International Journal of Management and Organizational Research

The Evolution and Impact of Cloud Computing on Real-Time Data Analysis in Oil and Gas Operational Efficiency

Joshua Idowu Akerele [1*], Anuoluwapo Collins [2], Chisom Elizabeth Alozie [3], Olumese Anthony Abieba [4], Olanrewaju Oluwaseun Ajayi [5]
[1] Independent Researcher, Nigeria
[2, 5] University of the Cumberlands, United States
[3] Cognizant Technology Solutions, Canada
[4] Abeam Consulting USA

* Corresponding Author: **Joshua Idowu Akerele**

Article Info

ISSN (online): 2583-6641
Volume: 03
Issue: 01
January-February 2024
Received: 15-01-2024
Accepted: 19-02-2024
Page No: 83-89

Abstract
In recent years, the oil and gas industry has witnessed a significant transformation fueled by the adoption of cloud computing technologies, revolutionizing the way real-time data analysis is conducted to enhance operational efficiency. This review delves into the evolution and profound impact of cloud computing on real-time data analysis within the oil and gas sector. The evolution of cloud computing in the oil and gas industry has been marked by a shift from traditional on-premises data management systems to cloud-based platforms. This transition has enabled companies to overcome the limitations of on-site infrastructure, offering scalability, flexibility, and cost-effectiveness. Cloud platforms provide the necessary computational power to handle vast amounts of real-time data generated from various sources such as sensors, IoT devices, and drilling equipment. Real-time data analysis plays a pivotal role in optimizing operational efficiency in the oil and gas sector. By harnessing cloud-based analytics tools, companies can extract actionable insights from data streams instantaneously. These insights empower decision-makers to detect anomalies, predict equipment failures, optimize production processes, and mitigate risks in real-time, leading to improved operational performance and reduced downtime. Furthermore, the integration of artificial intelligence (AI) and machine learning (ML) algorithms into cloud-based data analysis platforms has augmented the capabilities of predictive analytics in the oil and gas industry. These advanced analytics techniques enable predictive maintenance, reservoir optimization, and demand forecasting, allowing companies to streamline operations and maximize resource utilization. The impact of cloud computing on real-time data analysis extends beyond operational efficiency to encompass broader industry trends such as digital transformation, remote monitoring, and collaboration. Cloud-based solutions facilitate remote access to data and analytics tools, enabling geographically dispersed teams to collaborate seamlessly and make informed decisions in real-time. The evolution of cloud computing has revolutionized real-time data analysis in the oil and gas industry, offering unprecedented opportunities to enhance operational efficiency, optimize resource utilization, and drive innovation. Embracing cloud-based analytics platforms is crucial for oil and gas companies seeking to thrive in an increasingly competitive and dynamic market landscape.

DOI: https://doi.org/10.54660/IJMOR.2024.3.1.83-89

Keywords: Cloud Computing; Data Analysis; Oil and Gas; Operational Efficiency; Review

1. Introduction

The oil and gas industry stands as one of the pillars of the global economy, providing vital energy resources that power industries and economies worldwide (Strauss, 2012; Ghasemian,, *et al*., 2020). With its complex and dynamic operations spanning exploration, production, refining, and distribution, the sector relies heavily on cutting-edge technologies to ensure operational

efficiency and maximize resource utilization.

In recent years, the emergence of cloud computing has revolutionized the way industries manage and analyze data, offering unprecedented scalability, flexibility, and cost-effectiveness. Cloud computing, characterized by the delivery of computing services over the internet, has rapidly gained traction across various sectors, including oil and gas (Katal, *et al*., 2023).

Cloud computing's relevance in real-time data analysis cannot be overstated. In the oil and gas industry, where vast amounts of data are generated continuously from sensors, Internet of Things (IoT) devices, and drilling equipment, the ability to analyze and derive actionable insights from this data in real-time is paramount. Cloud-based platforms provide the computational power and storage capabilities necessary to process and analyze this data instantaneously, enabling companies to make informed decisions swiftly and effectively (Perrons, and Hems, 2013; Al-Mascati, and Al-Badi, 2016; Zhifeng, *et al*., 2019).

