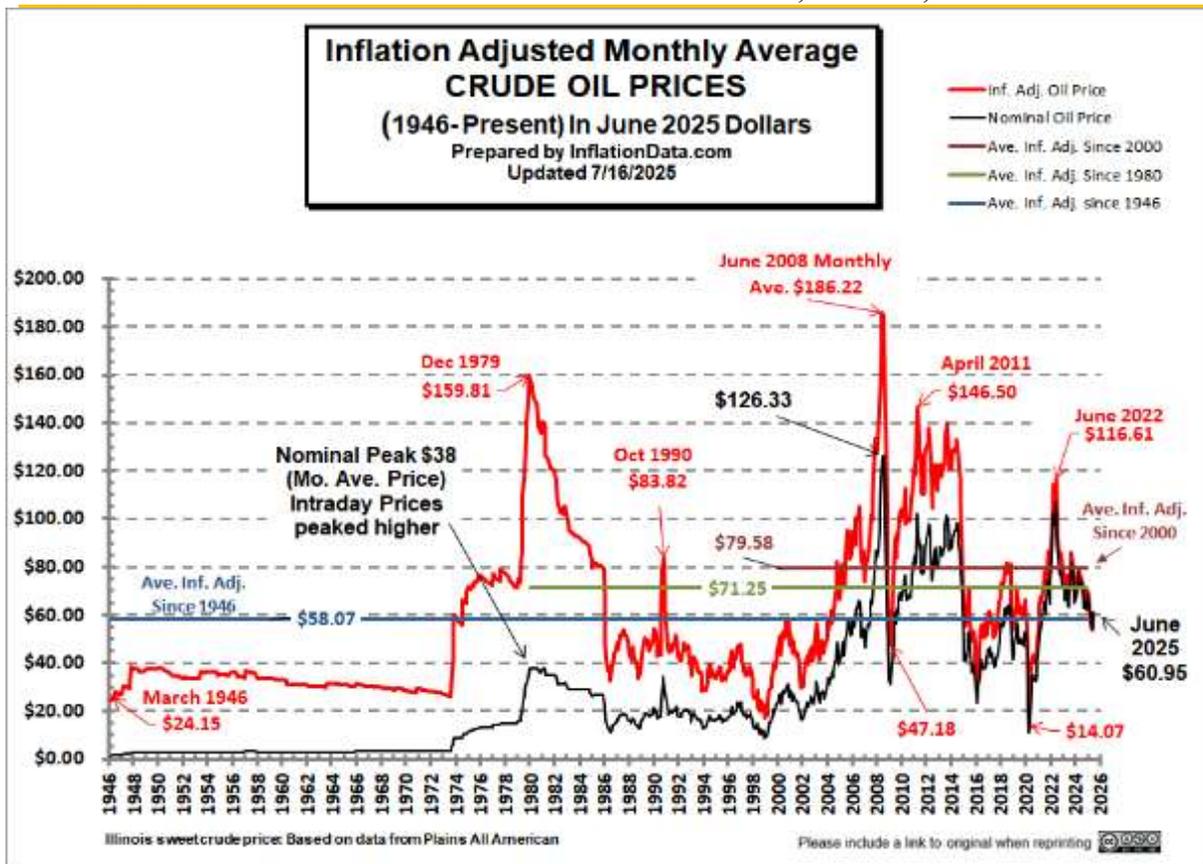


Figure 1. Chart: Brent vs WTI — Long-Term Price Comparison.

- The images above show historical price charts of Brent and WTI side by side (often over decades), including the period before, during, and after the COVID-19 pandemic.
- These charts highlight that while Brent and WTI generally **trend in the same direction**, there are periods of **spread (price difference)** — sometimes wide, sometimes narrow — depending on market conditions (supply, demand, transport constraints, geopolitics, regional factors). The chart below shows the different oil companies' revenue and net income before and after COVID -19

Table 2 Oil companies' revenue(billion USD)along with net income (Billion USD) from 2018 to 2024

Company	Year	Revenue (Billion USD)	Net Income (Billion USD)
ExxonMobil	2018	74.28	35.45
ExxonMobil	2019	79.86	25.97
ExxonMobil	2020	46.45	-62.69
ExxonMobil	2021	70.98	10.17
ExxonMobil	2022	77.77	26.99

ExxonMobil	2023	91.49	35.46
ExxonMobil	2024	88.5	29.25
Chevron	2018	215.41	8.26
Chevron	2019	231.95	10.53
Chevron	2020	121.53	-12.09
Chevron	2021	210.32	10.93
Chevron	2022	244.69	6.95
Chevron	2023	219.51	5.44
Chevron	2024	194.27	11.83
Shell	2018	442.77	27.91
Shell	2019	376.14	29.63
Shell	2020	181.5	-22.8
Shell	2021	332.09	12.81
Shell	2022	434.47	28.11
Shell	2023	458.7	36.01
Shell	2024	381.28	39.97
BP	2018	199.18	29.29
BP	2019	216.53	27.39
BP	2020	96.04	-16.47
BP	2021	193.27	27.68
BP	2022	231.68	40.98
BP	2023	212.38	34.2
BP	2024	187.36	19.66
TotalEnergies	2018	206.18	27.7
TotalEnergies	2019	223.64	28.45
TotalEnergies	2020	111.02	-43.7
TotalEnergies	2021	166.55	6.23
TotalEnergies	2022	212.79	19.29
TotalEnergies	2023	210.56	36.54
TotalEnergies	2024	196.73	15.07
Saudi Aramco	2018	343.85	12.78
Saudi Aramco	2019	371.35	13.36
Saudi Aramco	2020	202.84	-15.75
Saudi Aramco	2021	345.98	4.4
Saudi Aramco	2022	316.36	7.08
Saudi Aramco	2023	413.75	11.54
Saudi Aramco	2024	335.65	12.01
Equinor	2018	418.05	6.85
Equinor	2019	382.39	6.44
Equinor	2020	217.17	-8.57
Equinor	2021	292.66	2.23
Equinor	2022	484.35	9.86
Equinor	2023	444.82	5.36
Equinor	2024	485.45	8.95
ENI	2018	138.66	26.36
ENI	2019	124.47	33.67
ENI	2020	72.51	-26.24
ENI	2021	112.8	22.6
ENI	2022	130.08	39.34
ENI	2023	161.26	35.36

ENI	2024	143.76	32.69
Petrobras	2018	98.55	20.01
Petrobras	2019	92.23	19.6
Petrobras	2020	49.39	-27.83
Petrobras	2021	71.4	7.28
Petrobras	2022	102.16	16.09
Petrobras	2023	114.3	25.95
Petrobras	2024	93.49	26.18
Petronas	2018	173.38	1.99
Petronas	2019	165.68	1.67
Petronas	2020	79.91	-2.96
Petronas	2021	150.58	1.54
Petronas	2022	159.05	1.53
Petronas	2023	150.76	2.04
Petronas	2024	157.03	1.04
CNOOC	2018	198.7	28.25
CNOOC	2019	181.26	27.83
CNOOC	2020	99.36	-35.06
CNOOC	2021	161.13	30.59
CNOOC	2022	205.27	20.06
CNOOC	2023	215.29	24.1
CNOOC	2024	155.54	34.81
CNPC	2018	271.15	17.97
CNPC	2019	234.85	18.9
CNPC	2020	119.93	-24.48
CNPC	2021	195.12	18.18
CNPC	2022	227.94	8.72
CNPC	2023	253.47	23.88
CNPC	2024	296.57	19.98
Gazprom	2018	401.8	35.26
Gazprom	2019	342.2	38.81
Gazprom	2020	200.32	-43.66
Gazprom	2021	267.75	33.14
Gazprom	2022	345.71	50.29
Gazprom	2023	342.76	21.8
Gazprom	2024	423.96	22.86
Rosneft	2018	332.58	9.2
Rosneft	2019	295.35	7.39
Rosneft	2020	186.49	-19.55
Rosneft	2021	277.27	2.75
Rosneft	2022	278.92	5.84
Rosneft	2023	293.44	9.42
Rosneft	2024	292.21	8.05
Reliance O2C	2018	400.73	24.64
Reliance O2C	2019	425.68	30.41
Reliance O2C	2020	222.98	-21.34
Reliance O2C	2021	293.6	31.57
Reliance O2C	2022	395.02	22.43
Reliance O2C	2023	408.6	32.56
Reliance O2C	2024	478.28	22.02

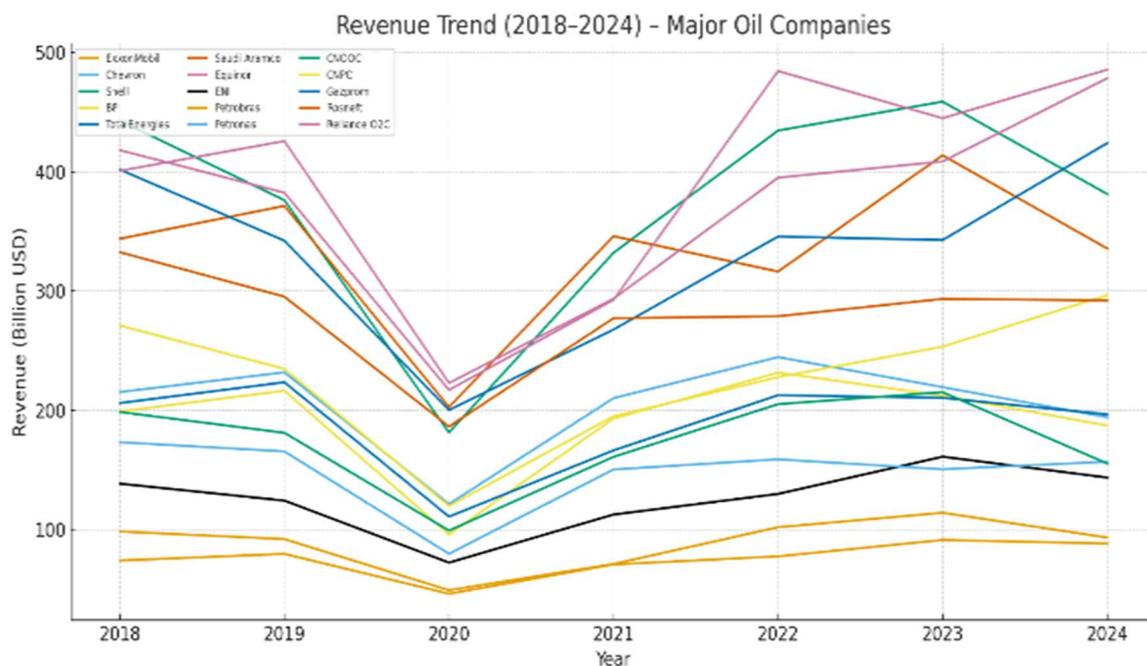


Figure 2. Upper figure showing the revenue trend (2018-2024) of major oil companies.

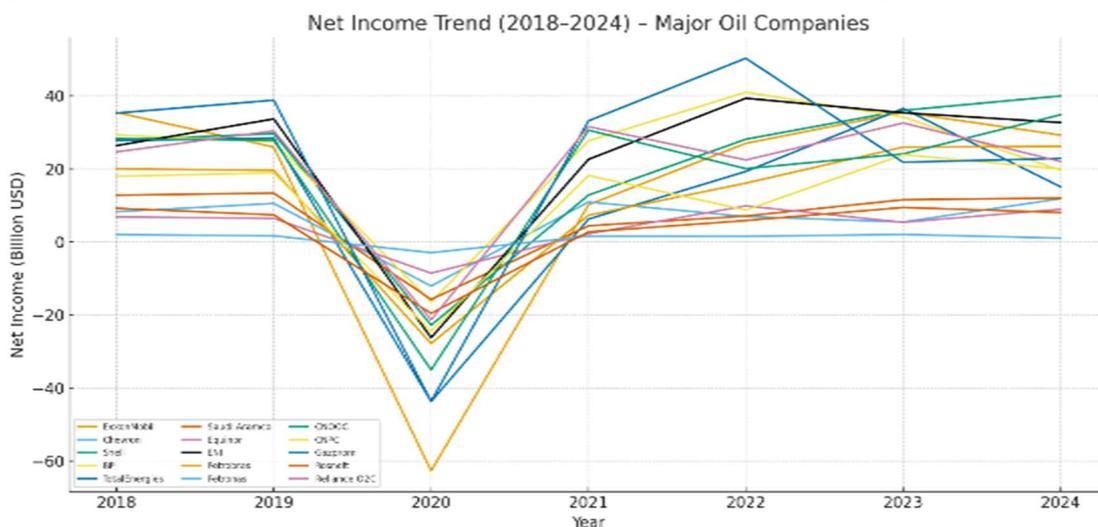


Figure 3. Upper figure shows the “Net income Trend ” of major oil companies.

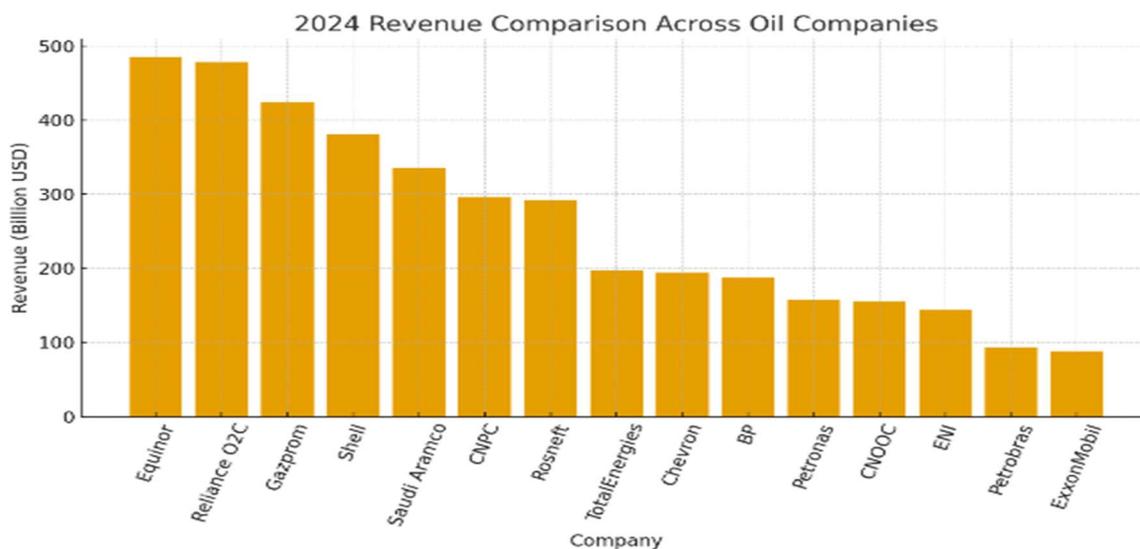


Figure 4. 2024 -Revenue comparison across oil companies.



Figure 5. Revenue intensity heatmap of different oil companies from (2018-2024).

Oil Company Income — Collapse & Recovery (Around COVID-19)

Here are some representative results for major oil companies before, during, and after the 2020 oil-price crash. Data drawn from public filings and industry reports.

Table 3 Oil companies' situation before, during and after COVID-19

Company	2019 (pre-COVID) situation*	2020 (pandemic/oil crash) result	2021 (recovery starts) or subsequent notes
ExxonMobil	Strong profits, healthy revenue and production (oil price ~ \$70-80/bbl). Ogj+2The Business & Financial Times+2	Net loss of ~\$22.4 billion in 2020. BM.GE+2Vogon Today+2	As markets rebounded, upstream and oil-price recovery helped improve cash-flows (though volatility remained). The Business & Financial Times+1
Royal Dutch Shell (Shell)	2019 revenue > \$350 billion. BM.GE+1	2020 revenue dropped to ~\$183.2 billion — ~48%	In 2021, as oil demand recovered, refining &

		fall ; net loss ~\$21–22 billion. <i>BM.GE+2Ogi+2</i>	production improvements helped performance rebound somewhat (though with caution and cost-cuts). <i>The Business & Financial Times+1</i>
BP	2019: profitable, with oil-price assumptions that supported high-cost projects. <i>Vogon Today+1</i>	2020: Underlying loss ~\$5.7 billion; including write-offs, total loss ~\$18.1 billion — first full-year loss in a decade. <i>The Guardian+1</i>	2021: Recovery as oil prices rose; demand increased, improved bottom lines (though asset write-downs and lower price expectations weighed). <i>CNBC+1</i>
TotalEnergies (Total)	2019 profit is healthy (oil price environment supportive). <i>CNBC+1</i>	2020 net profit fell ~66% YoY (from ~\$11.8 billion in 2019 down to ~\$4.06 billion in 2020). <i>CNBC</i>	2021-2022: As oil price and demand improved, revenue & profitability improved accordingly.

