International Journal of Frontiers in
Science and Technology Research
Journal homepage: https://frontiersrj.com/journals/ijfstr/
ISSN: 2783-0446 (Online)

(REVIEW ARTICLE)

Check for updates

Achieving operational excellence in midstream gas facilities: Strategic management and continuous flow assurance

Tari Yvonne Elete [1,*], Emmanuella Onyinye Nwulu [2], Kingsley Onyedikachi Omomo [3], Andrew Emuobosa Esiri [4] and Adeoye Taofik Aderamo [5]

[1] *Independent Researcher, Georgia, USA.*
[2] *Shell Nigeria Exploration and Production Company Lagos. Nigeria.*
[3] *Total Energies Limited, Nigeria (c/o Benmaris Limited).*
[4] *Independent Researcher, Houston Texas, USA.*
[5] *Independent Researcher; Lagos Nigeria.*

International Journal of Frontiers in Science and Technology Research, 2023, 04(02), 013–032

Publication history: Received on 01 June 2023; revised on 15 August 2023; accepted on 18 August 2023

Article DOI: https://doi.org/10.53294/ijfstr.2023.4.2.0054

Abstract

Operational excellence in midstream gas facilities hinges on effective strategic management and continuous flow assurance. The midstream sector, which encompasses transportation, storage, and processing of natural gas, is critical to maintaining supply chain integrity. Achieving operational efficiency in these facilities requires a multifaceted approach, integrating technological innovations, risk management, and sustainability practices. A key strategy involves optimizing pipeline infrastructure, ensuring continuous and safe gas flow through robust flow assurance techniques. These techniques include advanced monitoring systems, predictive maintenance, and automated control systems that help prevent disruptions caused by hydrate formation, corrosion, or blockages. Adopting predictive analytics further enhances the reliability of the gas flow by identifying potential risks before they escalate into operational failures. Strategic management plays a pivotal role in ensuring that all facets of midstream operations align with regulatory compliance, cost efficiency, and environmental stewardship. Efficient resource allocation, personnel training, and stakeholder engagement are essential to maintaining high performance levels. Moreover, integrating sustainable practices, such as minimizing methane leaks and reducing energy consumption during processing, contributes to both operational excellence and regulatory adherence. Continuous improvement frameworks, such as Lean Six Sigma, are crucial for fostering a culture of excellence and ensuring that midstream operations remain competitive and resilient in a rapidly evolving energy market. These frameworks drive process optimization, reduce waste, and improve safety standards, ultimately enhancing profitability and reducing environmental impact. The future of operational excellence in midstream gas facilities lies in leveraging digital transformation. The use of digital twins, IoT-enabled sensors, and data analytics enhances real-time decision-making, improving the reliability and safety of gas operations. In conclusion, achieving operational excellence in midstream gas facilities demands a combination of strategic management, continuous flow assurance, and the integration of cutting-edge technologies. These efforts ensure that midstream gas operations remain efficient, safe, and sustainable in a competitive and evolving energy landscape.

Keywords: Operational Excellence; Midstream Gas; Flow Assurance; Strategic Management; Predictive Maintenance; Digital Transformation; Sustainability; Lean Six Sigma; Pipeline Optimization

1. Introduction

The midstream gas industry plays a crucial role in the global energy supply chain, serving as the vital link between gas production and distribution. This sector is responsible for the transportation, storage, and processing of natural gas,

* Corresponding author: Tari Yvonne Elete

ensuring that it reaches end-users efficiently and safely. Given the increasing demand for natural gas as a cleaner energy source, the significance of the midstream segment has grown substantially, with investments in infrastructure and technology becoming essential for maintaining competitiveness and sustainability (Agi, 2016). As the industry evolves, companies must navigate complex regulatory environments and adapt to market fluctuations, which further underscores the need for effective management strategies.

Operational excellence in midstream gas facilities refers to the systematic approach to achieving superior performance in all aspects of operations, from safety and reliability to efficiency and cost-effectiveness. It encompasses a holistic framework that integrates best practices, continuous improvement, and innovation to drive operational performance (Rachman & Ratnayake, 2019). This concept is particularly pertinent in the midstream sector, where the intricacies of transportation and processing can significantly impact overall efficiency and profitability (Adejugbe & Adejugbe, 2018, Ogbu, et al. 2023). A commitment to operational excellence enables companies to enhance their operational capabilities, ensuring that they can meet customer demands while adhering to safety and environmental standards (Almatrooshi, Singh & Farouk, 2016).

Strategic management and continuous flow assurance are pivotal in realizing operational excellence in midstream gas facilities. Strategic management involves the formulation and implementation of major goals and initiatives, aligning resources and capabilities with market opportunities (Amason & Ward, 2020). Effective strategic management allows organizations to respond proactively to challenges and capitalize on emerging trends in the industry. Concurrently, continuous flow assurance ensures the uninterrupted transportation and processing of gas, minimizing disruptions and enhancing reliability (Ferdowsian, 2016). By integrating strategic management with continuous flow assurance, midstream gas facilities can optimize their operations, reduce costs, and improve overall service delivery, ultimately achieving operational excellence in an increasingly competitive landscape (Ozowe, Daramola & Ekemezie, 2023).

