

# DIGITAL TRANSFORMATION IN OIL AND GAS COMPANIES - A CASE STUDY OF BIEN DONG POC

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## Summary

The fourth industrial revolution (Industry 4.0) with the breakthrough of internet and artificial intelligence has had a strong impact, changing all aspects of global socio-economic life. Digital transformation in the spread of Industry 4.0 is no longer a choice but has become an inevitable development trend for businesses to truly stand up to the times. Digital transformation is the transformation of business activities, processes, products, and models to fully leverage the opportunities of digital technologies, characterised by development, growth, innovation, and disruption. In particular, "digital disruption" is the situation when new technology competes with the traditional business way that we now often refer to under the concepts of cloud computing, big data, and internet of things (IoT). This competition will help businesses utilise digitised data and processes to create a new model that is more efficient and convenient. Digital technologies in oil and gas companies can have a significant business impact as it contributes to increasing hydrocarbon recovery, ensuring safety across the business ecosystem, and improving operational reliability. This paper addresses the oil and gas industry's trends in digital transformation and the initiatives at Bien Dong POC.

**Key words:** Digital transformation, oil and gas industry, big data, AI, digitalisation.

## 1. Introduction

The oil and gas industry is undergoing a fundamental digitalisation era to unlock more energy at lower costs and delivers significant performance improvements. With real-time insights, improving equipment availability and getting ahead of obstacles become less challenging. To remain competitive, companies are adapting and transforming their trial and error models to take advantage of current paradigm shift to implement modern solutions and accelerate the impact of going digital.

Digitalisation is the integration of digital technologies and business models through applications such as big data, internet of things (IoT), cloud storage, connection, and artificial intelligence (AI), etc., in order to create major changes in the operational scheme and enhance the company's value [1].

The benefits from digital transformation can be summarised in four groups:

- Productivity improvement using maintenance

tools that combine data science, smart sensors and data communications can help prevent machine failures and improve productivity.

- Product quality and parameters are monitored throughout the entire manufacturing process.
- Operational costs of production when automated, intelligent and visualised production segments can reduce personnel involved in field monitoring, machine operation, technology systems, and logistics.
- Workplace safety is better ensured.

## 2. Opportunities for digital transformation in oil and gas industry

Energy consumption continues to increase over the years. As shown in Figure 1, although renewables will increase sharply, oil and natural gas will continue to be the biggest energy source used by the world's population, accounting for about 55% of total annual energy consumption. Since current oil and gas exploitation activities have naturally declined, the continuous growth of petroleum fuels will only be possible when there are technological leaps in exploration and production activities.



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The deployment of industrial revolution 4.0 applications is one of the necessary measures to increase production at lower costs.

Today, digital technologies in oil and gas focus on two aspects of IT optimisation and business optimisation. Digitalisation helps in creating a lean and agile IT service environment that concentrates on operational excellence. New IT technologies such as advanced analytics, data centre automation, and cloud computing are explored and employed. Meanwhile, digitalisation helps in enhancing business performance by implementing digital capabilities such as business simulation, integrated planning, and asset performance management.

It is showed that digitalisation amplifies business optimisation by creating seamless integration across organisational silos, thereby enabling operational agility at high

levels. It can drive substantial enhancements for worker productivity, and data-driven decision making, thereby accelerating a creative digital innovation. It also helps in promoting operational excellence by transforming the federated legacy operating environment into a lean, agile, and high performance computing business platform. Digital technologies can also facilitate combining data from financial, transactional, geophysical, and other systems. Thus, businesses are able to unleash business value by means of new forms of advanced analytics. Digital technologies can range from simple visualisations systems to complex simulation models that can reliably predict future performance, all the way to highly automated machine learning analytics.

Thus, implementation of digital technologies can facilitate operational excellence, thereby allowing oil and

