



# Data Analytics for Effective Project Management in the Oil and Gas Industry

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**Abstract.** This study aims to highlight the effectiveness of data analytics in project management within the oil and gas sector. Data analytics have increasingly improved efficiency and effectiveness in most sectors by boosting decision-making accuracy through an intensive data-driven forecasting model. Despite the importance of data analytics in most industries, limited studies have evaluated its role within the oil and gas industry. The research applied the case study research method. Executives from a multinational oil and gas company with significant working experience were approached for the interview sessions. The thematic content analysis method was applied to sort the qualitative data and elucidate findings on the role of data analytics within the company. The insights gained from the case study of this major international oil and gas company led to recommendations for the sector in general. Finally, the study established that better returns were achieved when data-driven decisions were made compared to situations where big data were ignored.

**Keywords:** Data Analytics · Project Management · Oil and Gas · Big Data · Case Study

## 1 Introduction

The application of data analytics has revolutionized most industries by enabling more accurate data analysis to obtain vital information, hence ensuring better decision-making. Data analytics is the systematic analysis of data using statistical models to obtain insights on trends and information crucial for decision making. Analytics facilitates performance evaluation of projects and systems using internal and external datasets for benchmarking is crucial in improving production efficiency. Moreover, it boosts the accuracy of decision-making by facilitating fast scenario analysis, enabling managers to perform a cost-benefit analysis before making crucial decisions. This research article aims to establish the effectiveness of data analytics in the oil and gas industry project management. While enormous studies have been conducted on the application of data analytics in different industries, research on its application within the oil and gas industry has been limited [1].

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The oil and gas industry plays a significant role in the global economy as the world's main fuel sources. Oil demand is projected to continue to rise for the next 20 years. This perspective emphasizes the role of improving production chain efficiency through innovation to meet growing demand. Meanwhile, digital technology plays an important role in achieving higher value in the industry and Big Data analytics is one of the major elements of digital transformation in the oil and gas industry. It is predicted that the global market value of oil and gas with Big Data could reach 10.935 billion USD by 2026 [2].

Data analytics boosts forecasting accuracy and predictability, which is crucial in oil and gas projects that often require huge capital outlay, posing huge financial risks. While applying strictly historical data in forecasting enables projects to track how the project was attained in terms of capital restrictions and time management. The application of data analytics provides more value as project managers can accurately predict the outcomes before committing capital. This reduces the financial risks associated with a project and ensures that companies only choose the invest in projects which pose reasonable risks. Furthermore, the ability to accurately forecast outcomes ensures corrective actions that prevent delay or increased cost.

Moreover, accurate forecasting reduces uncertainty arising during a project, ensuring they have avoided the pose risks to the project. The application of data analytics and the use of big data also enables time-series analysis where trends are identified over time, enabling decisions to be made on the direction of the project. The applications of data analytics in time series analysis enable projects to be adjusted through the execution phase. Hence, data analytics improves the quality of decision-making by providing accurate information throughout a project life cycle.

While the oil and gas industry has lagged in applying technology to improve operations, the industry has lately metamorphosed into a data-intensive industry [1].

Data intensiveness has emerged due to the introduction of data recording sensors and their application in oil and gas search, drilling, and production. This has resulted in the growing importance of data analytics and Big Data in the industry. Data recorded by sensors are applied in real-time decision-making, which has improved efficiency in oil drilling and production management. Hence lowering costs of production, boosting productivity, and also improving profitability. Power et al. established that data analytics encompasses the extraction or mining of insights from data, applying big data, and analyzing it to get valuable information applicable in decision making [3]. Data analytics incorporates numerous tools, methods, and processes for the analysis and management of the data. It includes gathering raw data, classifying and organizing the data, storing it, and using statistical analysis methods to derive trends and resolve problems for faster and more accurate decision-making. Data analytics enables analysts to focus on a specific or particular set or population from a huge pool of data gathered [4].

Brancaccio establishes that oil and gas firms can leverage data analytics to mine increased volume of gas and oil from reservoirs, reduce their costs (operational and initial capital investment), and improve investment decision-making accuracy. Data analytics are also valuable in helping the oil and gas firm boost safety and health outcomes and decline the rigorousness and possibility of environmental hazards. Within the oil and gas industry, different levels of data analytics are applied. The most common levels

are descriptive, diagnostics, and predictive analytics. Descriptive analytics is applied in describing past phenomena using data. For instance, applying descriptive analytics enables a company to understand underlying factors behind reduced productivity, losses, or even better profitability. Conversely, diagnostic and predictive analytics are applied in understanding trends and making future forecasts by observing factors influencing productivity and making scenario analysis that indicates the cost of production or expected profitability when making either of many decisions that the management might include [5].

