Oil and gas: Digital transformation using edge computing

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pwc

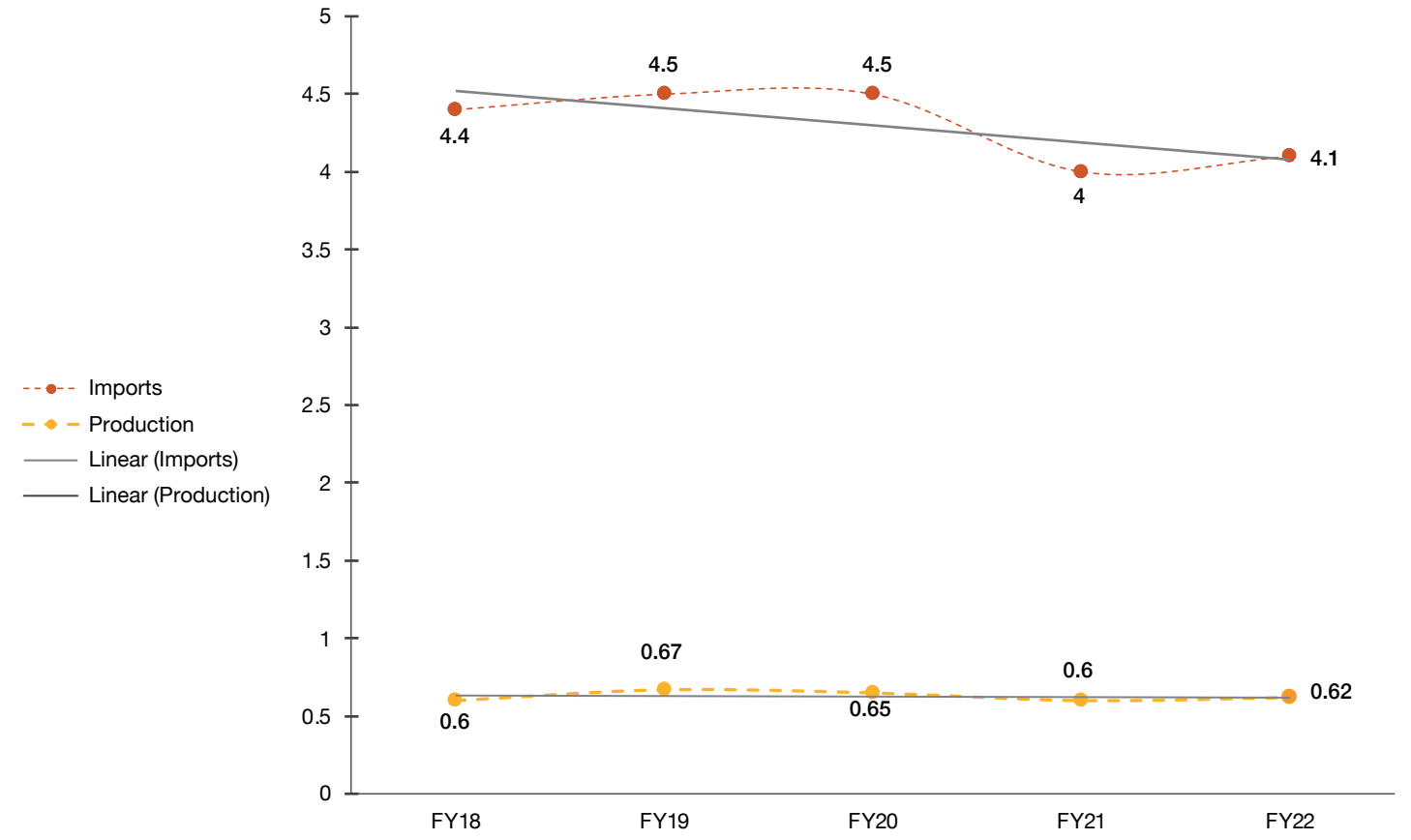
Introduction

Oil and natural gas are the primary sources of fuel in the global energy market and influence the global economy. The extraction, processing, storage and transportation of fuel use the latest technology and is an extremely complicated and expensive procedure. The oil and gas sector comprises three segments: upstream segment which includes the process from exploration to production; midstream segment comprises the transportation and storage of oil; and the downstream segment consists of the business of oil refinery and marketing. As the world is moving towards digitalisation, most oil and gas enterprises are catching up with this shift and see it as an opportunity to increase their revenue. Industry leaders anticipate that this digital transformation will deliver a substantial increase in revenue mostly due to the increase in production and reduction in the turnaround time of projects resulting in better operational efficiency in the coming years.

