



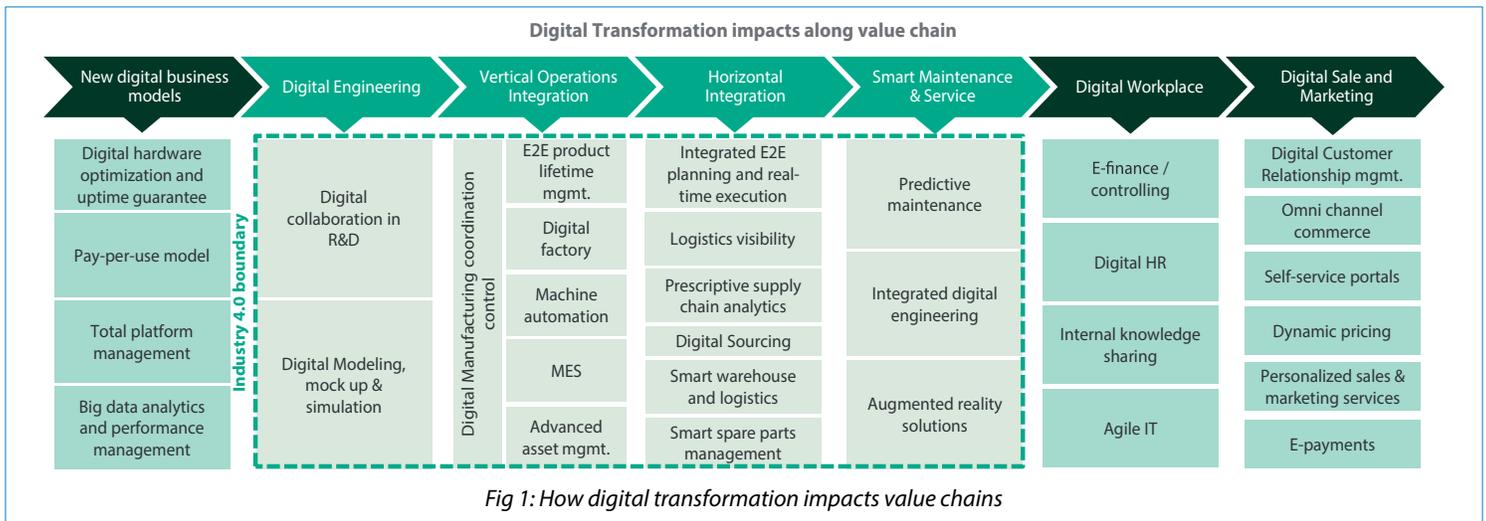
THE DISRUPTION IN OIL AND GAS UPSTREAM BUSINESS BY INDUSTRY 4.0

Executive summary

Advanced digital technologies and increased connectivity at lower cost are transforming organizations, their markets and the society at large. Now, digital transformation initiatives across industrial manufacturing environments are driving the emergence of the fourth industrial revolution or Industry 4.0. This white paper examines the value that Industry 4.0 brings to the oil and gas upstream industry. It delineates key Industry 4.0 solutions and analyzes their impact within this segment. It also explains how the Industry 4.0 Maturity Index can be leveraged to achieve maximum value from Industry 4.0 adoption.

1.0 Introduction

Digital transformation is one of the most discussed themes across the globe. The disruptive potential arising from the joint deployment of Internet-of-Things (IoT), robotics, artificial intelligence (AI), and other advanced technologies is projected to be over US \$300 trillion over the next decade [1]. The broad scope of digitalization means that companies can leverage new technologies across all their value chains in areas as diverse as sales, finance, research and development (R&D), and human resources (HR) [2].



Digitalization that is used to improve production within industrial manufacturing is referred to as Industry 4.0 or the fourth industrial revolution. It is important to note that while digitalization is broad in scope and includes any digital transformation that impacts value chains, Industry 4.0 is more limited in that it only includes digital transformation for industrial manufacturing facilities.