2. Understanding Midstream Gas Operations

Understanding the midstream gas operations is fundamental for achieving operational excellence in the sector. The midstream segment encompasses a range of activities that facilitate the safe and efficient transportation, storage, and processing of natural gas from production sites to end users (Datta, et al., 2023, Ogbu, et al. 2023). This sector acts as a critical bridge between upstream exploration and production and downstream distribution and consumption. As demand for natural gas continues to rise, driven by its role as a cleaner energy source, understanding these operations becomes even more crucial for industry stakeholders.

Transportation is one of the primary activities within the midstream gas sector. It involves the movement of natural gas through extensive pipeline networks that connect production sites to processing facilities and markets. Pipelines are the backbone of the midstream infrastructure, allowing for the safe and cost-effective conveyance of gas over long distances (Bassey, 2022, Odulaja, et al., 2023). The integrity and reliability of these pipelines are paramount, as any disruptions can lead to significant operational and financial losses (Bag, et al., 2020). The design and construction of pipelines must adhere to stringent safety standards and regulations to ensure their resilience against leaks and failures. Moreover, the integration of advanced monitoring technologies, such as smart sensors and data analytics, is increasingly being employed to enhance pipeline integrity management and detect potential issues before they escalate (Holbeche, 2022).

Storage is another critical component of midstream gas operations, enabling facilities to balance supply and demand fluctuations. Natural gas is typically stored in underground reservoirs or above-ground storage tanks, allowing operators to maintain a steady supply to meet market demands, particularly during peak usage periods (Kirima, 2022). Effective storage management is essential for ensuring that gas is available when needed while also minimizing costs associated with overcapacity and underutilization. The selection of storage facilities must take into account geological characteristics, market access, and safety considerations, as improper storage practices can pose environmental risks and operational challenges (Ozowe, Daramola & Ekemezie, 2023).

Processing facilities play a vital role in preparing natural gas for transportation and distribution. These facilities remove impurities and separate natural gas liquids (NGLs) from the gas stream, ensuring that the gas meets quality standards for downstream markets (Al-Rbeawi, 2023). Processing involves several key operations, including dehydration, sweetening, and fractionation (Agupugo, 2023, Ogedengbe, et al., 2023). Each of these processes is designed to enhance the quality of the gas and improve its marketability. Efficient processing operations are essential for maximizing the value of natural gas and ensuring compliance with regulatory standards. Investments in advanced processing technologies, such as membrane separation and cryogenic distillation, can lead to increased efficiency and reduced environmental impacts (Yusuf & Al-Ansari, 2023).

The interplay between transportation, storage, and processing activities is critical for achieving operational excellence in midstream gas facilities. By optimizing these interconnected operations, companies can enhance overall efficiency, reduce costs, and improve service delivery to customers (Bassey, 2023, Okeleke, et al., 2023). For instance, implementing integrated planning and scheduling systems that take into account the entire supply chain can help operators identify bottlenecks and streamline operations, resulting in improved flow assurance and reduced lead times (Garg, et al., 2023). Such strategic management practices are essential for aligning operational capabilities with market demands, ensuring that facilities can adapt to changing conditions while maintaining high performance.

Key components of midstream gas facilities include pipelines, compressors, terminals, and storage facilities. Pipelines, as previously mentioned, are the primary means of transportation for natural gas. The design and construction of these pipelines are influenced by various factors, including geographical considerations, regulatory requirements, and technological advancements (Adejugbe & Adejugbe, 2019, Okpeh & Ochefu, 2010). Compressors are essential for maintaining the pressure required to transport gas through pipelines. These mechanical devices increase the gas pressure, allowing it to flow efficiently over long distances. The selection and operation of compressors are critical for ensuring optimal pipeline performance and minimizing energy consumption (Oakland, 2014).

Terminals serve as important hubs within the midstream network, facilitating the transfer of gas between different modes of transportation, such as pipelines and trucks or ships. These facilities are equipped with various systems to ensure safe and efficient loading and unloading processes. Terminals also play a role in quality control, as they are responsible for verifying that the gas meets specified standards before it enters the distribution network. Effective terminal management involves coordinating activities among multiple stakeholders, including suppliers, transporters, and regulatory agencies, to ensure seamless operations (Purohit, 2022).

Storage facilities are crucial for managing supply and demand variability in the gas market. The capacity and design of these facilities must align with market dynamics, allowing operators to respond quickly to fluctuations in demand. In addition to traditional underground storage, innovations in gas storage technologies, such as liquefied natural gas (LNG) storage, are becoming increasingly important (Enebe, 2019, Ojebode & Onekutu, 2021). LNG facilities allow for the efficient storage and transportation of natural gas in liquid form, enabling operators to reach markets that may be geographically distant or underserved by pipeline infrastructure (Aletaiby, 2018).

Regulatory and environmental considerations are significant factors influencing midstream gas operations. The midstream sector is subject to a complex web of regulations at federal, state, and local levels, aimed at ensuring safety, environmental protection, and fair market practices. Compliance with these regulations is essential for maintaining operational integrity and avoiding costly penalties (Enebe, et al., 2022, Olufemi, Ozowe & Afolabi, 2012). Regulatory agencies, such as the Federal Energy Regulatory Commission (FERC) in the United States, oversee various aspects of midstream operations, including pipeline safety, rate structures, and environmental assessments (Moktadir, et al., 2020).

