Original Article: The Role of Artificial Intelligence in Optimizing Oil Exploration and Production

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ABSTRACT

Today, artificial intelligence (AI) has emerged as a vital tool and a driver of innovation in the oil, gas, and petrochemical industries. The use of AI in oil and gas exploration has transformed the capabilities of the industry and made the search for new reserves more efficient and reliable. AI can identify areas with high potential for oil and gas exploration by analyzing geological and geophysical data. These analyses can increase the accuracy and speed of exploration processes and reduce the costs associated with these processes. AI can analyze and summarize large and complex data and provide valuable information for strategic decision-making. AI and machine learning in the oil and gas industry are revolutionizing the exploration process by analyzing vast datasets, including seismic surveys, well logs, satellite imagery, and geological data. Machine learning algorithms can identify patterns and anomalies in this data, helping geologists more effectively identify potential oil reservoirs. For example, consider a scenario in which an exploration team is looking to identify offshore drilling sites. Rather than relying on traditional geological methods, the team is applying AI applications to the oil and gas industry. The AI system ingests data from multiple sources and performs complex analysis to identify areas most likely to contain oil reserves. This focused approach reduces exploration time and costs and minimizes environmental impact by drilling only in areas with high potential. AI also enhances the interpretation of seismic data, a critical aspect of oil exploration.

Introduction

The oil and gas industry, as one of the most important sectors of the Iranian economy, requires the use of new technologies to maintain and increase productivity and efficiency [1]. Given the international sanctions and restrictions, the importance of innovation and the use of advanced technologies to address challenges and strengthen domestic production is felt more than ever. This article examines the role of new technologies in the development of the Iranian oil and gas industry and analyzes the effects of these technologies on various aspects of this industry. New technologies in the field of exploration and extraction include new geological techniques, 3D mapping, and advanced drilling equipment that provide access to underground resources with greater accuracy and efficiency [2].

One of the most important developments in this field is the use of digital technologies and

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artificial intelligence to analyze geological data and identify new oil and gas reserves. These technologies help reduce exploration costs and increase the accuracy in identifying high-yield areas [3].

Applications of AI in Exploration and Drilling

In the oil and gas industry, exploration and drilling are among the most important and costly stages. By analyzing subsurface data and using predictive algorithms, AI has enabled more accurate and faster identification of suitable locations for drilling. With the help of data mining and machine learning techniques, AI is able to help identify high-potential points and reduce drilling-related risks. This not only leads to better control of processes, but also helps improve transparency in decision-making. For example, machine learning models can speed up geological and seismic data analysis and identify locations with potential reserves. In addition, AI allows researchers and engineers to use historical data analysis to predict pricing patterns and make better decisions about drilling and production timing. These predictions, along with trend analysis, help companies provide innovative solutions in the exploration and development of new fields. Artificial intelligence has proven to be a real enabler for oil and gas projects by offering numerous applications. Some notable use cases and application areas are presented in this article [4].

Surface Analysis/Geological Assessment

AI is literally a gold mine for oil and gas exploration leaders. For example, ExxonMobil plans to use AI robots in the deep sea to enhance its natural leak detection capabilities. ExxonMobil's AI-equipped robots will be able to detect these oil leaks well enough to ultimately reduce the risk of discovery and subsequent harm to marine life. AI platforms are used to examine subsurface geophysical data, accurately mapping underground oil reserves. This process ultimately provides accurate reservoir value and makes drilling methods more efficient [5].

Reduce Well/Equipment Downtime

Unplanned downtime costs oil and gas platforms millions of dollars a day in the event of a catastrophic failure. One of the largest oil and gas companies used AI to increase its ability to predict well collapses before they happen, reducing maintenance, operating wells more efficiently, and extending their remaining life. How did they do it? Plant engineers built a traffic light system that alerted them to the risks of a well collapsing. This enabled them to have a mechanism in place to reduce downtime. Using AI-powered assistants helped the plant reduce well recovery time by 83 percent and reduce replacement fuel costs by $20,000 per well per day [6].