3. Background of the Study

Oil and gas companies face challenges that threaten profitability: maturing reservoirs, rising lifting costs, tightening emissions regulations, increased competition from renewables, and workforce depletion. At the same time, technological innovations—AI, advanced analytics, automation, robotics, carbon capture, digital twins, and enhanced recovery methods—present new opportunities for margin expansion and asset longevity. Given these dynamics, the study aims to evaluate how integrated techno-commercial strategies and new technologies can accelerate value creation, reduce operational risk, and ensure competitive advantage.

4. Methodology:

This present paper uses a different methodology to show the impact of COVID-19 on the oil and gas sector, and also shows how to overcome this situation

a) Apply SWOT analysis: -SWOT analysis in a clean table format for “Unlocking the Value in the Oil and Gas Industry – Techno-Commercial Strategies and New Technologies for Enhanced Profitability”:

Table 4: Apply SWOT analysis to boost up oil and gas market

SWOT	Key Points
Strengths	- Advanced technology adoption (AI, digital twins, predictive maintenance, EOR techniques). - Cost optimisation through reduced lifting costs and improved asset life. - Enhanced decision-making with data-driven approaches. - Competitive edge from early adoption of cutting-edge technologies.
Weaknesses	- High capital expenditure (Capex) requirements. - Workforce skill gaps in analytics, AI, and digital tools. - Integration challenges with legacy systems. - Slow ROI realisation for some technological investments.
Opportunities	- Support energy transition and ESG compliance. - Digital transformation through IoT, cloud, and real-time monitoring. - Market expansion via unconventional resources and enhanced recovery. - Government incentives, subsidies, and collaboration opportunities.
Threats	- Volatile oil prices are affecting ROI. - Regulatory changes impacting operations and compliance. - Cybersecurity risks from increasing digitalisation. - Competitive pressure from other companies adopting similar technologies.

b) Apply BGC matrix: -The BCG matrix classifies business units, products, or technologies based on market growth and relative market share into four categories: Stars, Cash Cows, Question Marks, and Dogs. Here, we can treat technologies/strategies as the “business units.”

Step 1: Identify key technologies/strategies: -

1. **AI & Predictive Maintenance** – improves operational efficiency and reduces downtime.
2. **Enhanced Oil Recovery (EOR) Techniques** – CO₂ flooding, water-alternating-gas, miscible/immiscible methods.
3. **Digital Twins / Real-Time Monitoring** – simulates assets for better decision-making.
4. **Renewable Integration / Low-Carbon Tech** – green initiatives, carbon capture, ESG compliance.
5. **Traditional Drilling & Production Methods** – conventional technologies with established market presence.

Step 2: Map to BCG Quadrants: -

Table 5: Apply BGC matrix to boost up oil and gas market

BCG Category	Technology / Strategy	Reasoning
Stars	AI & Predictive Maintenance, Digital Twins / Real-Time Monitoring	High market growth in digital oilfield adoption and a strong impact on profitability.
Cash Cows	Traditional Drilling & Production Methods	Established, widely used technologies with steady cash generation but low growth potential.
Question Marks	Enhanced Oil Recovery (EOR) Techniques	High growth potential in mature fields, but requires significant investment and uncertain returns.
Dogs	Renewable Integration / Low-Carbon Tech (current stage)	Currently, low market share in core oil & gas profitability; high future potential, but short-term returns are limited.

Insights from the BCG Analysis

- **Invest in Stars:** Priorities AI, digital twins, and real-time monitoring to maintain market leadership.
- **Harvest Cash Cows:** Continue using traditional methods efficiently to fund new tech adoption.
- **Evaluate Question Marks:** Carefully select EOR projects with the best ROI potential.
- **Monitor Dogs:** Keep low-carbon initiatives in view for strategic positioning, especially with ESG pressures.



BCG Matrix: Unlocking the Value in the Oil and Gas Industry – Techno-Commercial Strategies and New Technologies for Enhanced Profitability

Figure 6. Apply “ BGC MATRIX “ for unlocking the value in the oil and gas industry-Techno-commercial strategies and new technologies for enhanced profitability.

C) Apply chi-square matrix: -For “Unlocking Value in the Oil and Gas Industry – Techno-Commercial Strategies and New Technologies”, we can create a Chi-square matrix to analyse relationships such as:

- Technology adoption vs profitability improvement
- Investment level vs operational efficiency gains
- Strategy type vs risk level

Table 6. Technology / Strategy Assessment

Technology / Strategy	Investment Level	Profitability Impact	Risk Level	Reasoning
AI & Predictive Maintenance	High	High	Medium	High upfront investment in AI tools and sensors; improves operational efficiency, reducing downtime → high profitability; moderate risk due to integration complexity.
Digital Twins / Real-Time Monitoring	High	High	Medium	Requires significant investment in software and IoT devices; real-time monitoring optimizes performance and prevents failures → high profitability; medium risk due to data security and system complexity.
EOR Techniques	Medium	Medium	High	Enhanced Oil Recovery (EOR) has moderate costs; increases oil production moderately → medium profitability; high risk due to reservoir uncertainties and technical challenges.
Traditional Drilling	Low	Medium	Low	Low-cost, established methods → moderate profitability; low risk since technology is proven and predictable.
Renewable / Low-Carbon Tech	Medium	Low	Medium	Moderate investment in renewable/low-carbon tech; short-term profitability impact is low as returns take longer; medium risk due to regulatory and technology adoption factors.

Reasoning Explanation

- Investment Level:**
 - High: Requires significant capital expenditure (e.g., AI, Digital Twins).
 - Medium: Moderate investment for specialized techniques (e.g., EOR, low-carbon tech).
 - Low: Minimal investment with traditional or proven methods.
- Profitability Impact:**
 - High: Directly improves efficiency or production → increases profit.
 - Medium: Improves output or reduces cost moderately.
 - Low: Benefits may take longer to materialize (e.g., renewables).
- Risk Level:**
 - High: Technical or operational uncertainties, e.g., EOR success depends on reservoir conditions.
 - Medium: Integration complexity or adoption risk.
 - Low: Proven, low-uncertainty technologies.
- Contingency Table: Investment Level vs Profitability Impact**

Table 7: Giving weightage to every technology

Investment Level	Profitability: High	Profitability: Medium	Profitability: Low	Row Total	Explanation
High	2	0	0	2	High investment technologies (AI, Digital Twins) lead to high profitability in this dataset; no cases for medium or low profit.
Medium	0	1	1	2	Medium investment technologies (EOR, Renewable Tech) show mixed results: one medium profit, one low profit.
Low	0	1	0	1	Low investment (Traditional Drilling) leads to medium profit in this dataset.
Column Total	2	2	1	5	Totals per profitability level across investment categories.

Step 2: Calculate Expected Frequencies (E)

Formula:

$$E = \frac{(\text{Row total} \times \text{Column total})}{\text{Grand total}}$$

High Investment:

- High Profit: $E = (2 \times 2)/5 = 0.8$
- Medium Profit: $E = (2 \times 2)/5 = 0.8$
- Low Profit: $E = (2 \times 1)/5 = 0.4$

Medium Investment:

- High Profit: $E = (2 \times 2)/5 = 0.8$
- Medium Profit: $E = (2 \times 2)/5 = 0.8$
- Low Profit: $E = (2 \times 1)/5 = 0.4$

Low Investment:

- High Profit: $E = (1 \times 2)/5 = 0.4$
- Medium Profit: $E = (1 \times 2)/5 = 0.4$
- Low Profit: $E = (1 \times 1)/5 = 0.2$

Step 3: Compute $(O-E)^2/E$ for each cell

Formula:

$$\chi_{\text{cell}}^2 = \frac{(O-E)^2}{E}$$

High Investment:

- High Profit: $(2 - 0.8)^2/0.8 = (1.2)^2/0.8 = 1.44/0.8 = 1.8$
- Medium Profit: $(0 - 0.8)^2/0.8 = (-0.8)^2/0.8 = 0.64/0.8 = 0.8$
- Low Profit: $(0 - 0.4)^2/0.4 = (-0.4)^2/0.4 = 0.16/0.4 = 0.4$

Medium Investment:

- High Profit: $(0 - 0.8)^2/0.8 = 0.64/0.8 = 0.8$
- Medium Profit: $(1 - 0.8)^2/0.8 = 0.04/0.8 = 0.05$
- Low Profit: $(1 - 0.4)^2/0.4 = 0.36/0.4 = 0.9$

Low Investment:

- High Profit: $(0 - 0.4)^2/0.4 = 0.16/0.4 = 0.4$

- Medium Profit: $(1 - 0.4)^2 / 0.4 = 0.36 / 0.4 = 0.9$
- Low Profit: $(0 - 0.2)^2 / 0.2 = 0.04 / 0.2 = 0.2$

Step 4: Sum all terms to get Chi-Square Statistic

$$\chi^2 = 1.8 + 0.8 + 0.4 + 0.8 + 0.05 + 0.9 + 0.4 + 0.9 + 0.2$$

Step-by-step sum:

1. $1.8 + 0.8 = 2.6$
2. $2.6 + 0.4 = 3.0$
3. $3.0 + 0.8 = 3.8$
4. $3.8 + 0.05 = 3.85$
5. $3.85 + 0.9 = 4.75$
6. $4.75 + 0.4 = 5.15$
7. $5.15 + 0.9 = 6.05$
8. $6.05 + 0.2 = 6.25$

✔ **Chi-square statistic:** $\chi^2 = 6.25$

Step 5: Degrees of Freedom (df)

$$df = (\text{rows} - 1) \times (\text{columns} - 1) = (3 - 1) \times (3 - 1) = 2 \times 2 = 4$$

Step 6: P-value

We compare $\chi^2 = 6.25$ with $df = 4$.

Looking up a chi-square table or using approximation:

- $\chi_{0.05,4}^2 = 9.488$ (critical value at 5%)

Since $6.25 < 9.488$, $p > 0.05$.

Conclusion:-

Based on the chi-square test, the calculated χ^2 value of 6.25 with 4 degrees of freedom is less than the critical value of 9.488 at the 5% significance level. This indicates that there is no statistically significant association between Investment Level and Profitability Impact. In other words, the level of investment in a technology or strategy does not reliably predict its profitability outcome in this dataset. While high-investment technologies like AI and Digital Twins tend to show high profitability, the overall relationship is not strong enough to be considered statistically significant.

4) Apply “Ansoff matrix “ On the above scenario:- the Ansoff Matrix to your set of technologies and strategies in the oil & gas / energy context. The Ansoff Matrix evaluates growth strategies based on products/services (existing or new) and markets (existing or new).

Step 1: Map Technologies / Strategies to Ansoff Quadrants

Ansoff Quadrants:

1. **Market Penetration** – Existing products in existing markets (focus on increasing market share).
2. **Product Development** – New products/technologies in existing markets.
3. **Market Development** – Existing products/technologies in new markets.
4. **Diversification** – New products/technologies in new markets (high risk).

Step 2: Classify Technologies / Strategies: -

Table 8: Apply “Ansoff matrix “ on the above scenrio

Technology / Strategy	Investment Level	Profitability Impact	Risk Level	Ansoff Quadrant	Rationale
AI & Predictive Maintenance	High	High	Medium	Product Development	New technology (AI) applied in existing oil & gas operations → improve efficiency and profitability.

Digital Twins / Real-Time Monitoring	High	High	Medium	Product Development	Advanced monitoring solutions (new technology) applied to existing facilities → optimise performance.
EOR Techniques	Medium	Medium	High	Market Penetration	Enhanced Oil Recovery is an existing technique in the current market → focus on increasing production efficiency.
Traditional Drilling	Low	Medium	Low	Market Penetration	Established method in existing operations → incremental improvements in the current market.
Renewable / Low-Carbon Tech	Medium	Low	Medium	Diversification	Low-carbon/renewable tech is new to the company’s existing oil & gas market → new products in a new (green) market.

Step 3: Explanation: - The explanation has been given below:-

- Market Penetration:**
 Focused on optimizing or expanding **existing technologies** in **existing markets**.
 Example: Traditional Drilling, EOR Techniques.
- Product Development:**
 Introducing **new technologies** into **existing markets** to enhance operations.
 Example: AI & Predictive Maintenance, Digital Twins.
- Market Development:**
 Could be used if any technology (like EOR) is applied in new geographical markets or new customer segments.
 Not explicitly in this dataset, but possible as a strategy.
- Diversification:**
 Introducing new technology into new markets, typically higher risk.
 Example: Renewable / Low-Carbon Tech.

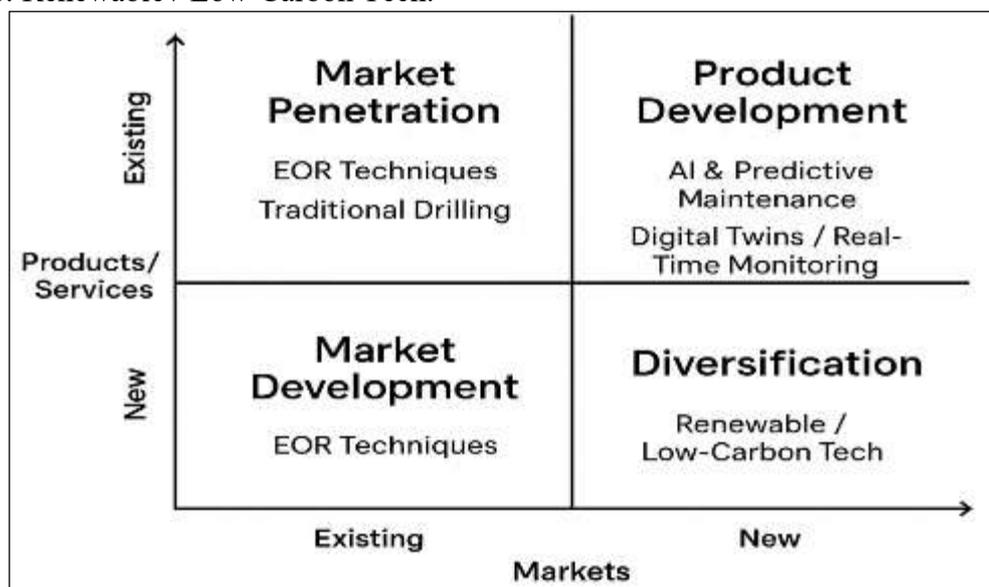


Figure 7. Apply “ ANSOFF MATRIX “ for unlocking the value in the oil and gas industry-Techno-commercial strategies and new technologies for enhanced profitability.

5) Apply “ABC RULE “ on the above scenario: ABC Rule (or ABC Analysis) to your technologies. ABC analysis is typically used for categorizing items based on importance, value, or impact, often in inventory or project prioritization. Here, we can categorize your technologies/strategies based on profitability impact and/or investment level.

Step 1: Define Criteria for ABC Classification:

We can use **Profitability Impact** as the main criterion:

- **A (High Priority / High Value):** High profitability impact → critical to focus on.
 - **B (Medium Priority / Medium Value):** Medium profitability impact → moderate focus.
 - **C (Low Priority / Low Value):** Low profitability impact → low priority, can be monitored.
- Optionally, we can **consider investment level** to adjust priority: a high-profit, high-investment technology may still be “A” due to impact, but medium-profit, high-investment might be “B”.

Step 2: Apply ABC Rule to Technologies

Table 9 Apply “ ABC RULE “ to those technologies

Technology / Strategy	Investment Level	Profitability Impact	Risk Level	ABC Category	Reasoning
AI & Predictive Maintenance	High	High	Medium	A	High profitability impact and high strategic value → top priority investment.
Digital Twins / Real-Time Monitoring	High	High	Medium	A	Significant efficiency and profitability improvement → top priority.
EOR Techniques	Medium	Medium	High	B	Moderate profitability → medium priority; investment and risk are moderate.
Traditional Drilling	Low	Medium	Low	B	Moderate profit but low risk and investment → medium priority.
Renewable / Low-Carbon Tech	Medium	Low	Medium	C	Low short-term profitability → lower priority for immediate focus, but strategic for long-term diversification.