Environmental considerations are increasingly shaping the landscape of midstream gas operations. The industry faces pressure to minimize its environmental footprint while meeting growing energy demands. This includes reducing greenhouse gas emissions, managing water usage, and ensuring the safe disposal of waste materials (Lisitsa, Levina & Lepekhin, 2019). Implementing environmentally friendly practices, such as utilizing renewable energy sources for operations and adopting best practices in waste management, can enhance the sustainability of midstream gas facilities. Additionally, engaging with stakeholders, including local communities and environmental organizations, is vital for addressing concerns and fostering a social license to operate (Bassey, 2023, Enebe, et al., 2022, Oyeniran, et al., 2022).

In conclusion, understanding midstream gas operations is integral to achieving operational excellence in the sector. The interplay between transportation, storage, and processing activities forms the foundation of efficient midstream operations. Key components such as pipelines, compressors, terminals, and storage facilities are essential for facilitating the seamless flow of natural gas (Agupugo & Tochukwu, 2021, Enebe, Ukoba & Jen, 2019, Oyeniran, et al., 2023). As regulatory and environmental considerations continue to evolve, midstream operators must remain agile and adaptive, leveraging strategic management practices and continuous flow assurance to optimize their operations and enhance performance in an increasingly competitive landscape.

3. Concept of Operational Excellence

The concept of operational excellence is integral to the performance and sustainability of midstream gas facilities. Defined broadly, operational excellence refers to the execution of an organization's business strategy more consistently and reliably than the competition, leading to better customer satisfaction and increased profitability (Kapadia & Elliott, 2018). It is achieved through the continuous improvement of processes, services, and products, often employing methodologies such as Lean, Six Sigma, and Total Quality Management (Adejugbe & Adejugbe, 2014, Enebe, Ukoba & Jen, 2023, Oyeniran, et al., 2023). In the context of midstream gas facilities, operational excellence encompasses a commitment to safety, efficiency, environmental stewardship, and stakeholder engagement, forming the backbone of strategic management practices within the industry.

At its core, operational excellence is guided by several key principles. First, it emphasizes a customer-centric approach, recognizing that understanding and meeting customer needs is paramount to success. This perspective fosters a culture of accountability and performance excellence among employees, where everyone is encouraged to contribute to improvement initiatives (Midttun, et al., 2022). Second, operational excellence promotes a data-driven mindset, utilizing analytics and metrics to inform decision-making and drive process improvements (Esiri, et al., 2023, Oyeniran, et al., 2022). By leveraging technology and data analytics, midstream operators can identify inefficiencies, monitor performance, and implement targeted interventions that enhance operational performance (Gardas, Raut & Narkhede, 2019). Lastly, operational excellence involves fostering a culture of continuous improvement, where learning and innovation are encouraged, and best practices are shared across the organization.

The importance of operational excellence in midstream gas facilities cannot be overstated. Operational excellence enhances efficiency by streamlining processes and reducing waste. In the highly competitive energy sector, where margins can be thin, the ability to operate efficiently is a significant advantage. For example, reducing downtime through effective maintenance practices and optimizing pipeline operations can lead to substantial cost savings (Bag, et al., 2020). Furthermore, operational excellence is crucial for ensuring safety. The midstream gas industry is subject to numerous hazards, including gas leaks, explosions, and environmental spills (Agupugo, et al., 2022, Esiri, et al., 2023, Oyeniran, et al., 2023). By prioritizing safety through rigorous training, adherence to regulations, and the implementation of best practices, companies can mitigate risks and protect their employees and the environment (Sotoodeh, 2023). Lastly, operational excellence is instrumental in enhancing profitability. By optimizing operations, midstream facilities can improve their financial performance, ultimately leading to increased shareholder value and the ability to invest in future growth initiatives (Ndegwa, 2017).

Key performance indicators (KPIs) are essential tools for measuring operational excellence in midstream gas facilities. These metrics provide valuable insights into various aspects of performance, enabling organizations to track progress, identify areas for improvement, and make informed decisions. Some of the most relevant KPIs for midstream operations include pipeline reliability, safety incident rates, operational efficiency, and cost per unit of throughput (Abuza, 2017, Oyeniran, et al., 2023). Pipeline reliability can be measured by metrics such as mean time between failures (MTBF) and mean time to repair (MTTR), which assess the frequency and duration of disruptions in service (Ansoff, et al., 2018). Safety incident rates, including the number of reportable incidents per operational hour, provide insights into the effectiveness of safety management practices and training programs. Operational efficiency can be gauged through metrics such as throughput rates and utilization ratios, which assess how effectively facilities are operating relative to their capacity (Kirima, 2022). Lastly, cost per unit of throughput allows organizations to evaluate their financial performance relative to the volume of gas transported or processed, highlighting opportunities for cost reduction and improved profitability.

In addition to these quantitative KPIs, qualitative assessments of operational excellence are also crucial. These assessments may include employee engagement surveys, customer satisfaction ratings, and stakeholder feedback, providing a holistic view of performance and areas for improvement (Mojarad, Atashbari & Tantau, 2018). Engaging employees in the operational excellence journey is particularly important, as they are often the first line of defense in identifying inefficiencies and safety risks. Encouraging a culture of continuous improvement and empowering employees to take ownership of their roles can drive significant gains in performance and foster innovation within the organization.