Despite the growing rate of data analytics application in the oil and gas industry, empirical research regarding the application, role, and impact of data analytics within the oil and gas industry is limited. In research to evaluate the impact of data analytics within the context of the Norwegian continental shelf, Vega-Gorgojo et al. recognized that even though research has been conducted to evaluate the role of data analytics within the supply chain management, manufacturing, healthcare, smart grids, and intrusion detection sectors, there were limited researches conducted within the oil and gas industry. This scarceness of empirical research on data analytics within the oil and gas industry forms an authentic gap that the study focused on [6].

Therefore, the research article aims to provide empirical data on the effectiveness of data analytics in project management in the oil and gas industry. To attain the above-mentioned objective, a qualitative case study research method was applied, an oil and gas company was used as the case study. The company is a major oil and gas company with operations across the globe; hence was a reasonable case study. Physical and online interviews were conducted with the company officials to gather data on how the company applied data analytics, its benefits, and its effectiveness in project management.

## 2 Literature Review

Alias et al. contended that project managers need to establish effective project scope management. Changes should be pre-assessed for the budget and agendas to be strictly scrutinized, facilitating the management of exceptional abnormalities [7]. Similarly, Radujković and Sjekavica maintain that project management relies on cultivating constant effective communications to appraise the stakeholders on the progress made in the project. Suppliers, customers, clients, the government, and local authorities require to access the contracts, progress reviews, and statements of work as poor communication has always been the cause of project failures [8]. Finally, Montenegro et al. argued that management support is an effective aspect of project management. The scholars argue that the agreement with the active and passive participants in a project is mandatory for success. Thus, ensuring that the management sees the value of the project in solving problems and adding value to the business is a necessity. The scholars posit that multiple projects could affect project quality, and thus, the management must agree on the best project for the firm [9].

On the other hand, big data is the datasets that are too large for processing by traditional data processing applications. It encompasses the three V's of big data (variety, volume, velocity) [10]. These include volume, which is the quantity of data to be analyzed. The second V is variety, which refers to the diversity of data sources and collection since big data arises from a wide variety of data. Furthermore, velocity refers to

the speed at which data flows from the networks, media, and business processes. Chen et al. postulated that big data gives companies the ability to make accurate decisions by offering business intelligence. Business intelligence engages big data by assorting tools, methodologies, and applications responsible for collecting the data. Business intelligence organizes the data analysis, runs examinations of its validity, creates reports, and visualizes the results in an easy-to-understand manner. Several scholars point out that big data improves business processes since the availability of the data provides actionable insights that can propel the business' decisions, market strategies, and revenue [11]. The scholars argue that big data allows business intelligence processes to ask crucial questions regarding the seasonal fluctuations noticed in the business.

Qin established that big data analysis goes through phases, ranging from data requirements and specifications to the final stage of communication, where the results of the data analysis are provided to the public. The first step of the data analytics process is the data requirement specifications. In this stage, the project manager establishes the requirements of the data analysts, the population, and the factors affecting the selected population. Successively, the data collection process follows, gathering information on the targeted variables as the data analysis requirements. At this stage, data is collected from various databases awaiting processing which is the third stage. Data cleaning follows the stage, and this stage prevents and corrects errors associated with incomplete processed and organized data. Subsequently, the data analysis stage is undertaken where processed, organized, and cleaned data is ready for analysis and various strategies such as data visualization, correlation, and regression analysis. Finally, the communication of the interpreted data is undertaken, keeping in mind the hypothesis set by the project managers [12].

