Sustainability through Artificial Intelligence in Oil and Gas Industry - A Case Study

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ABSTRACT

Background/Purpose: *Systems and procedures for producing and delivering oil and gas are highly expensive and rely on cutting-edge technology. This industry is one that is already exploring the possibilities of artificial intelligence. To keep a competitive edge in the face of rapid environmental change, the industry is spending extensively on artificial intelligence and other data technologies.*

Objective*: The benefits of AI directly address the major issues in the current oilfield. The oil and gas industry are realising the profound impact that AI can have on every industry along the whole value chain. The main problems in today's oilfield are directly addressed by AI's potential.*

Design/Methodology/Approach: *This study focuses on challenges faced by different streams of oil and gas industries and its acceptance and dependency on AI to overcome them.*

Findings/Result: *Now, oil and gas companies may use AI to estimate the value of specific reservoirs, customise drilling and completing plans to the specific geology, and assess the risks related to each well.*

Originality/Value: *This study provides a concise overview of the oil and gas industry's sustainability using artificial intelligence.*

Paper type: *A case study on how artificial intelligence has influenced the development of the oil and gas industries.*

Keywords: Artificial intelligence, *oil and gas companies*, machine learning, Big Data Analytics, IoT, NLP, Chatbot

1. INTRODUCTION :

Throughout human existence, the oil and gas business is crucial. It is thriving and there is high demand, which further boosts the national economy. It is one of the eight essentials of India. Numerous Indian petroleum and natural gas enterprises have significantly contributed to India's rapid economic expansion. It has become the main source of employment and also offers commercial relationships with various raw material suppliers [1].

Being one of the world's most essential energy resources, oil and gas continues to support modern economies worldwide. Five countries utilise nearly 48% of the world's oil. Every day, 97.39 million barrels were consumed in 2021, with the figure predicted to rise to 99.61 million barrels per day (b/d) in 2022 and 101.55 million b/d by 2023.

- United States is the largest oil consumer in the world with a consumption of 20.31% of the world's oil and ranks at the top spot not just as a consumer but even as an oil producer.
- China consumes close to 16% of the world's oil production, making it the second largest consumer in the world.
- India, with a daily consumption of 4.65 million barrels, is the third largest oil consumer in the world.
- Russia's consumption of 3.61 million b/d places it at the fourth spot and is the third largest producer of oil in the world, behind the U.S. and Saudi Arabia.

- Japan with a consumption of 3.43 million b/d, is the fifth largest consumer of oil in the world.
- Next in line are Brazil, Canada and Mexico. The list of largest producers of oil includes the U.S., Saudi Arabia, Russia, Canada and China.

By 2022, India intends to cut the amount of oil it imports from 82% to 67% by employing domestic ethanol production, renewable energy sources, and local exploration. India ranked second in net crude oil imports (including crude oil products) in 2019 with 205.3 Mt.

India is the third-largest consumer of crude oil in the world, behind China and the United States. India is the second-highest oil supplier after China and primarily dependent on imported crude oil. India depends on imports for 45.3% of its natural gas and 82.8% of its crude oil, respectively. Until its green energy resources, such as wind, hydroelectricity, solar power, and the plant matter, are sufficiently advanced to replace the nation's use of petroleum-based products, which also considerably contributes to global warming, India will need to rely extensively on crude oil imports for the foreseeable future [2].

2. RESEARCH RELATED WORK :

To find papers from 2018 to 2023, a systematic Google Scholar search is done using the terms “AI in oil and gas industries”,” Chatbot in oil and gas “,” downstream “, and “upstream”. The reviewed are listed in the below table.