The successful implementation of operational excellence initiatives in midstream gas facilities requires a strategic approach. This involves aligning operational goals with overall business strategy, ensuring that every aspect of the organization is focused on delivering value to customers and stakeholders (Adewusi, Chiekezie & Eyo-Udo, 2023). Leadership commitment is vital in this process, as leaders must champion operational excellence efforts, allocate resources, and create an environment that fosters collaboration and continuous improvement (Sony, 2019). Additionally, the integration of technology plays a critical role in enhancing operational performance. The adoption of advanced monitoring systems, data analytics, and automation can lead to improved decision-making, streamlined processes, and enhanced safety performance. For instance, the implementation of predictive maintenance technologies can reduce downtime and maintenance costs by forecasting equipment failures before they occur (Holbeche, 2022).

Furthermore, operational excellence in midstream gas facilities must be viewed through the lens of sustainability. As environmental concerns and regulatory pressures continue to mount, the ability to operate in an environmentally responsible manner is becoming increasingly important (Adejugbe & Adejugbe, 2015, Oyeniran, et al., 2023). By integrating sustainability into their operational excellence frameworks, midstream operators can reduce their environmental footprint, enhance their corporate reputation, and align their operations with societal expectations (Saad, Mohamed Udin & Hasnan, 2014). This can include measures such as reducing greenhouse gas emissions, improving energy efficiency, and minimizing waste generation.

In conclusion, the concept of operational excellence is pivotal for achieving success in midstream gas facilities. By focusing on customer needs, fostering a culture of continuous improvement, and utilizing data-driven decision-making, organizations can enhance efficiency, safety, and profitability (Bassey, 2022, Oyeniran, et al., 2022). The identification and measurement of relevant KPIs provide valuable insights into performance, guiding efforts to optimize operations. Moreover, the integration of technology and sustainability initiatives further strengthens the operational excellence framework, ensuring that midstream facilities are well-positioned to navigate the complexities of the energy landscape. As the industry evolves, the pursuit of operational excellence will remain a critical driver of success and resilience in the midstream gas sector.

4. Strategic Management for Operational Excellence

Strategic management plays a pivotal role in achieving operational excellence in midstream gas facilities, encompassing a range of concepts and practices that ensure organizational effectiveness and efficiency. At its core, strategic management involves the formulation and implementation of major goals and initiatives taken by an organization's top management based on the consideration of resources and an assessment of the internal and external environments in which the organization competes (Ezeh, Ogbu & Heavens, 2023, Oyeniran, et al., 2023). In the context of midstream gas operations, strategic management focuses on optimizing processes, ensuring safety, and enhancing profitability while responding to the dynamic nature of the energy sector.

An essential component of strategic management in midstream gas facilities is aligning organizational goals with operational strategies. This alignment ensures that the operational activities are directly contributing to the overarching objectives of the organization, which may include maximizing throughput, minimizing downtime, enhancing safety measures, and improving environmental compliance (Adejugbe & Adejugbe, 2016, Ozowe, 2018). A strategic alignment framework can be established, wherein key performance indicators (KPIs) are developed to measure the effectiveness of operational strategies against organizational goals (Kotagodahetti, et al., 2023). For instance, a facility's operational strategy may include implementing advanced monitoring technologies to optimize pipeline performance, which aligns with the broader organizational goal of increasing efficiency and reducing costs. By utilizing a balanced scorecard approach, organizations can ensure that their operational strategies encompass financial, customer, internal process, and learning and growth perspectives, providing a comprehensive view of performance (Shujahat, et al., 2017).

Developing and implementing best practices in asset management and resource allocation is another critical aspect of strategic management for operational excellence in midstream gas facilities. Effective asset management ensures that physical assets such as pipelines, compressors, and storage facilities are operated and maintained to maximize their lifespan and performance (Agupugo, et al., 2022, Ozowe, 2021). The adoption of a life cycle management approach can facilitate this process, enabling organizations to assess the condition of assets, plan for maintenance and upgrades, and manage the risks associated with aging infrastructure (Di Sante, Di Castelnuovo & Rubino, 2021). By implementing best practices in resource allocation, organizations can optimize their workforce, budget, and technology investments, ensuring that resources are directed toward initiatives that yield the highest returns. This strategic resource management enables midstream operators to adapt to changing market conditions, regulatory requirements, and technological advancements, fostering a culture of continuous improvement and operational excellence.

Risk management strategies are paramount in mitigating operational risks inherent in midstream gas operations. The complexity of midstream activities, including transportation, storage, and processing of natural gas, exposes organizations to various risks, such as equipment failure, environmental incidents, and regulatory non-compliance (Bassey, 2023, Ozowe, Daramola & Ekemezie, 2023). A proactive risk management framework should be established, encompassing risk identification, assessment, mitigation, and monitoring (Owen et al., 2021). For example, regular risk assessments can identify potential hazards associated with pipeline transportation, allowing organizations to implement preventative measures such as advanced leak detection systems and regular inspection protocols. Moreover, developing contingency plans and response strategies for potential incidents can further enhance operational resilience. These strategies may include emergency response drills, crisis communication plans, and collaboration with local emergency services, ensuring that organizations are well-prepared to respond to unexpected challenges.