Production and scheduling optimization

Oil projects face challenges such as cost overruns and scheduling. This can be attributed in part to weather delays, resource constraints, and scheduling risks. The complexity of the problem is further compounded by the large number of interdependent activities, such as drilling and rig installation, that are typically involved in the development of an oil field. It is therefore essential to find scheduling models that take into account these interdependent components and the associated risks in projects. For example, an AI-based program enables operators to prevent failures of electric submersible pumps (ESPs) while optimizing production. Cloud-based platforms provide operators with access to advanced analytics software with AI algorithms that analyze the data received for anomalies and ultimately

indicate the impending problem in the equipment under investigation [7].

Asset Tracking and Maintenance / Digital Twins

Asset management, including its monitoring and maintenance, project planning and lifecycle management, is one of the most critical areas where digital twin technology can play a vital role. In such a scenario, digital twins enable oil and gas companies to address challenges such as production imbalances, rapid changes in global economic conditions such as the COVID-19 pandemic, and equipment reliability issues. To respond in these busy and somewhat chaotic times, oil and gas companies need systems with the real-time visibility and flexibility that digital twins provide [8].

Fault Detection

One of the challenges that oil and gas companies face is detecting improper sealing in pipelines or defects in error-sensitive processes. Defects observed at the end of the production line due to upstream issues cause significant losses to factory resources and budgets [9]. To this end, AI can help validate production quality and provide deep insight into defect analysis. AI-based defect detection solutions are cost-effective. Pattern recognition using deep learning allows camera-recorded video feeds to alert if an employee is not wearing adequate clothing for operations. Additionally, predictive analytics alerts operators to the health status of equipment and enables preventive measures to avert a disaster with health, safety, and environmental consequences [10].

AI-powered cybersecurity

Siemens said that nearly 70 percent of oil and gas organizations have experienced security issues. The PWSC Global State of Information Security Survey found that 42 percent of energy companies admitted to being victims of phishing attacks [11]. The increase in the number of physical and cyber-attacks and the associated security costs have necessitated the need for AI tools to encrypt work systems for corporate security. Video cameras act as sensors to help companies monitor security threats around the clock [12].

Workplace safety

Oilfield operations pose risks to personnel as they involve heavy equipment, exposed rotating equipment, high-pressure operations, high temperatures, and chemicals. Many IT systems based on deep learning help safety officers identify problems with safety protocols [13].

Data is the new oil

Is a phrase that is used a lot these days, and in the case of oil and gas, it's a great metaphor. Oil and gas businesses deal with a lot of data coming from production processes. However, due to the lack of proper analytics tools, they are unable to make use of the huge data that is stored in data silos. Artificial intelligence algorithms examine different data streams from multiple sensors and machines, different plants or entire geoscience data sets, and provide real-time analytics to generate actionable insights based on business needs. Emission Tracking: According to a McKinsey report, several oil and gas companies have already set goals towards zero emissions. Despite the economic challenges, many companies are working to decarbonize their operations and value chains. Oil producers are also deploying AI software to track the volume of fugitive greenhouse gas emissions that escape from pipelines and oilfield equipment. Upstream oil companies are also using AI to optimize carbon dioxide storage to improve oil recovery [14].

Logistics Network Optimization

The supply chain in the oil and gas sector is a complex operation that includes decision nodes such as crude oil purchase, purchase price, transportation to the refinery, refining operations, sub-barrel operations, and retailing of finished products. AI also helps in coordinating the operations team with the warehouse to ensure the availability of critical components. AI can also support proper planning and execution, optimal route selection, etc. In turn, it helps refiners plan the optimal mix, forecast demand, estimate prices, and improvise customer relationships. In short, AI helps oil and gas companies in forecasting the market price of crude oil and finished products, planning and scheduling properly, enabling optimization of the crude oil portfolio, creating smart warehouses, maintaining inventories, managing transportation operations, hedging risks, and improving delivery times, and reducing overall costs [15].