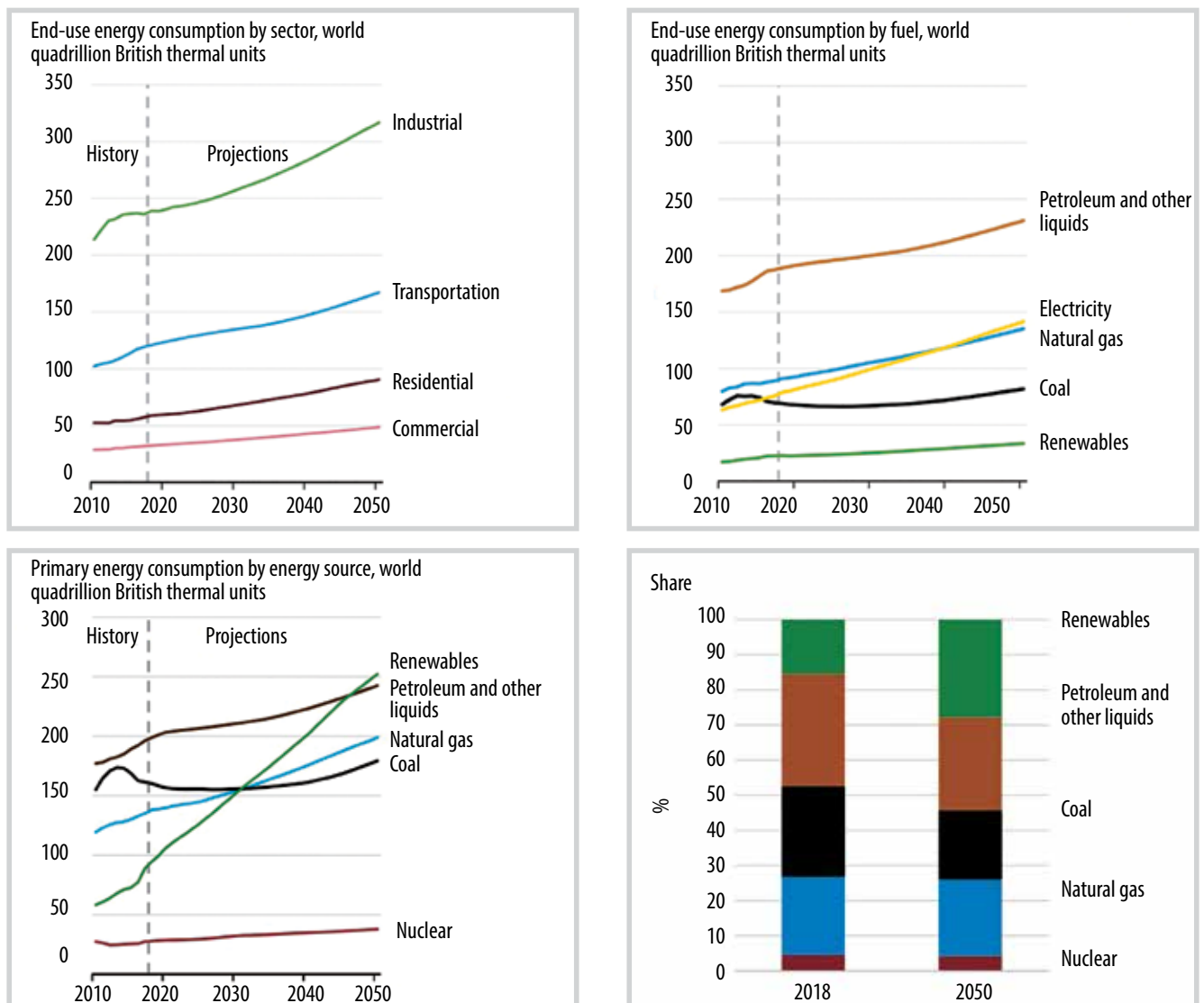


Figure 1. World annual energy consumption reported in International Energy Outlook 2019 [2].

