



OTC-28689-MS

The Impact of Digitalization on Offshore Operations

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This paper was prepared for presentation at the Offshore Technology Conference held in Houston, Texas, USA, 30 April–3 May 2018.

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Abstract

Most of today's digital initiatives in oil and gas are incremental rather than disruptive. Some companies are taking a step forward to make improvements in technical or operational capabilities, but many are not fully embracing the power digitalization can provide. Numerous benefits such as increased cost savings and significant improvements in collaboration, productivity, maintenance and revenue have been realized through digitalization...if only more offshore operators would take the technological plunge.

Online collaboration technologies provide offshore engineers the ability to digitize workflow and planning processes, optimize decisions between experts, disciplines and companies involved in the life of field perspective, and visually identify operational activities and maintenance events once projects are online. Through digitalization, all offshore field projects – assets and activities – are: easily understandable through online 2D/3D visualizations; rapidly created or replicated using existing field layouts with a 3D asset library; immediately monitored and reporting to real-time operating levels; and getting an instant view of the cost consequences due to a required action or change to a field. Offshore operations would dramatically change upon oil and gas companies embracing and upgrading their digital capabilities, thus improving the way they collaborate with and connect new data insights to their operating models.

The novelty for offshore engineers is that digital collaboration tools are easy to integrate and train the next generation of employees to, and capable of accelerating project timelines **by up to 80%**, especially during the early concept and FEED phases. These time savings can drive cost savings **as high as 70%** across a project's lifecycle. The benefits are undeniable when this technology is implemented across the oil and gas industry...regardless of current oil prices.

Introduction – Current state of the Industry, Potential for Innovation

Entering 2018, there is a sustained air of optimism in the oil and gas industry. The per-barrel price has risen to \$64.20 USD [as of January 10, 2018 (NASDAQ, 2018) and companies across the industry were reporting strong profits in Q3 of 2017 with similar trends expected to continue through Q4 2017 into Q1 2018 (Choudhury, 2018). Yet, despite the stabilization and return to profitability for companies across the oil and gas industry, most companies continue to see the need for further job cuts, with the offshore oil production sector especially affected by the lower oil prices. More than 440,000 jobs were lost in total throughout the industry since 2015 (Jones, 2017) and as the need for belt-tightening continues many companies are now examining ways to increase efficiencies, reduce expenditures, and maintain profitability, all without sacrificing essential manpower.

Digitalization technologies, as commonly defined in the oil and gas industry, are technologies both physical (e.g. smart sensors) or digital (e.g. Cloud-based field design platforms) which help augment normal workflow through the collection, analysis, and utilization of huge amounts of data. While not a silver bullet, the trend towards implementing digitalization within the oil and gas sector is expected to help mitigate capital and employee losses, return companies to long-term, sustainable profitability, and invigorate a new wave of industry innovations. Innovations which have the potential to spill over into adjoining sectors to create new avenues of revenue and potential market leaps for current oil and gas companies, all while requiring, for the digitalization technologies in particular, very little capital expenditure on behalf of the oil and gas company.

Section 1 – How has Delayed Implementation Hurt the Oil and Gas Industry?

Delayed implementation of digital field technology in the offshore oil and gas production realm has hurt oil and gas companies' short- and long-term profitability. Once an industry known for its advancements in cutting-edge innovations and technologies, now the industry is lagging behind due to a continued dependence on outdated methods and technologies coupled with a limited reliance on money- and time-saving digital solutions. According to Forbes contributor, Martha Aviles from Drillinginfo, oil and gas companies hamper their profitability due to the amount of time wasted through the continued reliance on human operators gathering data, doing data entry, or other job responsibilities best completed by a digital twin platform, smart sensor, or IoT (Internet of Things) connected sensor/work station. For example, Aviles writes:

If an operator is spending two-thirds of its time gathering data, ensuring quality control, and importing and exporting from multiple software tools simply to create a field plan or test a single "what if" scenario, how efficient is that? What if the same amount of work took less than 10% of the operators' time with the remaining 90% devoted to creating a next-level workflow that becomes the organization's competitive advantage? (Aviles, 2015)

Aviles' question raises an important limitation in the current operation paradigm of the oil and gas company in a difficult market: no time to innovate, must keep producing while making do with out of date technology. This unwillingness to take the time necessary to integrate crucial digital solutions across operations will continue to cost oil and gas companies billions in unseen potential revenue saved and gained through more efficient operations. As Cyril Widdershoven, director of Netherlands-based consultancy Verocy, puts it, "Based on higher costs of oil and gas production (and) an increasingly difficult production operation, the need to have a much better insight available is clear" (Hellenic Shipping News, 2017). Widdershoven goes on to elaborate that the way to increasing oil and gas companies' insights is through increasing reliance on digitalization and transformative connective technologies.

While according to a recent McKinsey study, individual oil and gas companies increased their capital expenditures by 20 percent yearly and increased operating costs by 3 to 5 percent in upstream, while increasing downstream costs by 2 to 4 percent simply by failing to implement digital solutions in their work processes (Choudhry et al, 2016).