AI-assisted inventory management

Companies suffer losses when inventory lags behind demand. AI helps increase efficiency in network planning and demand forecasting, allowing traders to be more proactive. As oil and gas companies gain more and more access to demand patterns, they can plan for seamless supply by adjusting the number of vehicles and directing them to locations where peak demand is expected. This leads to reduced operating costs [16].

Internal process optimization

AI technology allows sensors with fiber optic cables to transmit digital information about temperature, pressure and other field conditions to control centers where engineers continuously monitor production and make quick decisions about the best method/process for extracting oil and gas. In addition, these technologies help to activate underground valves electronically to better manage oil flow.

Supply chain and logistics optimization

Supply chain and logistics in the oil and gas industry require continuous optimization due to their numerous costs and complexities. By analyzing data related to supply and demand, AI allows for the prediction of future needs and optimal inventory management. Through prediction and optimization algorithms, processes such as raw material delivery scheduling and production planning can be improved [17].

For example, AI can analyze historical data to identify consumption patterns and make suggestions for cost reduction. In the area of supplier selection, AI systems can identify optimal suppliers by considering criteria such as quality, cost, and delivery time. These selections are made based on historical data and in-depth analytics, which makes the supply chain more reliable and efficient. These capabilities not only help reduce costs, but also improve supply chain efficiency and sustainability [18].

Increase safety and reduce risks

In the oil and gas industry, the safety of employees and equipment is of particular importance. By analyzing sensor data and operational data, AI enables companies to predict potential risks and take measures to prevent incidents. Using predictive models and machine learning, this technology can identify potential risks with high accuracy. For example, by analyzing temperature, pressure and other key parameters, AI can predict the occurrence of technical problems or safety risks and alert operational teams. These analyses allow companies to identify where and when incidents are likely to occur and prioritize appropriate preventive measures. As a result, safety levels are improved and costly

and dangerous incidents are prevented. This capability is particularly useful in the complex and high-risk conditions of oil and gas extraction and refining operations [19].

Preventive maintenance and asset management

One of the key developments in the field of AI is the use of digital twin technology. Digital twins are virtual models of equipment and systems that are updated with real-time data, allowing for continuous monitoring of equipment performance and condition. This technology helps companies analyze equipment performance data to identify the right time for preventive maintenance and avoid costs caused by unexpected failures. By combining sensor data and smart analytics, artificial intelligence can identify potential weaknesses and failures and take corrective actions in a timely manner. This approach helps reduce maintenance costs and extend the life of equipment, as well as prevent unexpected production stops. As a result, companies can plan maintenance more accurately and achieve greater productivity [20].

Improving quality and developing innovative products

AI can play an important role in the production and development of petrochemical products. This technology allows optimizing the quality of products by analyzing chemical compounds and processes. AI can produce higher quality and less polluting products by identifying new compounds and improving production processes. This helps companies get closer to sustainable development goals while increasing their competitiveness. In addition, AI can contribute to environmental sustainability by optimizing energy consumption and reducing pollution. In petrochemical processes, using AI to improve energy efficiency and reduce raw material consumption has a significant impact on reducing costs and improving productivity [21].

Challenges and requirements for adoption

Implementing AI in the oil and gas industries, especially on a large scale, requires initial investments and the development of the necessary infrastructure. To exploit this technology, companies must invest in training and upgrading the skills of their employees. Since AI analyzes complex and specialized data, employees must be familiar with data analysis techniques and AI tools. Also, the adoption and implementation of AI requires the creation of management regulations and specialized standards so that this technology can be used effectively and with safety principles. Companies should design training programs and management systems in such a way that human resources are familiar with this technology and have the necessary skills. These measures will enable the adoption and optimal use of AI [22].