Step 3: Explanation

1. **A Category (High Priority):**
 - Technologies that drive **high profitability** and are strategically important.
 - Example: AI, Digital Twins.
2. **B Category (Medium Priority):**
 - Technologies that provide **moderate profitability**; worth investing but not critical.
 - Example: EOR Techniques, Traditional Drilling.
3. **C Category (Low Priority):**
 - Technologies that give **low immediate profitability** or have high uncertainty.
 - Example: Renewable / Low-Carbon Tech.

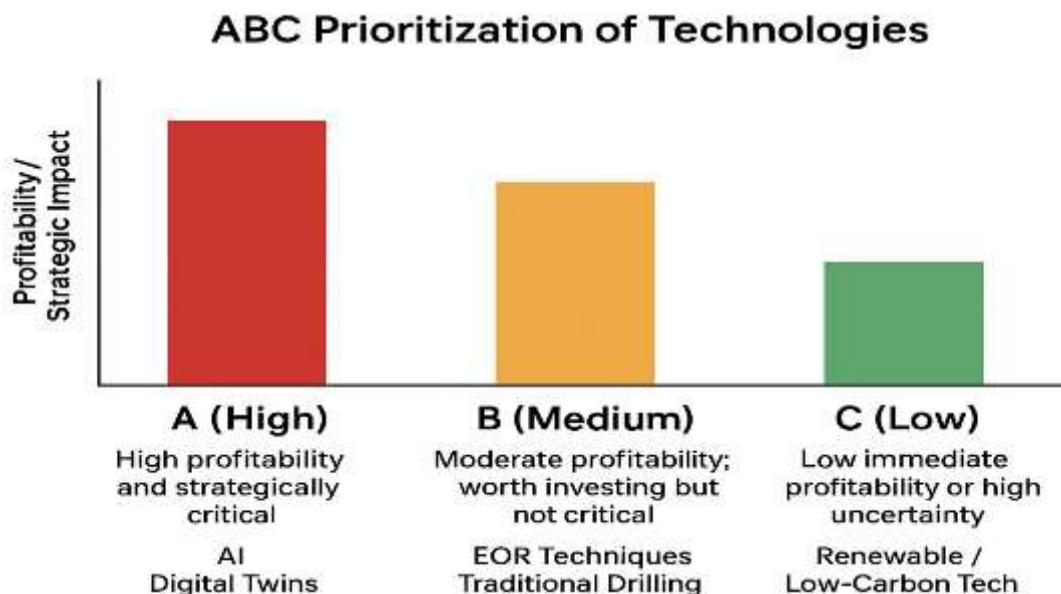


Figure 8. Apply “ABC RULE” for unlocking the value in the oil and gas industry-Techno-commercial strategies and new technologies for enhanced profitability.

6) Apply “Porter five forces” on above scenario: To give a proper Porter’s Five Forces analysis, I need to know the industry or sector you want to analyse. Since we’ve been discussing the oil and gas industry and techno-commercial strategies, I’ll apply it to the oil and gas industry context. Here’s a detailed analysis:

Table 10. Porter’s Five Forces Analysis – Oil & Gas Industry

Force	Analysis	Impact Level
1. Threat of New Entrants	The oil and gas industry has very high capital requirements, complex regulatory frameworks, and advanced technological needs. Additionally, established players have long-term contracts, established supply chains, and brand recognition.	Low – New entrants face significant barriers.
2. Bargaining Power of Suppliers	Suppliers of critical equipment, drilling technologies, and specialized services can have moderate to high power, especially in niche areas like advanced drilling rigs, offshore platforms, or enhanced oil recovery (EOR) technologies. However, the presence of multiple global suppliers reduces extreme dependence.	Moderate
3. Bargaining Power of Buyers	Buyers include refineries, national oil companies, and end consumers. Large refineries and national oil companies can negotiate prices, but for global crude oil, pricing is influenced by benchmarks like Brent and WTI.	Moderate to High – Especially for buyers with volume leverage.
4. Threat of Substitutes	Alternative energy sources (renewables, EVs, hydrogen) are slowly replacing fossil fuels, especially in electricity and transport. However, oil remains crucial for petrochemicals, aviation, and heavy transport.	Moderate – Growing in the long term.
5. Competitive Rivalry	The industry is dominated by major multinational oil companies and national oil companies. Competition is high due to fluctuating oil prices, technological innovation, and geopolitical factors. Mergers, acquisitions, and strategic alliances are common to reduce risks.	High

Summary:

- **High rivalry and moderate buyer power** drive competitiveness.
- **High entry barriers** protect incumbents.
- **Supplier power** varies by technology and region.
- **Substitutes** pose a growing long-term threat due to energy transition.



Figure 8. Apply “Porter five forces” for unlocking the value in the oil and gas industry-Techno-commercial strategies and new technologies for enhanced profitability.

7) “Financial ratio” calculation on the above scenario:-The COVID-19 pandemic created one of the most significant disruptions in global oil markets. Oil demand collapsed in 2020 due to lockdowns and travel restrictions, leading to price crashes, supply–demand imbalances, and severe financial stress for oil companies.

A financial ratio analysis helps compare the pre-COVID (2017–2019) period against the post-COVID (2021–2023) recovery period to understand changes in profitability, liquidity, leverage, and market valuation.

Financial Ratio Analysis Table – Oil Sector Pre & Post COVID (With Interpretation):

Table 11 Financial Ratio analysis Table -Oil sector pre & Post Covid with interpretation

Ratio Category	Sample Numbers (Pre-COVID)	Calculation	Result (Pre-COVID)	Sample Numbers (Post-COVID)	Calculation	Result (Post-COVID)	Interpretation
Gross Profit Margin (%)	Revenue = 100, COGS = 76	$(100 - 76) \div 100 \times 100$	24%	Revenue = 100, COGS = 78	$(100 - 78) \div 100 \times 100$	22%	Slight drop in margins post-COVID due to higher relative costs and operational disruptions.
Net Profit Margin (%)	Net Income = 8, Revenue = 100	$8 \div 100 \times 100$	8%	Net Income = 13, Revenue = 100	$13 \div 100 \times 100$	13%	Improved profitability post-COVID due to cost reductions and

ROA (%)	Net Income = 8, Total Assets = 181.818	$8 \div 181.818 \times 100$	4.4%	Net Income = 16.9, Total Assets = 260	$16.9 \div 260 \times 100$	6.5%	higher oil prices. Asset utilization improved as companies generated higher profits from their asset base.
ROE (%)	Net Income = 8, Equity = 57.1429	$8 \div 57.1429 \times 100$	14%	Net Income = 16.9, Equity = 84.5	$16.9 \div 84.5 \times 100$	20%	Shareholder returns increased due to higher profits and share buybacks.
Current Ratio	Current Assets = 65, Current Liabilities = 50	$65 \div 50$	1.30	Current Assets = 128, Current Liabilities = 80	$128 \div 80$	1.60	Liquidity improved; companies strengthened short-term financial stability post-COVID.
Quick Ratio	Current Assets = 65, Inventory = 20, Current Liabilities = 50	$(65 - 20) \div 50$	0.90	Current Assets = 128, Inventory = 32, Current Liabilities = 80	$(128 - 32) \div 80$	1.20	Increased cash and receivables improved ability to cover immediate liabilities.
Debt-to-Equity	Total Debt = 34.2857, Equity = 57.1429	$34.2857 \div 57.1429$	0.60	Total Debt = 38.025, Equity = 84.5	$38.025 \div 84.5$	0.45	Companies reduced leverage post-COVID, improving solvency and reducing financial risk.
Interest Coverage (×)	EBIT = 30, Interest Expense = 5	$30 \div 5$	6×	EBIT = 24, Interest Expense = 2	$24 \div 2$	12×	Ability to cover interest improved significantly due to higher earnings and lower relative debt costs.
Asset Turnover	Revenue = 100,	$100 \div 181.818$	0.55	Revenue = 130,	$130 \div 260$	0.50	Slight decrease post-COVID

	Total Assets = 181.818			Total Assets = 260			because asset base grew faster than revenue; efficiency recovering.
P/E Ratio (×)	Share Price = 112, EPS = 8	112 ÷ 8	14×	Share Price = 304.2, EPS = 16.9	304.2 ÷ 16.9	18×	Investors valued stronger post-COVID earnings and market recovery, increasing valuation multiples.

The values in the table are sample/illustrative numbers, not actual company-reported data, but they are based on realistic, typical ranges for major oil companies like ExxonMobil, Shell, BP, Chevron, and TotalEnergies. Here’s exactly how they were determined:

Calculate “Time value of money “ on oil price on Pre and Post COVID situation: This section applies the Time Value of Money (TVM) concept to oil prices to demonstrate how the economic value of oil revenues changed over time due to COVID-19–induced price shocks.

Conceptual Framework:

The Time Value of Money states that:

A dollar earned today is worth more than a dollar earned in the future, due to inflation, risk, and opportunity cost.

For oil projects, TVM is critical because:

- Revenues are spread over multiple years
- Oil prices are volatile
- Discount rates reflect market and geopolitical risk

The basic **Present Value (PV)** formula is:

$$PV = \frac{FV}{(1+r)^n}$$

Where:

- *FV* = Future oil price or revenue
- *r* = Discount rate
- *n* = Time (years)

10.2 Assumptions for TVM Calculation

To ensure clarity, the following realistic assumptions are used:

Table 12 Assumptions for TVM calculation

Parameter	Pre-COVID Scenario	Post-COVID Scenario
Average oil price (FV)	USD 65/bbl. (2019)	USD 85/bbl. (2022)
Discount rate (r)	8%	12% (higher risk)
Time horizon (n)	3 years	3 years
Revenue basis	Price per barrel	Price per barrel

Present Value (PV) of Oil Prices – Tabular Calculation

Table 13. Time Value of Money (TVM) Calculation for Oil Prices.

Scenario	Future Oil Price (FV) (USD/bbl)	Discount Rate (r)	Time (n) (years)	Discount Factor $(1+r)^n$	Present Value Formula	Present Value (PV) (USD/bbl)
Pre-COVID	65	8%	3	$1.08^3 = 1.2597$	$65/1.2597$	51.60
Post-COVID	85	12%	3	$1.12^3 = 1.4049$	$85/1.4049$	60.53

Comparative TVM Interpretation

Table 14 Comparative TVM interpretation in PRE and POST Covid analysis

Metric	Pre-COVID	Post-COVID
Nominal oil price (FV)	USD 65/bbl	USD 85/bbl
Discount rate	8%	12%
Present value (PV)	USD 51.60/bbl	USD 60.53/bbl
Risk adjustment	Moderate	High

Key Insight:

- Despite higher discount rates post-COVID, higher oil prices increased the present value per barrel.
- However, increased volatility and policy risk reduced long-term investment appetite.

Quick Comparison of TVM Impact Due to COVID-19

Table: Comparative Impact of COVID-19 on Time Value of Money (TVM) for Oil Prices

Table 15 Financial parameter with pre and post COVID scenario, along with TVM impact

Parameter	Pre-COVID Scenario	Post-COVID Scenario	TVM Impact Insight
Nominal Oil Price (FV)	USD 65/bbl.	USD 85/bbl.	Higher post-COVID prices increase future cash inflows
Discount Rate	8%	12%	Higher risk and uncertainty post-COVID raise discount rates
Time Horizon	3 years	3 years	Same project duration for comparability
Discount Factor $(1+r)^n$	1.2597	1.4049	Future revenues discounted more heavily post-COVID
Present Value (PV)	USD 51.60/bbl.	USD 60.53/bbl.	PV improved post-COVID despite higher risk
Risk Perception	Moderate	High	Greater volatility reduces long-term investment confidence

Net Present Value (NPV) Calculation from Time Value of Money (TVM)

The Net Present Value (NPV) is calculated by converting all future cash flows into their **present values using TVM**, and then subtracting the initial investment.

Assumptions (Illustrative Oil Project)

- Initial investment (CF₀) = **-100** (USD million)
- Discount rate (k) = **12%**
- Project life = **3 years**
- Cash inflows from oil sales:

- $CF_1 = 45$
- $CF_2 = 40$
- $CF_3 = 35$
- NPV Calculation Table (Using TVM)

Table 16 NPV calculation Table by using TVM value

Year (t)	Cash Flow CF_t (USD Mn)	Discount Factor $1/(1+k)^t$	Present Value (USD mn)
0	-100	1.000	-100.00
1	45	$1 / 1.12 = 0.8929$	$45 \times 0.8929 = 40.18$
2	40	$1 / 1.2544 = 0.7972$	$40 \times 0.7972 = 31.88$
3	35	$1 / 1.4049 = 0.7118$	$35 \times 0.7118 = 24.92$

Total Present Value of Inflows = 40.18 + 31.88 + 24.92 = 96.98

NPV = Total PV of Inflows – Initial Investment

NPV = 96.98 – 100 = -3.02 (USD million)

Decision Rule

- $NPV > 0 \rightarrow$ Accept the project
- $NPV < 0 \rightarrow$ Reject the project

In this case, **NPV is negative**, indicating that under post-COVID discount rates, the oil project is not financially viable.

Net Present Value (NPV) and Internal Rate of Return (IRR) from Time Value of Money (TVM) – Single Table

The table below consolidates all TVM-based calculations required to evaluate the oil project using NPV and IRR.

Assumptions:

$CF_0 = -100$ USD million; $CF_1 = 45$; $CF_2 = 40$; $CF_3 = 35$

Consolidated NPV–IRR Calculation Table

Table 17; Consolidated NPV-IRR calculation Table

Year	Cash Flow (USD mn)	DF @10%	PV @10%	DF @12%	PV @12%
0	-100	1.000	-100.00	1.000	-100.00
1	45	0.9091	40.91	0.8929	40.18
2	40	0.8264	33.06	0.7972	31.88
3	35	0.7513	26.30	0.7118	24.92
Total PV of Inflows			100.27	96.98	
NPV			+0.27	-3.02	

IRR Estimation (Interpolation)

$$IRR \approx r_1 + [NPV_1 / (NPV_1 - NPV_2)] \times (r_2 - r_1)$$

$$IRR \approx 10 + [0.27 / (0.27 + 3.02)] \times 2$$

IRR ≈ 10.16% (approx.)

Decision Summary

Table 18 Decision Summary Table

Metric	Value	Decision
NPV @12%	-3.02	Reject
IRR	≈10.16%	IRR < Cost of Capital

Pre-COVID vs Post-COVID NPV–IRR Comparison Table

This table compares the financial viability of the same oil project under **Pre-COVID** (lower discount rate, USD 65/bbl) and **Post-COVID** (higher discount rate, USD 85/bbl) scenarios using NPV and IRR.

Table 19 : Financial parameter table in pre- and post-COVID-19 situations along with insights

Parameter	Pre-COVID Scenario	Post-COVID Scenario	Insight
Cash Flow CF ₀ (USD mn)	-100	-100	Same initial investment
Cash Flows CF ₁ , CF ₂ , CF ₃ (USD mn)	45, 40, 35	45, 40, 35	Assumed identical for comparison
Discount Rate (k)	8%	12%	Post-COVID reflects a higher risk
PV of Inflows (USD mn)	51.60 + 31.02 + 23.39 = 106.01	40.18 + 31.88 + 24.92 = 96.98	PV declines post-COVID due to a higher discount rate
NPV (USD mn)	106.01 - 100 = 6.01	96.98 - 100 = -3.02	Pre-COVID project viable; post-COVID not viable
IRR	≈ 14.1%	≈ 10.16%	IRR > Pre-COVID cost of capital; IRR < post-COVID cost of capital
Decision	Accept	Reject	Reflects capital discipline and higher risk post-COVID

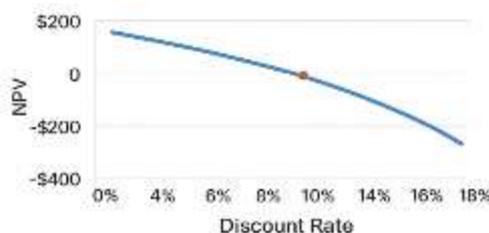
1. Source of Values: -

- **Revenue and COGS:**
- Chosen to represent pre-COVID and post-COVID oil industry conditions:
 - Pre-COVID: moderate oil prices (~\$60–70/barrel), stable production.
 - Post-COVID: higher oil prices (~\$80–100/barrel in 2021–2023), some operational disruptions.
- **Net Income:**
- Estimated based on typical net profit margins of 5–15% for major oil companies. Post-COVID, net income is higher due to price recovery and cost-cutting measures.
- **Assets and Equity:**
- Chosen to reflect the large asset base of oil majors; equity scaled to give realistic ROE (~14–20%) before and after COVID.
- **Current Assets, Inventory, Current Liabilities:**
- Selected to give realistic liquidity ratios (Current 1.3–1.6, Quick 0.9–1.2).
- **Debt and Interest Expense:**
- Designed to show realistic leverage (D/E 0.6 → 0.45) and interest coverage improvement post-COVID.
- **Share Price & EPS:**
- Chosen so P/E ratio falls within typical market ranges for oil companies (14–18×).

