Upstream Oil and Gas Projects Sustainability Framework Through the Lenses of Big Data Analytics, and Project Management

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Abstract

This study aims to propose a conceptual framework to determine factors of big data analytics capabilities implementation that affects upstream oilfield projects success, from the lenses of project management practice in ensuring project sustainability. Upstream oil & gas projects executed by project management office of oilfield service contractors globally are the focus of this study. This study offers pathways for future research in bridging resource-based theory of big data analytics, institutional theory, and project management practices, in the era of digitalization within the context of high-risk nature of upstream oil and gas projects.

Keywords

Big Data Analytics, Project Management, Upstream Oil & Gas, Sustainability, Oilfield Servic

1. Introduction

Oil companies outsource exploration and production to oilfield service contractors to limit exposure to operational, environmental and financial risks following the Deepwater Horizon Oil Spill and the subsequent oil price slump (Pitatzis 2015). Upstream services in the oil and gas industry, as well as offshore installations, rely heavily on oil field service companies. Low oil and gas prices have had a negative influence on the entire value chain, but many oil and gas companies appear to have been hit the hardest by the 2014 oil price drop (Duane et al. 2019).

The combination of low oil prices, high demand, and cancelled projects created an unexpected and disastrous environment for upstream oilfield services. However, to secure long-term success, oilfield service providers must restructure their businesses and embrace a new operating model (Duane et al. 2019; Eberhart 2021).
An estimated 100,00 oilfield service workers were let go due to the pandemic in North America alone, or 34% of the oilfield workforce (Worldoil 2020). As a result, there is an internal pressure from oilfield service businesses to maintain sustainable project execution with the fewest resources available, aided by the faster digitization that began in 2016.

Lack of resources during reorganization is a common occurrence in the upstream oilfield service business. The early stages of digital transformation, big data, and knowledge management adoption (Mittal el al. 2018, 2017) on a variety of high-risk projects in upstream oil and gas (Badiru 2013) requires significant resource investment to drive implementation.

In one of upstream oilfield service company, a preliminary study performed. Relations between reduction of oilfield service workforce, DPMO (defect per million opportunity) of job services, number of projects, and Oil Price (WTI) are represented in Figure 1.