Table 1: Works related to technologies applied in oil and gas industries (Source: Author)

S. No.	Area of Study	Focus	Reference
1	machine learning and AI	To understand the potential for hydrocarbons, measurements from the surface and subsurface are collected.	Sircar, A et al. (2021). [3]
2	Upstream activities include reservoir geology assessment, drilling optimisation, along with reservoir engineering.	creation of useful artificial intelligence-based solutions for upstream oil and gas	Dmitry Koroteev et al. (2021). [4]
3	network architecture, as well as the advantages and difficulties of implementing ML technologies	optimize the upstream, midstream, and downstream operations	Devansh Gupta et al. (2022). [5]
4	Study of the literature on how AI is affecting oil and gas developments.	a study of the literature on how AI is affecting oil and gas building projects	Ahsan Waqar et al. (2023). [6]
5	Using AI-based on-board processing to find leaks	monitoring gas and oil pipes in an unsafe area to check for breaches and cracks	Aysha Alharam et al. (2020). [7]
6	artificial intelligence in the exploration & production	Gathering data to make a decision based on data analytics.	Sachin Choube et al. (2020). [8]
7	AI based automatization	the adoption of electric propulsion for road transport	K. Nagy et al. (2018). [9]

3. OBJECTIVES OF STUDY :

Websites relating to the applications of AI in oil and gas industries have been visited to achieve sustainability, benefits, challenges and its disadvantages for this case study report.

The objectives of the report are:

1) To understand sustainability in oil and natural gas industries.
2) To study the different levels in oil and gas industries.
3) To learn the acceptance of AI in different Indian oil and gas companies.
4) To know the adaptation of different technologies in oil and gas industries.
5) To know Chatbot Use Cases in The Oil and Gas Industry

6) To study different Chatbot using oil and gas companies.
7) to examine how artificial intelligence is affecting the oil and gas industries.
8) To portray AI's contribution in sustainability.
9) To understand the AI uses, benefits, challenges, disadvantages through ABCD analysis.

4. IMPLEMENTATION OF AI TECHNOLOGIES :

The use of AI technology in the oil and gas industry will increase various operations' efficiency and allow for informed judgements. The convergence of different technologies will have a tremendous impact on the business, enabling it to create cutting-edge apps for managing and maintaining infrastructure, finding new oil wells, and promoting worker safety [10].

Table 2: Implementation of technology in oil and gas technology [Source: Author]

Technology	Implementation
Big Data Analytics	When combined with AI, big data analytics may result in estimation and model predictions that will aid in capturing and analysing the changing nature of the process of manufacture. Big data and predictive analytics can be utilised to improve upstream, downstream, and midstream operations.
The Internet of Things (IoT)	Sensors, cameras, drones, and other IoT field equipment collect data on temperature, and real-time interrelated variables and give predictive intelligence that increases productivity and ensuring safety. IoT gadgets with AI capabilities enable the tracking of distribution systems, pipelines, wells, petroleum refineries, and overseas oil and gas rigs.
Machine learning	The enhancement of reservoir modelling, drilling, troubleshooting troublesome wells, predictive and preventative maintenance, and the identification of shale resources are just a few of the activities that artificial intelligence (AI) and machine learning help with.
NLP	To streamline and organise news and information, NLP and AI collaborate. Oil the rate of recovery for drilling and exploration data may be improved via NLP, machine learning, and computer vision. NLP approaches also aid chatbots and virtual assistants in providing first IT support.

This generation's most important technology development is thought to be artificial intelligence. Organisations also need to become more digital and AI-driven if they want to succeed in the digital age. Furthermore, it is crucial to recognise the benefits that an AI maturity framework offers businesses. Due to this, it is even more important for each firm to evaluate the factors that contribute to AI adoption and their current stage of AI maturity. Many businesses have made the switch to digital operations and have begun to evaluate their own capacity to adopt and scale corporate AI solutions. Many businesses are still working to advance beyond the Proof of Concept (POC) stage or reach digital maturity (Kumari, D. et. al. (2021). [11]).

Modern organisations need both an AI-driven business model and a solid digital-first strategy in order to reach AI maturity. Our specialists have therefore created this five-step strategic roadmap based on the digital-first strategy approach to hasten the adoption and transformation of AI. AI can assist OFSEs in lowering risk and improving operations. With better forecasts, it can predict delays in the supply chain, equipment breakdowns, changes in the cost of materials, and changes in consumer demand.