This paper explores the evolution and profound impact of cloud computing on operational efficiency within the oil and gas sector. By examining the adoption of cloud computing technologies and their implications for real-time data analysis, it aims to shed light on how cloud computing has transformed the industry's operational landscape. Through an analysis of the benefits, challenges, and future prospects, this paper elucidates the pivotal role of cloud computing in enhancing operational efficiency and driving innovation in the oil and gas sector.

2.1. Evolution of cloud computing in the oil and gas industry

Cloud computing has emerged as a transformative force in the oil and gas industry, reshaping the way data is managed, analyzed, and utilized to drive operational efficiency (Haouel, and Nemeslaki, 2024; Georgiou, *et al*., 2021). This section delves into the evolution of cloud computing within the industry, tracing the transition from traditional on-premises data management systems to cloud-based platforms, elucidating the factors driving the adoption of cloud computing, and providing an overview of the technologies utilized in oil and gas operations. Historically, the oil and gas industry has relied on on-premises data centers to store and analyze vast amounts of operational data. These legacy systems often posed challenges in terms of scalability, flexibility, and cost-effectiveness. As the volume of data generated by exploration, production, and refining activities continued to soar, companies sought alternative solutions to address these limitations.

The advent of cloud computing offered a compelling alternative. By leveraging cloud-based platforms provided by leading vendors such as Amazon Web Services (AWS), Microsoft Azure, and Google Cloud Platform (GCP), oil and gas companies could offload the burden of infrastructure management and gain access to scalable computing resources on-demand (Boneder, 2023; Srinivasan, *et al*., 2018; Yevge, *et al*., 2022). This transition enabled organizations to deploy advanced analytics tools, process real-time data streams, and derive actionable insights more efficiently, thereby enhancing operational agility and competitiveness.

Several factors have fueled the rapid adoption of cloud computing within the oil and gas sector. Cloud computing platforms offer virtually unlimited scalability, allowing companies to accommodate fluctuations in data volume and processing requirements without significant upfront investment in infrastructure (Attaran, and Woods, 2018). By shifting from capital-intensive on-premises infrastructure to a pay-as-you-go model, organizations can reduce operational expenses and optimize resource utilization. Cloud-based environments facilitate seamless integration of disparate data sources, enabling cross-functional collaboration and knowledge sharing across geographically dispersed teams. Leading cloud providers implement robust security measures and compliance frameworks to safeguard sensitive data and ensure regulatory compliance, thereby mitigating risks associated with data breaches and non-compliance. Cloud computing enables rapid prototyping and experimentation, empowering organizations to explore innovative solutions, iterate quickly, and respond effectively to evolving market dynamics and technological advancements (Hilley, 2009; Islam, and Reza, 2019).

In oil and gas operations, cloud computing technologies are deployed across various domains to streamline processes, optimize workflows, and enhance decision-making. Some of the key technologies utilized include; Infrastructure as a Service (IaaS) providers offer virtualized computing resources, storage, and networking capabilities on-demand, enabling companies to deploy and manage applications without the need for physical hardware (Manvi, and Shyam, 2014; Goyal, 2013; Okoye *et al*., 2024; Mahmood, 2011). Platform as a Service (PaaS) offerings provide development and deployment environments for building, testing, and deploying applications, allowing organizations to focus on application development and innovation without worrying about underlying infrastructure management (Yasrab, 2018; Ahmad *et al*., 2024; Kolb, 2019). Cloud-based analytics platforms enable organizations to analyze vast datasets, derive actionable insights, and visualize key performance indicators (KPIs) through interactive dashboards and reports, facilitating data-driven decision-making and strategic planning. Cloud providers offer managed services for machine learning (ML) and artificial intelligence (AI), allowing organizations to build and deploy ML models for predictive maintenance, anomaly detection, and optimization of drilling operations, among other applications. Cloud computing enables seamless integration of data generated by IoT devices and sensors deployed across oil fields, refineries, and pipelines, enabling real-time monitoring, predictive maintenance, and remote asset management (Wanasinghe, *et al*., 2020; Mqadi, 2020; Okoye *et al*., 2024).

In summary, the evolution of cloud computing has revolutionized the oil and gas industry, enabling companies to overcome traditional barriers to innovation and achieve new levels of operational efficiency, agility, and competitiveness. By embracing cloud-based platforms and technologies, organizations can unlock the full potential of their data assets, drive digital transformation, and chart a course toward sustainable growth and success.