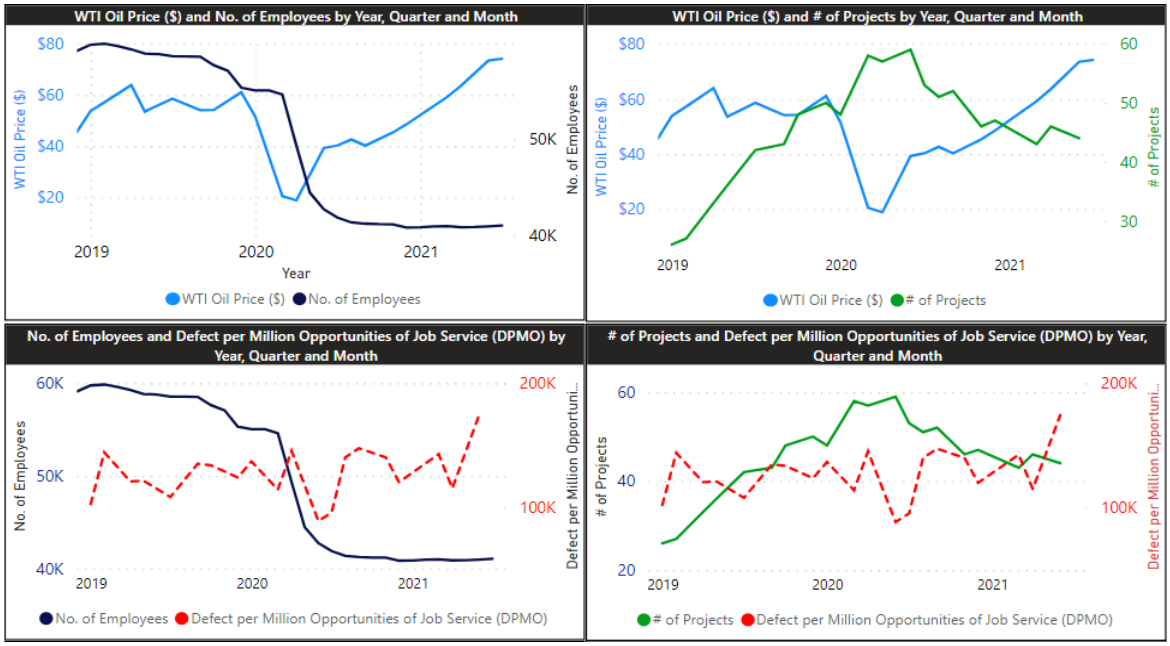

Figure 1. Employee reduction and increase of DPMO in one of upstream oilfield service company

This situation is exacerbated by the decreasing ratio of personnel performing work to the increasing number of defects in job. The indicator reflected in Figure 1 is DPMO (Defect per million opportunities) (Oakland 2014). This has raised question whether the company's project management practice able to minimize risk of safety incidents and equipment failures. The increase in defects per million opportunities is due to a variety of issues, the most significant of which is a lack of resources executing services (both people and equipment). Additionally, this limited resources need to cope up with large number of elements from project management methodology, and various integrated management system aspects which needed to ensure compliance in the heavily regulated upstream oilfield business; owing to the industry's inherent high risk character (Badiru 2013); however with uncertain impact on project success.

Operating digital technology has aided the oilfield sector in decreasing the average drilling time in shales from 35 days in 2012 to roughly 15 days presently; this is crucial for the industry's efficiency and cost savings. By implementing sophisticated analytics, upstream oilfield players might save $30 billion every year. Currently, it is planned to enhance learning by optimizing the drilling process using performance analytics, which entails generating new key performance indicators, assessing high-frequency drive signatures, and monitoring the utilization intensity of critical assets. However, over 300 oilfield service firms lack standardized cross-platform data formats, rendering analytical tools unable of collecting information from many vendors (Mittal et al. 2018, 2017).

What has made big data possible in the era of efficiency in the upstream oil & gas projects are the precipitous decline in data storage costs, increased computing speeds, advanced mathematical modelling that enables to see trends within chaotic raw big data, and advent of software tools to break large datasets to smaller chunks for more convenient analysis (Perrons et al. 2015). Additionally, upstream oilfield service companies offset the reduction of workforce by aggressively implementing digitalization mainly enhancing their big data analytic capability to further quantify risks and enable them to take mitigation action in their operations (Eberhart 2021).

Therefore, a research need to be conducted to study how emerging technology; big data analytics capability, could impact project sustainability (Mangla et al. 2020; Sang et al. 2021); as well as a study on how big data analytics helps to improve efficiency of project task to support project success (Sang et al. 2021).

2. Literature Review

2.1. Theoretical tenets: Resource-based view

Resource-based view has made important contributions to strategic management and international business by highlighting the organization's internal climate and reflecting its strengths and weaknesses through SWOT

analysis. Furthermore, the notion holds that a company's highly distinct resources and skills enable it to operate differently than competitors in the same industry (Peng 2001).

A business must have distinctive assets (resources and competencies) that provide it a competitive advantage and allow it to stand out from rivals in the industry, according to resource-based theory. There are two types of resources: tangible and intangible (Barney 1991). In this context, the phrases "resources" and "capabilities" are synonymous. Resources and capabilities are integrated and developed across a variety of functional areas, including distribution, human resources, marketing, production, and research and development (Peng 2001).

According to previous studies, large and complicated amounts of data may be leveraged to make sound strategic judgments and take effective action (Mikalef et al. 2019). Resource-based viewing methods analyse available resources thoroughly, distribute them correctly, and put them to cross-functional use (Mikalef et al. 2019).