Transport plans between production sites and locations for refining and processing are only one area in which operators in the midstream and downstream sectors might integrate AI. Demand forecasting can be done using extremely accurate predictive algorithms [12].

4.1 Quicker Closure of Exploration/Drilling Projects:

Those Companies engaged in drilling and exploration projects are employing AI to create algorithms that enable precise drilling, lowering the possibility of oil spills, mishaps, and fire. They can increase penetration rate while still using the same technology. These companies can improve their output by detecting areas where they are falling behind thanks to a different application of AI [13].

Table 3: Features of drilling project (Source: Author)

Better reliability and uptime of the equipment	By reducing unnecessary maintenance expenses and downtime due to equipment unavailability, AI helps organisations enhance their income. Preventative maintenance is carried out according to the manufacturer's schedule. This raises operational productivity and uptime as a result.
Cost Reduction	The perception of upstream oil and gas industry work as being very labour-intensive has changed as a result of AI. Businesses are now able to maximise production while reducing expenses.

4.2 Impact of Artificial Intelligence on Oil & Gas industry

Fig. 1: Impact of AI on oil and gas industry (Source: Author)

4.3 Chatbot Use Cases in the Oil and Gas Industry:

Without any human involvement, the Chatbot uses an AI-based system to generate the discussion [14]. The user's input is first gathered by the Chatbot, which then analyses it using machine learning and natural language processing (NLP) techniques to assign each input to a specific entity that is unique from the others and produce the final response (Wang, X. et al. (2022). [15], Gatzioufa, P. et al. (2022). [16], Chaves, A. P. et al. [17], Shumanov, M. et al. (2021). [18]). The Chatbot's capacity to establish a real-world connection and its provision of suggested solutions aid in determining the customer's true needs (Suhaili, S. M. et al. (2021). [19], Suhaili, S. M. et al. (2022). [20], Wilson, L. et al. (2022). [21], Chen, Q. et al. (2022). [22], Shum, H. Y. et al. (2018). [23], Dale, R. et al. (2016). [24], Jain, M. et al. (2018). [25]).

Upstream Oil and Gas Production: Exploration and production firms, sometimes referred to as upstream oil and gas corporations, locate deposits, drill wells, and collect raw materials from the earth.AI Chatbots assist in addressing the unique requirements of upstream oil and gas enterprises [26]. Some of the use cases include –

1. Provide workers on-demand support both in the office and on the job: Field workers can use AI chatbots to ask questions, get current information, and request assistance in an emergency without having to stop what they are currently doing. In order to swiftly get information such as lubricant specs, average reservoir porosity, specifics on problems, etc., the Chatbot connects to the company's internal and external sources. Additionally, as operators move from one location to another, voice-enabled bots can respond to queries and give status updates.
2. Provide quick fixes to onsite workers: An AI Chatbot can accept unstructured inputs from personnel performing maintenance on the ground. After examining these issues, it might offer quick remedies based on a sizable knowledge and insight database.
3. Lessen the learning curve for new hires: AI Chatbot maintain a substantial store of knowledge on procedures that can be useful for new hires. They can also help to speed up the process of gathering, interpreting, and simulating data. The bot may use the company's software to help employees with a variety of activities, including creating type curves, determining the optimum locations for infill drilling, prioritising well spacing, and more.
4. Refrain from potentially costly challenges: Prone to a variety of upstream issues, such as difficulty with pipelines and drilling, oil spills, risks to health and safety, etc. for instance, a production line fault could result in large losses and a million-dollar revenue loss.

5. When used successfully, AI Chatbot can warn users of potential disasters and provide pertinent information.

4.4 Chatbot in Indian companies:

(1) Indian Oil Corporation Limited (IOCL): is leading in the Indian market. Its headquarters is in New Delhi. and has been serving throughout the nation being the best oil and gas industry to rely upon [27]. IOC is ranked 212 *amongst Fortune Global 500 Companies* (2021) [28].