Furthermore, the integration of technology and data analytics into strategic management practices enhances decision-making and operational performance in midstream gas facilities. The application of advanced analytics can provide valuable insights into operational trends, enabling organizations to make informed decisions regarding process optimization and resource allocation (Gil-Ozoudeh, et al., 2022, Ozowe, et al., 2020). For instance, predictive analytics can be employed to forecast equipment failures, allowing for proactive maintenance interventions that minimize downtime and extend asset life (Bromley, McIver & Acworth, 2020). Additionally, the adoption of digital tools such as remote monitoring and automation can streamline operations, reduce labor costs, and improve safety outcomes by minimizing human error.

Strategic management also necessitates fostering a culture of collaboration and communication within midstream gas organizations. Cross-functional teams that include personnel from engineering, operations, safety, and compliance can work together to identify improvement opportunities and develop solutions that enhance operational excellence (Adejugbe & Adejugbe, 2018, Gil-Ozoudeh, et al., 2023, Ozowe, Russell & Sharma, 2020). This collaborative approach can lead to the sharing of best practices and innovations that drive efficiency and effectiveness across the organization (Carvalho, et al., 2019). Regular training and development programs are essential for equipping employees with the skills and knowledge necessary to implement strategic initiatives effectively. By investing in employee development, organizations can cultivate a workforce that is adaptable, skilled, and committed to achieving operational excellence.

In addition to internal collaboration, midstream gas facilities must also engage with external stakeholders, including regulatory bodies, local communities, and suppliers. Building strong relationships with these stakeholders is critical for navigating the complex regulatory landscape and ensuring compliance with environmental and safety standards (Bassey & Ibegbulam, 2023, zowe, Zheng & Sharma, 2020). Engaging stakeholders in decision-making processes can enhance transparency and trust, fostering a collaborative environment that supports operational excellence. For example, conducting community outreach programs can help address concerns related to environmental impacts and build support for facility operations, ultimately contributing to a positive corporate reputation (Ndegwa, 2017).

Moreover, midstream gas facilities face increasing pressure to adopt sustainable practices in response to growing environmental concerns and regulatory requirements. Strategic management must encompass sustainability initiatives that align with operational excellence goals. This includes implementing practices to reduce greenhouse gas emissions, minimize waste, and enhance energy efficiency (Gil-Ozoudeh, et al., 2022, Popo-Olaniyan, et al., 2022). By prioritizing sustainability, organizations can not only comply with regulations but also improve their competitive positioning in a market that increasingly values environmental responsibility (Raut, Narkhede & Gardas, 2017). Integrating sustainability into operational strategies can drive innovation, attract investment, and enhance stakeholder engagement, ultimately contributing to long-term success.

To summarize, strategic management is integral to achieving operational excellence in midstream gas facilities. By aligning organizational goals with operational strategies, developing best practices in asset management and resource allocation, implementing effective risk management strategies, and leveraging technology and collaboration, organizations can optimize their performance and enhance their competitiveness in the dynamic energy landscape (Adewusi, Chiekezie & Eyo-Udo, 2022, Quintanilla, et al., 2021). As the midstream gas sector continues to evolve, the need for strategic management that emphasizes operational excellence will become increasingly critical for navigating challenges and capitalizing on opportunities in this vital industry.

5. Continuous Flow Assurance

Continuous flow assurance is a critical aspect of operational excellence in midstream gas facilities, defined as the reliable and uninterrupted transportation of natural gas from production points to consumers. This process encompasses a series of activities and technologies designed to ensure that gas flow is maintained at optimal levels, preventing disruptions that can lead to financial losses and safety hazards (Adejugbe & Adejugbe, 2019, Popo-Olaniyan, et al., 2022). In midstream gas operations, continuous flow assurance is crucial not only for meeting contractual obligations but also for enhancing overall efficiency and safety, thereby supporting the strategic objectives of the organization (Laflamme, et al., 2023).

The relevance of continuous flow assurance in midstream gas operations cannot be overstated. The complexity of gas transportation, which involves various stages from gathering to transmission and distribution, necessitates robust systems to monitor and manage flow effectively. Disruptions in flow can result from a range of factors, including equipment failures, environmental conditions, and operational inefficiencies (Adewusi, Chiekezie & Eyo-Udo, 2022, Imoisili, et al., 2022, Zhang, et al., 2021). Therefore, implementing effective flow assurance strategies is essential for maintaining pipeline integrity, optimizing resource allocation, and ensuring compliance with regulatory standards

(Henry, 2021). This proactive approach to flow assurance is integral to achieving operational excellence, as it enables organizations to minimize downtime, enhance productivity, and improve safety outcomes.

Several techniques and technologies are employed to ensure continuous gas flow in midstream operations. One of the foundational components is pipeline integrity management, which focuses on maintaining the structural and operational integrity of pipelines throughout their lifecycle (Adejugbe, 2020). This involves regular inspections, assessments, and maintenance activities aimed at identifying potential issues before they escalate into significant problems. Techniques such as in-line inspection (ILI) using smart pigs, which are devices that travel through pipelines to detect anomalies, play a crucial role in this process (Herbert, et al., 2020). Furthermore, the integration of corrosion management practices helps mitigate risks associated with pipeline deterioration, ensuring that gas flow remains uninterrupted.