The Future of AI in the Oil and Gas Industry

Digitalization of oil extraction and production processes will become a necessity, along with the use of new technologies such as the meta verse and the Internet of Things. These technologies will allow experts to make better decisions in simulated environments using real-time data. In addition, the use of digital twins and AI can increase productivity and efficiency and reduce production costs. In the future, companies can maintain their superiority not only in terms of price but also in terms of innovation and productivity by using these technologies. As a key tool in the oil and gas industries, AI will play an important role in shaping a sustainable and competitive future by improving quality, reducing costs and increasing safety. Price volatility is an inherent challenge in the oil and gas industry, an

industry where market dynamics can change rapidly due to geopolitical events, economic factors and supply and demand imbalances. However, with the advent of AI in the oil and gas industry, companies can now manage these fluctuations more effectively and make data-driven decisions to mitigate risks. AI in the oil and gas industry is a powerful tool for controlling price fluctuations through advanced data analysis and predictive modeling. By absorbing large amounts of historical pricing data, market trends, and geopolitical indicators, AI algorithms can predict oil price movements and help companies design appropriate strategies. For example, consider an oil company that uses AI to analyze market data and predict oil price trends. The AI system identifies potential price drops and advises the company to protect its position and prevent financial losses. In addition, AI can identify patterns of price increases and encourage the company to optimize production and invest in favorable market conditions.

Machine learning in the oil and gas industry enables instant analysis of pricing data, allowing companies to react quickly to sudden price changes. AI algorithms can automate trading decisions, buying or selling oil contracts based on predefined criteria, ensuring minimal human intervention and faster response times. Beyond immediate responses to price fluctuations, AI can also help with long-term strategies. By continuously monitoring and analyzing various market factors, AI systems can help companies identify patterns and trends, helping them make informed investment and asset allocation decisions. The use of AI in oil and gas, especially in managing price fluctuations, empowers companies with data-driven insights and agility [23].

Improving Safety

Health, safety and environmental aspects are of utmost importance in the oil and gas industry. By integrating AI into the oil and gas industry, companies are witnessing a transformative impact on their safety practices, ensuring safer operations. AI solutions for oil and gas are increasing safety through predictive maintenance. By continuously monitoring the health and performance of equipment, AI algorithms can identify potential anomalies and failures before they become safety hazards. This proactive approach enables companies to plan maintenance and replacement activities, reduce the risk of accidents and ensure a safer working environment for employees. In addition, AI applications in the oil and gas industry enable real-time safety monitoring. AI-powered sensors track environmental conditions, equipment performance and personnel activities in offshore drilling operations. Data is analyzed instantly, and in case of any safety deviation, immediate alerts and corrective actions are generated, preventing potential incidents and improving emergency response. The role of AI in the oil and gas sector also extends to the transportation of oil and gas products. AI helps optimize transportation routes and reduces the risk of accidents while transporting hazardous materials. AI solutions for oil and gas help companies identify safer and more efficient transportation routes by analyzing traffic data, weather conditions, and road infrastructure. The integration of AI in the oil and gas industry is a game changer in improving safety for personnel working in the oil and gas sector [24].

Business Process Automation for Back-end Tasks

The oil and gas industry involves a multitude of back-end tasks that are typically repetitive and time-consuming. However, with the advent of

AI in the oil and gas industry, robotic process automation (RPA) or business process automation is revolutionizing the way these tasks are performed, bringing unparalleled efficiency and productivity to the sector. For example, invoice processing is an important but labor-intensive task that involves extracting data from invoices, validating them, and updating financial records. RPA bots can perform these tasks quickly and accurately, minimizing errors by reducing manual work. The role of AI in oil and gas goes beyond simple automation. RPA bots can also perform complex tasks that involve data integration and analysis. For example, in supply chain management, RPA bots can collect data from various sources such as suppliers, inventory systems, and demand forecasts to optimize purchasing decisions and maintain optimal inventory levels. The use of machine learning in the oil and gas industry further enhances the capabilities of RPA. Machine learning algorithms can be integrated into RPA bots to enable them to learn and adapt to new scenarios and become more efficient over time. RPA, by using artificial intelligence in the oil and gas industry, is transforming clerical tasks and enabling the industry to achieve greater operational efficiency and accuracy [25].