To offer value to its stakeholders, Indian Oil fosters the fundamental principles of Care, Innovation, Passion, and Trust within the company. As a part of our "Digital Initiatives" initiative and to further these ideals and facilitate information flow, we present to you the Chatbot known as "PRIA - (Procurement Resource Intelligent Assistant)." This Chatbot, called PRIA, was created to offer some useful information that suppliers commonly seek out, frequently regarding things like purchase orders, payments, bill details, supplies supplied, etc. Users will have an OTP issued to their registered number for verification. Information about past payments, POs, and bills is also available to verified users. It also has some useful FAQs that address typical queries from both new and experienced users [29].

(2) Bharat Petroleum Corporation Ltd. (BPCL): The first AI-enabled Chatbot in the country's oil and gas industry, Urja, was developed by Bharat Petroleum Corporation Ltd. (BPCL) to provide its customers with an interface for a seamless self-service experience and speedy resolution of issues. LPG cylinder booking, price and payment status, booked LPG cylinder delivery status, and history of refills are only a few of the services offered by the virtual assistant. It gives information on the cost of petrol and diesel as well as the location of the closest petrol station.

You may even utilise it to ask for fuel delivery right to your door. For digital integration, Urja is currently reachable on the corporate website for any enquiries for both B2B and B2C. Following a successful six-month WhatsApp trial project to facilitate LPG bookings, Urja now speaks 13 languages, including Hindi, English, Kannada, Telugu, Marathi, Gujarati, Oriya, Bengali, Tamil, Punjabi, Urdu, Malayalam, and Assamese [30].

5. SEGMENT-SPECIFIC COMPANY FEATURES :

Upstream, midstream, and downstream are the typical segments used to categorise the oil and gas industry. Although there are numerous distinct businesses in each of these sectors, the fact that well-known oil and gas companies have upstream, middle, and downstream operations suggests that these sectors are linked. Depending on whether a firm is privately, publically, or state-owned, different amounts of information are disclosed.

Every area of the industry is occupied by international oil companies, or IOCs. Market values for large integrated corporations range from $10 billion to $100 billion. One who processes no more than 75,000 barrels of crude oil on average per day over the course of a year, or who has annual retail sales of oil and gas that do not exceed $5 million, qualifies as an independent company that specialises in one sector of the industry.

For upstream companies, production and exploration are top concerns. National oil firms, such as OPEC, or integrated multinational oil businesses are in charge of the vast bulk of the crude oil production in the globe [31].

Midstream companies handle the transportation and storage of oil and gas. There are numerous independent transportation businesses in this sector.6 For midstream companies, in particular price-volume correlations, oil and gas volumes are crucial: The demand for midstream companies to provide transportation will disappear if the price falls too low and upstream companies quit producing. Downstream companies' control oil and gas marketing and refinement (Haroon, S. et al**.** (2018). [32], Kalam, S. et al. (2019). [33], Tariq, Z. et al. (2021). [34], Ferreira, J. J**.** et al**.** (2019). [35]).

Compared to upstream, [m industry, the market is less consolidated. When downstream companies sell their refined products for a profit, they must be able to return their investment in raw materials. Size and number of refineries are additional metrics.

After oil and gas are extracted, operations are referred to as "downstream oil and gas production". O&G players upstream are positioned closer to the consumer. Due to their proficiency with natural language, AI chatbots can answer customer questions, provide product information, and provide specialized product recommendations.

6. ABCD ANALYSIS OF ARTIFICIAL INTELLIGENCE IN OIL AND GAS :

The industry depends on AI to maximise and optimise their efficiency and revenues due to the rise in oil prices and the global decline in crude oil levels. Effective resource and activity prioritisation is made possible by the ABCD analysis, ensuring that the most crucial tasks are completed first. The ABCD framework helps to analyse the sustainability of oil and gas industries in its different streams (Aithal, P. S. et al. (2017). [36], Aithal, P. S. et al. (2017). [37], Priyadarshini P. et al. (2022). [38], Thomas, L. et al. (2022). [39], Madhushree, R. R., et al. (2018). [40]).