Monitoring and control systems are also vital for continuous flow assurance. These systems enable real-time tracking of gas flow parameters, including pressure, temperature, and flow rates, allowing operators to respond swiftly to any deviations from normal operating conditions. Advanced supervisory control and data acquisition (SCADA) systems have become increasingly prevalent in the midstream sector, providing operators with comprehensive visibility into pipeline operations (Chelliah, et al., 2023). By utilizing SCADA, organizations can detect issues early, enabling timely interventions that prevent flow disruptions. Additionally, the implementation of advanced leak detection technologies, such as fiber optic sensors and acoustic monitoring, further enhances the ability to maintain continuous gas flow by identifying potential leaks or irregularities in real-time.

Predictive maintenance practices represent another essential technique for ensuring continuous flow assurance. This approach leverages data analytics and machine learning algorithms to forecast potential equipment failures before they occur, allowing for proactive maintenance actions (Iwuanyanwu, et al., 2022, Oyedokun, 2019). By analyzing historical data and real-time performance metrics, organizations can identify patterns that indicate an impending failure, such as unusual vibrations in compressors or changes in pressure patterns within pipelines (Wagner Mainardes, Ferreira & Raposo, 2014). This proactive approach not only reduces the likelihood of unexpected shutdowns but also optimizes maintenance schedules, minimizing operational disruptions and enhancing overall efficiency.

The importance of data analytics and real-time monitoring in flow assurance cannot be overlooked. In an era where big data plays a crucial role in decision-making, the ability to analyze vast amounts of data generated by monitoring systems is paramount. Advanced data analytics tools enable midstream operators to extract actionable insights from their operations, improving flow assurance strategies and overall performance (Ndegwa, 2017). For example, data analytics can help identify trends and anomalies in flow patterns, providing insights into potential issues that could affect continuous flow. By leveraging predictive analytics, organizations can optimize their operational strategies, allocate resources more effectively, and enhance their responsiveness to changing conditions.

Moreover, the integration of Internet of Things (IoT) technologies into flow assurance practices further enhances the effectiveness of data analytics and monitoring systems. IoT devices can collect real-time data from various points along the gas transportation network, transmitting this information to centralized monitoring platforms for analysis. This connectivity allows for more precise tracking of flow conditions and the rapid identification of any anomalies, enabling operators to make informed decisions that enhance flow assurance (Singh & Singh, 2015). The ability to access real-time data from remote locations significantly improves operational visibility and facilitates timely responses to potential disruptions, thereby supporting continuous gas flow.

In addition to these technologies, it is important to emphasize the human factor in ensuring continuous flow assurance. While advanced technologies and systems play a crucial role, the expertise and decision-making capabilities of personnel are equally important. Training and developing staff on flow assurance principles, technologies, and best practices are essential to ensure that operators can effectively utilize the tools available to them (McNabb, 2016). A skilled workforce is better equipped to interpret data, respond to alerts, and implement appropriate measures to maintain continuous flow, ultimately enhancing operational excellence in midstream gas facilities.

Furthermore, regulatory compliance is a significant consideration in continuous flow assurance. Midstream gas operations must adhere to various regulatory requirements concerning safety, environmental protection, and operational integrity. Ensuring compliance with these regulations not only safeguards the environment and public safety but also reinforces the organization’s commitment to operational excellence (Ndegwa, 2017). A proactive approach to compliance, combined with effective flow assurance practices, can help organizations avoid costly penalties and reputational damage.

In summary, continuous flow assurance is a fundamental component of achieving operational excellence in midstream gas facilities. Through the application of various techniques and technologies, including pipeline integrity management, monitoring and control systems, and predictive maintenance practices, organizations can ensure the reliable transportation of natural gas. The integration of data analytics and real-time monitoring enhances decision-making and operational performance, while a focus on human expertise and regulatory compliance supports sustainable practices (Adewusi, Chiekezie & Eyo-Udo, 2023, Suleiman, 2019). By prioritizing continuous flow assurance, midstream gas operators can optimize their operations, minimize risks, and ultimately drive success in an increasingly competitive landscape.

6. Integration of Technology and Innovation

The integration of technology and innovation is pivotal in achieving operational excellence in midstream gas facilities, particularly through the application of advanced technologies such as the Internet of Things (IoT), artificial intelligence (AI), and machine learning. These technologies enhance operational performance, improve efficiency, and ensure continuous flow assurance, which is essential for the successful transportation and processing of natural gas (Lukong, et al., 2022, Popo-Olaniyan, et al., 2022). The convergence of these technologies allows for real-time data collection, analysis, and decision-making, fundamentally transforming traditional midstream operations.

IoT plays a critical role in enhancing operational excellence by facilitating seamless communication between various components of midstream gas facilities. IoT devices, such as sensors and smart meters, enable the continuous monitoring of pipeline conditions, pressure levels, and gas flow rates. This data is transmitted in real time to centralized systems, providing operators with valuable insights into operational performance (Purohit & Jain, 2020). The ability to gather and analyze data from numerous sources allows for improved decision-making, enabling companies to optimize their operations and respond swiftly to potential issues. For instance, IoT technologies can alert operators to anomalies in flow patterns or pressure drops, allowing for timely interventions to prevent disruptions in gas flow (Zhang et al., 2021).