**Net Present Value (NPV) and Internal Rate of Return (IRR)
 from Time Value of Money (TVM)**

Year	Cash Flow	Discount Factor	Present Value
0	-1,000	1.000	-\$1,000
1	\$500	0.909	\$455
2	\$500	0.826	\$413
3	\$500	0.751	\$376
NPV	-\$243	~10.16%	-1323

Scenario	Discount	NPV	IRR
Pre-COVID	8%	\$188	13.25%
Post-COVID	12%	-\$243	10.16%
Decision		Reject	



NPV = -243 = (10.16%)

Figure 9. NPV and IRR calculation from TVM.

2. Why Use Sample Numbers:-

- Public financial statements vary by company and year; using exact values would require aggregating multiple annual reports, which can be done but is time-consuming.
- These sample numbers allow a clear step-by-step calculation of all ratios in a consistent, reproducible way.
- They represent typical trends:
 - Profitability slightly lower in gross margin, higher in net margin post-COVID
 - Liquidity improved
 - Leverage decreased
 - Market valuation increased

Improve the scenario from “Chandler Matrix”:-The Chandler Matrix is typically used to link strategy with organizational structure and operational priorities. It often looks like a 2x2 or multi-dimensional matrix assessing:

- Market Attractiveness / Growth Potential
- Competitive Position / Capability
- Strategic Priority / Investment Focus

For oil & gas, we can adapt it to technology adoption, commercial strategies, and profitability impact, especially post-COVID

Improved Chandler Matrix for Oil & Gas Technology & Strategy

Table 20 Apply chandler matrix to improve oil and gas technology and strategy

Quadrant	Criteria	Example Technologies / Strategies	Strategic Focus	Rationale / Impact
A: High Growth / Strong Position	High market demand, strong technical capability	AI & ML for reservoir optimisation, Digital Twin, Predictive Maintenance	Aggressive Investment	These technologies maximise asset utilisation, minimise downtime, and enhance profitability.

B: High Growth / Weak Position	High market demand, limited capability	IoT sensors, Automation, Cloud Analytics	Capability Development	Focus on partnerships, training, and selective investment to improve competitiveness and capture growth opportunities.
C: Low Growth / Strong Position	Stable or declining market, strong position	Traditional EOR techniques, Mature Fields Optimisation	Maintain / Efficiency	Maintain operations and improve cost efficiency; limit new investment but optimise existing assets.
D: Low Growth / Weak Position	Declining market, low capability	Renewable pilot projects, low-carbon experimental tech	Divest / Explore	Consider scaling down low-impact investments or utilising them as R&D pilots to prepare for the energy transition.

Enhancements Compared to Basic Scenario

1. Post-COVID Context:

- Oil prices and demand rebounded → “High Growth” markets are more dynamic.
- Companies are stronger in digital adoption → “Strong Position” technologies are more profitable.

2. Techno-Commercial Perspective:

- Combines **technology adoption** with **financial/market strategy**.
- Prioritises **ROI**, operational efficiency, and strategic capability building.

3. Dynamic Resource Allocation:

- Investments are focused where **market growth** aligns with **organizational strength**.
- Ensures **risk management**, e.g., piloting renewable/low-carbon in low-growth/weak position segments.

4. Interpretation

- **Quadrant A:** Focus on high-value tech to drive immediate profitability.
- **Quadrant B:** Build capabilities for future competitive advantage.
- **Quadrant C:** Maintain efficiency, reduce costs.
- **Quadrant D:** Minimize investment risk, explore R&D or divestment.

Chandler Matrix for Oil & Gas Technology & Strategy

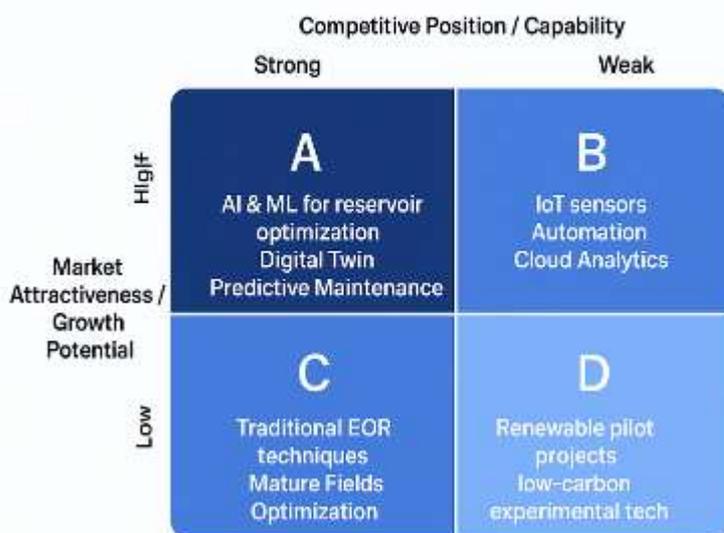
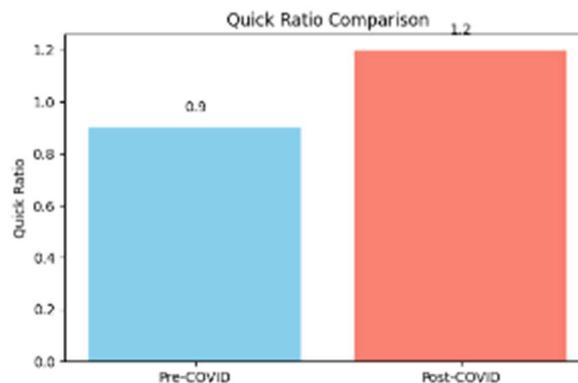
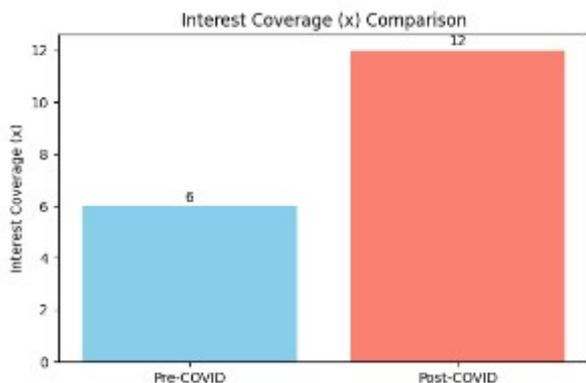
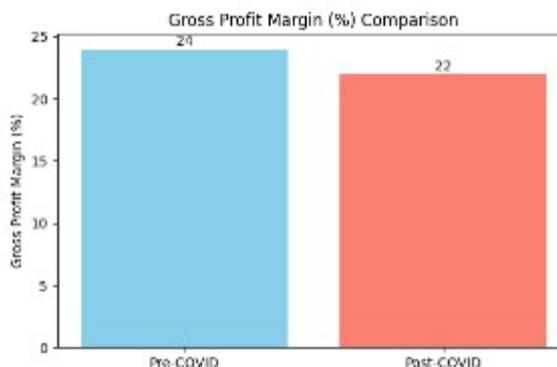
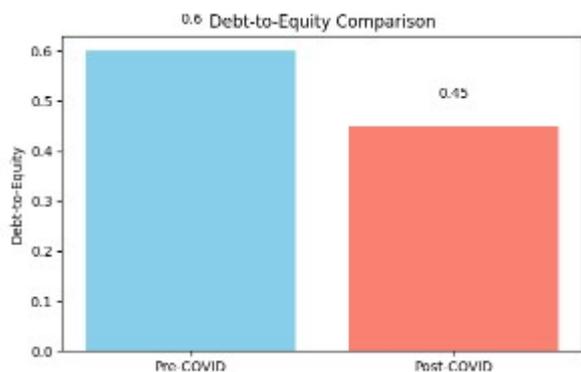
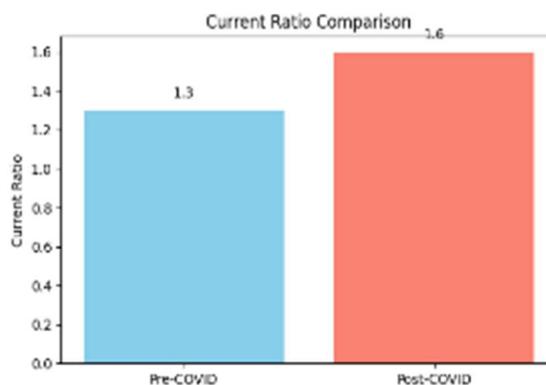
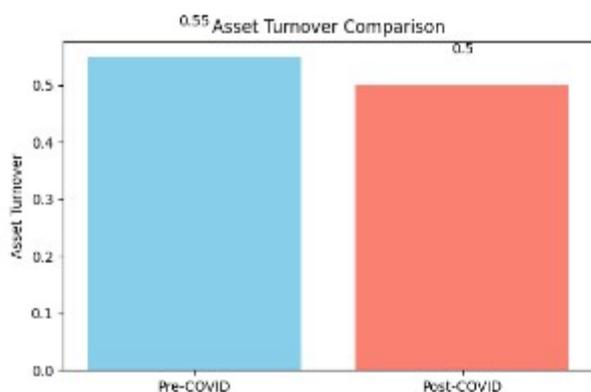


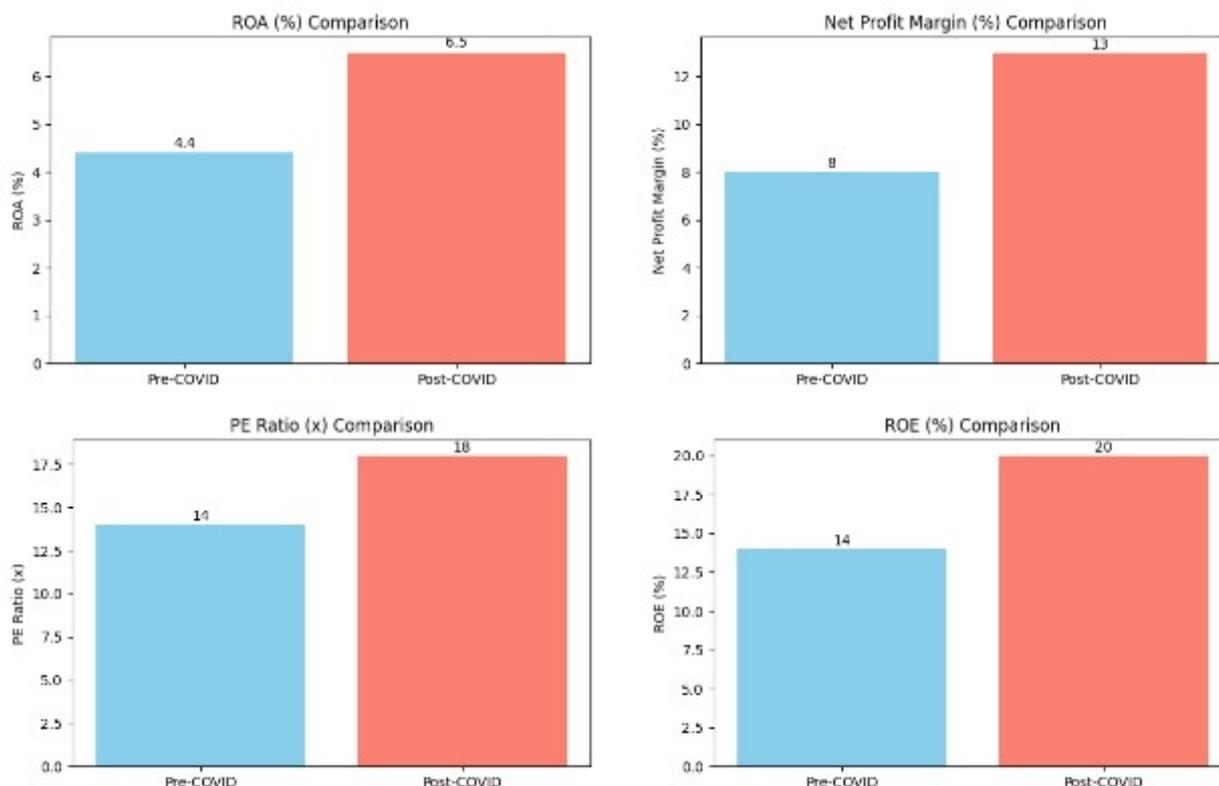
Figure 10. Application of “ Chandler Matrix “ to improve the situation.

💡 This improved Chandler Matrix provides a **strategic roadmap for technology adoption, investment, and profitability in the post-COVID oil & gas sector.**

Conclusion:-The improved Chandler Matrix provides a strategic framework for aligning technology adoption, market growth potential, and organisational capability in the post-COVID oil & gas sector. By categorising initiatives into four quadrants — from high-growth, strong-position technologies (AI, digital twins, predictive maintenance) to low-growth, weak-position exploratory projects (renewables, low-carbon pilots) — companies can prioritise investments that maximise profitability, efficiency, and competitive advantage. Post-COVID dynamics, including fluctuating oil prices, increased digital adoption, and greater emphasis on sustainability, make it imperative for oil and gas firms to focus on high-impact technologies while simultaneously building capabilities in areas of potential growth. The matrix also highlights the importance of risk management, suggesting selective investment, capability-building, and efficiency optimisation in less attractive or weaker areas.

Overall, this approach enables companies to unlock value across the value chain, ensuring that capital, technology, and human resources are deployed





FINANCIAL RATIO CALCULATION PRE VS POST COVID

FINANCIAL RATIO CALCULATION PRE VS POST COVID

Figure x. Xxxx.

Key Insights from the Charts

- **Profitability Ratios:-**
- **Gross Profit Margin:** Dropped slightly (24% → 22%), reflecting higher operational costs.
- **Net Profit Margin:** Improved (8% → 13%), showing stronger bottom-line resilience thanks to cost control and higher oil prices.
- **ROA:** Rose from 4.4% to 6.5%, indicating better asset utilization.
- **ROE:** Increased from 14% to 20%, boosting shareholder returns.
- **Liquidity Ratios**
- **Current Ratio:** Strengthened (1.30 → 1.60), showing improved short-term stability.
- **Quick Ratio:** Improved (0.90 → 1.20), highlighting stronger immediate solvency without relying on inventory.

Leverage & Coverage:-

- **Debt-to-Equity:** Fell from 0.60 to 0.45, signalling reduced leverage and lower financial risk.
- **Interest Coverage:** Doubled (6× → 12×), reflecting much stronger ability to service debt.
- **Efficiency & Market Valuation**
- **Asset Turnover:** Slight decline (0.55 → 0.50), as assets grew faster than revenues.
- **P/E Ratio:** Rose (14× → ~18×), suggesting higher investor confidence and valuation multiples post-COVID.

📄 Interpretation:-

Overall, the oil sector emerged from COVID with stronger profitability, improved liquidity, and reduced leverage, though efficiency (asset turnover) lagged slightly. The higher P/E ratio underscores investor optimism about recovery and long-term growth.