6.1 Applications of Artificial Intelligence in Oil and Gas:

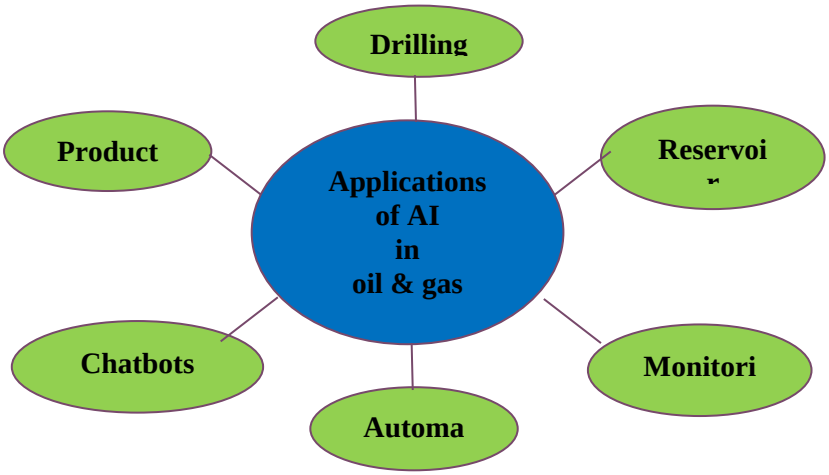

Fig. 2: Applications of Artificial Intelligence in Oil and Gas (Source: Author)

(1) Drilling - The unprocessed hydrocarbons and other elements needed to make fuel are mined and drilled by companies in the industry using AI. By developing algorithms that give precise and accurate intelligence to monitor drills on land and in water, AI helps these enterprises. Precision drilling speeds up penetration and reduces the risk of mishaps, oil leaks, and fires (ALGULIYEV, R. **et al.** (2020). [41]).

(2) Production - output is maximised in companies with the help of AI by locating unproductive spots. In order to train AI systems to automatically spot patterns and refine the data to provide analytics, large amounts of unprocessed production data might be utilised.

(3) Reservoir Management- Oil reservoir management requires a high level of optimisation and maintenance that takes into account a variety of technical aspects, including seismic interpretation, geology, reservoir management, production, etc. [42].

(4) Chatbots- Customer engagement and support are crucial for any business. The firms can interact with their customers by utilising AI-powered chatbots to respond to inquiries, provide product information, offer recommendations, and more (Gupta, D. et al. (2022). [43]). Can be used to get feedback from customers by conducting online surveys on their websites.

(5) Monitoring - Monitoring of petrol stations, oil fields, factories, mines and machinery will guarantee the security of workers as well as the general health of the environment. AI-powered cameras, robots, drones, and other devices can monitor accidents to lessen the possible damage (Neuroth, M. et al. (2000). [44]). Regular equipment inspections and risk assessments will assist businesses in implementing preventative steps to steer clear of unforeseen events.

(6) Automation - Task automation results in time, labour, and financial savings. The employees face a great deal of uncertainty every day. AI and machine learning help automate practically all routine jobs while identifying the best practises, protecting employee life in addition to reducing human error and increasing productivity.