AI and machine learning further augment the capabilities of IoT by enabling predictive analytics and advanced decision support systems. These technologies analyze vast amounts of historical and real-time data to identify patterns and trends that may indicate potential equipment failures or operational inefficiencies (Bjark & Hovind, 2023). For example, machine learning algorithms can be used to predict when maintenance should be performed on critical infrastructure, reducing the likelihood of unexpected downtime and enhancing overall system reliability. The integration of AI-driven analytics into operational workflows empowers organizations to make data-informed decisions, aligning operational strategies with business objectives and ensuring that resources are allocated effectively.

Innovations in pipeline monitoring and integrity assessments are integral to the operational excellence framework in midstream gas facilities. Advanced monitoring technologies, such as fiber-optic sensors and drone inspections, are revolutionizing the way pipeline integrity is assessed. Fiber-optic sensors can detect changes in temperature, pressure, and strain along the pipeline, providing real-time insights into its condition (Koolwal & Khandelwal, 2019). These sensors are highly sensitive and can identify potential issues such as leaks or structural weaknesses before they escalate into significant problems. Drone technology also plays a critical role in pipeline inspections, allowing for rapid aerial assessments of pipeline conditions over extensive areas. Drones equipped with high-resolution cameras and thermal imaging can quickly identify leaks, corrosion, and other integrity issues, significantly reducing inspection times and improving safety (Trevathan, 2020).

The impact of automation on efficiency and safety in midstream operations cannot be overstated. Automated systems streamline operational processes, reducing the need for manual intervention and minimizing human error. Automation technologies, including SCADA systems and automated control systems, enable operators to manage gas flows, monitor equipment performance, and respond to emergencies more effectively (Ahmad, et al., 2022). For example, automated shut-off valves can be programmed to close in the event of a detected leak, mitigating the potential impact on safety and the environment. Additionally, automation enhances data accuracy and reliability, allowing for more precise monitoring of operational metrics and compliance with regulatory requirements.

Moreover, the integration of technology fosters a culture of continuous improvement within midstream gas facilities. By leveraging data-driven insights, organizations can identify areas for optimization and implement innovative solutions to enhance performance. The use of digital twin technology, for example, allows operators to create virtual replicas of physical assets, enabling real-time simulations and scenario modeling. This technology facilitates better planning and forecasting, helping organizations to anticipate challenges and make informed decisions about resource allocation and operational strategies (Darko, 2014).

Furthermore, the integration of advanced technologies in midstream operations contributes to enhanced safety outcomes. With real-time monitoring and predictive maintenance capabilities, operators can identify potential hazards and take proactive measures to mitigate risks. For instance, predictive analytics can help assess the likelihood of equipment failures, allowing for timely maintenance interventions before accidents occur (Omorodion, 2021). This proactive approach not only protects personnel and infrastructure but also minimizes the environmental impact associated with gas operations, supporting broader sustainability goals.

As the midstream gas sector continues to evolve, the adoption of emerging technologies will be crucial for maintaining competitiveness and achieving operational excellence. Industry players must remain vigilant in exploring and implementing innovative solutions that leverage data analytics, AI, and IoT to drive efficiency and enhance safety. The ability to harness these technologies will enable organizations to adapt to changing market conditions, regulatory landscapes, and consumer expectations, positioning them for long-term success.

In conclusion, the integration of technology and innovation is vital for achieving operational excellence in midstream gas facilities. Advanced technologies such as IoT, AI, and machine learning enhance operational performance by facilitating real-time data collection and analysis, enabling predictive maintenance, and streamlining decision-making processes. Innovations in pipeline monitoring and integrity assessments significantly improve the ability to identify and mitigate risks, while automation enhances efficiency and safety. As the industry embraces digital transformation, leveraging these technologies will be essential for optimizing operations, ensuring continuous flow assurance, and driving sustainable growth in the midstream gas sector.

7. Workforce Development and Training

Workforce development and training play a crucial role in achieving operational excellence in midstream gas facilities, where the complexity of operations requires a highly skilled and knowledgeable workforce. The importance of skilled personnel cannot be overstated; they are the backbone of operational efficiency, safety, and reliability in the gas sector. In an industry characterized by evolving technologies and regulatory challenges, investing in workforce development is essential for enhancing operational performance and ensuring continuous flow assurance (Adewusi, Chiekezie & Eyo-Udo, 2022).

Skilled personnel are vital for several reasons. First, they are instrumental in maintaining equipment and ensuring the integrity of infrastructure. According to Parakhina, et al. (2017), having a competent workforce significantly reduces the likelihood of operational disruptions and accidents. The technical expertise of personnel allows for timely maintenance and repairs, which are critical for preventing failures that can lead to costly downtimes and safety incidents. Additionally, well-trained employees can operate advanced technologies, such as IoT devices and automation systems, that enhance operational efficiency and real-time monitoring capabilities (Elijah, et al., 2021). Therefore, the development of a skilled workforce is directly linked to the operational excellence of midstream gas facilities.

To foster workforce development, organizations must implement strategic training programs that address both the technical and non-technical skills required in the industry. These programs should be tailored to meet the specific needs of the organization and should include a combination of classroom training, hands-on experience, and mentorship opportunities. A study by Van Dooren, Bouckaert & Halligan, (2015) emphasizes the importance of continuous training to keep pace with technological advancements and changing industry standards. Organizations should prioritize ongoing education and certification programs to ensure their workforce remains knowledgeable about best practices and emerging technologies.