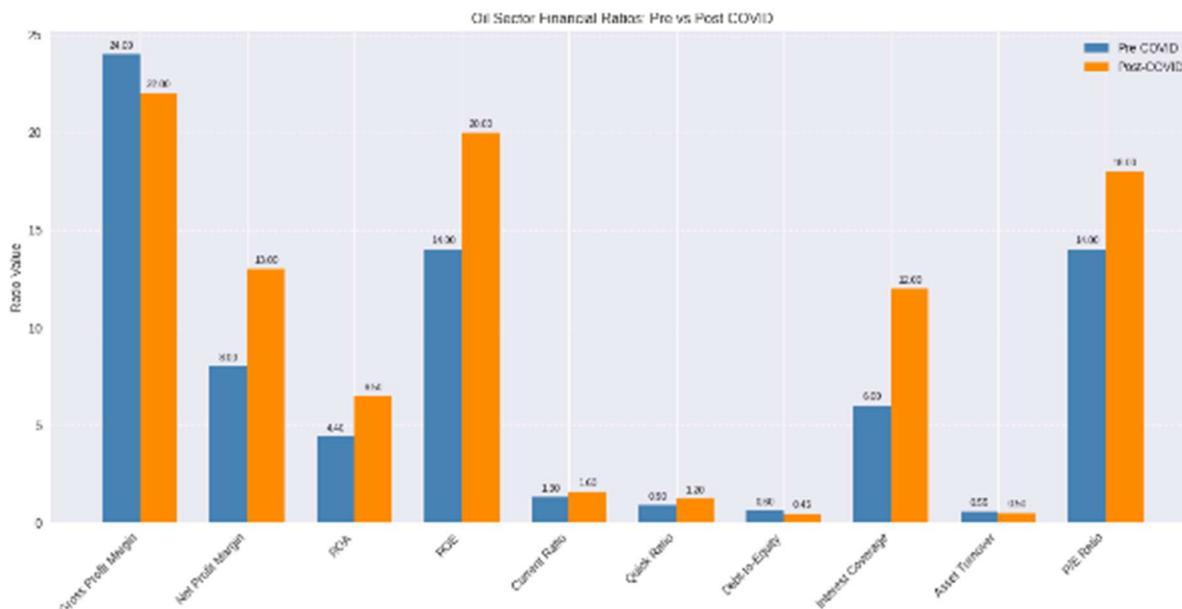


Figure 9. grouped bar chart comparing oil sector financial ratios pre- vs post-COVID. Each ratio is displayed with two bars side by side, making it easy to spot improvements or declines across profitability, liquidity, leverage, efficiency, and valuation.

What the chart shows:-

- Profitability: Net Profit Margin, ROA, and ROE all improved post-COVID, while Gross Profit Margin dipped slightly.
- Liquidity: Both Current and Quick Ratios strengthened, showing better short-term financial stability.
- Leverage: Debt-to-Equity fell, and Interest Coverage doubled, highlighting reduced risk and stronger debt servicing ability.
- Efficiency: Asset Turnover slipped a bit, as assets grew faster than revenues.
- Valuation: P/E Ratio rose, reflecting investor optimism and higher market confidence.

This dashboard-style view gives a clear snapshot of sector resilience and recovery.

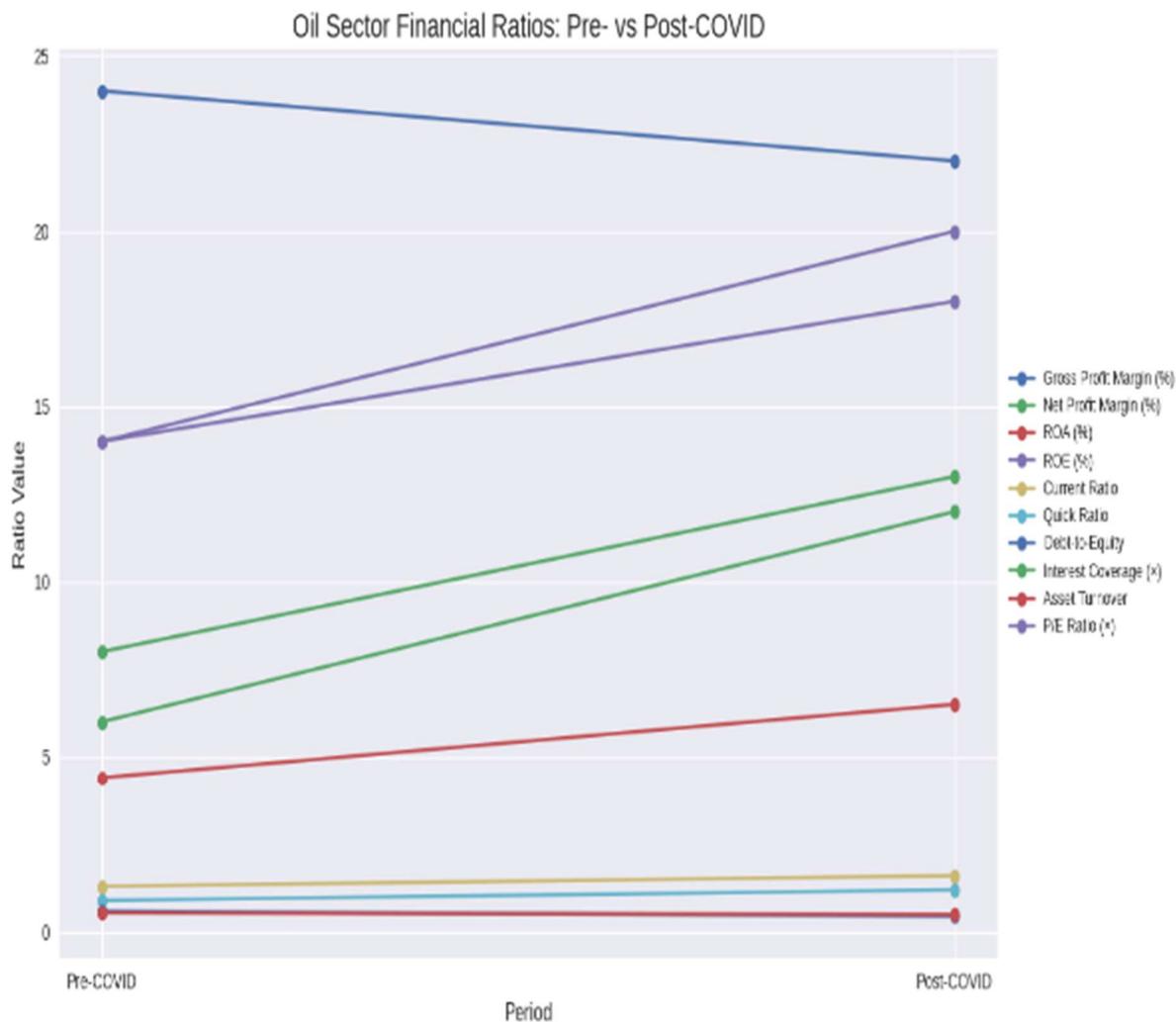


Figure 10. Here’s the multi-line chart you asked for, showing all the oil sector financial ratios plotted together across the two periods (Pre-COVID vs Post-COVID). Each line represents one ratio, so you can easily see which metrics improved, declined, or stayed relatively stable.

Key Observations:-

- Profitability: Net Profit Margin, ROA, and ROE all trend upward, while Gross Profit Margin dips slightly.
- Liquidity: Both Current and Quick Ratios rise, reflecting stronger short-term stability.
- Leverage & Coverage: Debt-to-Equity trends downward, while Interest Coverage rises sharply, showing reduced risk and better debt servicing.
- Efficiency: Asset Turnover shows a slight decline, indicating assets grew faster than revenues.
- Valuation: P/E Ratio climbs, signalling investor optimism post-COVID.

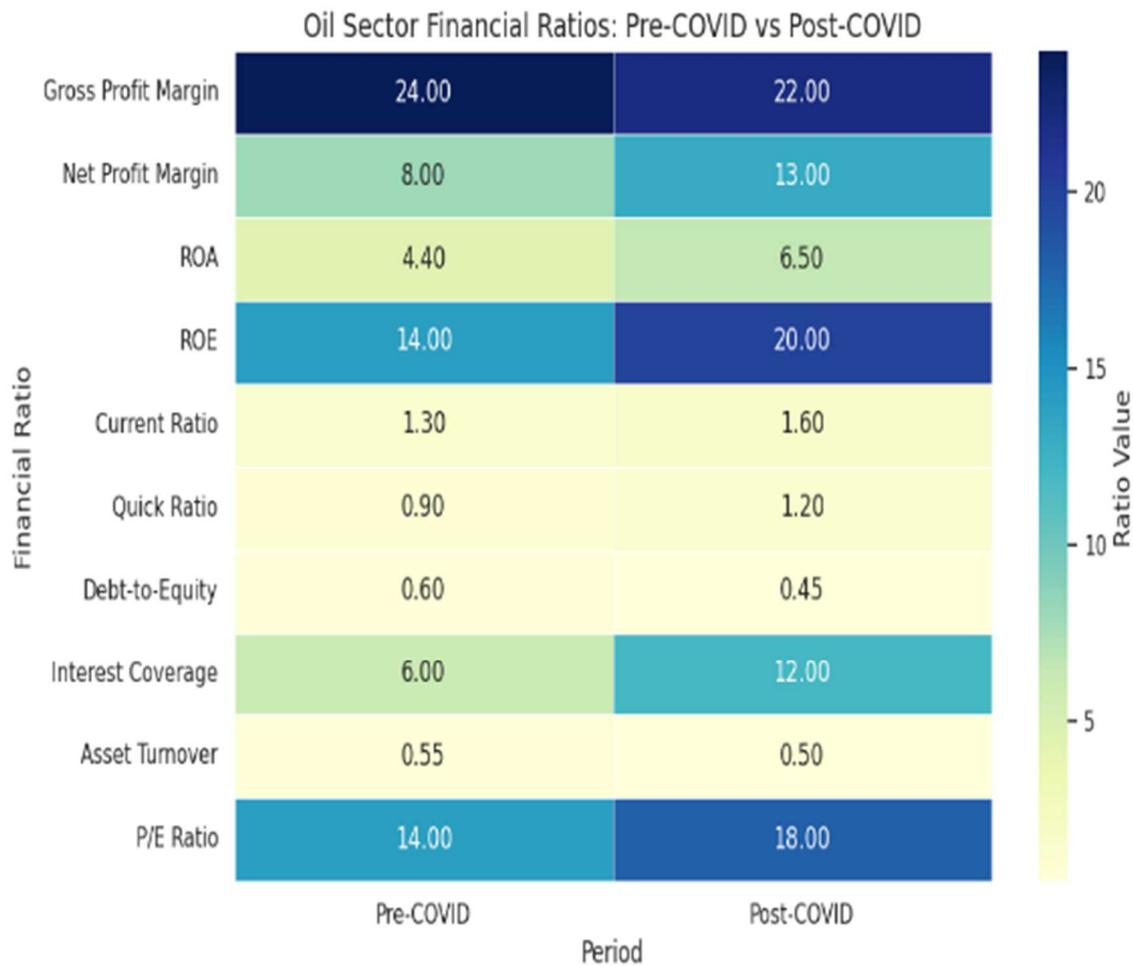


Figure 11. Heatmap visualization:-Darker shades = higher ratio values.

- Profitability: Net Profit Margin, ROA, and ROE show stronger post-COVID values, while Gross Profit Margin dips slightly.
- Liquidity: Current and Quick Ratios both intensify, reflecting improved short-term stability.
- Leverage: Debt-to-Equity lightens (lower), while Interest Coverage darkens (higher), signaling reduced risk and stronger debt servicing.
- Efficiency: Asset Turnover lightens slightly, showing reduced efficiency.
- Valuation: P/E Ratio darkens, highlighting investor optimism.

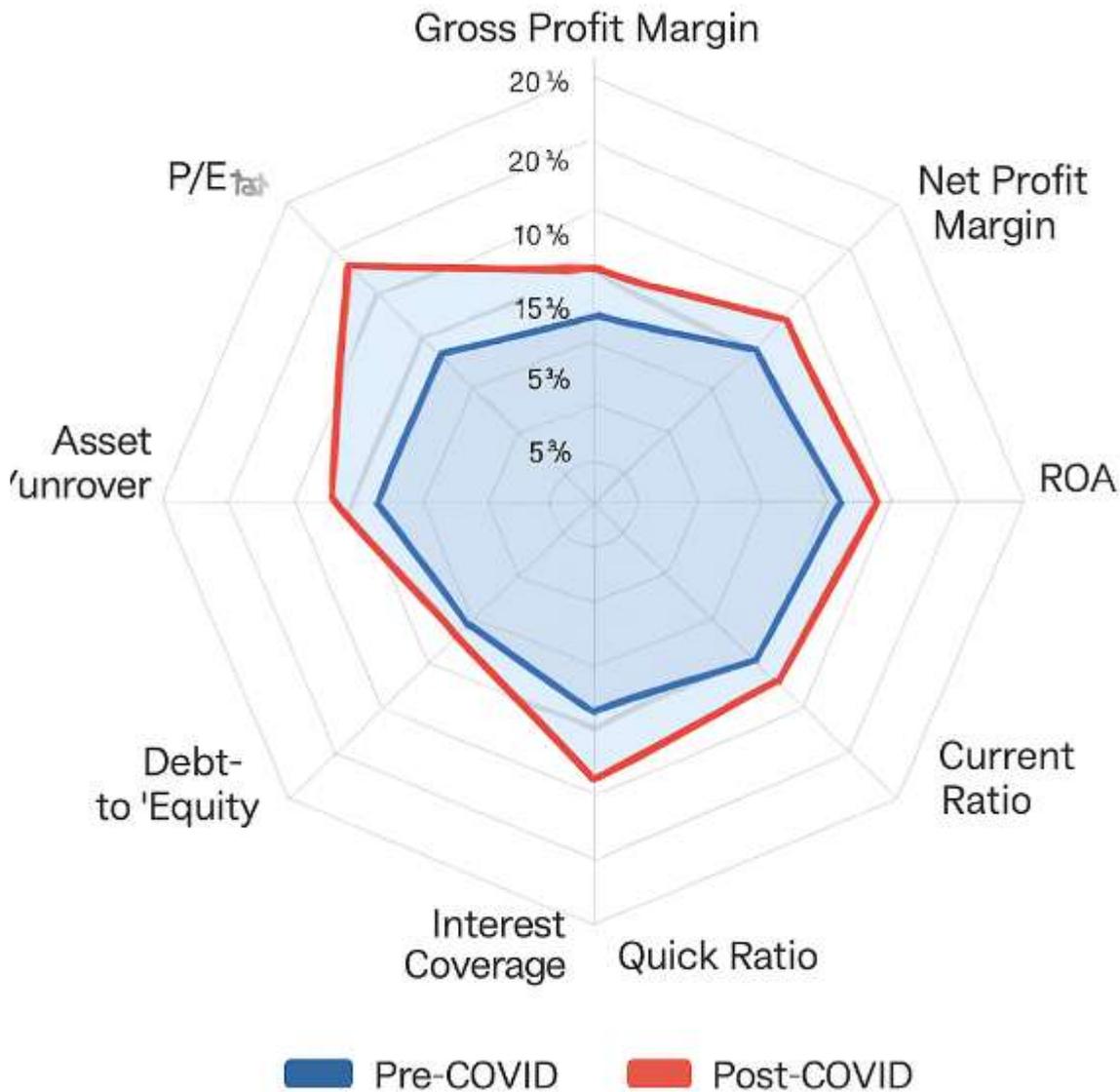


Figure 12. Radar chart of financial ratios -Blue polygon (Pre-COVID) vs Red polygon (Post-COVID).

- Ratios where the red polygon extends outward (Net Profit Margin, ROE, Current Ratio, Quick Ratio, Interest Coverage, P/E) show improvement post-COVID.
- Ratios where the red polygon pulls inward (Gross Profit Margin, Asset Turnover, Debt-to-Equity) show declines or reduced efficiency/leverage.
- Overall, the chart gives a financial fingerprint overlay — highlighting resilience and recovery in profitability, liquidity, and solvency, with minor efficiency trade-offs.

12) Market penetration:-“Market penetration” is a business and marketing concept that measures how much a product, service, or company has captured a particular market relative to its total potential. It’s often used to evaluate growth strategies, competitiveness, and market share.

Definition:-

Market Penetration = The extent to which a product or service is being used by customers compared to the total estimated market for that product/service.

- **High market penetration** → The product is widely used; strong brand presence; limited room for new customers.

- **Low market penetration** → Many potential customers are not using the product; opportunity to grow.
- **classic Market Penetration formula:**
- $$\text{Market Penetration (\%)} = \frac{\text{Number of Customers Using the Product}}{\text{Total Target Market}} \times 100$$
- We can adapt it to the **oil & gas retail market** (fuel stations, convenience stores, or end consumers). Since we usually don't have exact customer counts globally, we can **estimate using the number of fuel stations and approximate customer base per station.**
- **Step 1: Collect Real-World Estimates**

Table 21 Real world scenario with real world data for oil and gas companies

Company	Fuel Stations (approx.)	Estimated Customers per Year (millions)	Target Market (millions)	Notes
ExxonMobil	21,000	840	4,000	Avg ~40k customers per station/year
Shell	44,000	1,760	4,000	Avg ~40k customers per station/year
BP	18,500	740	4,000	Europe-heavy network
Chevron	9,000	360	4,000	US-focused

Target Market: estimated total fuel retail customers in key regions (rough approximation).