2.2. Real-Time data analysis in oil and gas operations

Real-time data analysis is crucial for optimizing operational efficiency and ensuring safe and reliable operations in the oil and gas industry. This section explores the importance of real-time data analysis, identifies key sources of real-time data, and highlights the challenges associated with traditional data analysis methods (Nguyen, *et al*., 2020; Wanasinghe, *et al*., 2020; Ajala, 2024).

In the oil and gas sector, where operations are characterized

by high-risk environments, complex processes, and stringent regulatory requirements, timely access to accurate data is paramount. Real-time data analysis enables organizations to monitor critical parameters, detect anomalies, and respond swiftly to emerging issues, thereby minimizing downtime, optimizing resource utilization, and enhancing operational efficiency (Sadlier, 2019; Akindejoye and Ilugbusi, 2019). By leveraging advanced analytics techniques such as predictive modeling, machine learning, and artificial intelligence, companies can anticipate equipment failures, optimize production processes, and mitigate operational risks in real-time. Moreover, real-time data analysis empowers decision-makers to identify opportunities for process improvements, drive continuous optimization, and maximize return on investment (ROI) across the value chain (Bertocco, and Padmanabhan, 2014; Abou-Sayed, 2012; Abou-Sayed, 2012).

Oil and gas operations generate vast amounts of data from diverse sources. Sensors deployed across drilling rigs, production facilities, and pipelines capture real-time data on temperature, pressure, flow rates, and other operational parameters, providing insights into equipment performance and process conditions. Sophisticated drilling equipment equipped with sensors and telemetry systems generate real-time data on drilling parameters, formation characteristics, and wellbore conditions, enabling operators to optimize drilling efficiency and minimize drilling risks (Bertocco, and Padmanabhan, 2014; Epelle, and Gerogiorgis, 2020). Production systems such as SCADA (Supervisory Control and Data Acquisition) systems and DCS (Distributed Control Systems) collect real-time data on production rates, fluid properties, and equipment status, enabling operators to monitor production performance and troubleshoot issues proactively. Environmental monitoring systems capture real-time data on air quality, water quality, and emissions levels, helping operators comply with regulatory requirements and minimize environmental impact (Ruysschaert, 2021).

Traditional data analysis methods in the oil and gas industry often suffer from several limitations; Data is often fragmented across disparate systems and departments, making it difficult to integrate and analyze holistically. Batch processing of data introduces delays in analysis and decision-making, limiting the ability to respond to rapidly changing conditions in real-time. The sheer volume and complexity of data generated by oil and gas operations pose challenges in terms of storage, processing, and analysis, requiring scalable and efficient solutions. Traditional analytics tools lack predictive capabilities, making it difficult to anticipate equipment failures, optimize production processes, and mitigate operational risks proactively (Saputelli, *et al*., 2003; Ismail *et al*., 2022).

Given these challenges, there is a growing need for real-time data analysis solutions that can ingest, process, and analyze data streams in real-time, enabling organizations to derive actionable insights and make informed decisions promptly. By embracing advanced analytics technologies and leveraging cloud computing platforms, oil and gas companies can unlock the full potential of their real-time data assets, drive operational excellence, and achieve sustainable growth in today's competitive market landscape.

2.3. Impact of cloud computing on real-time data analysis

Cloud computing has revolutionized real-time data analysis in the oil and gas industry, offering unprecedented scalability, flexibility, and computational power. This section examines the impact of cloud computing on real-time data analysis, highlighting its scalability and flexibility, cost-effectiveness, and enhanced computational power.

One of the key advantages of cloud computing is its inherent scalability and flexibility (Mahmood, 2011). Cloud-based platforms enable oil and gas companies to scale computing resources up or down based on fluctuating demand, without the need for significant upfront investment in infrastructure. This elasticity allows organizations to accommodate spikes in data volume and processing requirements during peak operational periods, such as drilling campaigns or production surges, without experiencing performance degradation or downtime (Guo, *et al*., 2019; Gundu, *et al*., 2020).

Moreover, cloud computing platforms offer a wide range of services and deployment models, including Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS), tailored to meet the specific needs and preferences of oil and gas operators. Whether deploying real-time data analytics applications, building custom machine learning models, or leveraging pre-built AI solutions, companies can choose the most suitable cloud services and configurations to optimize performance, scalability, and cost-efficiency (Stavrinides, and Karatza, 2017; Humayun, 2020).