6.2 Benefits of Using AI in Upstream Oil and Gas

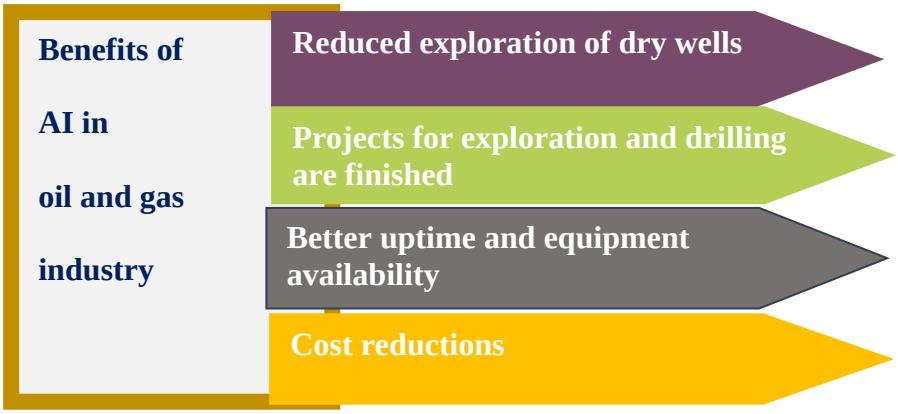

Fig. 3: Benefits of Using AI in Upstream Oil and Gas (Source: Author)

(1) **Reduced exploration of dry wells:** Now that geophysical characteristics like rock formations can be recognised, upstream oil and gas companies may avoid wasting time drilling ineffective wells. Modern AI-based methodologies enable this (Hanga, K. M. et al. (2019). [45]). Geologists are able to make educated assumptions about the location of potential oil and gas deposits.
(2) **Projects for exploration and drilling are finished:** Companies engaged in drilling and exploration projects are employing AI to create algorithms that enable precise drilling, lowering the possibility of oil spills, mishaps, and fires. They can increase penetration rate while still using the same technology (Devold, H. et al. (2019). [46]).
(3) **Better uptime and equipment availability:** By reducing unnecessary maintenance expenses and downtime due to equipment unavailability, AI helps organisations enhance their income. Preventative maintenance is carried out according to the manufacturer's schedule. This enhances operational productivity and consequently uptime.
(4) **Cost reductions:** There is a good reason why 52% of big oil and gas companies are using AI/ML in their operations, according to E&Y. The perception of upstream oil and gas industry work as being very labour-intensive has changed as a result of AI.

6.3 Constraints in Oil and Gas Industry

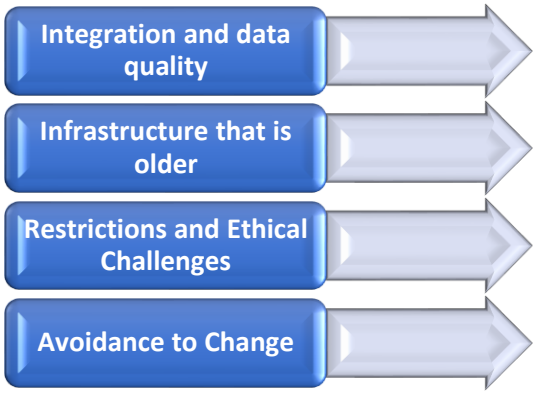

Fig. 4: Constraints in Oil and Gas Industry (Source: Author)

(1) Integration and data quality: The industry provides enormous amounts of data from numerous sources, such as sensors, instruments, and drilling operations. It is difficult to gather and interpret this data due to its frequent variation quality and is stored in a number of different formats.
(2) Infrastructure that is older: Considering that many of the companies have outdated infrastructure and processes that are incompatible with AI technology, it could be difficult to

integrate and implement new concepts. Upgrades to existing infrastructure can be costly and time-consuming, which makes it challenging to integrate new technologies (Di, S. et al. (2021). [47]).

(3) Restrictions and Ethical Challenges: The use of AI in the industry raises ethical and legal issues, particularly in regard to issues like transparency, bias, and data protection. Businesses must ensure that the use of AI conforms with all relevant legal requirements and ethical standards.

(4) Avoidance to Change: The industry has a reputation for conservatism and reluctance to change, which can make it difficult to implement new practices and technologies. Employees, clients, and regulators are just a few of the stakeholders who could be averse to change.