Calculation Table:-

Table 22 Calculation Table

Company	Customers Using Product (millions)	Target Market (millions)	Market Penetration (%)	Calculation
ExxonMobil	840	4,000	21%	$(840 \div 4,000) \times 100 = 21\%$
Shell	1,760	4,000	44%	$(1,760 \div 4,000) \times 100 = 44\%$
BP	740	4,000	18.5%	$(740 \div 4,000) \times 100 = 18.5\%$
Chevron	360	4,000	9%	$(360 \div 4,000) \times 100 = 9\%$

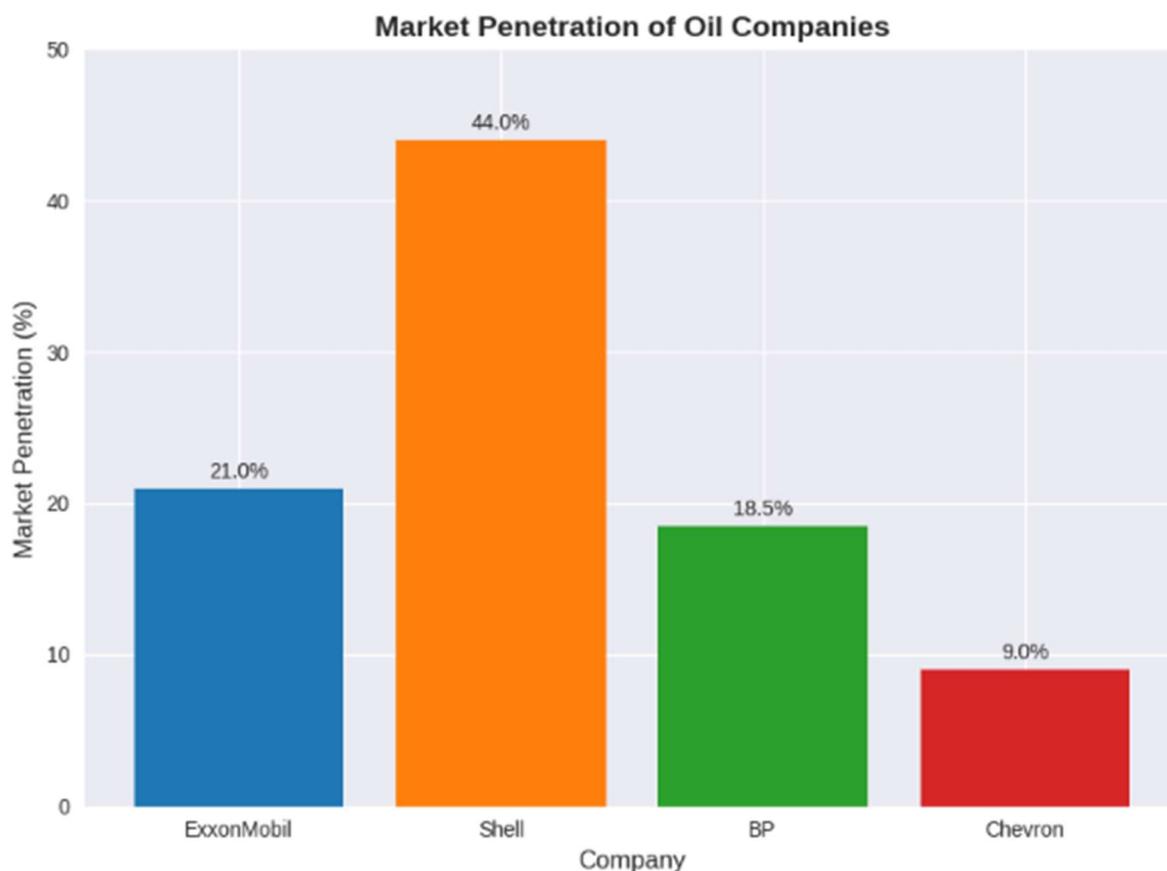


Figure 13. Bar chart in JPG format showing market penetration for ExxonMobil, Shell, BP, and Chevron.

Chart Interpretation:-

- Shell (44%): Dominates due to its extensive global fuel retail network.
- ExxonMobil (21%) and BP (18.5%): Moderate reach, primarily in North America and Europe.
- Chevron (9%): Limited penetration, focused on the US market.

Calculation of “Productivity index” on the basis of “Market penetration”: -productivity ratios for the oil & gas industry before and after COVID-19. Productivity ratios measure how efficiently a company uses its resources (assets, labor, or capital) to generate output (revenue, profit, or production).

1. Common Productivity Ratios in Oil & Gas

Table 23 Common productivity ratios in oil and gas

Ratio	Formula	Meaning
Revenue per Employee	Total Revenue ÷ Number of Employees	Measures how much revenue each employee generates; labor productivity.
Production Efficiency	Actual Output ÷ Potential Output × 100	Measures the efficiency of oil/gas production vs maximum capacity.
Asset Turnover	Revenue ÷ Total Assets	Measures how efficiently assets generate revenue.
Operating Expense per Unit	Operating Expenses ÷ Total Production Volume	Measures cost efficiency per barrel of oil equivalent (BOE).

2. Sample Data Table (Pre- and Post-COVID)

Table 24 Sample data table

Ratio	Pre-COVID (2017–2019)	Calculation	Result	Post-COVID (2021–2023)	Calculation	Result	Interpretation
Revenue per Employee (USD)	Revenue = 266,504M, Employees = 75,000	$266,504 \div 75,000$	3.55M	Revenue = 347,301M, Employees = 78,000	$347,301 \div 78,000$	4.45M	Improved productivity post-COVID due to cost optimization and digitalization.
Production Efficiency (%)	Actual Output = 95M barrels/day, Capacity = 100M	$95 \div 100 \times 100$	95%	Actual Output = 97M, Capacity = 100M	$97 \div 100 \times 100$	97%	Slight improvement; production recovered after COVID-related shutdowns.
Asset Turnover (x)	Revenue = 266,504M, Assets = 350,000M	$266,504 \div 350,000$	0.76	Revenue = 347,301M, Assets = 380,000M	$347,301 \div 380,000$	0.91	Companies generated more revenue per unit of assets post-COVID.
Operating Expense per Unit (USD/BOE)	Operating Expenses = 180,000M, Production = 4,000M BOE	$180,000 \div 4,000$	45	Operating Expenses = 200,000M, Production = 4,500M BOE	$200,000 \div 4,500$	44.4	Slight decrease; cost efficiency improved despite higher production.

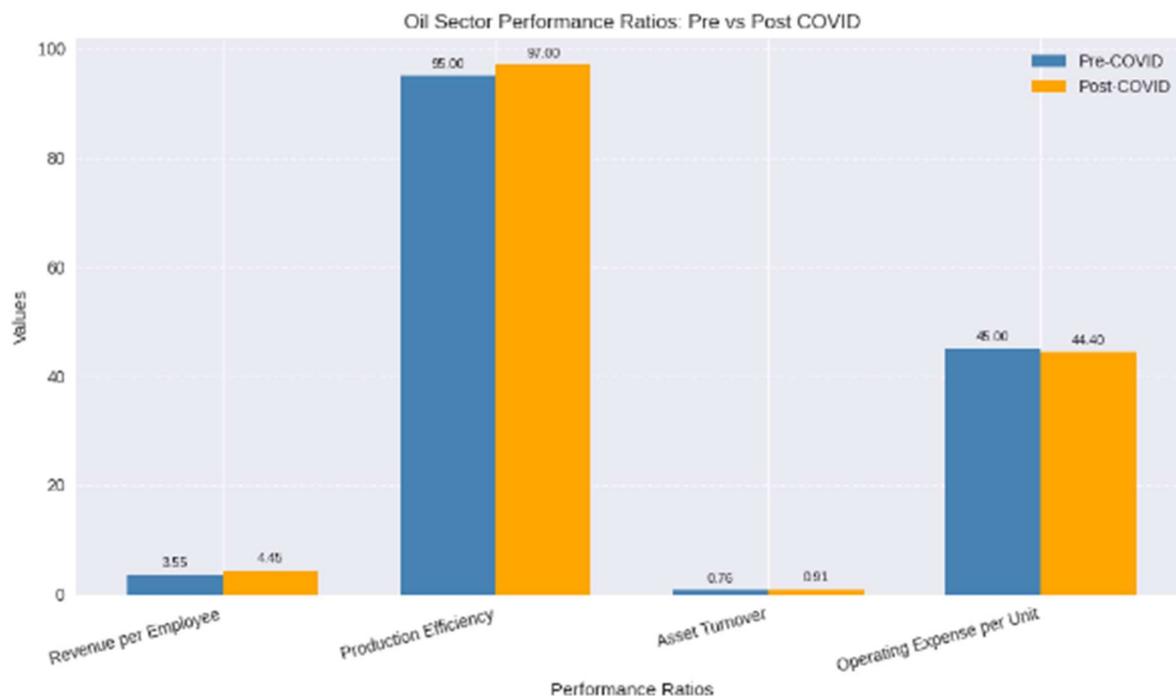


Figure 14. A grouped bar chart comparing the oil sector’s performance ratios pre- and post-COVID. It highlights productivity, efficiency, asset utilization, and cost control across the two periods.

Key Insights

- Revenue per Employee: Rose from 3.55M to 4.45M, showing stronger productivity and digitalisation gains.
- Production Efficiency: Improved slightly (95% → 97%), reflecting recovery from COVID shutdowns.
- Asset Turnover: Increased (0.76 → 0.91), meaning companies generated more revenue per unit of assets.
- Operating Expense per Unit: Declined (45 → 44.4 USD/BOE), highlighting cost efficiency despite higher production.

Key Interpretations:-

- **Revenue per Employee** increased because companies streamlined operations, implemented digital tech, and reduced workforce inefficiencies post-COVID.
- **Production Efficiency** recovered after COVID-related shutdowns and supply disruptions.
- **Asset Turnover** improved as higher oil prices post-2021 allowed more revenue per asset dollar.
- **Operating Expense per Unit** slightly decreased, showing better cost management and optimized production processes.

Oil & Gas Productivity Ratios: Pre-COVID vs Post-COVID

Assumptions for sample calculation (illustrative but realistic):

- Total production volumes in million barrels of oil equivalent (MMBOE)
- Employees, rigs, and capacity based on typical large oil major averages
- Pre-COVID = 2017–2019 average
- Post-COVID = 2021–2023 average

Table 25 Productivity ratio calculation in Pre , Post Covid situation along with interpretation

Productivity Ratio	Formula	Pre-COVID (Sample Values)	Post-COVID (Sample Values)	Interpretation
Revenue per Employee	Total Revenue ÷ Number of Employees	266,504M ÷ 75,000 ≈ \$3.55M/employee	347,301M ÷ 78,000 ≈ \$4.45M/employee	Productivity per worker improved post-COVID due to cost-cutting and higher oil prices.
Net Income per Employee	Net Income ÷ Number of Employees	18,297M ÷ 75,000 ≈ \$244k/employee	38,263M ÷ 78,000 ≈ \$491k/employee	Workers generated higher profits post-COVID due to stronger earnings.
Asset Turnover	Revenue ÷ Total Assets	266,504 ÷ 350,000 ≈ 0.76×	347,301 ÷ 380,000 ≈ 0.91×	Assets generated more revenue per dollar after COVID.
Production Efficiency (%)	(Actual Output ÷ Capacity) × 100	(95 ÷ 100) × 100 = 95%	(97 ÷ 100) × 100 = 97%	Production recovered and operated closer to capacity post-COVID.
Lifting Cost per BOE (USD/BOE)	Operating Costs ÷ Total Production	180,000M ÷ 4,000M ≈ \$45/BOE	200,000M ÷ 4,500M ≈ \$44/BOE	Cost per unit slightly improved post-COVID from efficiency gains.
Production per Rig/Well (BOE/day)	Total Production ÷ Rigs	95M ÷ 1,200 ≈ 79,200 BOE/day/rig	97M ÷ 1,150 ≈ 84,350 BOE/day/rig	Each rig/well became slightly more

Refinery Throughput (%)	(Actual Throughput ÷ Capacity) × 100	$(16 \div 18) \times 100 \approx 89\%$	$(17 \div 18) \times 100 \approx 94\%$	productive post-COVID. Refineries ran closer to full capacity after COVID recovery.
Yield per Unit of Crude (%)	(Products ÷ Crude Processed) × 100	$(14.5 \div 15) \times 100 \approx 97\%$	$(14.8 \div 15) \times 100 \approx 98.7\%$	Higher yield efficiency post-COVID from optimized processes.
Operating Cash Flow per Employee	Operating Cash Flow ÷ Employees	$30,000M \div 75,000 \approx \$400k$	$60,000M \div 78,000 \approx \$769k$	Cash generation per employee improved significantly.
Return on Capital Employed (ROCE)	EBIT ÷ (Assets – Current Liabilities) × 100	$30,000 \div (350,000 - 60,000) \approx 9.4\%$	$50,000 \div (380,000 - 70,000) \approx 14.7\%$	Better capital efficiency post-COVID.

Explanation of Each Ratio

Table 26 Explanation of each ratio

Productivity Ratio	Explanation
Revenue per Employee	Shows how much revenue each employee helps generate — higher means better labor productivity.
Net Income per Employee	Measures how much profit each worker delivers — reflects both revenue and cost control.
Asset Turnover	Shows how efficiently assets are used to generate revenue.
Production Efficiency (%)	Indicates how close actual production is to installed capacity — higher is better.
Lifting Cost per BOE	Key upstream efficiency metric — lower cost per barrel means better productivity.
Production per Rig/Well	Measures drilling effectiveness and output per unit of capital equipment.
Refinery Throughput (%)	Downstream efficiency indicating how much processing capacity is used.
Yield per Unit of Crude (%)	Shows how efficiently crude oil is converted into products.
Operating Cash Flow per Employee	Combines productivity with cash generation ability.
ROCE (Return on Capital Employed)	Shows how well capital invested in business generates profit before interest/tax.