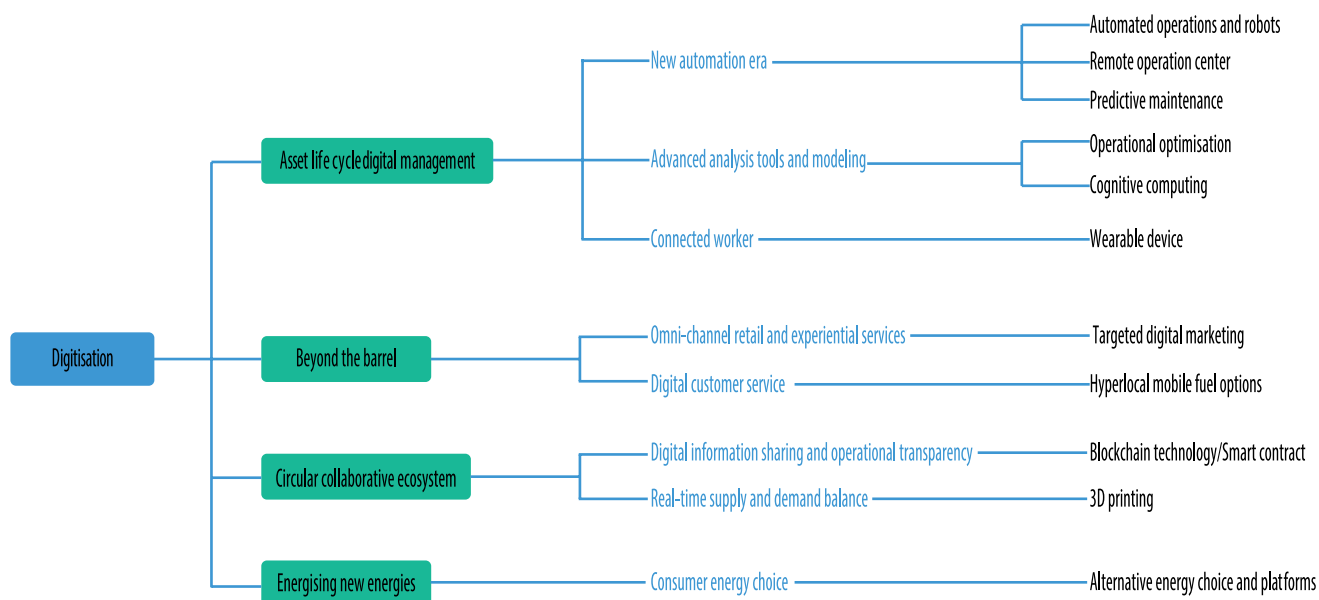


Figure 2. Applications based on digital platform in petroleum industry [4].

gas leaders to effectively prove that they are running their assets safely, sustainably, reliably, and cost-effectively.

In fact, recently, there are a few sectors in the oil and gas industry that can afford new technologies, but they are just separate solutions in field management, production, and maintenance. According to Deloitte's report in 2015, digitalisation in the petroleum industry was rated 4.68 on a 10-point scale [3]. Only a few leading oil and gas companies are highly digitalised and are developing towards smartisation. Therefore, in order to become a "4.0 company", a company needs to take advantage of the following factors:

- New technologies with smart sensors, IoT and intelligent technologies enable workers to work remotely,
- High-speed bandwidth connection improves data transmission between on-shore and off-shore platforms,
- Big data and large data storage capacity becomes available at a much cheaper cost. Cloud computing technology and cloud storage platform make the cost of operation, maintenance and upgrade much cheaper than on-premise database server systems,
- Advanced analytical methods and advanced simulation greatly assist in making timely and accurate oil and gas field operating decisions.
- New business models and smarter workflow processes help improve productivities.

The digital transformation process undergoes three key steps: (1) digitisation, (2) digitalisation of the process (digitalisation), and (3) digital transformation (DT). In par-

ticular, digitisation is the first step and also plays the most important role because it can significantly increase productivity, save time and make the system more secure. In other words, the result of the digitisation process is the condition required to perform the digital transformation.

In the 1980s, oil and gas companies began to apply digital technology to accurately estimate the reserves and potential production of the hydrocarbon resources as well as to improve operational efficiency of the oil and gas fields in the world [4]. However, over the years, the oil and gas industry has not fully seized the opportunity to use data and technology in a meaningful way. For example, an oil and gas platform can generate trillions of bytes of data per day [4], but only a small portion is used for decision making. The reason is that the data processing technology has not met the requirements, the information technology infrastructure system of the oil and gas industry is going slowly compared to the times. Modern central distributed control systems still use infrastructure with slow transmission speeds such as Supervisory Control and Data Acquisition (SCADA), Highway Addressable Remote Transducer (HART) Protocol, and Fieldbus, etc. Therefore, digitalisation in the oil and gas upstream industry is still in the early stage.

In the future, digital transformation in oil and gas should focus on the following four topics: asset life cycle digital management, the concept of "beyond the barrel", the circular collaborative ecosystem and energy optimisation [4]. Different themes will create respective applicable innovations and technologies (Figure 2):

**Table 1.** Amount of generated data in petroleum engineering disciplines [4]

Section	The amount of data
Drilling data	0.3 GB/well/day
Electric submersible pump monitoring	0.4 GB/well/day
Wireline data	5 GB/well/day
Fiber optic data	0.1 GB/well/day
Seismic data	100 GB/survey
Plant process data	4 - 6 GB/day
Pipeline inspection	1.5 TB/600 km
Plant atmospheric data	0.1 GB/day
Plant operational data	8 GB/year
Vibration data	7.5 GB/year/customer

- Asset life cycle digital management is the process of digital transformation and equipment operation modelling and improvement of strategic decision-making based on data science. The process relies on dedicated sensors to collect real-time information from physical assets, and on analytical tools to process data. Companies make decisions and strategies to advance business performance as well as operating model.

- The circular collaboration ecosystem uses an integrated digital platform to better collaboration among stakeholders in the petroleum ecosystem, while accelerating innovation, reducing costs, and improving transparency in governance and administration.

- The concept of "beyond the barrel" refers to the application of a customer model, supplier participation in innovation and flexibility, using expert knowledge and opening new opportunities for petroleum operation.

- Energy optimisation refers to the use of advanced technologies to improve the efficiency and effectiveness of production systems.