Oil Spill and Hydrocarbon Detection and Response

Oil and hydrocarbon spill detection is one of the major uses of AI in the oil and gas sector. Environmental protection is a top priority for the oil and gas industry, and with the advent of AI in oil and gas, companies are seeing significant improvements in detecting and responding to oil and hydrocarbon spills. AI in the oil and gas industry plays a critical role in the early detection of potential environmental hazards. Advanced AI algorithms can analyze satellite imagery, aerial photography, and remote sensing data to identify signs of oil spills in marine environments or leaks in pipelines. By detecting these incidents early, companies can take rapid action to mitigate environmental impacts and prevent the release of pollutants. For example, an oil company with AI-based monitoring systems can detect oil spills in a remote marine area. AI algorithms can calculate the path of a spill and predict its potential impact on sensitive ecosystems, helping the company coordinate an effective response and deploy containment measures to minimize damage. AI solutions for oil and gas enable real-time monitoring of critical infrastructure, such as offshore platforms and pipelines. AI-powered sensors continuously analyze data, detecting abnormal temperatures, pressures, and flow rates. Any signs of a potential leak or malfunction send immediate alerts, allowing operators to take quick action to prevent further escalation. The application of machine learning and AI in the oil and gas industry extends to response planning. AI-powered simulations can model different scenarios and responses to oil or hydrocarbon spills, helping companies develop more effective emergency response plans and train their personnel accordingly. The use of AI in the oil and gas industry is transforming environmental protection efforts by increasing oil and hydrocarbon spill detection and response capabilities. With early detection, real-time monitoring, and AI-powered simulations, companies can be better prepared to protect the environment and respond quickly to potential incidents [21].

Regulatory Compliance

Meeting regulatory compliance requirements is a critical aspect of the oil and gas industry, and AI in the oil and gas industry plays a key role in ensuring that companies adhere to complex and evolving regulations. One of the key challenges of regulatory compliance is managing vast volumes of data and staying up

to date with changing laws and standards. The use of AI in the oil and gas industry addresses this challenge by automatically collecting and analyzing data. Machine learning algorithms can sift through vast documents and datasets, extract relevant information, and highlight areas that need attention to meet regulatory requirements. For example, consider an oil company facing new environmental regulations. AI-powered systems can quickly assess the company's current practices and identify gaps that need to be addressed to stay compliant. This enables the company to make the necessary changes and ensure compliance with the latest environmental standards. AI helps assess and manage risk, which is critical for regulatory compliance. AI algorithms can analyze historical data on safety incidents, environmental violations, and operational disruptions to predict and prevent potential compliance risks. In addition, AI-powered analytics can monitor operations in real time and provide ongoing compliance monitoring. Any deviation from regulatory standards can trigger immediate alerts, enabling companies to take corrective action quickly. By automating data analysis, improving risk assessment, and providing real-time monitoring, AI empowers companies to proactively address compliance challenges. Embracing AI in the oil and gas industry is a strategic move toward a more compliant, responsible, and sustainable future for the sector.

AI-powered supply chain management

The oil and gas industry is experiencing a major shift in supply chain management thanks to AI. Using the power of machine learning, AI is transforming the way companies manage their supply chains, leading to increased efficiency and cost-effectiveness. AI-powered route optimization is streamlining transportation in the industry. AI finds the most efficient delivery routes by taking into account real-time data, including traffic and weather conditions. This saves time, reduces fuel consumption, and reduces transportation costs. AI enables better decision-making by assessing supplier performance. Companies can identify reliable suppliers, monitor their adherence to quality standards, and maintain healthy relationships with suppliers. In addition, AI facilitates accurate cost estimation by analyzing historical data and market trends. This helps companies plan and control budgets and ensure that projects stay within financial limits. From predictive maintenance to inventory optimization, route planning, supplier management, and cost estimation, AI use cases in oil and gas are changing the way supply chain management is done in the industry. As technology continues to evolve, the oil and gas sector can expect even more significant benefits and improvements in its supply chain operations [22].