In a similar study from Ernst and Young entitled, "Project Efficiency in Oil and Gas," the authors found that four out of seven significant inefficiency areas (listed below) which currently exist in Industry standard practices could

be quickly rectified through the implementation of smart digital collaborative technology focused on the digitalization of the field design, planning, costing, and building process (Ernst and Young, 2016).

Current inefficiency areas:

- Rework: Redesign, re-planning, recheck, re-measure, recalibrate, etc. field development projects
- Waiting: For data, decisions, approvals, test results, signature, etc. waiting for resources to become available, waiting for others to complete tasks
- Transportation and handovers: Handover of tasks, documents, jobs, projects etc., between departments, companies, persons etc.
- Inventory: Incomplete tasks, backlog requiring coordination, prioritization, planning etc., excess documentation, unimportant information

Section 2 – Changing Market Dynamics are Spurring Industry Adoption

The tipping point for investment into the digital technology market for many oil and gas companies emerged in 2017 and will continue to draw in oil and gas companies in 2018 through the developing “new normal” of lower-for-longer oil prices. This “new normal” has forced oil and gas businesses to develop a new philosophy of *better margins* for finding profitability within operations. Simply put, more oil and gas companies are beginning to invest in disruptive digitalization technology because stock holders and analysts are moving away from an emphasis on profit creation through *big production* to profit creation through more efficient business practices, i.e. *better margins* (Clark, Anvar 2016). A stabilized bull market effectively prohibiting high oil production levels has resulted in slimmer profit margins and turned what was once seen as an opportunity for innovation into a need for innovation. Decisive, timely, and structured steps into the implementation of digitalization technologies are now critical to oil and gas companies’ who wish to create long-term cost savings and develop new business practices to make their \$3.4 trillion asset base smarter and more reflective of the leaner oil and gas company of the 21st century (Mittal, et al 2017).

Iain Armstrong, an analyst at Brewin Dolphin, supports such a theory and suggests that the common theme among all oil companies [in the years ahead] will be a determination to avoid a return to the wasteful spending of the boom years (Financial Times, 2017).

Not to be ignored, there is at least one other market dynamic which is driving the oil and gas industry towards broader implementation of smart field technology and that is: the fear of being left behind or being seen as outdated by current clients, stock holders, and industry competitors. As industry competitors increasingly relying on marginal improvements in physical technology to gain an advantage over one another in the throughout oil and gas stream, there will be a digital “race to the moon” in the coming years as oil and gas companies race to develop and implement technologies which will improve profit margins and help promote an image of the company as being on the forefront of the digital “field of the future.”

Theories as to what is truly driving the increased interest and implementation of digitalization technology in oil and gas belie the more important, fundamental question to the usefulness of these technologies: how are they implemented? Changing market dynamics and advancements in technology aside, how do these ideas and technologies go from buzzwords to actual revenue increasing business technologies and practices for oil and gas companies? Enter the Chief Digital Officer (CDO). In a recent report by GE’s blog, “Someone has to do the heavy lifting required to plug companies into the Industrial Internet age. But the current enterprise IT is not set up to easily deliver business answers to technology questions” (GE Digital 2016). As previously explored, the current top-down company structure common in oil and gas companies across the world prevents almost all early adoption of any form of technology or new business practice due to management’s need to be involved in structural decisions. Until structural changes are made to streamline and strategically position legacy oil and gas companies for competitive success in the new oil and gas market, the responsibility for aggressive and strategic identification of emerging digitalization opportunities and the implementation of these technologies will fall on the CDO within each company. Therefore, the previous “wait for them to come to us” strategy for technology identification will no longer suffice. CDOs will need to transform their roles into a two-fold responsibility: on the one hand, looking inward to the functions of the company, striving to improve the digitalization efforts already underway within the company, while on the other hand, looking outward to strategically identify new and current digitalization technologies and screening these opportunities for application within their own company. In the interim testing period between identifying a new digital opportunity and actually implementing the new transformative technology into wide-spread practice within the company – the company runs the risk of falling

behind the competition and never being able to make up for ground lost due to late identification, slow testing periods, or limited implementation. The oil and gas company whose CDO fully explores and implements digitalization technologies into operations will be the company who is insulated against future price variances, better positioned for longevity within extreme oil procurement environments, and manages more effectively and efficiently their oil and gas operations throughout the entire life-cycle of their operations.

Section 3 – Steps to Adoption

Regina Mayor, global energy leader at KPMG, says, “The energy sector is an incredible place to be right now. Innovative technologies have the capacity to completely disrupt the way we operate, and it’s clear from our study that global oil and gas executives recognize that these technologies – when properly implemented – put us in a position to make big change” (Mayor, Oussov, 2017).

“When properly implemented” is incredibly crucial since, “by 2018, 70 percent of siloed digital transformation initiatives will ultimately fail because of insufficient collaboration, integration, sourcing, or project management,” according to the International Data Corporation’s predictions of CIOs 2016 agendas. If costly failure will be the predicted norm in the early stages of digital technology integration, what are the correct steps to digitalization adoption and what will ensure that these technologies are properly implemented and used once adopted?