### 3. Challenges and opportunities in digital transformation

The implementation of digital transformation in an oil and gas company consists of three main pillars: human, process (corporate culture, administration, digital strategy and process improvement) and new technologies application. For the culture and digital strategy, the human factor is the biggest challenge. First, defining the business's Mission - Vision - Core value and digital strategy are restructuring, changing the mindset, working method of the entire enterprise in the direction of digitisation. In addition, when experience is weak, leaders should also provide learning opportunities to project team or divide the project into different phases with separate milestones. The lack of feedback loops (Plan-Do-Check-Act) is a challenge in the development of Oil and gas 4.0. The board of

directors as well as all technical team and support staffs of the oil and gas company need to ensure continuous and multidisciplinary involvement throughout the project life cycle. Continuous feedback will assist in shaping timely and accurate project planning and implementation. Second is the lack of training and retraining of personnel in the development of smart oilfield projects. Third, the shortage of skilled labour in the oil and gas industry and the lack of experience in similar projects are equally a challenge. People with knowledge and experience from successful implementation of digital transformation projects are very rare even in the world.

For process and improvement, one challenge is the large number of traditional processes that need to be re-evaluated and digitised into digital processes that require huge amounts of time, manpower, and technological factors. The second one is the inertia or resistance to non-traditional change. Meanwhile, for the application of new technologies, the two biggest challenges are limited budget and limited expertise. In the current period with the constant and unpredictable fluctuations of oil and gas prices, budget for technology application becomes a challenge. Besides, the continuous change and improvement of technology also have a significant impact on the immediate investment decisions or are waiting for more effective and smarter solutions in the near future.

Analysis and data management poses many challenges for the oil and gas engineering team. The first is the ability to analyse, synthesise and process a large amount of fragmented data in many places with many different technical disciplines. The second challenge is security when data needs to be centralised, strictly confidential and decentralised to access. Real-time data retrieval and response to oil and gas facilities are also a major challenge as most people in complex geographic locations find it difficult to secure a continuous broadband connection.

**Table 2.** Lists of major challenges in digital transformation

<b>Challenges</b>	<b>Description</b>	<b>Solution</b>
System safety	Interaction and integration of different technologies can lead to errors. The supporting platforms and facilities are yet to be deployed.	Companies in different technology sectors will work together to overcome existing technical challenges and limitations.
Digitalisation strategy	Poor alignment between real project goals and the needs and operating status of the company. The goals are becoming outdated in terms of technology that is constantly changing.	Defining the Mission - Vision - Core value of the business and defining the digital strategy are restructuring, changing the mindset, working method of the entire enterprise towards digitalisation.
Geography	New oil and gas fields are increasingly in remote locations. Limited bandwidth between offshore platforms and onshore headquarters because offshore platforms are often located in remote locations, out to sea. The data is fragmented due to the nature of the work and is not synchronised.	<ol style="list-style-type: none"> <li>1. Upgrade communication and connection to meet the new needs.</li> <li>2. It is necessary to focus on digital data soon. As a premise for advanced analysis and artificial intelligence.</li> <li>3. Research and deploy edge computing applications.</li> </ol>
Macro policy	Lack of government policy and planning.	<p>Governments will coordinate with businesses to make policy, propaganda, and guidance planning. Oil and gas, computer science, automation and other engineering disciplines will be linked together based on the master plan and the guidelines of each country.</p> <p>In Vietnam, the following resolutions and action plans are available:</p> <ol style="list-style-type: none"> <li>1. Resolution No. 52-NQ/TW, dated September 27, 2019 of the Politburo on several guidelines and policies to actively participate in the Fourth Industrial Revolution.</li> <li>2. Directive 16/CT-TTg dated May 4, 2017 of the Prime Minister on strengthening access capacity to the Industrial Revolution 4.0.</li> <li>3. Contents of the Action Plan in Decision No. 4246/QD-BCT dated November 10, 2017 of the Minister of Industry and Trade.</li> </ol>
Traditional process	With everything digitally connected, we no longer have to rely on traditional paper-based processes and operate in silos; There will be no more room for manual and time-consuming processes.	Businesses need a modern and comprehensive digital solution that replaces outdated, error-prone paper processes and takes advantage of this digitised data.
Resistance to change	Where is the organisation on the changes? Most employees are entrenched in traditional daily mission processes. When it comes to improving processes and incorporating new technologies, they resist. They see change management as a challenge to their roles/responsibilities and a threat to their job safety. Many people resist the change of their working environment because digital disruption is seen as a threat to many employees in the profession. Besides, a new and difficult problem is always sceptical and uncooperative.	<ol style="list-style-type: none"> <li>1. Companies should have the best digital solution to minimise time-consuming processes, improve employee efficiency and reduce work pressure by allowing access to work from anywhere, at any time, regardless of location.</li> <li>2. The era of "Oil and gas 4.0" must be initiated from the leadership level. Company management needs to deliver the highest level of commitment and be passed on to each employee as part of the digital transformation process.</li> <li>3. Transparency and effective communication are essential to keep people motivated about the potential of this new technology.</li> <li>4. Improve employees' capacity and awareness.</li> </ol>
Outdated business model	Businesses are very comfortable in their existing systems. The need for upgrading is not clear without seeing the results of pioneering projects.	<ol style="list-style-type: none"> <li>1. Manufacturers need to leave their comfort zones, revamp their business models, and move towards more efficient, accurate, and fast business processes using modern digital technologies instead of current generation of outdated systems.</li> <li>2. If there is an early awareness of Industry 4.0 and assessment of advantages and disadvantages of the current model, it is the choice. If it is late, it is a life-and-death decision, vital to the business.</li> </ol>
Limited automation	Many repetitive, redundant, and time-consuming tasks that are performed manually by a group of employees consume a large amount of work time resulting in high costs.	Organisations can automate or reduce manual tasks, allowing for faster product updates and response times by embracing the right digital solution.