Globally, the oil and gas sector has shown a steady growth of nearly USD one billion between 2022 to 2023 with a compound annual growth rate (CAGR) of 4.6% to 5.1%. The market is currently poised to reach USD eight billion by 2026–2027.

Industry landscape in India

Figure 1: Oil imports and production

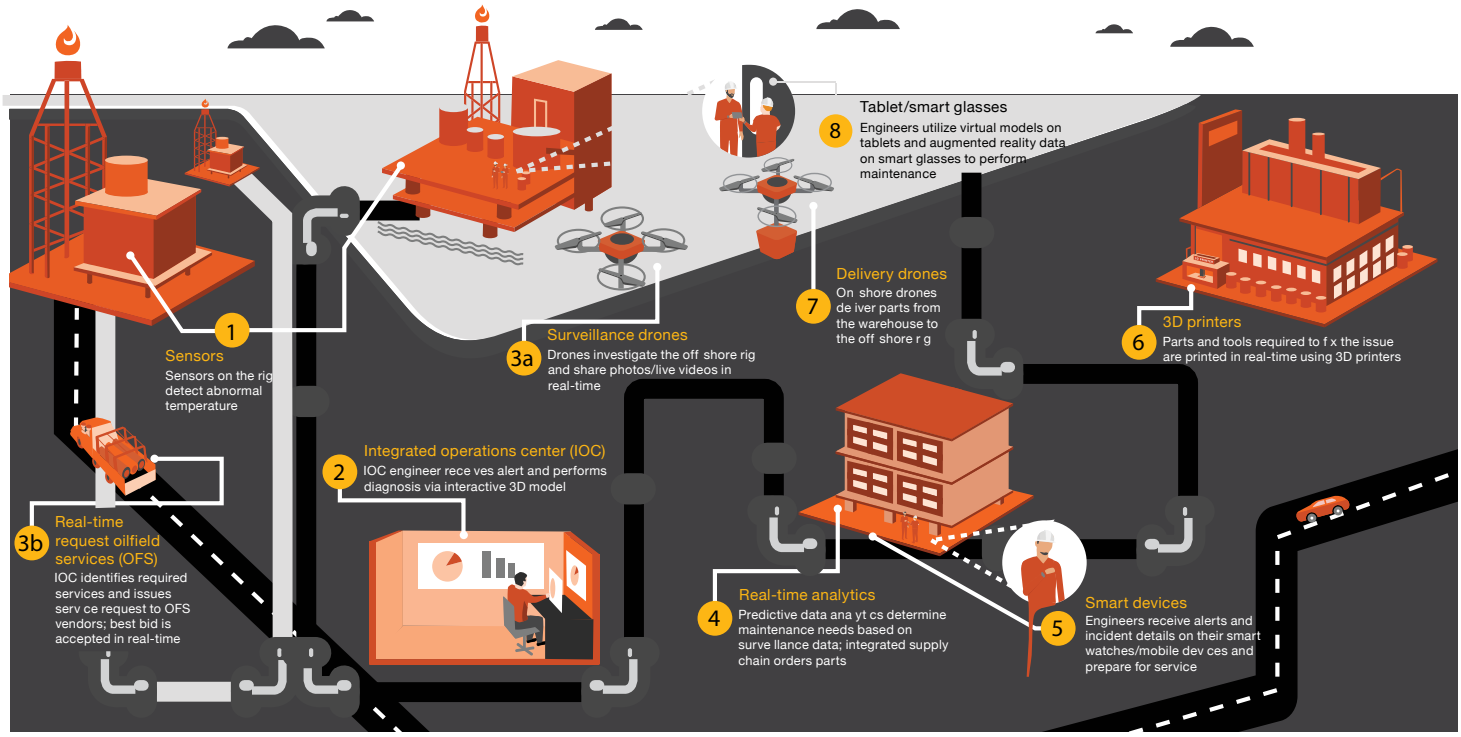


1 https://guides.loc.gov/oil-and-gas-industry

In India, the oil and gas sector is among the core industries and plays a predominant role in influencing the decision-making for the other important sectors of the economy. India is currently the third-largest oil and gas consumer in the world.