The value of deploying Industry 4.0 comes from using technology to link physical and digital systems. By connecting physical production assets with digital systems, manufacturers can generate and analyze insights to make better decisions about their assets, thereby creating the Industry 4.0 value loop [3]. By building a network that links industrial machines and enables automated decision-making, Industry 4.0 helps companies respond in real-time to unexpected events that might affect production. In fact, over 50% of industrial manufacturing companies expect Industry

4.0 to improve their agility and increase their production efficiency by over 20% over the next five years [2].

From 2016 to 2020, organizations are expected to spend as much as US \$907 billion per year on Industry 4.0. Moreover, the benefits of efficiency improvements can be shared across the economy through significant cost-savings in engineering and construction (US \$78 billion), electronics (US \$62 billion) and metals (US \$54 billion) until 2020 [2].

2.0 Implementing Industry 4.0 in the oil and gas upstream industry

Currently, the future outlook of oil and gas is challenging owing to many factors. The most prominent of these are low oil prices, emergence of new hydrocarbon sources, increasing penetration of renewable energy, electric vehicles, strict carbon regulations, and better energy storage technologies [4].

To deal with these challenges, many companies involved in the mid and downstream industry of oil and gas are changing their business models and shifting their main revenue streams [4]. However, this is not an option for the upstream industry whose business is built entirely on oil and gas extraction. Thus, the only way for upstream companies to overcome the above challenges is to improve their efficiency [5] – and this is where Industry 4.0 can help.

Despite shrinking margins, most upstream companies have sufficient budgets to invest in a robust Industry 4.0 strategy from exploration to production. This strategy should include solutions that improve project design and evaluation, enable unmanned drilling operations, increase reliability on the ecosystem, and predict maintenance needs. Such capabilities will not only increase efficiency but also support profitable growth [4].

Here are some Industry 4.0 solutions that will help upstream companies achieve these goals:

Industry 4.0 applied on the Oil & Gas Upstream's Stacks

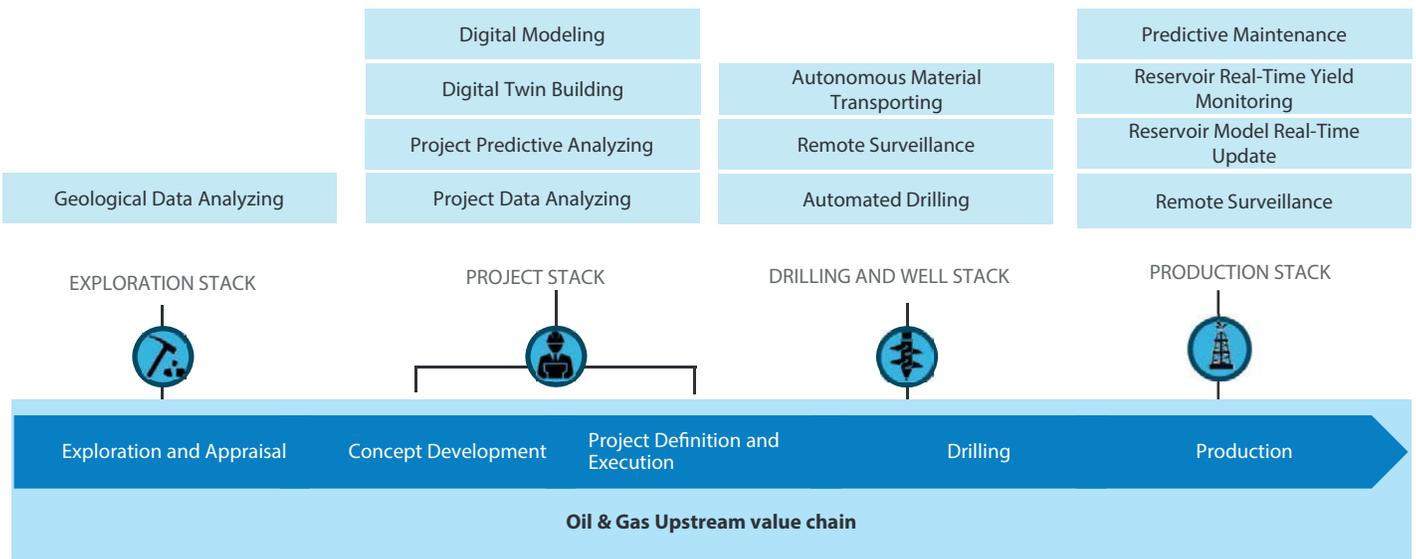


Fig 2: How Industry 4.0 can be applied in the oil and gas upstream industry

2.1 Upstream exploration stack 4.0

Exploration companies can build capacities to analyze geological data by digitizing all the data and knowledge gathered or developed by them. Applying advanced analytics and machine learning techniques on such big data sets will provide exploration teams with precise and meaningful insights [4].

How digitalization will transform Oil and Gas Upstream's exploration stack

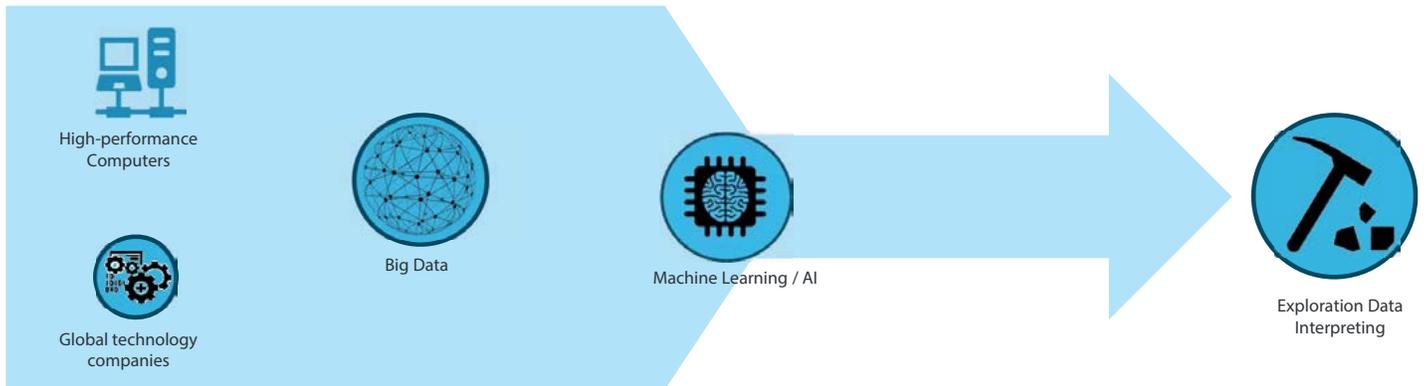
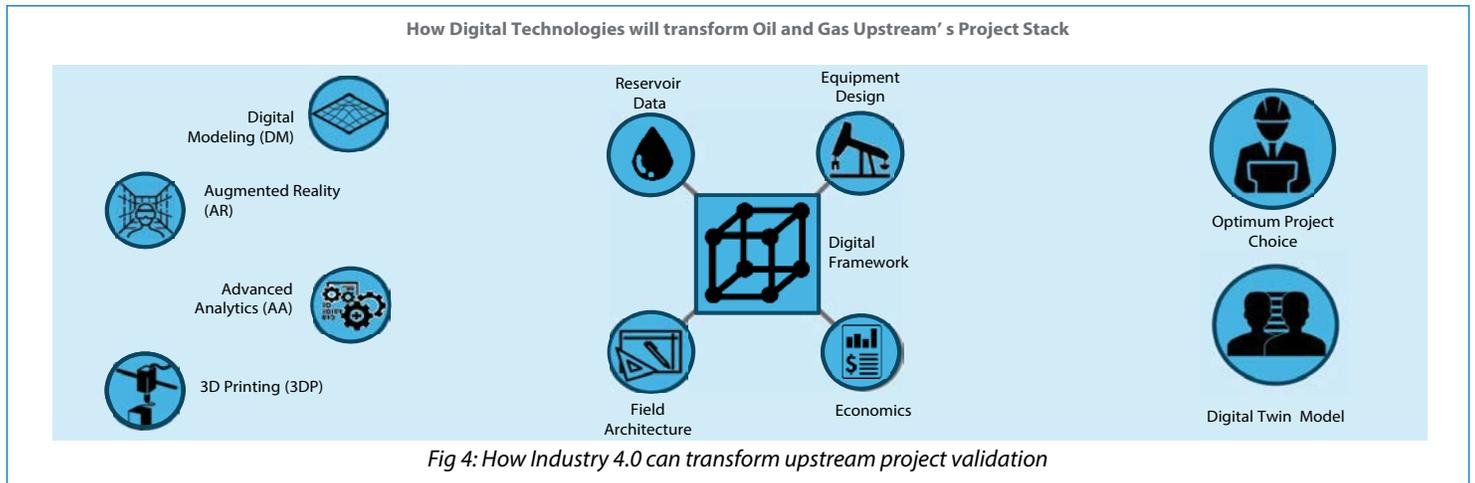