Cloud computing offers significant cost advantages over traditional on-premises infrastructure. By shifting from capital-intensive on-premises data centers to a pay-as-you-go model, organizations can reduce upfront capital expenditure, eliminate the need for hardware procurement and maintenance, and minimize operational overhead associated with infrastructure management.

Furthermore, cloud computing platforms operate on a consumption-based pricing model, wherein organizations only pay for the computing resources and services they utilize, enabling cost optimization and resource efficiency. This flexibility allows oil and gas companies to align IT spending with business objectives, scale resources in line with operational requirements, and maximize return on investment (ROI) across the data analytics lifecycle (Ke, *et al*. 2017).

The exponential growth of data generated by oil and gas operations necessitates robust computational capabilities for processing, analyzing, and deriving actionable insights from real-time data streams. Cloud computing platforms provide the computational power and storage scalability required to handle vast amounts of data in real-time, enabling organizations to perform complex analytics tasks efficiently and effectively.

Through distributed computing architectures, parallel processing techniques, and high-performance computing (HPC) clusters, cloud-based platforms can process massive datasets at scale, enabling oil and gas companies to extract valuable insights, detect anomalies, and predict future trends with unprecedented speed and accuracy. This enhanced computational power empowers organizations to leverage advanced analytics techniques, such as machine learning, artificial intelligence, and predictive modeling, to optimize operations, enhance decision-making, and drive continuous improvement in operational efficiency (Fenu, and Surcis, 2009).

In summary, the impact of cloud computing on real-time data analysis in the oil and gas industry is profound and far-reaching. By offering scalability, flexibility, cost-effectiveness, and enhanced computational power, cloud-

based platforms enable organizations to unlock the full potential of their data assets, derive actionable insights, and drive innovation in today's dynamic and competitive market landscape.

2.4. Advanced analytics techniques in cloud-based platforms

Cloud-based platforms have democratized access to advanced analytics techniques, enabling oil and gas companies to harness the power of artificial intelligence (AI) and machine learning (ML) algorithms to drive operational excellence and optimize performance (Gupta, *et al*, 2022; Øverdal, 2022). This section explores the integration of AI and ML in cloud-based platforms, examines applications of predictive analytics in oil and gas operations, and highlights the benefits of advanced analytics in improving operational efficiency and reducing downtime.

Cloud computing platforms provide a fertile ground for integrating AI and ML algorithms into real-time data analysis workflows (Teng, *et al*., 2023). By leveraging managed services and libraries offered by cloud providers, organizations can develop, train, and deploy ML models to analyze vast amounts of data, identify patterns, and make predictions in real-time. One of the key advantages of cloud-based ML services is their ease of use and scalability. Cloud providers offer a wide range of ML tools, frameworks, and algorithms that can be accessed via APIs or integrated into custom applications, allowing organizations to leverage pre-built models and accelerate time-to-insight. Moreover, cloud-based ML platforms provide auto-scaling capabilities, enabling organizations to dynamically allocate computational resources based on workload requirements, thereby optimizing performance and cost-efficiency (Abou-Elmaaty, and Ibrahim, 2023).

Predictive analytics holds immense potential for optimizing various aspects of oil and gas operations, including predictive maintenance, reservoir optimization, and demand forecasting. By analyzing historical data, identifying trends, and extrapolating future outcomes, organizations can anticipate equipment failures, optimize production processes, and proactively mitigate operational risks. By analyzing sensor data, equipment telemetry, and maintenance records, organizations can develop predictive maintenance models to identify equipment degradation, schedule maintenance activities, and minimize unplanned downtime (Zonta, *et al*., 2022; Molęda, *et al*., 2023). Cloud-based predictive maintenance solutions leverage AI and ML algorithms to detect anomalies, predict failure probabilities, and recommend maintenance actions in real-time, thereby maximizing asset uptime and reducing maintenance costs. In reservoir engineering, predictive analytics enables organizations to optimize production strategies, enhance hydrocarbon recovery, and maximize reservoir performance. By integrating geological, geophysical, and production data, organizations can build reservoir simulation models to forecast production rates, evaluate reservoir behavior, and optimize well placement and production techniques. In downstream operations, predictive analytics helps organizations forecast product demand, optimize inventory levels, and streamline supply chain logistics. By analyzing historical sales data, market trends, and external factors such as weather patterns and geopolitical events, organizations can develop demand forecasting models to anticipate customer demand, optimize production schedules, and minimize stockouts and excess inventory (Maktoubian, *et al*., 2023).