Discussion

In recent years, the use of artificial intelligence has been developing, especially in analyzing data related to climate change, energy management, and customer behavior analysis. From forecasting market demand and optimal supply chain management to preventing crises such as fuel shortages or floods, this technology can have significant impacts on industrial performance, with many companies seeking to use artificial intelligence to optimize their operations with a new approach to not only reduce costs but also improve productivity. In today's world, artificial intelligence is known as one of the advanced technologies in various industries and has wide applications in various fields, including oil, gas, and petrochemicals. In Iran, despite its significant potential, there are still challenges in implementing this technology in large industries. Artificial intelligence can create a major transformation

in the productivity of various industries. In the oil and gas industries, especially in the field of equipment management and cost reduction, this technology can play a very effective role [23]. Artificial intelligence in these industries allows us to make accurate predictions about failures, equipment depreciation, and energy consumption optimization. For example, predicting equipment failures can help reduce equipment downtime and repair costs. But the important point is that in Iran, the use of artificial intelligence in the oil and gas industry still faces limitations in many sectors. One of these problems is the limited access to accurate and reliable data. Currently, companies are reluctant to share their data, and this prevents us from using this data to train artificial intelligence models in the best way.

Artificial intelligence can be effective in different layers of industries, especially in oil and gas. At the management level, artificial intelligence can help managers make predictions about future trends and make better decisions based on existing data. This can help improve performance and reduce costs at a macro level. In the technical and operational sector, specifically in the petrochemical industry, artificial intelligence can be very effective in production processes and monitoring the quality of materials and products. For example, in production processes, artificial intelligence models can help identify potential problems at different stages of production. Also, in this sector, the use of this technology can reduce machine downtime and increase productivity. In the oil and gas industries, the use of artificial intelligence can greatly help improve exploration and extraction processes. For example, one of the biggest challenges we face in these industries is the complexity of analyzing data related to underground structures. Artificial intelligence can perform these analyses more accurately using data collected from various sensors and equipment, helping us make better decisions about resource extraction. Another important application of artificial intelligence in the oil and gas industry is reducing the costs associated with equipment maintenance and repair. We can use the data obtained from the equipment to predict their failure time and take preventive measures. This can reduce repair and maintenance costs by up to 40%. As an expert in this field, I must say that one of the most important things in using artificial intelligence in the oil and gas industry is collecting data and analyzing it. This data serves as the main input for artificial intelligence models.

One of the key applications of AI in these industries is predicting future conditions. In particular, in the oil and gas industry, AI can help predict geological situations as well as the likelihood of oil and gas resources in different areas. These predictions can make the exploration process more efficient and ultimately reduce the high costs of exploration. In addition, in the petrochemical industry, AI can be very effective in improving production processes and reducing waste of raw materials and energy. This technology can continuously monitor the condition of devices and provide predictions for when to replace parts or carry out repairs in a timely manner, which can reduce maintenance costs [24].

Green technologies and reducing environmental impacts

Given the increasing concerns about the environmental impacts of the oil and gas industry, the use of green technologies and innovations related to reducing pollutants and energy consumption is essential. Technologies related to the recovery of associated petroleum gases, the use of renewable energy sources in production processes, and the optimization of energy consumption in facilities are among the

important measures in this field. In addition to reducing environmental impacts, these technologies can help improve the public image of the industry and attract international support [23].

Developments in refining and conversion processes

The processes of refining and converting oil and gas into various products have also been improved by using new technologies. The use of advanced technologies in refineries can help improve the quality of final products, reduce energy consumption, and increase the efficiency of processes. In addition, new technologies can help increase productivity in the production of petrochemical products and reduce waste from refining processes [25].