Challenges	Description	Solution
Budget limitation	A substantial investment in a manufacturing facility is required during the digital transformation journey. The benefits are many, both short term and long term, but it is important for each company to have a strategy that matches its business model, revenue, and total operating costs.	<ol style="list-style-type: none"> <li>1. Companies will gradually realise the great benefits of digital transformation and increase their investments.</li> <li>2. Appropriate planning of the investment process is required, and no two digital transformation schemes are alike.</li> <li>3. Having a long-term vision is crucial to achieving a truly valuable future goal. Avoid short-term influences such as Covid-19 or oil prices slump that could interrupt or stop the programme.</li> <li>4. Solid solutions (return on investment - ROI) should be selected and considered as a proof-of-concept method (POC).</li> </ol>
Lack of knowledge	<p>Without the right expertise, the introduction of the technology alone is not enough to make it work. Increasing employee knowledge is an essential part of the application of digital technologies into production.</p> <p>Lack of experience from doing a similar project is equally a challenge.</p> <p>Lack of interdisciplinary talent, the current education system focuses too much on cultivating a single specialty.</p>	<ol style="list-style-type: none"> <li>1. In case the company's existing expertise is inadequate, a partnership with outside consultants or hiring new staff should be considered.</li> <li>2. The digital transformation programme responsibility should be a common goal of the entire organisation and should not be limited to just a few employees or departments.</li> <li>3. Universities offer interdisciplinary courses.</li> </ol>
Unsuitable training programme	Lack of training and retraining of personnel in developing smart oilfield projects; shortage of skilled workers in the oil and gas industry.	<ol style="list-style-type: none"> <li>1. The leaders should also provide learning opportunities to the project team or break the project into small sections with separate milestones. The lack of feedback loops (Plan-Do-Check-Act) is a challenge in the development of Oil and gas 4.0. Ensuring continuous and multidisciplinary involvement throughout the life of the project between the project team, the board of directors as well as all technical and support personnel of the oil and gas company.</li> <li>2. Need a methodical and scientific training programme to develop smart oilfield projects. This helps to add knowledge that is lacking and is not usually found in oil and gas operating businesses such as cloud computing, data mining, or artificial intelligence.</li> </ol>
Inflexible structure	<ul style="list-style-type: none"> <li>- The introduction of the Industrial Internet of Things (IIoT) or AI into an offshore platform is not just a small improvement. The organisation needs a new technological background, people, and business model. If necessary, the structure must be established and reorganised to meet the changing needs of Industry 4.0.</li> <li>- The application of new technologies takes a certain amount of time to evaluate, and to adjust the existing strategy according to the new environment.</li> </ul>	<ol style="list-style-type: none"> <li>1. To solve this problem, it is necessary to form a project team from many disciplines including engineers, operating technicians, data analysts and experts into the team responsible for the transformation. The team will nurture ideas, research new technologies, and then develop execution plans promoting collective strength and wisdom.</li> <li>2. Large and multinational oil and gas companies have been at the forefront of the pilot work. The models and benefits have been clearly indicated and documented, companies with a smaller model will build their own digital transformation model.</li> </ol>
Security	Cyber security is a major concern for any digital transformation project as the network works and control systems will be connected to the internet.	<ol style="list-style-type: none"> <li>1. Vulnerable issues should be identified and recorded.</li> <li>2. Several layers of protections and insecure mechanisms need to be in place to ensure the system is safe, secure, and reliable.</li> </ol>

The major challenges in digital transformation can be identified in Table 2.

#### 4. Digital transformation in oil and gas upstream industry

Oil and gas upstream is characterised by strong competition in terms of area, capital and market; therefore all oil and gas producers must focus on production efficien-

cy. Oil prices are highly volatile and extraction costs often rise in more challenging environments, such as deep and arctic waters and unconventional resources (e.g. oil and shale gas). Mature fields need to optimise exploitation costs; efficiency and competitiveness in finding and supplying oil and gas for domestic and global markets have to be improved.