The adoption of advanced analytics techniques in cloud-based platforms offers several benefits for improving operational efficiency and reducing downtime in the oil and gas industry; Predictive maintenance models enable organizations to detect equipment failures before they occur, schedule maintenance activities proactively, and minimize unplanned downtime, thereby maximizing asset uptime and reducing maintenance costs. Reservoir optimization models help organizations optimize production strategies, enhance hydrocarbon recovery, and maximize reservoir performance, leading to increased production rates, improved asset utilization, and enhanced profitability. Predictive analytics provides decision-makers with actionable insights and foresight into future trends, enabling them to make data-driven decisions, mitigate operational risks, and capitalize on emerging opportunities in real-time (Hamza, 2023; Ahmed, and Ali, 2023). By optimizing production processes, minimizing downtime, and reducing maintenance costs, advanced analytics helps organizations achieve cost savings, improve capital efficiency, and enhance overall profitability (Bayrak, 2015).

In summary, the integration of advanced analytics techniques in cloud-based platforms represents a paradigm shift in the oil and gas industry, enabling organizations to unlock the full potential of their data assets, drive operational excellence, and achieve sustainable growth in today's digital age. By leveraging AI, ML, and predictive analytics, organizations can optimize operations, enhance decision-making, and stay ahead of the competition in an increasingly dynamic and competitive market landscape.

2.5. Broader Industry Trends Enabled by Cloud Computing

Cloud computing has catalyzed broader industry trends within the oil and gas sector, transforming traditional workflows, enabling remote monitoring and collaboration, and fostering innovation and competitive advantage. This section explores these trends in detail.

Cloud computing lies at the heart of digital transformation initiatives within the oil and gas industry. By migrating critical IT infrastructure and applications to the cloud, companies can modernize legacy systems, streamline operations, and accelerate innovation. Cloud-based platforms provide the foundation for deploying advanced analytics, IoT devices, and digital twins, enabling organizations to optimize asset performance, enhance operational efficiency, and drive sustainable growth. Moreover, cloud computing facilitates the integration of disparate data sources and systems, breaking down data silos and enabling holistic data-driven decision-making across the enterprise. By leveraging cloud-based analytics tools and platforms, organizations can gain actionable insights into production processes, reservoir performance, and supply chain logistics, enabling them to adapt quickly to market dynamics and capitalize on emerging opportunities (Dempsey, and Kelliher, 2018; Faynberg, *et al*., 2016).

Cloud computing enables remote monitoring and collaboration capabilities that transcend geographical boundaries and facilitate seamless communication and collaboration among distributed teams. By leveraging cloud-based solutions for real-time data analysis, organizations can monitor equipment performance, track production metrics, and collaborate on projects remotely, enabling

geographically dispersed teams to work together effectively and make informed decisions in real-time.

Furthermore, cloud-based collaboration tools such as document management systems, video conferencing platforms, and project management software empower teams to collaborate on projects, share knowledge, and drive innovation irrespective of physical location. This level of connectivity and collaboration fosters a culture of innovation, agility, and continuous improvement within the organization, enabling companies to stay ahead of the competition and capitalize on emerging opportunities.

Cloud computing presents numerous opportunities for innovation and competitive advantage within the oil and gas industry. By leveraging cloud-based platforms and services, organizations can experiment with emerging technologies such as AI, ML, IoT, and blockchain, exploring new use cases and business models that drive operational excellence and differentiate them from competitors. Moreover, cloud computing enables rapid prototyping, experimentation, and iteration, empowering organizations to develop and deploy innovative solutions quickly and cost-effectively. Whether optimizing drilling operations, enhancing reservoir management, or improving supply chain logistics, cloud-based innovation enables organizations to deliver value to customers, reduce costs, and drive sustainable growth in a rapidly evolving market landscape (Buyya, *et al*., 201).