The Deloitte Insights group has created three fundamental questions which they believe are crucial to the success of any digitalization undertaking within an oil and gas company (Mittal, et al 2017). The approach should answer three strategic questions on digital —

1. How digital are you today? As a starting point, this self-assessment will allow CTOs and other chief digital officers to create a matrix of current digitalization within their company which should then be the framework for the next step to forward-thinking implementation goals.
2. How digital should you become? Starts with reference to the previous question and developed framework. Based upon a company’s starting level of digitalization, their ability to widely implement digital technology, and their current capital reserves together help to create a destination and roadmap for step by step digital implementation. This roadmap should answer the crucial questions of “why,” and “why now,” along with giving CTOs and other digital officers an understanding of their company’s place within the industry field and the unique role they play in leveraging their specific skills to create market advantages, increase the effectiveness of collaborations, and distinguish themselves and industry standard definers.
3. How do you become more digital? While many CTOs and current publications suggest there are several starting points for digitalization technology integration, there is really only one place to start when it comes to successfully transforming the digital capacity of an oil and gas company. Despite the industry’s fascination with buzzwords such as “big data,” the “Internet of Things,” and “Smart Technologies,” these systems are all essentially useful only when their data can be sorted and processed into something meaningful. That happens within the processing systems of oil and gas companies or, as the technology continues to prove itself, in Cloud-based platforms, programs, and databases.

Currently as yet unrealized – or where implemented, underutilized – cloud-based platforms are foundational to the longevity, success, and risk-management of all new oil and gas digitalization efforts. Cloud-based servers, platforms, and databases are the basis on which the data deluge from Smart devices, IoT sensors and connected equipment, or other planning and seismic data information comes into play, how it is assimilated, processed, and interpreted.

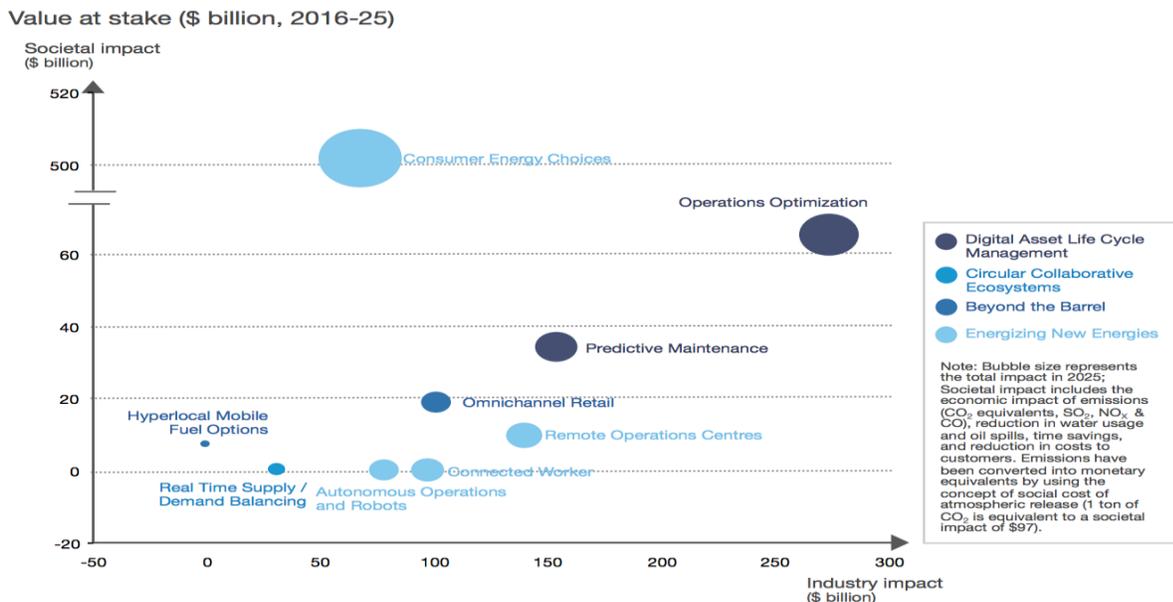
Without a comprehensive Cloud-based system, all of this rich and operation-encompassing data (from design of a field to operations to decommissioning) is going into storage or out of one program and into another where parts of the data will not be seamlessly compatible, or go missing in its multiple iterations, essentially rendering a portion of the data oil and gas companies are paying hundreds of millions to produce, understand, and use for future modeling, unusable. In the Cloud systems and programs are unlimited in their scalability and the Cloud allows for more data to be accessed by analytics tools in real-time avoiding the risk of using the wrong or outdated version of project. This is where the concept of a “digital twin” emerges and why Cloud-based computing will be transformational to any oil and gas

company which fully embraces it. With a digital twin of an existing or future oil field or installation schedule, etc. companies with offices and operations across the world are able to reduce their risks load to single digit percentages in some cases, use their digital twin to effectively model alternatives, or save the twin for reproduction in other similar fields elsewhere in the world, all while engaging a broader field of expertise regardless of geographical location. Graham Bennett, vice president at DNV GL – Oil & Gas, supports the usefulness of a digital twin hosted within the Cloud by pointing out that, “Poor utilization of existing information is often a hidden cost, accounting for up to a fifth of operational budgets, while a single unscheduled downtime can cost millions of dollars per day” (Maslin, Leon 2017). A digital solution based in the Cloud will solve for the risks associated with utilizing old information or incorrect measurements through increasing collaboration and exercising greater control over proper data assimilation. In the Cloud, as Bennett further notes, all existing and live data about a facility or facilities is kept and can be used for simulations, modeling, analytics, in order to prevent downtime, predict maintenance requirements, and optimize operations, from drilling to decommissioning.