Figure 2: Digitising the future of oil fields

The digital journey



With the increase in consumption of oil and gas around the world, industries are under constant pressure to reduce costs and manage the rise in demand using technology that facilitates real-time monitoring, quick decision-making, improved data security, better visibility, and data optimisation to facilitate the operations associated with production. Large oil and gas conglomerates deploy and rely on an array of equipment in their plants that can sense and generate an enormous amount of data during the operations at the plant.

Digital transformation of asset-heavy industries like oil and gas has become a necessity for the enterprises and its implementation will be difficult if the enterprise lacks appropriate IT strategies. Previously, slow to adapt, there has now been a significant impetus for oil and gas industries to actively invest in and utilise emerging digital technologies like cloud, edge computing, artificial intelligence, augmented and virtual reality, and the Internet of things (IoT) to generate higher revenue.

Implementing these new technologies has become one of the core strategies of any oil and gas enterprise with many of them appointing technology consultants to seamlessly introduce inventive digital applications that could alter the course of business, have a strategic edge over competitors and help in countering new challenges that arise in the market. Digital transformation can also act as an enabler for various systems and can have an indirect influence on many operational metrics such as production costs, operating costs, project delivery schedules, employee health and safety, and environmental performance. For example, advanced analytics applications can support better decision making leading to an improvement in production, management of resources and cost-cutting.

Digital transformation with edge computing

One of the prime benefits of introducing edge computing is converting the data into actionable insights. The data can be analysed to optimise a system, gain efficiencies in the workflow through gathering and processing the data from the sensors and conducting real-time diagnosis and predictive analysis on the spot.

Edge computing may also improve the health and safety of the workforce by extracting critical health-related information from medical sensors, and wearables attached to or worn by the workers at the plant. The AI/ML models running on edge can promptly identify deteriorating health conditions that requires medical attention.

For operational efficiency, near-edge devices enhance asset tracking, efficient surveillance and monitoring of the environment, instantaneous prediction of component failures and coordination of asset movements with high efficiency.

The points below address some of the major benefits of edge computing in the oil and gas sector from a from the perspective of technological advancement and safety.

01 Real-time analysis

- The vast array of data that is generated at each point of the upstream, midstream, and the downstream process can be collected by the near-edge devices or edge controllers and tracked, analysed or examined in real-time so that potential deviations can be spotted and the respective prevention systems can be initiated to avert an incident.
- Data from various environments such as underground and deep sea oil rigs, hazardous locations with high pressure and temperature, and locations that are remotely accessible from the surface can be collected. Some of the possible instances for data collection could include:
  - Rugged devices can be installed to withstand harsh environments. Even if connectivity is a challenge, data can be stored at the nearest location and consumed there directly. Hence the need to send data continuously to datacenters (DCs) can be avoided, thereby reducing the carbon footprint considerably.
  - Data sets from ore, vibrations and power consumption during boring using high-performance rugged edge computers placed at near-edge locations during the drilling of wells at remote terrains can be analysed and stored to help engineering personnel carry out their work more efficiently.

02 Health and safety

- Edge computing can help in monitoring the health and safety of the workers and facilitate authorities in conducting inspections in real-time without traveling to the site itself as the data generated by sensors and monitoring equipment placed in these areas can be difficult to access.
- Rescue and emergency response teams can survey wireless-enabled physical fitness/activity trackers worn by workers to proactively carry out health checks for the employees working in hazardous areas.