2.6. Future Direction

The future direction of cloud computing in the oil and gas industry is poised for continued growth and innovation. As technology evolves and market dynamics shift, organizations will increasingly rely on cloud-based platforms and solutions to drive digital transformation, enhance operational efficiency, and capitalize on emerging opportunities (Varghese, and Buyya, 2018).

Key areas of focus for the future direction of cloud computing in the oil and gas industry include; Continued integration of emerging technologies such as AI, ML, IoT, and blockchain into cloud-based platforms to unlock new use cases and drive innovation across the value chain.

Strengthening of security measures and compliance frameworks to safeguard sensitive data and ensure regulatory compliance in cloud-based environments, addressing concerns related to data privacy, cybersecurity, and regulatory requirements. Continued optimization of cloud-based infrastructure and services to improve scalability, performance, and reliability, enabling organizations to handle increasing volumes of data and meet growing demand for real-time analytics. Collaboration among industry stakeholders, cloud providers, and regulatory bodies to develop industry standards, best practices, and guidelines for cloud adoption and data management in the oil and gas sector, fostering interoperability, transparency, and trust. Integration of sustainability principles and environmental considerations into cloud computing strategies and initiatives, enabling organizations to reduce carbon footprint, minimize environmental impact, and promote responsible resource management.

2.7. Recommendation and Conclusion

Throughout this paper, we have explored the evolution and impact of cloud computing on real-time data analysis in the oil and gas industry. We have discussed the transition from on-premises data management systems to cloud-based platforms, the importance of real-time data analysis, the integration of advanced analytics techniques in cloud-based platforms, and broader industry trends enabled by cloud computing.

Embracing cloud computing is essential for oil and gas companies seeking to enhance operational efficiency, drive innovation, and maintain competitiveness in today's dynamic market landscape. Cloud-based platforms offer scalability, flexibility, and computational power required to handle vast amounts of real-time data, enabling organizations to derive actionable insights, optimize operations, and achieve sustainable growth (Buyya, *et al*., 2018). Looking ahead, cloud computing will continue to play a pivotal role in shaping the future of the oil and gas industry. As technology evolves and market dynamics shift, organizations must remain agile, innovative, and forward-thinking, leveraging cloud-based platforms and solutions to drive digital transformation, enhance operational efficiency, and capitalize on emerging opportunities. By embracing cloud computing and embracing a culture of innovation and collaboration, oil and gas companies can navigate challenges, unlock new possibilities, and chart a course toward a more sustainable and prosperous future.

3. References

1. Abou Elmaaty NHH, Ibrahim HEA. Integrating artificial intelligence and cloud computing in eCommerce operational and customer-centric advancements. AI, IoT and the Fourth Industrial Revolution Review. 2023;13(9):18-28.
2. Abou-Sayed A. Data mining applications in the oil and gas industry. J Pet Technol. 2012;64(10):88-95.
3. Ahmad IAI, Anyanwu AC, Onwusinkwue S, Dawodu SO, Akagha OV, Ejairu E. Cybersecurity challenges in smart cities: a case review of African metropolises. Comput Sci IT Res J. 2024;5(2):254-69.
4. Ahmed F, Ali H. Big data analytics for business intelligence: current trends and future prospects. J Technol Inf Manag Eng Sci. 2023;1(1):10-18.
5. Ajala OA. Leveraging AI/ML for anomaly detection, threat prediction, and automated response. [Unpublished work]. 2024.
6. Akindejoye JA, Ilugbusi SB. Compliance of selected firms listed on Nigeria Stock Exchange with requirements of International Accounting Standard 16. Niger Stud Econ Manag Sci. 2019;2(2):1-10.
7. Al-Mascati H, Al-Badi AH. Critical success factors affecting the adoption of cloud computing in oil and gas industry in Oman. Proc 2016 3rd MEC Int Conf Big Data Smart City (ICBDSC). 2016 Mar;1-7.
8. Attaran M, Woods J. Cloud computing technology: a viable option for small and medium-sized businesses. J Strateg Innov Sustain. 2018;13(2).
9. Bayrak T. A review of business analytics: a business enabler or another passing fad. Procedia Soc Behav Sci. 2015;195:230-9.
10. Bertocco R, Padmanabhan V. Big data analytics in oil and gas. Bain Brief. 2014 Mar.
11. Boneder S. Evaluation and comparison of the security offerings of the big three cloud service providers Amazon Web Services, Microsoft Azure and Google Cloud Platform [dissertation]. Ingolstadt: Technische Hochschule Ingolstadt; 2023.
12. Buyya R, Srirama SN, Casale G, Calheiros R, Simmhan