What has been lacking is a way to store, manage and then apply analytics to the information created in the oil field and while the Cloud is a perfect solution, security has, up to this point, been the main sticking point for broader implementation and utilization since many in the IT departments across oil and gas companies are hesitant to place such sensitive information in what they view as programs and platforms operating on the World Wide Web. Visions of data breaches, loss of data due to crashes, or leaked sensitive information due to sloppy program give IT officials pause. However, regardless of the public perception surrounding data security in Cloud-based systems, the unprecedented data breaches which are more and more common in recent years, such as the complete breach Equifax experienced, have happened on private servers and within companies’ own systems, not on Cloud-based platforms. Fundamentally, Cloud-based anything is more secure than data stored on personal computers, company databases, or in off-site “secure” private servers. According to David Linthicum, “on-premises environment users or customers actually suffer more incidents than those of service provider environments. On-premises environment users experience an average of 61.4 attacks, while service provider environment customers averaged only 27.8. On-premises environment users also suffered significantly more brute force attacks compared to their counterparts” (Linthicum, 2014).

It is important to realize that digitalization is not simply focused on the latest technology and devices; rather, the digitalization of the oil and gas sector, when done properly, is about adjusting the way we work. Technology remains crucial to combining the benefits of simultaneously managing diverse technologies while protecting sensitive data and mitigating security risks. As Accenture notes, “It is therefore critical to put in place platforms and operating models to address the consequences of digital convergence across...business information technology applications and the operational technologies of mission-critical control” (Coombs 2017).

Figure 6: Potential Value of Digital Initiatives and Technologies in Oil and Gas, for the Industry and Society



Source: World Economic Forum/Accenture analysis

As previously mentioned, company structure and culture have a great deal to do with the longevity of a digital technology's success within a company, and in return, the success of that company within the industry. As shown on the chart above, "Operations Optimization" is currently the leading innovation within digitalization which has the greatest potential impact on a company's profitability. Establishing the right attitudes towards innovation and developing employees in working groups for deeper and broader application of digital systems outside of the "project silo," etc. are crucial to overcoming the tendency for innovation to be suppressed within a rigid chain of command and/or isolated within working groups. In order to achieve a dynamic and disruptive influence on the market, focusing working groups and different digital platforms on the problem of adopting and expanding digitalization solutions which can optimize operations will have the greatest effect on a company's long-term success. In a working paper from Bain & Co. they note that "People are the most important component of a winning digital strategy, yet failing to upgrade their capabilities is the most common pitfall in unsuccessful transformations. Executives should assess their team's current capabilities and develop a plan to manage change and improve technical expertise" (Bertocco et al, 2016).

Achieving a mastery of digital technology within the business and then leveraging that internal success to greater industry dominance is dependent on establishing the right behaviors across the organization (Coombs, 2017). When it comes to proper adoption of digitalization technology, the development of new skills outside the typical engineering and data-protective perspective, such as increasing collaboration, non-linear thinking in design applications, and "rethinking the approach to innovation with a reward system that gives 'permission' to fail fast or, 'adjust and scale-fast' once proven" (Coombs, 2017) will ensure the longevity of an oil and gas company's digital prowess and market influence, regardless of whether or not individual ventures fail. Investing in the right environment for digitalization adoption and fostering the right skills in people is what keeps companies in a disrupter's role and constantly climbing the "s-curve" of innovation called a "Circular collaborative ecosystem" according to the World Economic Forum. In the WEF's recently in their white paper on "Digital Transformation Initiatives in oil and gas industries", they write that, "Applying integrated digital platforms enhances collaboration among ecosystem participants, helping to fast-track innovation, reduce costs and provide operational transparency" (World Economic Forum, 2017).

Section 4 – Benefits of Adoption

Reviewing the two biggest contributors to the oil market downturn which began in 2015 were 1, that oil and gas companies suffered due to a lack of actionable intel on the correct levels of production coupled with 2, a lack of understanding as to how to mitigate falling prices with more cost-effective operation standards. Digital technologies are better at preparing oil and gas companies to weather any similar future storms than traditional technologies because digital technologies have a "mitigating" effect on the variances in the market which destroy capital and wreak havoc on short-term profitability.