Numerous studies have examined the correlations data analytics with data variables with regards to the project's performance to contradicting findings. Wamba et al. examined big data analytics and firm performance in the Chinese IT industry by conducting an online survey on its managers. The study finds that the entanglement and conceptualization of big data analytics directly impact the financial performance of firms by improving insights into the organization's decision-making processes [13]. Using a mixed-method approach, Mikalef et al. undertook a similar examination to understand the impact of big data analytics on Greek firms' financial performance using 175 observations. The scholars posit that the gains in terms of financial performance differed in the case studies used to establish the findings. The scholars note that three out of four case studies showed higher financial performance using big data analytics. At the same time, a few registered stagnating financial performance regardless of the model adopted. The minority forms underperforming are argued to revolve around the technological challenges in adopting and effectively implementing the models [14]. On the other hand, Ortiz et al. agree with the scholars citing that the demonstration of algorithms using the PerfEnforce analytics services depicts that it is beneficial to the organizations used as case studies as it reinforces the parameters, workloads, and performance thresholds in different settings [15].

### 3 Methodology

This section discusses the methods and procedures used in the study. The study was designed to investigate and illustrate the advantages of incorporating data analytics in project management in the oil and gas industry via the case study of a major multinational company.

#### 3.1 Case Study Protocol

The research applied several data sources and data collection techniques, including interviews, questionnaires, observations, as well as secondary data from analyzing reliable and relevant documents within the oil and gas industry. The research reached out to employees in different departments. If some could not partake in the interviews, the researcher formulated a questionnaire comprising similar questions as in the interviews to ensure consistency and enable the respondents to respond at their convenience rather than attend the physical or online interview. Additionally, observations of the participants undertaking their project management roles were done as the researcher had access to this. To provide focus, the case study participants were kept to those involved with a particular North Sea project and covered upstream, midstream as well as downstream sections of the company. Specifically, the upstream processes include mining of oil and gas from the ground. Midstream involves the collection and transportation of raw resources via pipeline, storing, processing, and marketing. Finally, downstream operations are the conversion of oil and gas into finished products for various markets.

The respondents were selected based on having experience in completing a project in the company. Furthermore, all respondents had over two years of experience on an oil and gas project thus had a proven ability to evaluate the efficiency of data analytics and the application of big data in such projects. The semi-structured interviews were designed to gauge the effectiveness of data analytics and were guided by the following main questions from which follow-up questions were asked based on the answers to ensure clarity as well as good insights; 1) How is big data analytics used to manage the project specifically, and projects within the oil and gas industry in general? 2) What are the benefits associated with the use of big data analytics for managing the project and for project management in the oil and gas industry broadly? 3) How has the use of data analytics affected project management effectiveness?

#### 3.2 Analysis Strategy

The research was conducted in the form of an explanation-building case study analysis of an oil and gas company. Explanation building data analysis for the research was established based on previous similarities [16]. The research sought to provide an adequate and acceptable justification of the research questions. The analyses were presented in a narrative form explaining the causal connection between the data analytics policies adopted by the organization with the social science theories answering the 'what', 'how', and 'why' questions.

## 4 Findings and Discussions

The findings are presented below according to the major departments in the firm.

### 4.1 Exploration and Production Department

According to one interviewee, a drilling engineer responsible for undertaking the ANS project, the integration and application of data analytics in the oil and gas industry have been successful due to the tools' ability to handle challenging tasks faced by drilling engineers across the globe with much ease and at a faster rate. By 2021, most tasks and projects handled using traditional techniques were replaced by faster and more reliable modern techniques powered by data analytics tools that have eased the engineering processes and other challenges that emerge through the oil and gas production process. Information provided on company websites bears out respondents' claims of the increased usage of data analytics tools to improve the efficiency of the engineering department. Another engineer in the department shared that data analytics has been reliable in evaluating project risks especially when drilling deep inside the earth's crust. Specifically, when monitoring oil reservoirs, they noted that the data analytics models adopted fewer iterative resources and reduced human bias. Furthermore, the respondent identified that adopting the data learning in the form of Machine Learning, provided them with prediction models that can accurately pinpoint the drilling location faster. Exploration often use huge resources, and several oil rigs have been left unproductive after drilling without recouping the costs resulting in poor project results. Thereby, the respondents agreed that data analytics improved conversion and exploration pace significantly.

### 4.2 Gas and Power Department

The second department interviewed was the Gas and Power Department. The department invested \$5 million into the development of geospatial analytics capabilities using machine learning and spectral imagery to monitor the environment. Furthermore, they sought to deploy complementary methane detecting system to identify methane emissions and environmental changes resulting from hydrocarbon mining. The company seeks to be a zero-emission firm. Thus, it continues to work with scientists and technologists to produce innovative solutions for effective and efficient processes. For the ANS project specifically, analytics used in production of renewable energy sources were applied to determine cheaper energy sources for the extraction process out in the oil fields. Challenges such as water inflow have been avoided in the long run by the management through the combination of fibre optic data with hybrid analytics. Ultimately, it has enhanced the production of the fields significantly. Other applications include the analysis of seismic and micro-seismic data, reservoir simulation and characterization, optimization of the drill time, while ensuring drilling safety.