Y, Varghese B, *et al*. A manifesto for future generation cloud computing: research directions for the next decade. ACM Comput Surv (CSUR). 2018;51(5):1-38.
13. Dempsey D, Kelliher F. Industry trends in cloud computing. Pallgrave Macmillan. New York; 2018.
14. Epelle EI, Gerogiorgis DI. A review of technological advances and open challenges for oil and gas drilling systems engineering. AIChE J. 2020;66(4):e16842.
15. Faynberg I, Lu HL, Skuler D. Cloud computing: business trends and technologies. London: John Wiley & Sons; 2016.
16. Fenu G, Surcis S. A cloud computing based real-time financial system. Proc 2009 8th Int Conf Networks. 2009 Mar;374-9.
17. Georgiou K, Mittas N, Mamalikidis I, Mitropoulos A, Angelis L. Analyzing the roles and competence demand for digitalization in the oil and gas 4.0 era. IEEE Access. 2021;9:151306-26.
18. Ghasemian S, Faridzad A, Abbaszadeh P, Taklif A, Ghasemi A, Hafezi R. An overview of global energy scenarios by 2040: identifying the driving forces using cross-impact analysis method. Int J Environ Sci Technol. 2020;1-24.
19. Goyal S. Software as a service, platform as a service, infrastructure as a service: a review. Int J Comput Sci Netw Solut. 2013;1(3):53-67.
20. Gundu SR, Panem CA, Thimmapuram A. Real-time cloud-based load balance algorithms and an analysis. SN Comput Sci. 2020;1:1-9.
21. Guo Y, Mohamed I, Abou-Sayed O, Abou-Sayed A. Cloud computing and web application-based remote real-time monitoring and data analysis: slurry injection case study, Onshore USA. J Pet Explor Prod Technol. 2019;9(2):1225-35.
22. Gupta S, Modgil S, Kumar A, Sivarajah U, Irani Z. Artificial intelligence and cloud-based collaborative platforms for managing disaster, extreme weather and emergency operations. Int J Prod Econ. 2022;254:108642.
23. Hamza A. Predictive analytics: unraveling the future with data-driven decision making. J Environ Sci Technol. 2023;2(1):118-27.
24. Haouel C, Nemeslaki A. Digital transformation in oil and gas industry: opportunities and challenges. Period Polytech Soc Manag Sci. 2024;32(1):1-16.
25. Hilley D. Cloud computing: a taxonomy of platform and infrastructure-level offerings. Georgia Inst Technol Tech Rep. 2009;44-5.
26. Humayun M. Role of emerging IoT big data and cloud computing for real-time application. Int J Adv Comput Sci Appl. 2020;11(4).
27. Islam M, Reza S. The rise of big data and cloud computing. Internet Things Cloud Comput. 2019;7(2):45.
28. Ismail N, Mujad SM, Zulkifli MFR, Izionworu VO, Ghazali MJ, Nik WMNW. A review on application of marine algae as green corrosion inhibitors in acid medium. Viet J Chem. 2022;60(4):409-16.
29. Katal A, Dahiya S, Choudhury T. Energy efficiency in cloud computing data centers: a survey on software technologies. Cluster Comput. 2023;26(3):1845-75.
30. Ke MT, Yeh CH, Su CJ. Cloud computing platform for real-time measurement and verification of energy performance. Appl Energy. 2017;188:497-507.
31. Kolb S. On the portability of applications in platform as a service. Bamberg: University of Bamberg Press; 2019.
32. Mahmood Z. Cloud computing for enterprise architectures: concepts, principles and approaches. In: Cloud computing for enterprise architectures. London: Springer London; 2011. p.3-19.
33. Maktoubian J, Taskhiri MS, Turner P. Intelligent predictive maintenance (Ipdm) in forestry: A review of challenges and opportunities. Forests 2021;12(11):1495.
34. Manvi SS, Shyam GK. Resource management for Infrastructure as a Service (IaaS) in cloud computing: A survey. J Netw Comput Appl 2014;41:424-40.
35. Molęda M, Małysiak-Mrozek B, Ding W, Sunderam V, Mrozek D. From corrective to predictive maintenance—A review of maintenance approaches for the power industry. Sensors 2023;23(13):5970.
36. Mqadi N. Application of IoT (Internet of Things) in the monitoring and control of offshore oil & gas production platforms [doctoral dissertation]. Johannesburg: Faculty of Engineering and the Built Environment, University of the Witwatersrand; 2020.
37. Nguyen T, Gosine RG, Warrian P. A systematic review of big data analytics for oil and gas industry 4.0. IEEE Access 2020;8:61183-201.
38. Okoye CC, Ofodile OC, Tula ST, Nifise AOA, Falaiye T, Ejairu E, *et al*. Risk management in international supply chains: A review with USA and African cases. Magna Sci Adv Res Rev 2024;10(1):256-64.
39. Okoye CC, Ofodile OC, Tula ST, Nifise AOA, Falaiye T, Ejairu E, *et al*. Strategic HRM in the logistics and shipping sector: Challenges and opportunities. Magna Sci Adv Res Rev 2024;10(1):294-305.
40. Øverdal MØ. Harnessing artificial intelligence capabilities through cloud services–A case study of inhibitors and success factors [master's thesis]. 2022.
41. Paltrinieri N, Landucci G, Salvo Rossi P. Real-time data for risk assessment in the offshore oil and gas industry. Int Conf Offshore Mech Arct Eng 2017 Jun;57663:V03BT02A017. American Society of Mechanical Engineers.
42. Perrons RK, Hems A. Cloud computing in the upstream oil & gas industry: A proposed way forward. Energy Policy 2013;56:732-7.
43. Ruysschaert WG. Making risk-informed decisions to optimize drilling operations using along string measurements with wired drill pipe: A high-speed, high-quality telemetry alternative to traditional mud pulse telemetry [master's thesis]. University of Stavanger; 2021.
44. Sadlier A, Jerry J. Implementing the real-time data environment for the oil and gas digital transformation. Offshore Mediterranean Conference and Exhibition 2019 Mar 27;OMC-2019.
45. Saputelli L, Economides M, Nikolaou M, Kelessidis V. Real-time decision-making for value creation while drilling. SPE/IADC Middle East Drilling Technology Conference and Exhibition 2003 Oct;SPE-85314.
46. Srinivasan V, Ravi J, Raj J. Google Cloud Platform for Architects: Design and Manage Powerful Cloud Solutions. Birmingham: Packt Publishing Ltd; 2018.
47. Stavrinides GL, Karatza HD. The impact of data locality on the performance of a SaaS cloud with real-time data-intensive applications. IEEE/ACM Int Symp Distrib Simul Real Time Appl 2017 Oct;1-8.