Big data mining has become a buzzword, though, like many of the emerging trends in digital solutions for oil and gas, it is little understood from the modern digital perspective. What does that mean? Simply put, as recently highlighted in an article by *GE*, the oil and gas industry is full of data historians so naturally oil and gas companies think, "we have been doing Big Data since the 80s," therefore, many hold parallel perceptions about their standing within analytics capabilities (Miklovic, 2016). However, these new efficiencies and data collection new trends are as similar to the old collection and analysis methods as riding a bike is similar to BMX competitions: they both involve a bicycle. As physical infrastructure is exchanged or improved through the addition of Cloud-based computing infrastructure, "the sheer amount of data companies can harness and further analyze through automation, will reduce operational expenses, down well times, and lessen risk," according to Inc. Magazine's assessment of digitalization trends and opportunities in oil and gas operations (Medal, 2017). The new methods of analyzing and improving oil field construction and oil production are now being made possible when the power of big data, mined from smart devices, is collected and analyzed in Cloud-based platforms. The *GE* article concludes, "With a modern IoT and cloud platform underlying the next generation of applications and analytics, the oil and gas industry *can move beyond* just doing the same thing faster or cheaper and *adopt new levels of productivity*" (Miklovic, 2016).

Indeed, new levels of productivity are possible with increased implementation of cloud-based digitalization technology. Painting with broad strokes, the World Economic Forum approximated that the "Digital transformation in the Oil and Gas industry could unlock approximately \$1.6 trillion of value for the industry, its customers and wider society between 2016 and 2025" (World Economic Forum, 2017). Highlighted below are, in short, the most remarkable ways the digitalization of the oil and gas industry is revolutionizing the entire lifecycle of oil operation and production.

One of the biggest improvements digitalization can bring to the work-flow of oil and gas production is through increased standardization across fields and operations. In Ernst and Young’s yearly review of the oil and gas sector, they found that, “The oil and gas industry lags behind other asset-based industries in adopting standardization. By treating each project as being largely unique, the industry misses opportunities to develop a common project management template or standards for equipment and components” (Ernst and Young, 2017). By packing away each finished field design in a storage system and not cataloguing it for future review or cross-reference of proposed fields’ design optimization, but rather approaching each new project as a blank slate, this forces oil and gas companies to reinvest enormous costs each time a new field is being developed, “rather than identifying opportunities to replicate existing solutions” (Ernst and Young, 2017). The resulting complexity and duplication of current operating norms ensure field development will continue to be costly, time-intensive, suffuse with workforce underperformance, budget overruns and schedule delays.

In an era of volatile oil prices and extreme pressure on cost, the industry must embrace greater standardization as a tool to improve project development economics.

Standardization should focus on four key areas as detailed in the chart below provided by Bain & Co. (Bertocco et al, 2016). First, an oil and gas company could see incredible improvements to project time tables if they would integrate Cloud-based collaborative platforms focusing on speeding up information sharing among teams during exploration and field development in order to make decisions in real-time and avoid delays or misunderstandings.

Figure 2: Although digital will affect the entire oil-and-gas value chain, four key application areas are already emerging

		Exploration	Development	Production	Refining & processing	Sales & Marketing
	Improve performance through better decisions and faster insights	Make real-time decisions with 3D visualizations	Predictive analytics: improve drilling accuracy, identify anomalies & prevent undesired events	Real-time data analysis of sensor data from reservoirs to optimize production	Better prediction of the differential between crude and refined products—the “cracking spread”—to improve yields	Identify future transportation needs to reduce costs
	Optimize data for process modeling and appraisal	Appraise acreage auctions using competitive intelligence dashboard	Build realtime data into earth model on rigs and onshore	Automatic update of well model		Integrated financial planning; aligning production to peak sales opportunities
	Enable automatic management of systems and processes	Automated prospect analysis, integrating large amounts of data from aerial, analog and other sources	Automated concept selection optimization	Reduce onsite personnel with remote operations Optimize maintenance, minimizing shutdowns with predictive analytics/maintenance		Spot market analysis, long-term demand and trend analysis
		Increase certainty	Increase speed	Increase ultimate recovery, decreasing risks & operational cost	Optimize higher yields production, increasing safety	Optimize pricing and sales channels

Sources: SPE Reports; Microsoft; IBM; IDC; Bain experience

Second, the implementation of a cloud-based platform within an oil and gas company’s operation flow through the utilization of real-time data gathered from IoT connected equipment monitors would optimize production and reduce over or under production from wells.

Third, through the widespread utilization of collaborative Cloud-based platforms, companies are able to reduce the number of personnel required at specific operation sites or in geographically strategic offices. This means an oil and gas company can drastically reduce the costs associated with moving and hosting a wide variety of specialists, engineers, managers, etc. at specific job locations globally. With the integration of a global workforce system, an engineer in Sweden could collaborate with a designer in the United States to create a field layout for an installation team offshore in Indonesia, without ever having to leave their offices. Fourth, the optimization of engineering and design approaches creates a domino effect for the optimization of field-maintenance and follow-up costs associated with fixing field layouts or improving well placement, etc. Ernst and Young concludes,

Industry standardization can develop standard project design templates and project management methodologies around which teaching and new technology can be aligned to reduce variance in delivery performance, improve the efficiency of maintenance and modification works, and, simultaneously, reduce the cost of equipment and technology.

Extrapolating on the previously mentioned notion that time is money for oil and gas companies waiting for first oil,

McKinsey found in a comprehensive survey of a specific oil and gas company's processes, that "AB Oil Co. employs tens of thousands of engineers and technicians working on thousands of projects...Instinctively, we know that not all those projects can be successful, or even efficient in how they operate." Enter digital field design tech (Ward, 2016). By leveraging cloud computing capabilities, accuracy and transparency are achieved in the shortest amount of time to drastically improve well-cost management.