Utilizing big data may benefit a variety of areas, including analysis of resources, customer relationship management, operational risk management, and the general efficiency and effectiveness of the organization. (Bertello et al. 2020). Numerous organizations have invested in developing skills that enable managers to utilize big data to gain new insights and simplify old processes. Although different organizational structures have been created to deal with large data, Bertello et al. (2020) employed resource-based theory and organizational learning as anchor viewpoints to connect the phenomena of big data to traditional strategic management.

2.2. Big Data Analytic Capabilities and Project Management Practice in Upstream Oil and Gas

The fuel and source of decision-making is digital transformation, and it is critical to handle complicated consumer expectations systematically. Consumer expectations are exceeded through collecting actionable data. In industry 4.0, big data technology and the environment are linked to extract hidden information and invent. Big data analysis for digital transformations causes disruptions, forcing companies to create value. Big data is now being used by both the private and public sectors to ensure customer understanding. Large volumes of customer data are now a competitive advantage for organizations. Using big data, businesses may better understand their customers' needs, exchange best practices, and keep up with new developments and innovations (Kim 2020).

Intelligent information management allows businesses to automate and optimize fundamental business activities while also extracting data to capture business insights and values. This point of view analyses current data management techniques in the oil and gas industry and compares them to the practices and philosophies of new enterprises leading big data efforts (Perrons & Jensen 2015).

According to (Behl 2020), the combination of the big data with the help of the digital transformation is considered to increase the performance of any projects in starting up phase (in which is in upstream industry for this case) because it can detect the problem and the deficiency of business model at the same time. Defects and issues found in oilfield service delivery can also provide insight into oilfield risk management. Using the data, a decision maker may make an educated choice on how to improve the quality performance, which can then be applied further upstream in the oil and gas value chain.

By examining the big data and organizational performance literatures, new and enhanced technological intervention has aided businesses in improving their performance and efficiency. Additionally, the literature shows a favourable and considerable influence of businesses' big data capabilities on their financial performance metrics and has aided inefficient stakeholder management (Behl 2020). With project operational skills, businesses may expand into new markets and achieve exceptional performance. Big data enables forecasting and stabilization of the environmental circumstances affecting SMEs (Mangla et al. 2020).

Project Success: Historically, project success was defined by conformance to cost, schedule, and scope objectives. Additional strategic elements such as influence on the client, project efficiency, business success, future preparation, and impact on the team were included in the definition of project success. Social and environmental elements of sustainability have been integrated in recent years. BDA helps assure the compliance, monitoring and tracking to conform with cost, schedule and scope (Mangla et al. 2020; Martinez Sanz et al. 2020).

As a result, oil and gas sectors have been slow to adopt digital applications and processes since the sector is still working out what to do with the massive amounts of data being generated (Perrons et al. 2015). Businesses must grasp the entire breadth of what is required to advance their digital transformation in order to be successful (Pandey 2020). It is not just about technology; it is also about upskilling people, altering work cultures, and recognizing areas where digital technologies may greatly improve operations' sustainability and efficiency.

With the advent of big data analytics, many operational units are experimenting with new policies and organizational structures to facilitate the use of Big Data tools and techniques across a range of domains, from subsurface exploration to well management to health and safety. As a result, a new breed of data scientists with experience in upstream oil and gas operations has emerged (Perrons et al. 2015). These are the critical components that will enable oilfield service companies to be more competitive, efficient, connected to suppliers, high awareness to environmental and health risks, as well as responsive to client needs, resulting in a more sustainable operations (Pandey 2020).

2.3. Project Sustainability Performance of Upstream Oil & Gas

For Oilfield Service Companies to withstand the market upheavals caused by the oil price fall and a shortage of resources during a pandemic, the first step the industry should do is to guarantee sustainability in upstream oilfield projects. Sustainable development is a set of activities that businesses focus on in order to contribute to a vision of society goals such as safety, environmental protection, social justice, and economic progress (Schendler 2021). These sustainability mission should be embedded in all of the planned, and executed projects by incorporating internal resources such as digitalization, in the forms of Big data analytics utilized to analyse resources, customer operational risk management, and the overall efficiency and performance of the business (Bertello et al. 2020), in this case projects in upstream oil and gas.