Fig 3: How Industry 4.0 can transform upstream exploration



2.2 Upstream project stack 4.0

Industry 4.0 will change how organizations design, evaluate and choose the best project by allowing them to consider as many parameters as possible. When advanced analytics and digital modeling techniques are applied to various data inputs, they create a digital framework that can generate and evaluate an exhaustive number of projects. Based on these evaluations, companies can then choose projects that suit their chosen parameters [4].





2.3 Upstream drilling and oil well stack 4.0

Digital solutions can be used to revamp the upstream oil well stack by enabling better coordination among different stakeholders involved in executing and automating drilling.

For instance, blockchain technology can set the standards of collaboration among stakeholders and service providers. It can also boost data security by enabling secure sharing of sensitive data within the ecosystem. Besides reducing risk, blockchain saves cost by eliminating transaction fees [6].

How Digital Technologies will transform Oil and Gas Upstream's Drilling and Well Stack

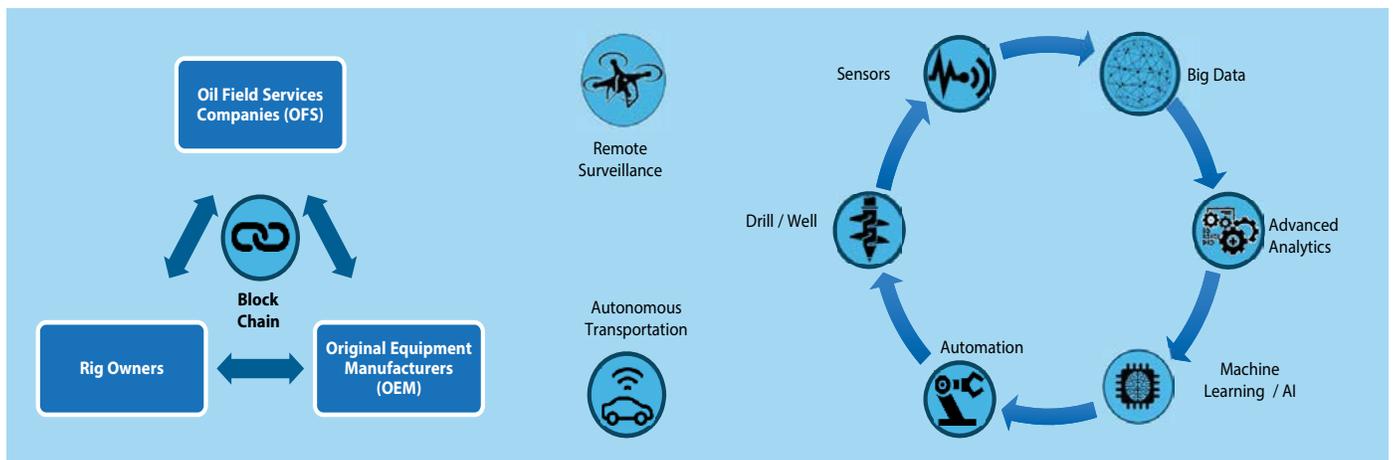


Fig 5: How Industry 4.0 can transform the upstream drilling and oil well stack

However, before automating the upstream drilling and oil well stack, companies must first integrate physical assets and digital systems using digital technologies to create a physical-to-digital value loop. Here, IoT sensors can be used to gather