In the space between standardization and improved risk management, companies can achieve significant improvements through internal standardization which specifically affect initiatives and the ways in which they design and implement new field development or alter existing fields. In fact, Wood Mackenzie report that, standardization has the potential to structurally remove 10% to 20% of project costs (Ernst and Young, 2017).

Finally, digitalization improves the longevity of investments for oil and gas companies through improved understanding of equipment stresses, and repair needs, etc. As oil and gas companies look for ways to reduce expenditures, many are beginning to move away from infrastructure-intense re-developments and are instead investing in Smart technologies and such as equipment sensors which monitor equipment status through the logging of thousands of daily readings across a myriad of categories. These sensors and IoT connected devices are being utilized to prolong the life of costlier permanent equipment such as manifolds, wellheads, and subsea pumps, etc. Cloud-based platforms are necessary to collect this information and properly assimilate, model, make predictive analyses, and store the data for future reference. According to McKinsey's use-case study on digitalization in oil and gas companies specifically focusing on IoT connected devices, they found that through frequent optimization, reporting on the current stress of equipment, records of prolonged use, etc, the Cloud-based digitalization of oil and gas companies is revolutionizing how equipment talks to the user and to other equipment to optimize oil flow, transportation, and use – thereby reducing costs and overhead expenditures (Martinotti et al, 2014)

From the way oil and gas companies plan out and build new fields to the way they manage existing infrastructure and decommission fields, if the previously mentioned hurdles and barriers to adoption are overcome through systematic and intentional changes within individual companies and the way in which they interact with each other, digital technology will, without a doubt stabilize production, drive up revenue, and ensure the longevity of oil and gas companies for decades to come.

Section 5 – Potential barriers to adoption

Digitalization technologies, according to Nate Clark, an analyst for PricewaterhouseCoppers's Oil and Gas industry strategy consulting business, can and will "bring substantial operational improvements to the field..." (Clark, Anvar 2016). However, the adoption and implementation of digital technology solutions into daily oil and gas operations is not without its potential pitfalls and costs.

According to a recent study by KPMG of 51 global oil and gas CEOs, the majority reported a high degree of confidence that their companies would grow in the next twelve months to three years (Mayor, Oussov, 2017). In order to achieve growth in the short term, 88% of CEOs surveyed said they planned to invest in data and analytics tools (i.e. digitalization technology) followed by the IoT (82%).

While the majority of CEOs surveyed reported an intention to invest in digitalization technology, many still operate from the previous notion that digital software and smart sensors will help bring efficiencies and curb costs without understanding that *proper implementation* is just as crucial as recognizing the initial need for digitalization technologies within the field.

Typical for the industry, most energy companies employ a rigid, top-down governing and innovation structure. Such a rigid structure ensures company policy, technology, and operations, etc. are significantly delayed or unresponsive to the implementation of digital transformative technology which other industries, such as the Health and Service industries, incorporated months or years ago. Reuters confirmed such an assessment in December 2017 when they reported that such "top-down", structured operations for everything from refinery maintenance to the structure of meetings, squeezes out bottom-up innovation and the timely adoption of innovative technology. Furthermore, a McKinsey "organizational health" survey of oil and gas companies – a type of stress test for company resilience – found that oil and gas companies scored worryingly below the global median average in receptivity to innovation (Reuters, 2017).

In addition to disadvantages to digital technology implementation due to internal company structures, the sharp down-turn in oil prices and sustained but rebounding low profit margins or, in some cases continued losses, have made the industry innovation and risk-adverse. A cautious industry, governed by technologically unfamiliar management, and a perhaps misplaced-emphasis on reducing spending to improve the bottom-line, has created an environment in which large companies, who could greatly benefit from deep investment in digital technology, are lagging behind other industries in technology adoption and dissemination across all departments due to a fear of over-extension of capital reserves. However, recent trends support a positive change as Malcolm Dickson, an analyst at Wood Mackenzie, says, "The industry has moved out of survival mode, through a phase of adaptation to lower prices and now it is beginning to think about renewed growth" (Financial Times 2017).

In a 2016 PricewaterhouseCoopers survey, of the 2,500 largest public companies in the world, the oil and gas industry lagged behind all other industries in the number of officers appointed to digital or technology leadership positions (Peladeau et al, 2017). The study found that 19% of the surveyed companies had appointed CDOs by year-end 2016, a 13% increase from the year before. While only 3% of the oil and gas companies surveyed had made such appointments by 2016, which also significantly lagged behind other energy industries like utilities, at 12%.

The discrepancy between other industries' numbers and those of oil and gas suggest an industry still largely governed by overly cautious and technologically unfamiliar leadership, who still view digital technology as overly expensive, unsafe, and non-utilitarian in a hamstrung market. Such views are largely reinforced due to a lack of "digital native" talent at the senior level and structurally throughout the managerial levels of oil and gas companies according to a survey by Petroplan, a Houston-based oil and gas recruitment company. Their research found that more than a third of the more than 2,000 oil workers surveyed, "pointed to the growing need for IT skills," within oil and gas companies in order to make the digital oil field possible (Endress, 2017).