Digital transformation in Shell's oil industry: from artificial intelligence to advanced simulation

Shell is transforming the way it produces and supplies energy by leveraging digital technologies and artificial intelligence. These technologies are not only improving the efficiency and safety of its operations, but are also helping to expand the use of renewable energy sources. Digital transformation has enabled Shell to lead the way in energy while moving towards a sustainable future. "It takes decades to develop new things, but Shell has made great strides in this direction," says Indranil Rudra, one of the company's directors. Founded in 1907, Shell specializes in the exploration, production, refining and marketing of oil and natural gas, and uses high-performance computing and artificial intelligence to accelerate the analysis and interpretation of data. The oil giant's partnership with NVIDIA and the use of NVIDIA DGX-2 and DGX A100 systems has also helped improve its analytics performance. Tim Wieber, Shell's director of data science and subsurface operations, and his colleagues are using deep learning neural networks to identify salt boundaries, which leads to better interpretation of hydrocarbon flow and more accurate subsurface models. These models can free up interpreters' time to focus on areas of greater expertise. In addition, Shell's Digital Rock team uses micro-CT images to predict reservoir properties such as permeability and porosity, and has created an end-to-end chain from micro-CT scans to flow simulations using NVIDIA GPUs. NVIDIA's DGX A100 imaging system has led to significant improvements in the image reconstruction process. In the single-step reconstruction method, the efficiency increase is 25%, and in the iterative reconstruction method, it is up to 40%. This performance improvement demonstrates the system's remarkable ability to process and optimize complex image reconstruction processes. Shell is also using digital simulation to evaluate the best options. "We use computational fluid dynamics to predict events in reactors," says Piet Mollerker, director of the company's fluid flow and reactor engineering division. "The DGX A100 system helped the team perform large, extensive computational fluid dynamics simulations, completing calculations that previously took two weeks in five days." In addition to its application in the oil and gas sector, the method can also be used in the development of new facilities, such as wind farms or hydrogen power plants.

BP uses AI to optimize oil processes

BP is another company that uses AI and machine learning to improve exploration and production processes and reduce costs. The company optimizes resource utilization and reduces operating time and costs by analyzing big data. The British oil giant also uses advanced simulations to predict and manage risks.

ExxonMobil Oil Company; Optimizing Oil Operations with AI and Collaboration with Microsoft

ExxonMobil is another major oil company that has increased the efficiency of its operations by using advanced technologies in data analysis and complex simulations. The company uses AI to improve decision-making in resource exploitation and reduce environmental risks, and uses machine learning to optimize refining and production processes. The company, in partnership with Microsoft, is optimizing oil and gas operations in the Permian Basin, a large oil-producing region in West Texas and southeastern New Mexico [12].

Chevron optimizes drilling operations with digital technologies and artificial intelligence

Digital technologies are also being used to optimize Chevron's drilling and extraction operations. The company is using big data and artificial intelligence to make better decisions about natural resource exploitation. Chevron uses simulation systems to provide more accurate analysis and reduce operating costs, and has used artificial intelligence to improve the efficiency and safety of its operations. A review of these examples of operational applications of artificial intelligence in the oil and gas industry demonstrates the widespread and growing impact of artificial intelligence and digital technologies in this field and highlights how these technologies can help improve efficiency, reduce costs, and increase safety [18].

Developing Oilfields with Artificial Intelligence

AI helps companies make better, more informed decisions about resources and assets, while enabling new sources of data from connected sensors. Today, AI is taking oilfield development to the next level. AI solutions support oilfield planning by improving and complementing traditional physics-based simulation models. Cognitive AI software that combines historical and real-time data with embedded human knowledge and human-like reasoning now augments existing forecasting methods, helping field planners identify drilling opportunities and reducing reservoir data processing time from months to days. AI-based solutions support the life of wells so that exploration companies can achieve the best possible recovery rate and ensure that resources are utilized to the fullest extent possible. By combining historical data with real-time sensor data and human expertise, powered by cognitive reasoning technology, AI enables companies to extend the productive life of their wells, maximize recoverable resources, and reduce the need for new drilling. Even after the reservoirs are depleted, cognitive AI solutions can be used to help with sustainability efforts. These advances can help refiner operators become more profitable. Some cognitive AI solutions have optimized refineries in a short period of time and improved operational planning by up to 17%. Better plant management and maintenance increases uptime and extends asset life, while also reducing risk to assets, personnel, and potential environmental contamination [1].