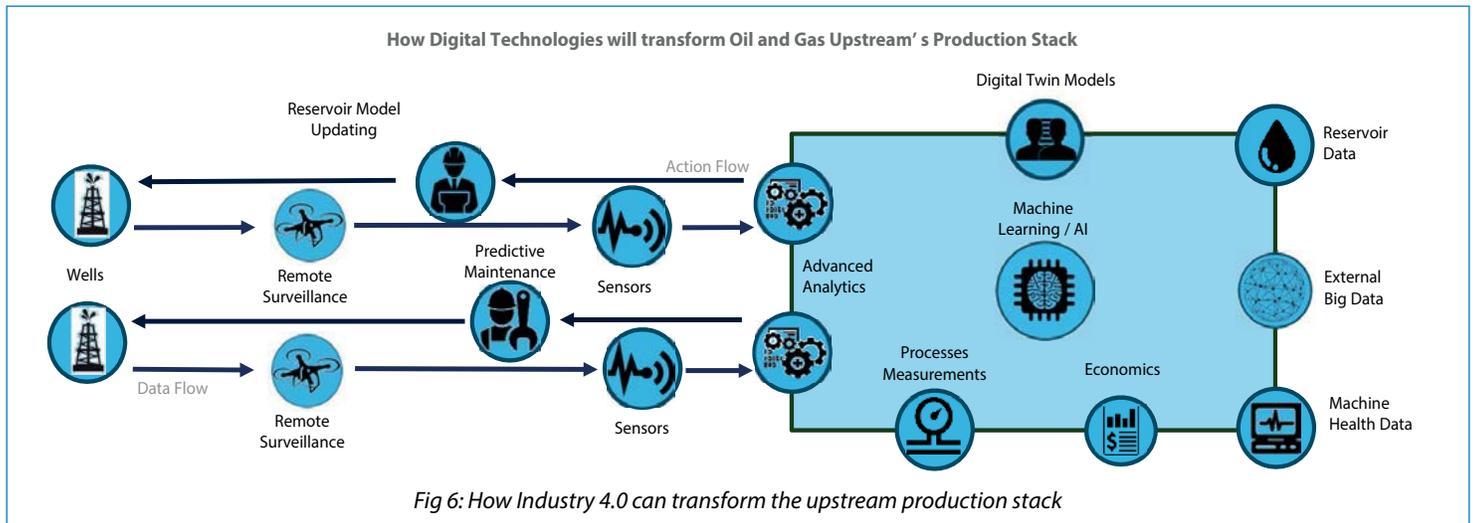
data from the oil well or the drill field. This data should then be collated with big data from sources such as historic data, asset suppliers' standards, etc. Applying advanced analytics on this aggregated big data set will provide insights into operations and reveal

opportunities for implementing automation and AI. For instance, robots can be used to execute operational decisions on the oil well/drill field, and drones or autonomous vehicles can be used to oversee operations or assist with risky tasks [4].

2.4 Upstream production stack 4.0

Industry 4.0 can help upstream companies digitally connect operational assets and evaluate asset performance for efficiency, damage and maintenance needs. This will have a positive impact on top as well as bottom lines of the operations' profit and loss (P&L).

IoT sensors and remote-controlled drones can gather operational data and surveil individual assets in real-time, allowing companies to better understand on-ground operations.





Data aggregation can be used to collate data from different sources such as external big data, digital twin models, machine health standards, economics standards, and asset performance metrics. Applying advanced analytics and artificial intelligence techniques on such data will help companies evaluate asset productivity, predict maintenance needs and make better decisions on how to improve oil fields in real-time, thereby boosting agility and efficiency [4].