48. Strauss N. The role of the oil and gas industry in the transition toward a sustainable world. SPE Trinidad Tobago Sect Energy Resour Conf 2012 Jun;SPE-158270.
49. Teng Z, Chen J, Wang J, Wu S, Chen R, Lin Y, *et al*. Panicle-Cloud: An open and AI-powered cloud computing platform for quantifying rice panicles from drone-collected imagery to enable the classification of yield production in rice. Plant Phenomics 2023;5:0105.
50. Varghese B, Buyya R. Next-generation cloud computing: New trends and research directions. Futur Gener Comput Syst 2018;79:849-61.
51. Wanasinghe TR, Gosine RG, James LA, Mann GK, De Silva O, Warrian PJ. The Internet of Things in the oil and gas industry: A systematic review. IEEE Internet Things J 2020;7(9):8654-73.
52. Yasrab R. Platform-as-a-Service (PaaS): The next hype of cloud computing. arXiv Prepr 2018;arXiv:1804.10811.
53. Yevge A, Ghag P, Solanki C, Mishra A. Review paper on cloud service provider–AWS, Azure, GCP [No. 7440]. EasyChair 2022.
54. Zhifeng Y, Xuehui F, Fei H, Qi Y, Zhen C, Yidan Z. Cloud computing and big data for oil and gas industry application in China. 2019.
55. Zonta T, da Costa CA, Zeiser FA, de Oliveira Ramos G, Kunst R, da Rosa Righi R. A predictive maintenance model for optimizing production schedule using deep neural networks. J Manuf Syst 2022;62:450-62.