6.4 Challenges in Oil and Gas Industry:

Fig. 5: Challenges in Oil and Gas Industry **(Source: Author)**

(1) Detecting errors and improving quality control: One of the concerns in the energy industry is identifying errors in devices or poor threading in pipes. Industrial and financial resources are used up by upstream issues that result in errors at the conclusion of the production process. For instance, putting a machine or oil pipeline into service while it has a fault could have serious consequences. In contrast, the expense of implementing AI is significantly greater than these losses. (Neuroth, M. et al. (2000). [44]).

The production's quality may be checked, and any errors can be thoroughly analysed, using an electronic vision-based system. Solutions for defect detection powered by AI are very affordable and cost-effective when compared to the standard procedures.

(2) Maintain High Levels of Security and Safety: The danger of harm is significantly higher than in traditional manufacturing environments at oil and gas plants since they work in such critical situations. Employees in oil refineries must be mindful of several moving parts, work in a variety of temperatures, and occasionally breathe poisonous gases. Injuries and financial penalties might come from failing to adhere to adequate safety protocols.

Safety regulations that are enforceable by law must be followed by businesses. Heavy fines are imposed for breaking these rules. Despite the abundance of data available to monitor safety concerns, most activities are still manual, like manual review of camera feeds or performing physical safety sweeps, to ensure that precautions are still effective. The current approaches only guarantee that workers are donning PPE at the point of getting into the factory, not all day long (Li, H. et al. (2021). [48]).

To keep an eye on the job site to make sure that employees are strictly adhering to safety standards, AI computer vision system can be used. The camera input is sent into an AI system, which analyses it and sends alerts and suggestions that are proactive. Even the smallest compliance deviations can trigger an alarm from AI solutions to management.

(3) Decrease production and maintenance expenses: Oil or gas that has been obtained through oil rigs is kept in a central location before being dispersed via pipelines. Because of several changes in temperatures and environmental factors companies can experience material deterioration and corrosion. Corrosion can weaken the pipeline by causing component distortion, which leads to faded threading. Failure to address this issue could cause catastrophic harm that would halt all production. One of the major issues facing the sector is this, thus businesses hire corrosion experts to keep an eye on and

manage the overall wellness of components to prevent corrosion activities (Shafiee, M. et al. (2019). [49]).

(4) Boost Support with Voice Chatbots: Virtual agents and chatbots are advantageous to field operators, and by incorporating a voice-enabled component, operators can carry chatbots with them while out in the field.

(5) Learn New Information About Oil and Gas Exploring: The US Energy Information Administration (EIA) forecasts that domestic crude oil production in the US will exceed 11 million barrels per day by 2050 as the country's energy sector continues to expand. This makes it abundantly evident that exploration efforts must be stepped up. Despite the fact that this policy and aim significantly enhance the business, a fundamental factor—the expensive and time-consuming nature of oil and gas exploration—remains a source of worry for the sector.

Adopting independent AI-powered robots for exploring is a wonderful way to simplify this procedure and collect exact data. Leading oil and gas corporations collect seismic photos with drones while information is extracted using image processing algorithms. On the basis of these analyses, investigations are conducted. This procedure reduces the risk to humans while ensuring data accuracy.

7. FINDINGS :

Companies that successfully implement AI will stand aside from other operators that are unfamiliar with their reservoirs, operational procedures, and creating assets. Managing downstream activities improves spreads and also saves costs. With AI, operators may reduce geologic risk and gain a better understanding of their reservoirs. The data gathered today has enormous, but unrealized, value. With better predictions of least transaction prices, operators can utilise it to optimise acquisition strategies and make better exploration and production decisions.

8. CONCLUSION :

Oil and gas upstream digitization requires somewhat business to business approaches and is more of a deployment challenge than a technology one. It is always risky to find opportunities that solve business challenges and the necessity for replication and constant upscaling is also a challenging for a large business like this. Despite the promises offered by the deployed technology, strong governance is more important than anything else in the dependency of AI in upstream oil and gas.

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