According to Korovin and Tkachenko, the Oil and

gas 4.0 programmes focus on the integration of production operations, decision making and the application of modern information technology [5]. From an application perspective, the smart oil and gas field not only replaces repetitive human work, but also replaces human analysis, which is a knowledge creation process. The process is: Awareness → Analysis and Alerts → Decision → Implementation → Optimisation).

In recent years, smart oil fields have grown rapidly and many large companies are working on them. For example: BP's "Field of the future" uses smart sensors and automation process to transmit real-time data from the field to a remote centre for rapid analysis and decision-making [6]. This programme started in 2003 and BP deployed this programme for 80 wells around the world in 2012. They also established the "Advanced Collaboration Centre" worldwide to allow remote co-operation in many fields of oil and gas engineering and exchange expertise between locations. At the beginning of project implementation, a programme structure was proposed, consisting of three layers: digital infrastructure and IT architecture, remote performance management, and system optimisation.

In Shell's "Smart Fields" programme, sensors and control valves in complex reservoir environments are connected to improve operational efficiency through real-time monitoring [7]. According to estimates by large

companies, smart oil fields can increase production by 2 - 7% and reduce operating costs by 5 - 20%. In addition, according to the practice of smart oil field projects, smart oil fields need to have the following functions: (1) real-time data accessing and sharing; (2) ability to analyse the current state, predict future trends and make optimisation decisions; (3) ability to achieve operational integration; and (4) automatic control capabilities.

In addition, Table 3 addresses the opportunities for applications implemented in the oil and gas industry.

### 5. Digital transformation at Bien Dong POC

Facing the oil price slump in recent years, the task of oil and gas companies is to optimise exploration and production costs, improve efficiency and competitiveness in finding and supplying oil and gas for domestic and world markets. Bien Dong POC has made efforts to look for the potential oil and gas prospect and focused on researching solutions to maximise the amount of recovered oil and gas in the Hai Thach - Moc Tinh fields, improving efficiency of oil and gas production activities. However, it can be seen that traditional approaches for search and exploration of oil and gas fields, especially condensate fields, as so far employed in Vietnam have reached the boundary of economic efficiency, forcing us to consider using modern and non-traditional technologies, particularly digital

**Table 3.** Industrial Revolution 4.0 applications in oil and gas industry [4]

Area	Application	Reference
Exploration	<ul style="list-style-type: none"> <li>- Geological data</li> <li>- Seismic interpretation.</li> <li>- Geological maps 1D, 2D, and 3D.</li> </ul>	[8 - 11]
Drilling	<ul style="list-style-type: none"> <li>- Rig optimisation.</li> <li>- Productivity.</li> <li>- Non-production time reduction (NPT).</li> <li>- Risk reduction.</li> <li>- Characterising the drill string dynamics.</li> </ul>	[12 - 16]
Reservoir Engineering	<ul style="list-style-type: none"> <li>- Reservoir management.</li> <li>- Closed-loop reservoir management-CLRM), (Integrated asset modelling - IAM).</li> <li>- Heavy oil reservoir optimisation.</li> <li>- Unconventional reservoir characterisation.</li> <li>- Improved hydraulic fracturing.</li> <li>- Improved enhanced oil recovery projects.</li> </ul>	[17 - 23]
Production Engineering	<ul style="list-style-type: none"> <li>- Improved decline curve analysis.</li> <li>- Production back allocation.</li> <li>- Electric submersible pump (ESP) optimisation</li> <li>- (Rod pump optimisation.</li> <li>- Improved hydraulic fracturing operation.</li> <li>- Improved reservoir surveillance.</li> </ul>	[24 - 30]
Maintenance	<ul style="list-style-type: none"> <li>- Asset management.</li> <li>- Well completion optimisation.</li> </ul>	[31 - 32]
Health and Safety Environment - HSE)	<ul style="list-style-type: none"> <li>- Effective HSE management.</li> <li>- Improved risk assessment method.</li> </ul>	[33 - 36]

transformation, application of big data processing technology, automation and development of artificial intelligence systems to support decision-making. Accurate determination to improve the efficiency of management and exploitation of oil and gas fields has become a real need in the development of production.

In recent years, having identified the core values that can bring return on investment (ROI), Bien Dong POC is implementing an action plan for the Industry 4.0 programme in the following main directions.

First, Bien Dong POC starts to build a digital project, a centralised data platform for the whole company (digital platform). The data can be used for the intelligent oil and gas management system (oil and gas business intelligence); and bring oil and gas field management, analysis, and operations tools to cloud computing and mobile platforms.