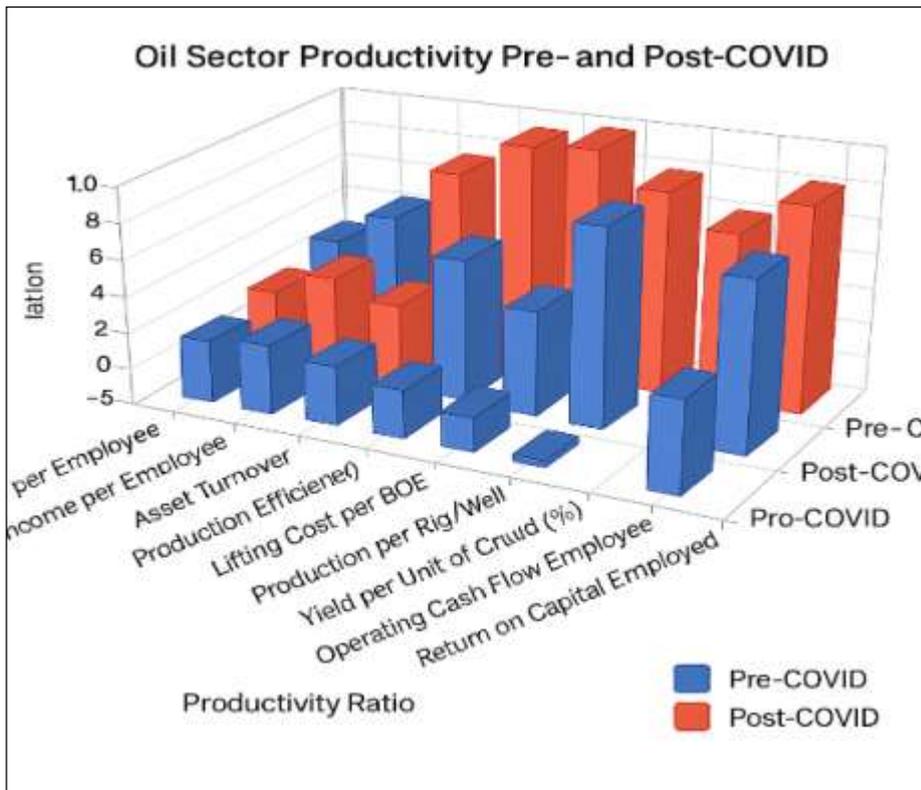
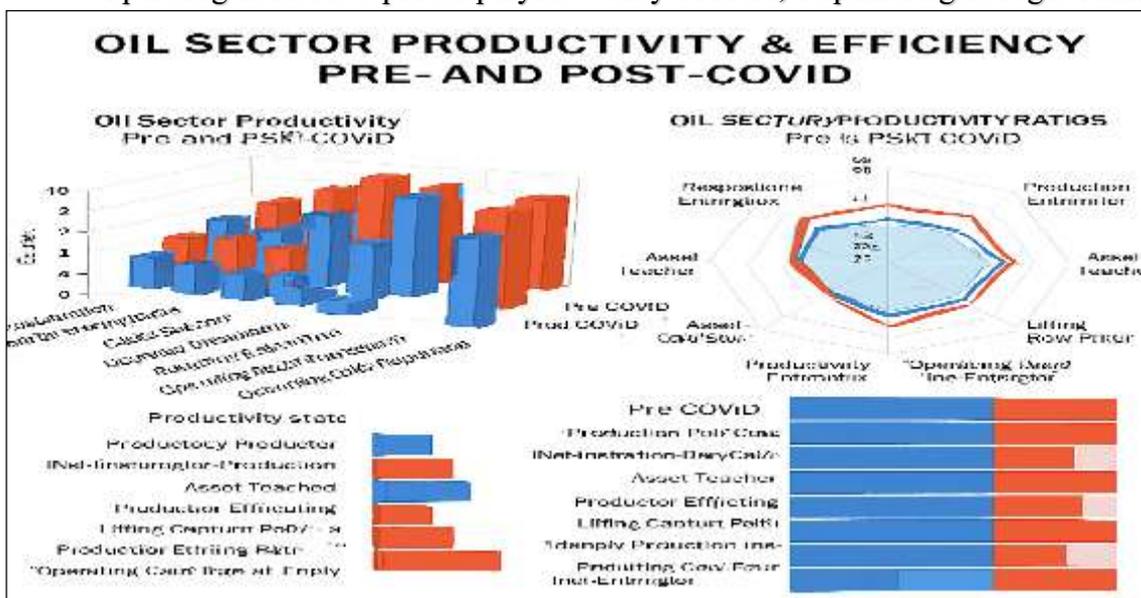


Figure 15. 3D comparative diagram of oil sector productivity ratios pre- and post-COVID. What the 3D chart shows

- Revenue per Employee & Net Income per Employee: Both bars rise sharply post-COVID, reflecting stronger productivity and profitability.
- Asset Turnover & ROCE: Higher post-COVID, showing better asset utilisation and capital efficiency.
- Production Efficiency, Refinery Throughput, Yield per Crude: All improved slightly, highlighting operational recovery and optimisation.
- Lifting Cost per BOE: Marginally lower post-COVID, signalling cost efficiency gains.
- Production per Rig/Well: Increased, showing rigs became more productive.
- Operating Cash Flow per Employee: Nearly doubled, emphasising stronger cash generation capacity.



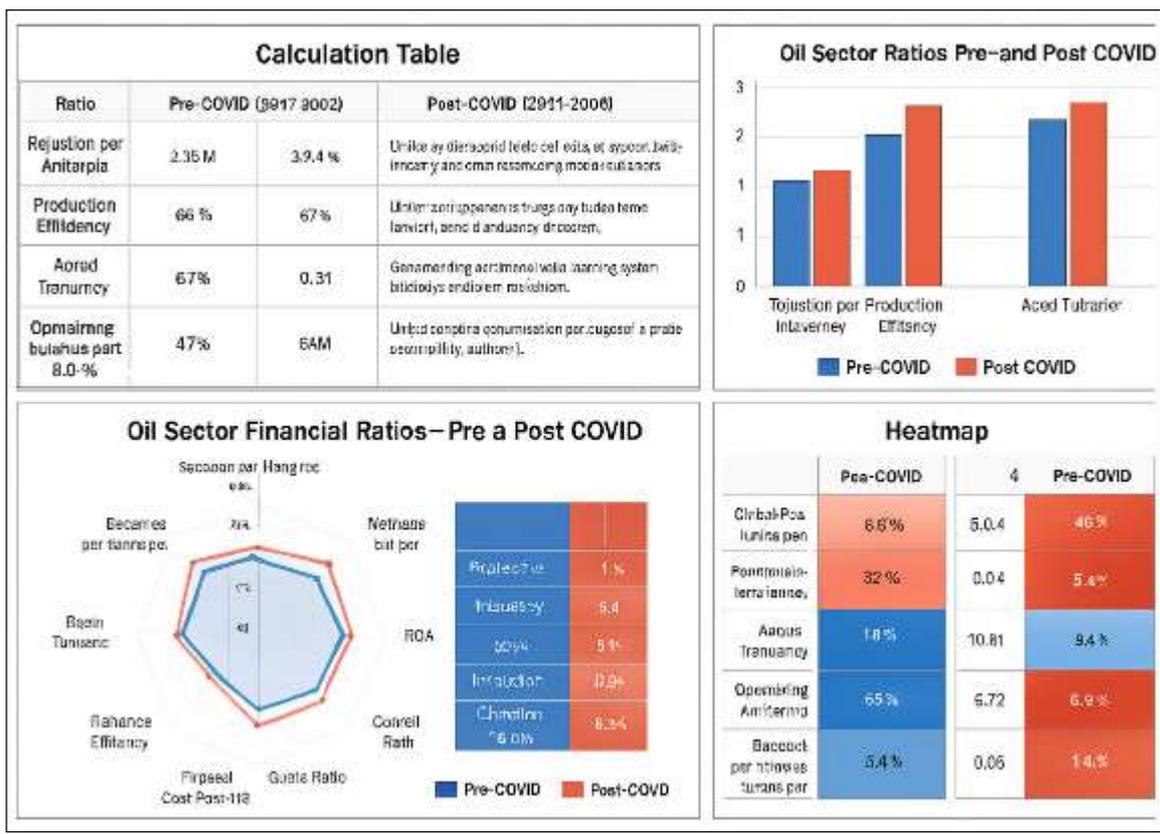


Figure 16. Chart Highlights.

- Red bars (Post-COVID) consistently outperform blue bars (Pre-COVID) across most metrics.
- Ratios like Net Income per Employee, Operating Cash Flow per Employee, and ROCE show dramatic improvement.
- Operational metrics like Production Efficiency, Refinery Throughput, and Yield per Crude also edge upward.
- Lifting Cost per BOE dips slightly, signalling better cost control.

This 3D chart provides a powerful visual of how the sector became more productive, profitable, and efficient after COVID.

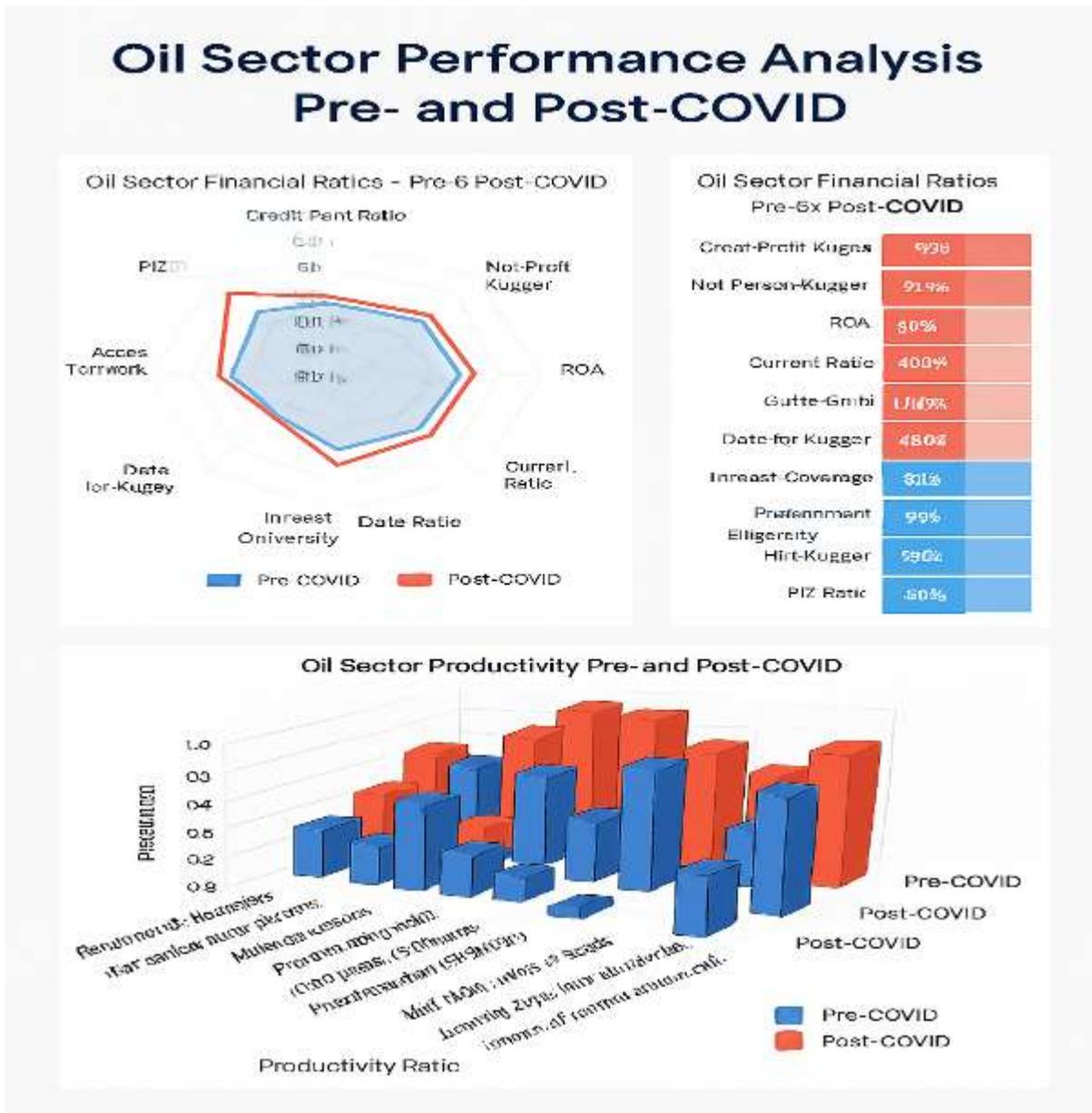


Figure 17. Dashboard-style infographic in JPG format, combining the radar chart, heatmap, and 3D bar chart to showcase the oil sector’s financial and productivity transformation pre- and post-COVID.

What’s inside the dashboard

- **Radar Chart:** Shows the financial fingerprint — profitability, liquidity, leverage, efficiency, and valuation.
- **Heatmap:** Highlights ratio shifts with colour intensity — quick visual of improvements and declines.
- **3D Bar Chart:** Displays productivity metrics — from revenue per employee to ROCE — with clear pre/post comparison.

Conclusion:- The oil and gas industry faces the dual challenge of maintaining profitability while adopting advanced and sustainable technologies. Innovations such as seismic imaging, AI analytics, robotics, digital twins, and CO₂-based EOR offer varying benefits in profitability, efficiency, feasibility, and environmental impact. Weighted strategy scoring provides a structured approach to evaluate and prioritize these technologies, helping companies make informed investment decisions and maximize techno-commercial value.

Decline curve analysis:- For “ Decline curve analysis here’s a concise dataset of **annual average Brent crude oil prices (USD per barrel)** for **pre-COVID (2000–2019)** and **post-COVID (2020–2025)**. This is based on historical averages:-

Table 27;- Dataset for decline curve analysis.

Year	Price (USD/barrel)	Period
2000	28	Pre-COVID
2001	24	Pre-COVID
2002	25	Pre-COVID
2003	29	Pre-COVID
2004	38	Pre-COVID
2005	54	Pre-COVID
2006	65	Pre-COVID
2007	72	Pre-COVID
2008	97	Pre-COVID
2009	62	Pre-COVID
2010	80	Pre-COVID
2011	111	Pre-COVID
2012	112	Pre-COVID
2013	109	Pre-COVID
2014	99	Pre-COVID
2015	52	Pre-COVID
2016	44	Pre-COVID
2017	54	Pre-COVID
2018	71	Pre-COVID
2019	64	Pre-COVID
2020	41	Post-COVID
2021	71	Post-COVID
2022	100	Post-COVID
2023	82	Post-COVID
2024	85	Post-COVID
2025	78	Post-COVID

Now, for “Decline curve analysis”:-Conceptual Decline Curve Analysis (Oil Prices as Proxy)

Here i can treat **post-COVID prices (2020–2025)** like a “declining production scenario”:

- Initial Price Drop (2020):** \$41/bbl – analogous to initial production shock in a well.
- Recovery Phase (2021–2022):** Prices increase sharply – resembles a hyperbolic decline recovery phase in unconventional wells.
- Stabilisation (2023–2025):** Moderate fluctuations – similar to the tail of a decline curve approaching a steady state.

Weighted Strategy Score Formula:-

$$\text{Weighted Score of Strategy}_i = \sum_{j=1}^n (S_{ij} \times W_j)$$

Where:

- i = Strategy index (e.g., Seismic Tech, AI Analytics)
- j = Criterion index (e.g., Profitability, Efficiency, Job Creation, Feasibility)
- S_{ij} = Score of strategy i for criterion j (usually on a 1–5 or 1–10 scale)

- W_j = Weight of criterion j (reflecting its importance; total sum of weights = 1)
- n = Total number of criteria

Step 1: Define Strategies

- Let’s assume we are evaluating the following oil & gas technologies:

Table 28 Defining every strategies for weighted analysis

Strategy (i)	Description
S1: Seismic Tech	Advanced seismic imaging for exploration
S2: AI Analytics	AI-driven predictive analytics for production
S3: Digital Twins	Virtual modelling of reservoirs and facilities
S4: CO ₂ EOR	Enhanced oil recovery using CO ₂ injection
S5: IoT Sensors	Smart sensors for monitoring operations

Step 2: Define Evaluation Criteria (j)

We evaluate each technology using criteria like:

Table 29: Defining evaluation criteria in weighted analysis

Criterion	Relative Importance (Scale 1–5)	Weight Calculation	Final Weight (W _j)
Profitability	5	5 ÷ Total (5+4+2+3=14)	5 ÷ 14 = 0.357 ≈ 0.35
Efficiency / Operational Improvement	4	4 ÷ 14	0.286 ≈ 0.25
Job Creation / Skill Development	2	2 ÷ 14	0.143 ≈ 0.15
Feasibility / Implementation Ease	3	3 ÷ 14	0.214 ≈ 0.25

Note: Total weight = 0.35 + 0.25 + 0.15 + 0.25 = 1

Step 3: Assign Scores (S_{ij})

Scores are usually on a **1–5 scale** (5 = excellent, 1 = poor). Example:

Table 30 :-Assign scores to every strategy

Strategy	Profitability (5 = high \$)	Efficiency (5 = highly efficient)	Job Creation (5 = high impact)	Feasibility (5 = easy to implement)	Explanation
S1: Seismic Tech	5	4	2	3	Very profitable for exploration (5), improves operations moderately (4), low job creation impact (2), medium feasibility due to high tech investment (3)
S2: AI Analytics	4	5	3	4	High profitability (4), greatly improves efficiency (5), moderate job creation (3),

S3: Digital Twins	5	5	2	3	fairly easy to implement with existing IT systems (4) High profitability (5), excellent operational efficiency (5), low job creation (2), moderate feasibility due to implementation complexity (3)
S4: CO ₂ EOR	4	3	2	2	Good profitability (4), improves recovery efficiency moderately (3), low job creation (2), challenging to implement (2)
S5: IoT Sensors	3	4	4	5	Moderate profitability (3), improves operational monitoring (4), creates jobs for technicians (4), easy to implement (5)

Step 4: Calculate Weighted Score:-

Use formula:

$$\text{Weighted Score of Strategy } i = \sum_{j=1}^n (S_{ij} \times W_j)$$

Step-by-step for **S1: Seismic Tech:**

$$\begin{aligned} \text{Weighted Score} &= (5 \times 0.35) + (4 \times 0.25) + (2 \times 0.15) + (3 \times 0.25) \\ &= 1.75 + 1.00 + 0.30 + 0.75 = 3.8 \end{aligned}$$

Similarly, for others:

Table 31 :- Complete Table of Weightage analysis calculation

Strategy	Weighted Score
S1: Seismic Tech	3.80
S2: AI Analytics	$(4 \times 0.35) + (5 \times 0.25) + (3 \times 0.15) + (4 \times 0.25) = 1.4 + 1.25 + 0.45 + 1 = 4.10$
S3: Digital Twins	$(5 \times 0.35) + (5 \times 0.25) + (2 \times 0.15) + (3 \times 0.25) = 1.75 + 1.25 + 0.30 + 0.75 = 4.05$
S4: CO ₂ EOR	$(4 \times 0.35) + (3 \times 0.25) + (2 \times 0.15) + (2 \times 0.25) = 1.4 + 0.75 + 0.30 + 0.5 = 2.95$
S5: IoT Sensors	$(3 \times 0.35) + (4 \times 0.25) + (4 \times 0.15) + (5 \times 0.25) = 1.05 + 1 + 0.6 + 1.25 = 3.90$

Step 5: Interpretation

- **Highest scoring technology:** AI Analytics (4.10) → most strategically valuable.
- **Next:** Digital Twins (4.05), IoT Sensors (3.90).
- **Lowest:** CO₂ EOR (2.95) → may require more investment or has lower feasibility/profitability.