3.0 Creating a roadmap to implement Industry 4.0

While Industry 4.0 improves operations through technology, it is more than just a simple technology implementation

and mandates a corporate design strategy. Companies and executives must understand that while Industry 4.0 can transform their business, it is also important to evaluate how it aligns with future goals, corporate culture and the organization's core strengths and corporate strategy [7].

Thus, designing an Industry 4.0 roadmap requires a holistic understanding of the entire organization including its capabilities, priorities, culture, and digital maturity level. As such, it demands the direct involvement of C-level executives, particularly CEOs who possess in-depth understanding of the organization. Such senior leadership are well-positioned to lead Industry 4.0-driven transformation

and change management [8].

Studies show that the integrated and connected assets of oil and gas companies can generate as much as 1.5 terabytes of data per day. Despite this, many companies still lack the capabilities to leverage this information for relevant business insights [9]. To overcome this digital bottleneck, companies must look at adopting Industry 4.0 using an enterprise-wide and holistic approach.

The Industry 4.0 Maturity index developed by the acatech lead consortium provides a useful framework for organizations to evaluate their current maturity and define the roadmap for Industry 4.0 implementation.

3.1 The Industry 4.0 Maturity Index

The Industry 4.0 maturity index [7] assesses organizations from three perspectives – cultural, organizational and technological. In this section, the focus is on how the Industry 4.0 Maturity Index can be applied for the the oil and gas upstream industry.