Second, the company replaces traditional processes with electronic, digital, software-based application, and centralised database-based working methods; builds a corporate culture based on digital ideology, innovate creative thinking towards the application of digital technology to increase cohesion, develop expertise, improve productivity, and ensure continuity. Tools and softwares are deployed to support teamwork and online meetings, manage work assignments, and share data. The online approval process (e-approval) is built and implemented to increase efficiency and work consistency. This helps simplify, streamline, and ease text-approval processes.

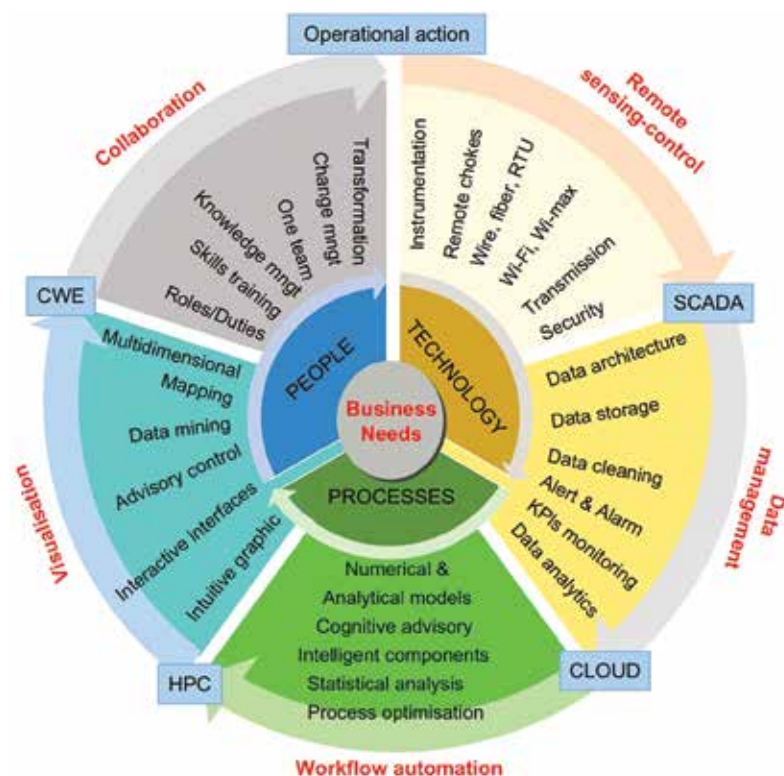


Figure 3. The components of digital oil field [37].

Third, the company conducts researches develops goals and action plans in the coming time for oil and gas field management and operation programmes, including: (1) predictive maintenance programme (predictive maintenance - PdM); (2) programme asset performance management and technology system optimisation (process optimisation); and (3) enterprise performance management programme. This helps to optimise maintenance run times; minimises unplanned breakdown or well closing times; ensures the safe and continuous operation of the technology system and helps to minimise equipment maintenance costs. Bien Dong POC has so far applied the Solar turbine operation parameter monitoring system to monitor the performance of the equipment, make predictions, early warnings and corrective plans for the failure-potential parts before machine damages.

Fourth, researching and planning are conducted to apply artificial intelligence tools to support the process of analysing and linking geological documents, well geophysics and exploitation data to improve the efficiency of management, operation and exploration of Hai Thach - Moc Tinh condensate gas fields.

Fifth, in order to successfully carry out digital transformation towards the global trend, the digital human resources development program must go one step ahead, and focus on investment in human resources. The strategy is to attract and develop high-tech talents with digital thinking, vision, and skills. For that reason, Bien Dong POC has established a research team on Industry 4.0, specialising in monitoring and updating opportunities for development and application of digital technology in management and business. In addition, the company also focuses on developing and training to improve working capabilities for all employees in the context of the Industrial Revolution 4.0 (Empowering Industrial 4/0 Workforce).



## 6. Bien Dong POC digital transformation strategy

Bien Dong POC's digital transformation strategy is based on the three main pillars of People, Technology and Systems Process (Figure 3).

### 6.1. People

People management is a challenging task. The obstacle one can see in human nature is "resistance to change". This is very common due to feelings of personal interests being affected; new ways of doing things will require employees to change and adapt, and scepticism about the feasibility and benefits of Industry 4.0 does exist among them. However, these barriers to the implementation of the digitalisation programme can be overcome by a bottom-up approach, with which stakeholders are fully engaged from the start. The benefits of digitalisation programmes need to be consistent with the production and business goals of the company, and directly attached to each employee in developing personal capacity, thus improving efficiency.

Projects are easily accepted when you absorb the team's intrinsic dynamics. The corporate cultural environment needs to be reviewed and adjusted if necessary. A modification to the organisational model should also be taken into account when implementing it.