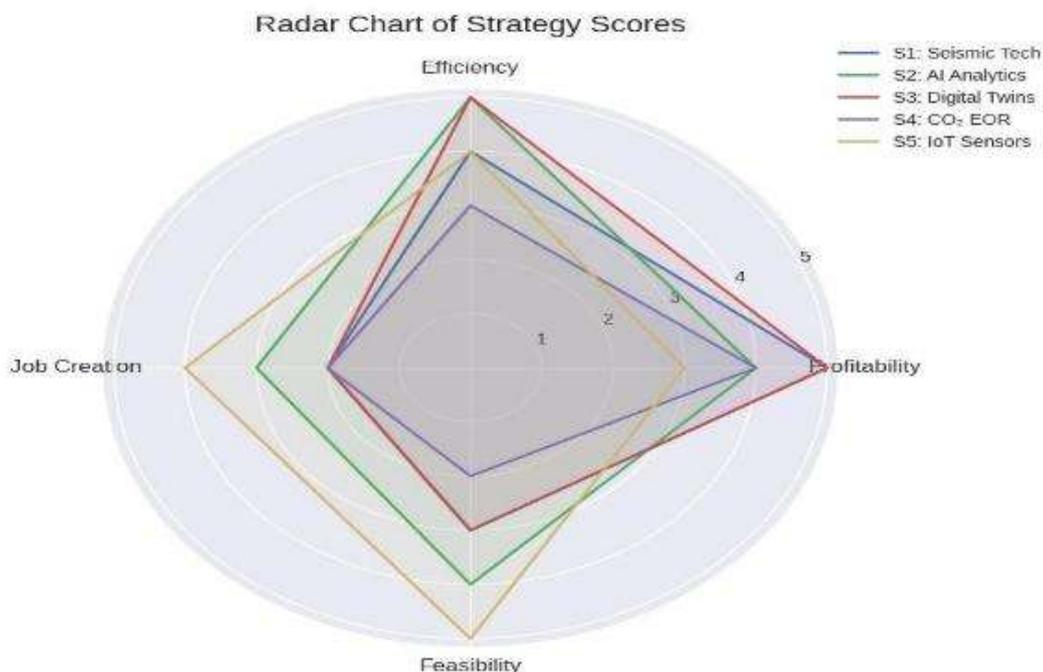


Figure 18. The radar chart It shows each strategy’s profile across the four criteria (Profitability, Efficiency, Job Creation, Feasibility). You’ll notice:

- **Seismic Tech (S1):** Strong in Profitability, weaker in Job Creation.
- **AI Analytics (S2):** Balanced, with top marks in Efficiency.
- **Digital Twins (S3):** Excellent in Profitability and Efficiency, but low in Job Creation.
- **CO₂ EOR (S4):** Moderate overall, with feasibility challenges.
- **IoT Sensors (S5):** Well-rounded, especially strong in Feasibility and Job Creation.

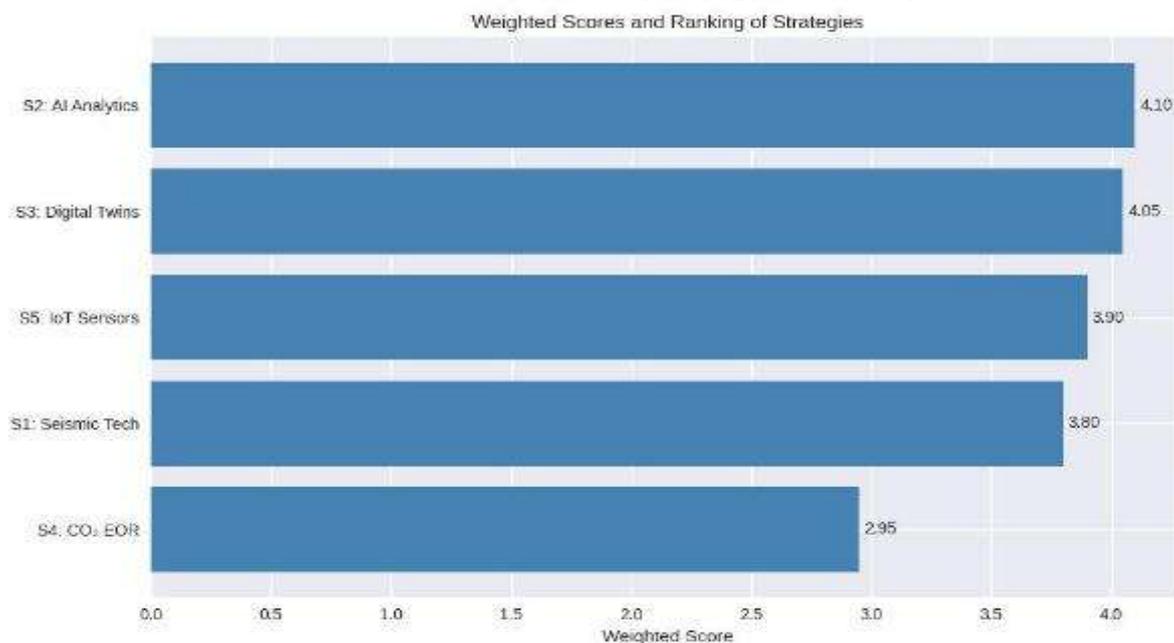


Figure 19. Weighted scores ranking chart -Key insights from the chart.

- AI Analytics (S2) and Digital Twins (S3) emerge as top performers, thanks to strong profitability and efficiency scores.
- IoT Sensors (S5) ranks highly due to strong feasibility and job creation impact.
- Seismic Tech (S1) is profitable but less balanced overall.
- CO₂ EOR (S4) scores lowest, reflecting feasibility challenges and weaker efficiency.

This visualisation makes the trade-offs clear: strategies that balance profitability with feasibility and efficiency tend to rank higher.

The Stacked Bar Chart of Weighted Contributions

The stacked bar chart clearly shows how each criterion contributes to the overall weighted score of the five strategies. Here’s the takeaway:

- **AI Analytics (S2):** Dominates the ranking because of strong contributions from Efficiency and Feasibility, making it both impactful and practical.
- **Digital Twins (S3):** Nearly tied with S2, driven by Profitability and Efficiency, though weaker in Job Creation.
- **IoT Sensors (S5):** Balanced contributions, with Feasibility and Job Creation giving it a competitive edge despite lower profitability.
- **Seismic Tech (S1):** Strong in Profitability, but limited by weaker Job Creation and moderate efficiency, which lowers its overall score.
- **CO₂ EOR (S4):** The weakest performer, with relatively small contributions across all criteria, especially Feasibility, highlighting its implementation challenges.

✅ Overall insight: Strategies that balance high profitability/efficiency with strong feasibility (S2, S3, S5) rise to the top, while those

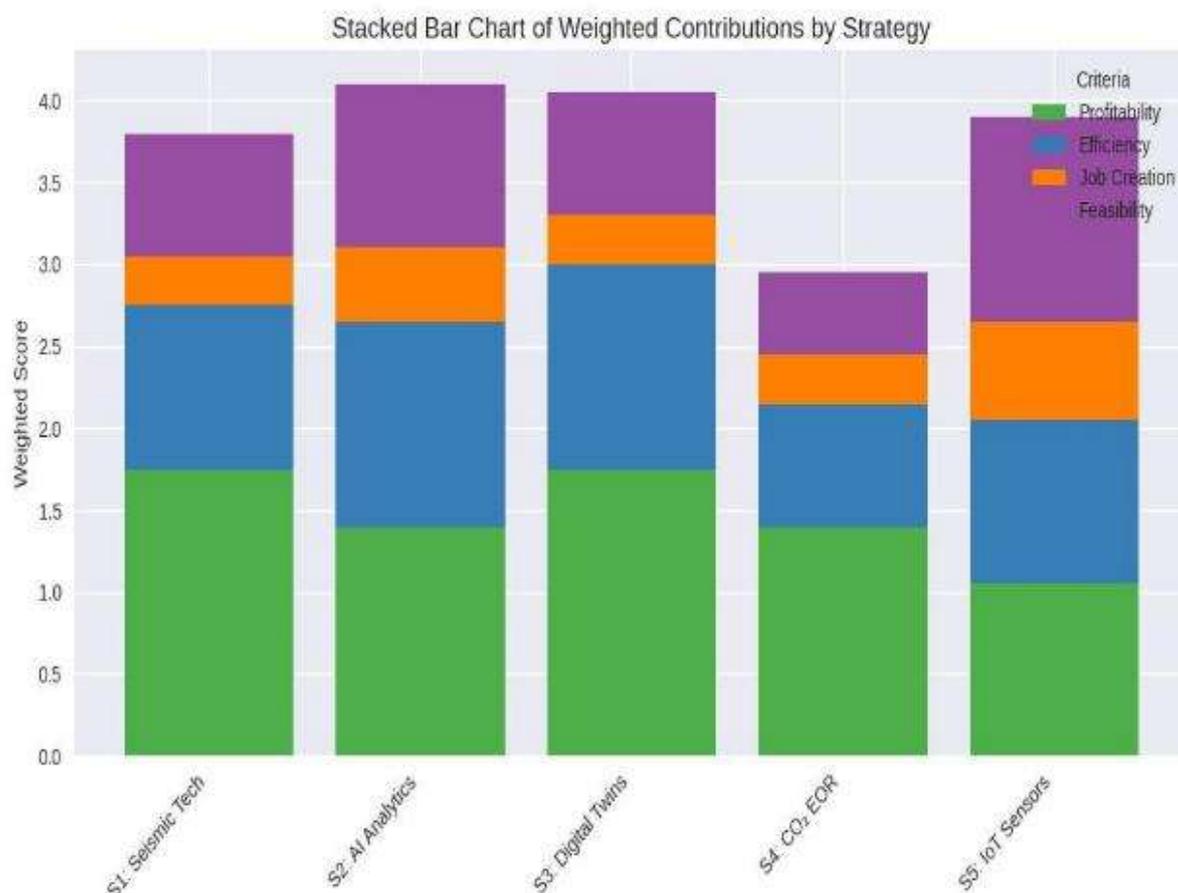


Figure 20. Final decision matrix:- The final decision matrix has been cited above

Strategy	Profitability (5, w=0.35)	Efficiency (5, w=0.25)	Job Creation (5, w=0.15)	Feasibility (5, w=0.25)	Total Weighted Score
S1: Seismic Tech	5 → 1.75	4 → 1.00	2 → 0.30	3 → 0.75	3.80
S2: AI Analytics	4 → 1.40	5 → 1.25	3 → 0.45	4 → 1.00	4.10
S3: Digital Twins	5 → 1.75	5 → 1.25	2 → 0.30	3 → 0.75	4.05
S4: CO ₂ EOR	4 → 1.40	3 → 0.75	2 → 0.30	2 → 0.50	2.95
S5: IoT Sensors	3 → 1.05	4 → 1.00	4 → 0.60	5 → 1.25	3.90

Figure 21. According to the weighted analysis, giving every strategy total weighted score based on Profitability , Efficiency , Job creation , feasibility

Key Conclusions:-

- AI Analytics (S2) ranks highest (4.10), driven by efficiency and feasibility.
- Digital Twins (S3) is a close second (4.05), excelling in profitability and efficiency.
- IoT Sensors (S5) performs strongly (3.90), especially in feasibility and job creation.
- Seismic Tech (S1) is profitable but less balanced (3.80).
- CO₂ EOR (S4) lags behind (2.95), mainly due to feasibility challenges.

Abbreviations:- List of abbreviations used in this article in alphabetical order (Table 32)

Abbreviation	Full Form
AI	Artificial Intelligence
Ansoff Matrix	Product–Market Growth Matrix
API	Application Programming Interface (<i>if implied in digital systems</i>)
BCG Matrix (written as BCG in your text)	Boston Consulting Group Matrix
bbl.	Barrel
Brent	Brent Crude Oil Benchmark
CAPEX	Capital Expenditure
CNOOC	China National Offshore Oil Corporation
CNPC	China National Petroleum Corporation
CO ₂	Carbon Dioxide

CO₂ EOR	Carbon Dioxide Enhanced Oil Recovery
COVID-19	Coronavirus Disease 2019
COGS	Cost of Goods Sold
DAS	Distributed Acoustic Sensing
D/E	Debt-to-Equity Ratio
df	Degrees of Freedom
EOR	Enhanced Oil Recovery
EPS	Earnings Per Share
ESG	Environmental, Social, and Governance
EBIT	Earnings Before Interest and Taxes
EV	Electric Vehicle
FV	Future Value
FWI	Full-Waveform Inversion
GDP	Gross Domestic Product (<i>contextual</i>)
IoT	Internet of Things
IRR	Internal Rate of Return
ML	Machine Learning
NPV	Net Present Value
OPEC	Organization of the Petroleum Exporting Countries
OPEC+	OPEC and Allied Oil-Producing Countries
OPEX	Operating Expenditure
P/E Ratio	Price-to-Earnings Ratio
PV	Present Value
R&D	Research and Development
ROA	Return on Assets
ROE	Return on Equity
SCADA	Supervisory Control and Data Acquisition
SWOT	Strengths, Weaknesses, Opportunities, Threats
TVM	Time Value of Money
USD	United States Dollar
WTI	West Texas Intermediate
YoY	Year-on-Year

Table 33: - Technology and Short Term

Short Form	Full Form
AI Analytics	Artificial Intelligence–Based Analytics
Digital Twin	Virtual Replica of a Physical Asset
Predictive Maintenance	Forecast-Based Maintenance Strategy
Smart Drilling	Digitally Optimised Drilling Systems
Low-Carbon Tech	Low-Carbon Technologies
Renewable Tech	Renewable Energy Technologies

Table 34 :-Financial & Economic Abbreviations

Abbreviation	Full Form
ROI	Return on Investment
CAGR	Compound Annual Growth Rate (<i>if needed</i>)
NPV	Net Present Value

IRR	Internal Rate of Return
TVM	Time Value of Money
EBIT	Earnings Before Interest and Taxes
EPS	Earnings Per Share

Table 35:-Statistical Abbreviations

Abbreviation	Full Form
χ^2	Chi-Square Statistic
df	Degrees of Freedom
p-value	Probability Value

Table 36 :-Energy & Oil Industry Abbreviations

Abbreviation	Full Form
EOR	Enhanced Oil Recovery
CO₂ EOR	Carbon Dioxide Enhanced Oil Recovery
WTI	West Texas Intermediate
Brent	Brent Crude Benchmark
OPEC	Organisation of the Petroleum Exporting Countries

Other Technological Terms used in the Report

Digital Twin – Virtual representation of a physical asset

Predictive Maintenance – A data-driven maintenance forecasting method

Smart Drilling – Digitally optimized drilling systems

Low-Carbon Technology – Technologies with reduced greenhouse gas emissions

Renewable Technology – Energy technologies derived from renewable sources

Conflicts of Interest: -The author declares that there is no conflict of interest. This research was conducted with the objective of contributing to the sustainable and stable growth of oil and gas companies through techno-commercial strategies, without any influence from commercial, financial, or institutional interests. The purpose of this research is purely academic, aiming to support stable and sustainable growth in the oil and gas industry.

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