03 Integration, monitoring, and tracking

- Real-time data from cameras, illumination, noise, vibration, fire prevention sensor/IoT devices deployed at various locations inside the mines and rigs can be stored in near-edge devices and further analysed to maintain a healthy environment by measuring toxic gas and SPO2 levels, monitoring traffic patterns, implementing demand-based routing to prevent congestion and provide automated visual and auditory guidance during normal times and during an emergency to avoid dangerous situations.
- On-condition and preventive maintenance using edge devices can alert and help authorities to take action before the machinery is rendered defunct.
- Sensors that are attached to the equipment can detect unusual activity in real time and can either alert the maintenance personnel or automatically isolate the system to prevent further damage. This could lead to a significant reduction in downtime and a considerable decline in cost savings as unwanted interruptions in the processes due to the repair and replacement of equipment can be avoided.
- Edge computing can enable the tracking of resources as it traverses the pipelines, generating digital predictive models for analysis at the edge location using applications hosted on the cloud to increase the efficiency of operations
- Connected vehicles within the premises that are connected via V2X and V2V communication can be controlled, routed, or loaded using the data, which is picked up, stored, and analysed by edge computers located in the vicinity.

The supervisory control and data acquisition system (SCADA) collects and analyses data in real time from a large number of complex machineries situated at remote and rugged terrains in the oil and gas industry. Yet, when it comes to the processing and storage of that data, the SCADA systems rely heavily on cloud and on-premises DCs. In such cases, edge computing can be of excellent use as it employs the distribution of edge devices at or near the source of the data, thereby bringing the utilities of cloud computing near the source of data generation. Edge computing can be used for monitoring, storage, analysis and running AI and ML models and other critical applications by the SCADA systems in the cloud using the local edge devices.

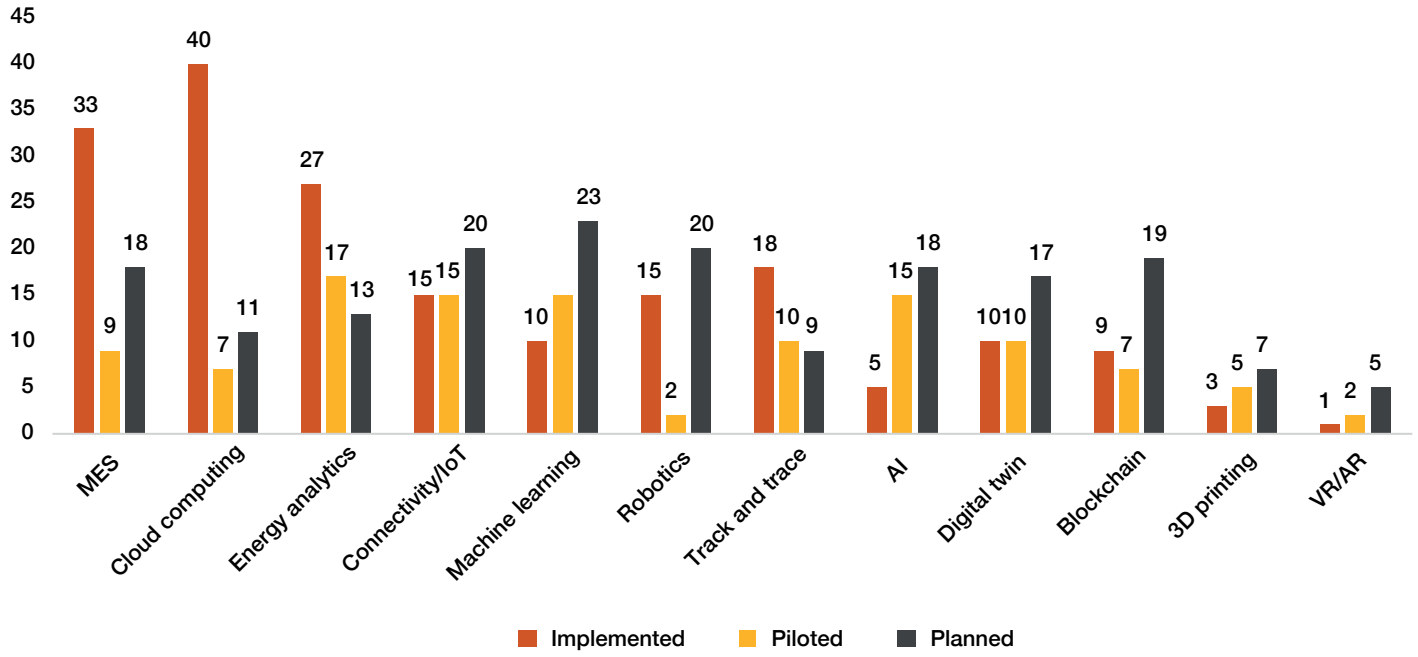
Oil and gas organisations are often known to be at the forefront of the ESG dilemma and have always faced the challenge to maintain a balance between the CO2 emission levels and maintaining adequate production and generating profits. Additionally, the large amount of data generated by these enterprises, power plants and data centers across the globe have become mammoth energy-consuming and carbon-emitting hubs. Edge computing enables the positioning of near-edge devices and processing data at the source which reduces the latency. Further, edge computing transmits only the data that needs to be processed at the cloud data centers or far-edge locations, which reduces the energy consumption and may help the organisation in reducing their carbon footprint. The possibility of using solar and wind energy as power sources for running edge devices could further reduce the carbon footprint of the industry.[2]