Reducing Oil and Gas Production and Maintenance Costs with AI

Another application of AI in oil and gas is reducing production and maintenance costs; According to the International Journal of Industrial Chemistry from the Springer Group of Journals, the annual cost imposed on the oil and gas industry due to corrosion and decay of equipment is about $ 1.372 billion. Artificial intelligence can prevent such incidents. Using the Internet of Things, artificial intelligence can analyze various parameters and detect signs of corrosion and also predict the occurrence of

such incidents. With the help of these systems, necessary warnings are sent to pipeline operators, and as a result, companies can predict and control the damage caused by such incidents. Also, reviewing the available information can provide a specific schedule for servicing and repairing machinery, and possible costs will be reduced [25].

Conclusion

In the modern world, the oil and gas industry, as one of the most important economic sectors, faces major challenges. These challenges include the need to increase efficiency, reduce costs, and better manage natural resources. Significant advances in the field of artificial intelligence (AI) have created new opportunities to address these challenges. Artificial intelligence can play a significant role in optimizing oil refining and production processes, including predicting and preventing equipment failures, improving product quality, and reducing environmental impacts. Predicting the life of oil reservoirs is another major challenge in the oil and gas industry. This prediction is critical for operational planning, financial decisions, and resource management. With the advancement of technology, the use of artificial intelligence as an efficient tool in this field has been considered. Therefore, one of the important applications of artificial intelligence in the oil industry is the use of machine learning algorithms to predict the behavior of oil reservoirs. These algorithms can analyze various data, including pressure, temperature, chemical composition, and production rate, at high speed and predict future trends with high accuracy.

The resulting estimates help engineers make better decisions about reservoir management and increase productivity. Artificial intelligence can also play an effective role in identifying reservoir problems. Intelligent systems can identify early signs of problems by analyzing records and provide the necessary warnings. This capability prevents major accidents and losses and helps maintain the safety and efficiency of operations. According to a recent Ernst &Young survey, 92% of oil and gas companies worldwide are investing in artificial intelligence or plan to do so within the next 5 years; While the impact of artificial intelligence in this industry is also evident as about 50% of oil and gas managers use this new technology to solve challenges across all processes of their organization. Companies in this industry are changing operations by adopting artificial intelligence, from optimizing exploration and drilling to simplifying production and logistics. With advances in automation and data analytics, the oil and gas sector has seen significant improvements in productivity, safety, and environmental sustainability. Despite the pivotal role of AI in the future of oil and gas operations and production, its adoption needs to expand rapidly and reach the operational stage. However, despite AI's significant impact, its adoption rate among some oil and gas firms remains slow. "Compared to other industries, we are not seeing the adoption of new AI technology tools in the energy sector as we should," Kumar Lakshmipathi, principal architect of Amazon Web Services solutions, said at the April 2023 Data Science Convention in Houston. Consulting firm Gartner also found in a survey that only about half of all AI projects progress from the pilot stage to actual production. While this represents a significant improvement over such projects in 2018, the slow uptake of the technology remains a significant challenge. A study by McKinsey Management Consulting shows that AI models have clear advantages over traditional analytical methods. For example, AI-based forecasting applied to supply chain management reduces errors by 20 to 50 percent. AI can be a major game-changer for

the oil and gas industry, and its potential to increase efficiency and productivity in this industry is enormous. Companies that invest in AI can reap the benefits of cost savings and speed up process execution. It is important to note that while AI offers vast possibilities for the oil and gas sector, human ingenuity must also be used to reduce risk and ensure sustainable development. The integration of human and AI solutions will be essential for the industry to meet future challenges.

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