Even when oil and gas companies appoint digital and technology-focused leadership roles, the previously mentioned PwC survey concludes that there are still significant hurdles for these officers to overcome in guiding their companies to greater digital competence. For example, most digitalization initiatives "lack[...] central oversight, (are conceptualized in) a traditional culture that resists change...and (are inoperable on) legacy systems and structures that threaten to derail their [CDOs'] ambitions" (Puthiyamadam, 2017).

From the digital perspective, many of these technologies are new and not yet widely supported across the industry. In a January report by Accenture on digitalization in the oil and gas industry, cites the primary barriers to adoption from the digital perspective as:

- Regulatory frameworks that are struggling to adapt to a new era of data sharing along value chains;
- A lack of standardization in data coming from sensors;
- An inability to share information across the ecosystem; and
- The challenge of recruiting millennials with industry and software skills to replace an aging workforce

Finally, some offshore operators are investing heavily in technologies which are only capable of making marginal improvements in technical or operational capabilities. Meaning most oil and gas companies are not fully embracing the power digitalization can provide, but rather, are heavily investing in digital initiatives in oil and gas which are incremental rather than disruptive. This subtle barrier to industry disrupting digital technology innovations is highlighted in the above mentioned KPMG study which also found that "Eighty-six percent [of CEOs] say these investments [digital technology] will primarily focus on physical infrastructure" (Mayor, Oussov, 2017). An emphasis on infrastructure investments is a classic example of pre-low-price norms thinking and references the management of companies by what was earlier described as, "technologically unfamiliar" and "digitally skeptical" leadership.

A less expensive alternative to the heavy investment necessary in physical smart technology, with greater dollar per dollar returns on investment, would be an investment in big data software and the digitally disrupting technology of smart, Cloud-based field development and construction visualization programs, which are able to reduce time from design to first oil.

Further proof of the many pitfalls to an investment model based on physical smart hardware can be the expensive initial costs associated with the burgeoning technology and high potential for the smart tech to become obsolete within two or three years. This hesitancy to invest heavily today in tomorrow's potentially obsolete technology is what Jim Montague of Control Global reports an oil executive at a top super big firm as describing as the dynamic between consumers and oil companies: "Consumers and IT-based firms know the early bird gets the worm, but oil

and gas players would rather be the second mouse that gets the cheese. This is because it's more costly to be the first to adopt new oil and gas innovations" (Montague, 2017).

The biggest potential barrier to adoption of digital technologies in the oil and gas industry, then, is not the costs of the technologies themselves but rather that these technologies require "...serious reform in management and the organization's perspectives, and sometimes temporary shutdowns of oil fields and wells —all of which can be time consuming and could further impact the producer" (Hellenic Shipping News, 2017).

Section 6 – Case study of early adopter

Even before implementing new and potentially costly technological investments into the daily operation of an oil and gas company, CTOs have the potential, through digitalizing data and field design to create huge savings in the short term for their companies. As a recent McKinsey report found, "Making better use of existing technology can deliver serious returns: up to \$1 billion in cost savings or production increases" (Choudhry et al, 2016).

Driven by need to respond to the falling price of crude oil, the offshore industry has undergone a wave of bankruptcies and consolidations over the past few years. Yet, far fewer greenfield and brownfield offshore sites can be drilled profitably today.

This increasingly competitive environment requires operators to squeeze margins from its suppliers. In the past, operators typically funded pre-FEED (Front End Engineering Design) and concept work since there were many more new fields and a limited number of suppliers. Today, operators expect those costs to be absorbed by engineering companies, which in turn only reap rewards if they do a great job and win the bid. In other words, doing the work has become the cost of getting a sale.

Further, operators expect engineering companies to provide more extensive concepts and images, and to invest in expanded engineering work, using real-world data before the operator awards any projects. Therefore, an engineering company that does not showcase its engineering skills in the bidding process has limited chances of progressing through the process and winning the bid.

Embracing Digitalization: Digitalization is emerging as a technological driver of change around the world and provides businesses with abundant opportunities for growth and monetary gain. While industries like manufacturing and healthcare have taken the Digitalization world by storm, the oil and gas industry has been remarkably slow to adopt this new way of thinking.

It is true that oil and gas has been "digitized" for some time. True digital transformation, however, now requires adoption of the Internet of Everything (IoE) — the networked connection of people, process, data, and things — throughout the value chain. Innovative oil and gas companies are using today's volatile market landscape as an opportunity to grab competitive advantage by embracing new IoE technologies.

Most of today's digital initiatives in oil and gas are incremental rather than disruptive. Some offshore operators are taking a step forward to make improvements in technical or operational capabilities, but many are not fully embracing the power Digitalization can provide. Numerous benefits such as increased cost savings and significant improvements in collaboration, productivity, maintenance and revenue have been realized through Digitalization...if only more offshore operators would take the technological plunge.

The barriers to change or adoption of Digitalization in the oil and gas industry include the usual suspects: regulatory frameworks that are struggling to adapt to a new era of data sharing along value chains; a lack of standardization in data; inability to share information across the ecosystem; and the challenge of recruiting millennials to replace an aging workforce.