2 https://impakter.com/the-environmental-case-for edge-computing/#:~:text=By%20processing%20data%20closer%20to,as%20solar%20and%20wind%20power.

How PwC's technology consulting can help the oil and gas sector

Globally, in capital-intensive industries like oil and gas, major petroleum companies have exhibited a steady shift towards the latest digital technologies like edge computing to monitor their equipment, run analyses to curb costs and extract more productivity from the resources at hand. This is because edge computing can be easily integrated with the legacy systems for real-time data and render advanced analytics from data to churn out early predictions for faster and better decision-making.

Figure 3: Stages of implementing digital technology in the oil and gas sector as of 2020



A study conducted by PwC suggests that leaders of oil and gas enterprises tend to be inclined towards technologies involving data and analysis, which includes manufacturing execution systems to integrate individual pieces of equipment with the company's ERP systems, cloud computing to manage large volumes of data generated from operations, energy analytics, connectivity and IoT with machines carrying sensors for remote monitoring and machine learning.[3]

Professionals across emerging technology consulting practices can help organisations find ways to thrive in the era of Industry 4.0 whether it is for adopting a new technology by committing to a readiness analysis or implementing a technology transformation process based on assessing the technology maturity, business strategy and risk management of the enterprise. This could generate customer value by paving a use case-based roadmap for clients who want to adopt edge computing for their infrastructure.

Oil and gas companies are facing challenges in effectively utilising and harnessing the data retrieved from their respective ecosystems using their legacy IT systems. Moreover, these rugged environments are mainly manned by operational technology (OT) personnel. Edge computing and technology can intervene and merge these standalone IT and OT systems into an effective IT-OT convergence model. This model can subsequently address challenges arising from real-time demands and obstructions in resilience, visibility, connectivity, and security.[4]

Technology consulting solutions include readiness assessments which can help the enterprises across distinct dimensions based on four readiness scales and associated criteria to demarcate the current state of capabilities, an enterprise framework evaluation based on multiple dimensions and maturity parameters to identify and analyse the areas of improvement and provide recommendations to the clients

3 https://www.pwc.com/us/en/industries/assets/pwc-eu-m-web-graphics-midtream-digital.pdf