Data analytics and knowledge management are not just about technology implementation; they also involve upskilling people, changing work cultures and fostering collective learning as well as identifying areas where digital technologies can have a significant impact on the sustainability and efficiency of an organization's operations. (Pandey 2020). New policies and organizational structures needs to be considered to accommodate data scientists professionals in upstream oil and gas project to ensure sustainability in leveraging the wealth of data for strategic decision and risk management (Perrons et al. 2015).

Possessing big data analytic capabilities has a beneficial effect on the planning and control, operational, and risk management capabilities of project management teams (Bag et al. 2021; Kim 2020; Rialti et al. 2019; Sang et al. 2021; Yu et al. 2020) in the upstream oilfield sector. Secondly, Oilfield service firms must extensively adopt big data analytics in order to increase their chances of project success and long-term sustainability (Behl 2020; Ferraris et al. 2019; Rialti et al. 2020; Sang et al. 2021; Shabbir and Gardezi 2020) in the upstream oilfield sector.

3. Methods

This study focuses on upstream oil & gas project subcontracted to oilfield service providers, with unit of analysis of project management office (PMO) leader of upstream oilfield service contractors globally. A well-executed upstream oil & gas project will ensure sustainability; this sustainability are seen through lenses of environmental / health and safety, along with social responsibility such as philanthropic and social practices (Akter et al. 2016; Badiru 2013; Bag et al. 2021; Cavaleri et al. 2012; Chin et al. 2020; Dubey et al. 2019; Felsberger and Reiner 2020; Mangla et al. 2020). Big data analytic capability is thought to be enabler for PMO leader to be able to quantify risk of uncertainties of operations and environments in project situation to be able to take accurate mitigation or contingency plans.

From the analysis of previous research, the hypothetical model can be proposed with Big data analytic capability as independent variable, as the strategic advantage tool to integrate and analyser within oil & gas project ecosystem (Perrons and Jensen 2015). On the other hand, the dependent variable which is often referred to as the output variable, the criteria, the consequent, a variable that is influenced or becomes a result, because of the independent variable (Gravetter and Forzano 2012). Project management practices and Project sustainability performance are proposed as dependent variable as seen in Figure 2.

Figure 2. Proposed Research Model

4. Discussion and Conclusion

This conceptual paper presents a paradigm for evaluating whether the capacity to leverage Big Data in the upstream oil and gas sector has an effect on project management system practices, which would have an effect on project performance due to the high-risk profile of the upstream oil and gas business (Badiru 2013).

The suggested conceptual framework seeks to identify the components inside an organization's internal resources that, when coupled with digitalization, allow the efficient and effective execution of project management required for project success at a time of scarce resources. Bridging Institutional and Resource-Based Theories in the context of project management adoption as a tool for standardization (isomorphisms) but also enabling internal uniqueness for the organization to retain project success through flexible adoption

In a practical sense, this article lays out logical framework for organizations to implement digitalization to better suit their internal characteristics when executing projects and managing risks to gain a competitive edge, particularly in the upstream oil & gas projects. Additionally, this study gives information and feedback to regulators and standardization organizations on components of normative standards for project management body of knowledge (PMBOK) that have a significant impact on an organization's performance following a restructuring. It is believed that empirical research linked to project management practices needs to be conducted to make a difference in building a new perspective of big data analytics capabilities in the organizations that in turn may lead to better and longer project sustainability of the firm to deal with the environmental changes. It can be conducted by collecting primary data through a formal survey to the member of project management teams as respondents and followed by in-depth interviews. The new form of concept of big data analytics capabilities, project management practice, and project sustainability concerning the global environmental changes should be further explored and investigated.

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