Moreover, some senior industry leaders have not yet made the necessary shift in mindset to embrace digital's potential value. They simply do not like change. Especially when it comes to their technology infrastructure. For decades, companies have invested millions upon millions of dollars in creating a technology infrastructure that attempts to solve every problem and address every need in the business.

Realizing the Benefits: Digital collaboration technologies provide oil and gas, and specifically offshore engineers, a multitude of benefits. These include but are not limited to: the ability to digitize workflow and planning processes, optimize decisions between experts, disciplines and companies involved in the life of field

perspective, visually identify operational activities and maintenance events once projects are online, and assist with decommissioning when a well has come to the end of its life cycle.

Through Digitalization, all offshore field projects – assets and activities – can be easily understandable through online 2D/3D visualizations; rapidly created or replicated using existing field layouts with a 3D asset library; immediately monitored and reporting to real-time operating levels; and getting an instant view of the cost consequences due to a required action or change to a field.

For offshore operators, subsea and topside assets are their most valuable players. The foundation of these structures comprises years of knowledge, engineering talent and commitment. Our technology-savvy world is moving to a digital environment and in order for the oil and gas industry to respond to this trend, offshore assets must reside there too. Offshore operations would dramatically change upon oil and gas companies embracing and upgrading their digital capabilities, thus improving the way they collaborate with and connect new data insights to their operating models.

Real-World Results: A Houston-based organization that provides engineering services to the global subsea oil and gas industry has a pre-FEED group that develops complex proposal documents and presentations for use with complementary organizations to tender for new subsea drilling and well construction projects.

In the past, the bidding process used by the company was very basic. The engineers captured brainstormed ideas on flipcharts and in PowerPoint, then converted them into static visuals using Visio, Corel Draw and MS Paint. These documents would be sent to an outsourced engineering house for conversion into CAD files using the rudimentary engineering data. The CAD files were then used to develop the tender by the company.

In the past, outsourced design firms could be hired to rapidly develop draft drawings and concepts, without draining resources from the company. However, these firms either no longer exist in the marketplace or were not a cost-effective option. As a result, the company was left without the tools and internal resources required to provide the type of work needed to submit winning bids.

Upon introduction to visualization technology, the company realized very quickly the field development software was precisely the digital solution that could resolve its pressing issues. The company can now build visually pleasing 2D and 3D fields directly in a collaborative web environment. The fields themselves can incorporate the necessary engineering data to allow asset managers to make sound business decisions.

The additional smart functionality eliminates the pre-FEED CAD work during the proof-of-concept stage and the previous requirement to engage an outsourced engineering firm. Further, by using the digital solution the company has streamlined its entire field design process, so it can rapidly produce many more concept designs for multiple fields that include important information, such as flowline data.

In the past, the company would have not considered incorporating bathymetry data at this early stage. Now, it is able to load accurate bathymetry data that includes real-world coordinates such that right from the project's outset an accurate data set is built, providing the confidence that data used to build bids sets can be later used for decision-making purposes.

Leveraging digital solutions has completely altered the way the company is conducting business. It can generate many more field concepts in a much shorter time, eliminate inappropriate options quickly, and know that the options being presented to the client are accurate —without the need to spend significant up-front expense on outsourced engineering firms.

The ability to eliminate the need for outsourced engineering houses during pre-FEED was the most immediate cost-saving. An outsourced team of four drafters would cost up to \$2,000 per day, with work taking two to three weeks to complete, thus driving a net base cost savings of \$25,000-\$40,000 in the initial concept design phase. Additional savings also were derived from using fewer internal resources to develop bid documents and proposals. Such savings could easily triple the amount of immediate cost savings.

Equally important in today's competitive climate, the company can now respond far more rapidly and efficiently to project opportunities. It can develop concept proposals in 20 percent of the time it took in the past and respond to questions from operators and partners directly by being able to directly access key data. As a result, the company is winning more bids and driving new revenue in offshore engineering projects –at a time when management is closely monitoring business units' effectiveness.

Conclusion

As discussed above, Digitalization has the potential to create tremendous value for both the industry and society as a whole. However, for the offshore industry, such a transformation will require organizations to implement a focused digital strategy championed by the C-suite, executive teams, information technology leaders and a culture of innovation and technology adoption. It will also need investment and commitment to revisit, renew and upgrade current processes, infrastructure and systems; and, a willingness to share and collaborate across the ecosystem. All the aforementioned suggested steps towards implementation will need to be followed, the existing hurdles – which exists in company structure and operation – overcome, and a long-term commitment to new digital standards, emphasis on employee technology competencies, quick response times to and implementation of digital and emerging innovations, and highly digitalized operations within an oil and gas company in order to ensure a successful digital transformation for the agile and highly profitable oil and gas company of tomorrow.

“As the digital transformation scales up, CIOs have the opportunity of a lifetime to lead innovation, integration, and incorporation, thus making a major difference in their company's future,” says Serge Findling, vice president of research for IDC's IT Executive Programs (IEP) (Findling et al, 2015).

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