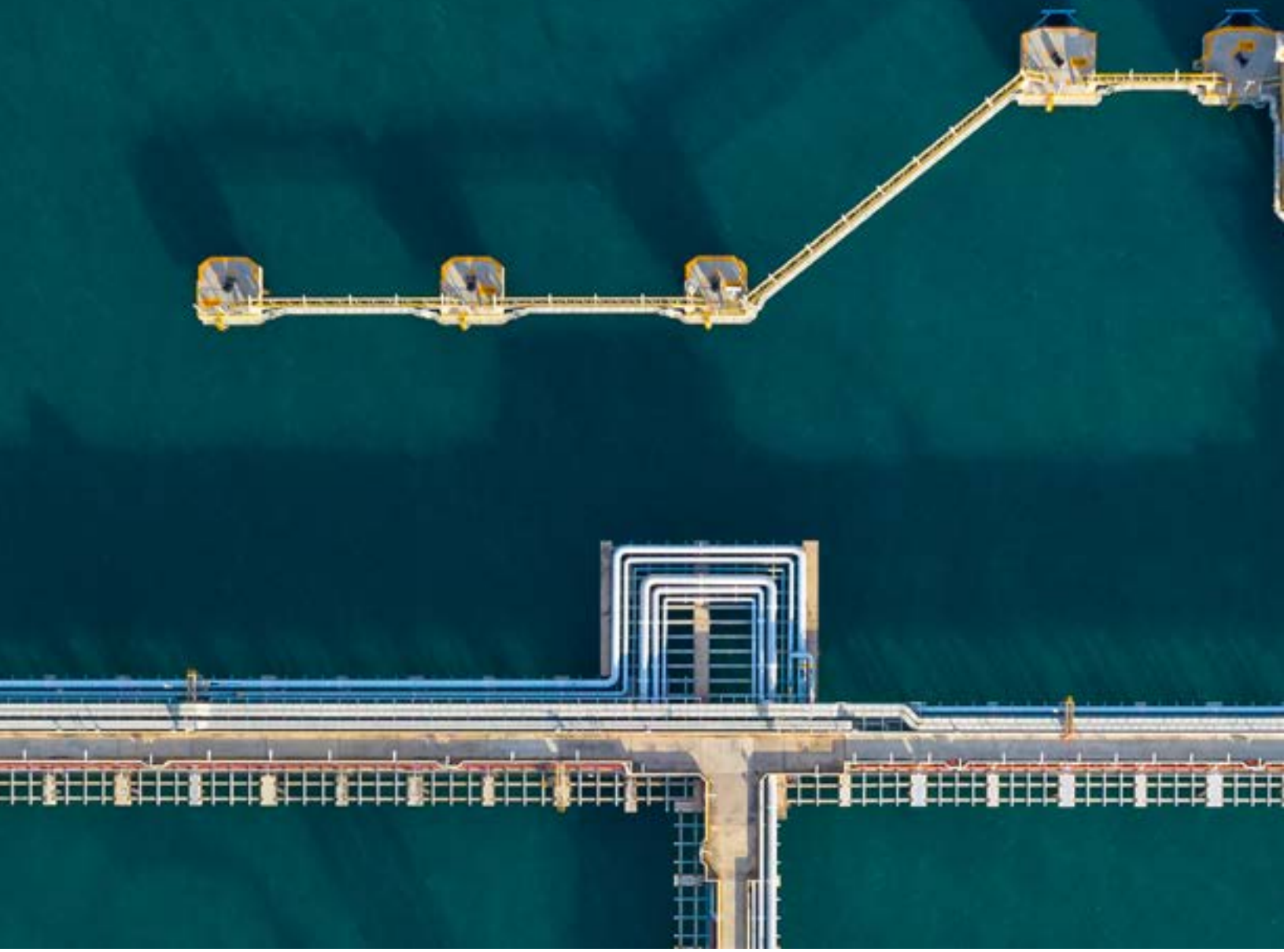
4 https://www.forbes.com/sites/forbestechcouncil/2021/04/05/how-edge-technologies-pave-the-way-for-it-ot-convergence/?sh=41c466b81455

in their edge computing adoption journey and assessments purely based on prioritisation of use cases where enterprises will be evaluated based on multiple adaptation levels for major verticals like governance, risk and compliance (GRC), technology, strategy, and innovation.

The underlying processes of the above-mentioned evaluations will be based on a strategy-through-execution approach that involves evaluation, selection, design and implementation of edge computing-based technologies for clients to transform their operating model and deliver internal and external business solutions.

Conclusion

Oil and gas companies encounter many challenges related to production, revenue, monitoring and profitability. As a result, prices have been impacted and the urgency to tackle these issues has increased dramatically. One way to address these challenges is to accelerate the implementation of digitisation strategies to help improve resilience and encourage innovation. Adopting edge computing in the supply chain with transparent operating guidelines can be one such measure which organisations can implement. With digital transformation strategies and solutions, organisations can seamlessly leverage agility and efficiency to enable their enterprises to become adaptable for further growth.



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