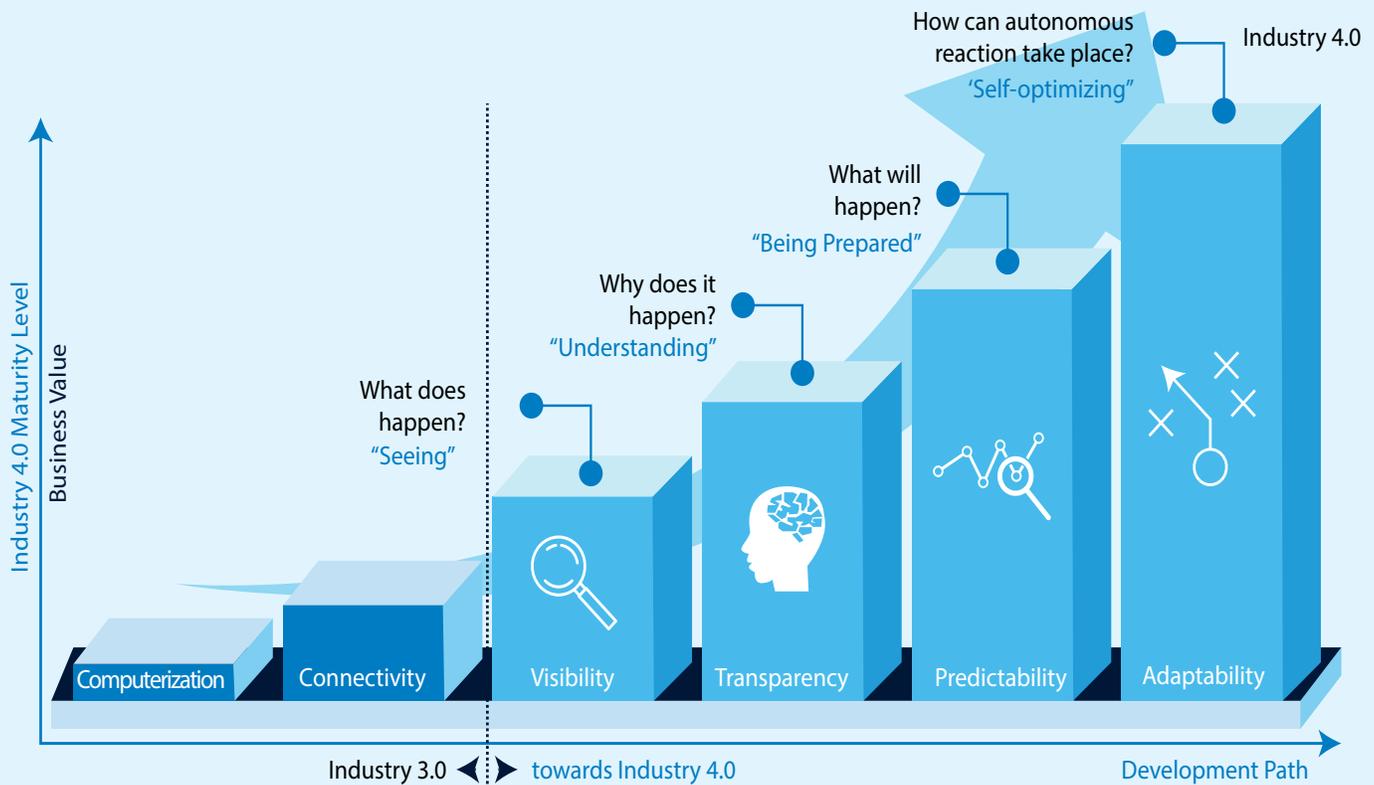


Fig 7: The Industry 4.0 Maturity Index (source: Infosys)

The first step is to analyze the organization's current situation and goals. The key questions to be considered are:

- What are the strategic goals and objectives over the next few years?
- What technologies and systems are currently implemented?
- How do these technologies and systems operate within the company?

The answers to these questions will determine the current capabilities of the organization. It is important to note that successful transformation does not happen overnight; it requires a strategic and phased approach. Thus, organizations must identify the specific benefits they want to achieve along with the implementation priorities and measures.

Through this approach, organizations can define a digital roadmap to implement Industry 4.0 across all relevant areas of business. Further, the step-by-step approach helps companies reduce investment cost and implementation risks.

The Industry 4.0 Maturity Index contains four levels of maturity as described below:

- **Visibility** – Real-time process monitoring through sensors and devices generates an up-to-date digital model of factories or a digital twin
- **Transparency** – Applying root cause analysis and engineering knowledge enables complex and rapid decision-making
- **Predictability** – By simulating various

future scenarios and identifying the most probable ones, organizations can anticipate future developments, thereby improving decision-making

- **Adaptability** – Data from the digital twin can drive decisions that can be automatically implemented, leading to the best possible results in shorter timeframes. This degree of adaptability depends on the complexity of the decisions and cost-benefit ratios.

It is important to note that, in this framework, every stage builds on the strong foundation established in the previous stage. Thus, to ensure a successful Industry 4.0 implementation, all four stages should be followed in sequence for maximum benefit.

4.0 Conclusion

Industry 4.0 is the strategic deployment of digital technologies along the production assets of industrial manufacturing organizations. For oil and gas upstream companies, Industry 4.0 can play a vital role in helping them tackle the challenging landscape of the industry. Here, capabilities such as unmanned drilling, digital modeling and predictive maintenance can drive efficiency and sharpen the competitive edge for companies that struggle with ever-changing demand-and-supply cycles and shrinking margins.

However, the focus of implementing Industry 4.0 should not rest solely on the technology aspects. To achieve true differentiation, Industry 4.0 must be viewed as an enterprise-wide initiative that meets present and future organizational goals. The Industry 4.0 Maturity Index developed by the acatech lead consortium provides a clear framework for companies to assess their maturity and define a roadmap while considering the organization's needs, core competencies, values, culture, and corporate strategy. Doing so will help oil and gas upstream companies maximize value from digital transformation and gain a clear advantage.





About the Authors

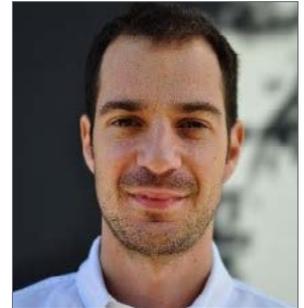


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