In most oil and gas operating companies, there is no pre-project staff training programme, especially with the digitalisation programme. The lack of staff with passion for technology and ambition poses challenges to the deployment of digital transformation. Staff with passion and motivation are the key to project success [37]. In addition, being able to form up a team with different areas of expertise from reservoir management, production and operation, IT or data science engineers also brings a great challenge to implementing digitalisation.

### 6.2. Technologies

In the past, the oil and gas industry applied high technology in several specific technical disciplines. For example, the reservoir operation simulation models were built and the production model analysis was developed very early. Over the years, technology has matured. Many new technologies have emerged, enabling oil and gas companies to apply and integrate them into the field management and operation. Some of the latest technologies we have discussed here - such as big data, cloud computing and IIoT or artificial intelligence and machine learning

allow us to build truly smart solutions to be able to self-monitor, learn and intelligently control the comprehensive operations at fields.

These technologies provide an open environment for smart solutions with a comprehensive workflow through all stages. Therefore, the development of digitalisation programmes has never been so favourable and supported. But advanced technologies also require more competent human resources and higher costs to be able to develop and maintain these systems.

### 6.3. Process

As technology develops, it is increasingly involved in oil and gas field management and operation processes. Technologies are built and used to support smarter and automated management of oil and gas field operations.

Oil and gas field management and operation is a closed loop of processes such as validation, stock update reporting, field and production monitoring, processing systems and equipment maintenance. When any change arises, the other activities must also be adjusted. These are continuous daily activities consuming manpower time and each decision greatly affects environmental health and safety, production efficiency and costs.

The development of these workflows requires extensive knowledge of many areas in oil and gas engineering, modern corporate governance practices, as well as data-driven, science-based and systematic approaches. In addition, digital transformation also requires the application of modern technologies to transform work processes to improve labour efficiency and safety, and create more value from an asset.

The production and operation outputs can be measured with different well openings through well test activities and at the outputs of the oil and gas processing systems. Being able to accurately calculate the production output at different well openings and across the entire production network is extremely important for oil and gas field management and operations to maximise economic potential of the reservoir. In addition, incorrect forecasting of yield can lead to false reservoir estimates and make erroneous decisions about well exploitation regime. The construction of non-parametric reservoir models based on pressure and temperature data has proven to be a valid and cost-effective solution [37].

The "Production Performance Monitoring" (PPM) process has been successfully implemented in Bien Dong POC. The PPM goal is to create automated workflows to improve productivity, data and process management methodology, and data standardisation. The components of this solution consists of (1) building a monitoring infrastructure system of operational activities; (2) collecting and storing real-time data; (3) standardising the production activity and allocation process; (4) tracking and evaluating allocation results automatically; and (5) building reliable simulation models. Figures 5 and 6 show some examples of the oil and gas field governance workflows applied in Bien Dong POC. It is the result of automatic activities and expert knowledge of many departments. The goal is to be able to make accurate and fast decisions based on raw data.

## 7. Conclusions

Digital transformation is a large-scale business shift. The opportunity for the overall digital transformation is driven by large database of oil and gas field operations, and advanced management tools by companies.

The scope of Bien Dong POC's digital transformation project is to lay out foundations for a digital platform, that can be leveraged to deliver digital services. All data will be standardised, examined and linked on a centralised, flexible and scalable digital platform, meeting current needs and future growth of Bien Dong POC. It involves considerable costs as this necessitates investment in IT as well as engineering initiatives. This opportunity is of strategic importance because it is targeted to improve the efficiency of operation and management process.

The digital transformation programme has exploited important opportunities through the timely application of digitalisation and mine dynamics analysis to promote capture and create high value in oil and gas operations. With collected data converted into decisive information, Bien Dong POC has safely, effectively and continuously operated production over the years. Future forecasts, management reports such as asset monitoring, production performance diagnostics and production optimisation are performed accurately and promptly for investors and stakeholders. Operating data is systematically exploited, stored and managed in the corporate office, and synchronised with Microsoft Azure cloud server to ensure data consistency, reliability and accuracy. Applying digital technology, deploying real-time connectivity technology solutions is a response to unforeseen events such as natu-

ral disasters and epidemics to ensure a continuous connection. During the peak period of the Covid-19 epidemic in Vietnam, when the measures of social isolation and isolation were applied, the Bien Dong POC office was still operating based on the digital platform and centralised-digitalised central database.

The trade-off involved in the implementation is considered the extensive training to engage employees and drive adaption and a broader cultural change. Leadership development is needed to foster an aspirational outlook, with managers acting as change agents. In addition, the digital transformation programme is also a prerequisite for research, goal development and future action plans for the future advanced oil and gas field management programmes in Bien Dong POC, such as: (1) predictive maintenance programme (predictive maintenance - PdM); (2) programme asset performance management and technology system optimisation (process optimisation); and (3) enterprise performance management programme.

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