### 4.3 Marketing Department

The consensus amongst the marketing team is that the department's application of data analytics has improved decision-making specifically and performance in general. Specifically, the perception was that there had been a mark increase in data accuracy that enable better decisions. More importantly for the department, data analytics has improved customer experience because of the reliable information. One interviewee shared; the industry is characterised by price volatility due to vast accumulation of the reserves, high production rate, and producers price wars. Thus, data analytics enable for better monitoring and forecasting that ensure sustainable market performance. Relating to the ANS Project, the department head reported that they have jointly developed a Plants Operation Advisory system. The system work across 1200 critical mission equipment pieces and analyse 155 million entries per day. The subject notes that this benefited them in the project scheduling and management tasks.

### 4.4 Project Entity Management Department

The final department engaged was the Project Entity Management Department. According to one of the managers, they had been increasingly adopting data analytics to improve their performance. Specifically, in the last five years, the respondent noted that there had been an increase in the application of data analytics to ensure data-driven decisions, limiting the level of risks, and ensuring financial efficiency in projects within the company. The team attributed early realisation of the reliability of data analytics for the wide integration of the technology in the department's processes. One of the key benefits that they identified was the significant improvement in the collaborations amongst project stakeholders. Another was in project communications whereby accurate real-time updates and forecasts on the projects' operations had improved. Furthermore, project managers are now better able to stay up to date and suggest faster changes to derailed processes and minimise risks to their project's success.

### 4.5 Discussions

The research findings postulate that data analytics are applied across all aspects of projects in the oil and gas sector. This finding concurs with the available empirical evidence on the application of data analytics in the oil and gas industry [17]. These findings also coincide with Cowles who highlighted that the upstream, midstream, and downstream sections of oil and gas production cover the entire process from oil exploration to transportation to the market, and they all depend on sound decisions based on strategic data analytics from the analysis of big data [18].

This study further established that data analytics and big data are useful in resource allocations, ensuring optimal productivity and profitability. In the production process, data analytics automates decline analysis and maximizes the performance of the electric submersible pumps and pump wells to ensure that it enhances hydraulic fracturing for shale projects. The findings align with Yuan et al. who postulated that Big Data is being used to detect faults in catalytic cracking units. It highlights that the models benefit the organization to establish better management mechanisms and enabling a quality

production facility that monitors environmental conditions within the upstream segment [19].

The findings presented that data analytics ensures the firm uses fewer resources while delivering more, as evident in this paper in the company's case. Moreover, the study established that data analytics provides integrated views and improves information management to deal with information explosion throughout the upstream processes. These echoes Hamzeh's findings that productivity improvements were noted with the adoption of data analytical tools by companies within the industry [17]. The application of data analytics also improves the production efficiency. The study presents that companies would benefit by adopting data analytics mechanisms in their exploration processes. The findings agree with those of Brun and Trench, which establishes that a typical production platform attains over 77% production efficiency [20].

The findings align with Hassani and Silva, which argues that the successful exploitation of Big Data enables firms in the oil and gas industry to benefit from fresh insights, improved business value, enhanced profitability, and lasting competitive advantages [21]. The scholars argue that big data is used to smarten the drilling platforms and pipeline infrastructure to prevent failures and anticipate issues that derail the project.

## 5 Conclusions

The primary objective of the research was to investigate the effectiveness of data analytics for project management in the oil and gas industry. The study interviewed teams in various departments from Exploration and Production; Gas and Power; Marketing; and Project Entity Management departments. The data were applied to establish the role of big data analytics in ensuring effective and efficient project management within oil and gas industry. The research established that data analytics plays a huge role in oil and gas project management. Furthermore, data analysis presents significant benefits by improving the efficiency of operations in the industry. Data analytics benefits companies by expanding production efficiency, lowering production costs, and ensuring fast and accurate forecasting and decision making. Finally, the study established that better returns were achieved when data-driven decisions were made possible via data analytics and big data technologies.

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