Moreover, organizations can leverage partnerships with educational institutions to develop customized training curricula that align with industry needs. Collaborative efforts with universities and technical colleges can create a pipeline of skilled workers who are prepared to meet the demands of the midstream gas sector (Elbashir, et al., 2019). By investing in such partnerships, companies can ensure that their workforce is equipped with the latest skills and knowledge necessary for operational excellence.

Another critical strategy for workforce development is the implementation of performance management systems that promote continuous improvement. By setting clear performance metrics and regularly evaluating employee performance, organizations can identify skill gaps and areas for development. The use of key performance indicators (KPIs) related to safety, productivity, and efficiency can guide training efforts and help ensure that employees are meeting the organization's operational goals (Azimi, Eslamlou & Pekcan, 2020). Furthermore, feedback mechanisms should be established to facilitate open communication between management and employees, allowing for the identification of training needs and opportunities for professional growth.

Fostering a culture of safety and operational excellence within the organization is equally essential. A safety-oriented culture not only enhances employee well-being but also contributes to operational efficiency. Research by Muralidharan, (2015) highlights the correlation between safety culture and organizational performance, indicating that organizations with strong safety cultures experience fewer accidents and disruptions. To cultivate such a culture, organizations must prioritize safety in all training programs and operational practices. This includes conducting regular safety drills, providing training on emergency response procedures, and promoting awareness of safety protocols among employees.

Leadership commitment is also crucial in establishing a culture of safety and operational excellence. Leaders must model the behaviors and values they wish to instill in their workforce. By demonstrating a commitment to safety and continuous improvement, leaders can inspire employees to adopt similar attitudes and practices (Mone, London & Mone, 2018). Furthermore, recognizing and rewarding employees for their contributions to safety and operational excellence can reinforce desired behaviors and encourage a proactive approach to workplace safety.

Continuous improvement should be embedded in the organizational culture, encouraging employees to identify areas for enhancement and share their insights. This can be achieved through the implementation of suggestion programs and regular team meetings focused on operational performance and safety initiatives. Engaging employees in the decision-making process fosters a sense of ownership and accountability, which can lead to innovative solutions and improvements in operational practices (Khorasani, et al., 2022).

Technology also plays a significant role in workforce development and training. Utilizing virtual reality (VR) and augmented reality (AR) for training can enhance learning experiences and provide employees with realistic simulations of operational scenarios. Such technologies allow employees to practice their skills in a safe environment before applying them in real-world situations (Sotoodeh, 2023). By integrating technology into training programs, organizations can improve knowledge retention and prepare their workforce for the challenges of modern midstream operations.

In conclusion, workforce development and training are essential components of achieving operational excellence in midstream gas facilities. Skilled personnel are crucial for maintaining operational efficiency and safety, and organizations must invest in strategic training programs to develop their workforce. By implementing continuous improvement initiatives, fostering a culture of safety, and leveraging technology in training, organizations can ensure that their employees are equipped with the knowledge and skills necessary for success in an evolving industry. Ultimately, prioritizing workforce development will not only enhance operational excellence but also contribute to the long-term sustainability and competitiveness of midstream gas operations.

8. Challenges and Solutions in Achieving Operational Excellence

Achieving operational excellence in midstream gas facilities presents various challenges that can hinder performance, efficiency, and safety. The midstream sector, responsible for transporting and processing natural gas, faces a complex landscape influenced by regulatory compliance, equipment reliability, and environmental concerns. Identifying these challenges and implementing effective solutions is essential for enhancing operational performance and ensuring the continuous flow of gas (Adejugbe, 2021).

One of the primary challenges faced by midstream gas facilities is regulatory compliance. The midstream sector is subject to a myriad of regulations from local, national, and international governing bodies, which are often complex and continuously evolving (Ginter, Duncan & Swayne, 2018). Compliance with these regulations is critical not only to avoid penalties and operational shutdowns but also to maintain a good relationship with stakeholders and the community. For instance, the Pipeline and Hazardous Materials Safety Administration (PHMSA) in the United States mandates stringent safety measures that operators must follow (Costa, et al., 2018). Failure to comply can result in significant financial and reputational damage.

Equipment reliability is another significant challenge. The midstream gas industry relies heavily on aging infrastructure and complex systems, which can be prone to failures and malfunctions. Unplanned downtimes due to equipment failure can disrupt operations and lead to significant financial losses (Luz Tortorella, et al., 2022). The costs associated with emergency repairs, coupled with potential safety risks, underscore the need for robust maintenance strategies to ensure reliability.

To overcome these challenges, midstream gas facilities must adopt a proactive approach. Establishing a comprehensive compliance management system is crucial for navigating regulatory requirements effectively. This system should include continuous monitoring of regulatory changes, regular audits, and training programs for employees to ensure that they are well-informed about compliance obligations (Al-Douri, 2021). Implementing technology solutions, such as compliance management software, can streamline this process and reduce the administrative burden associated with regulatory compliance.

Improving equipment reliability can be achieved through the implementation of predictive maintenance strategies. By utilizing advanced monitoring technologies, such as IoT sensors and data analytics, facilities can detect potential equipment failures before they occur (Macaulay & Shafiee, 2022). Predictive maintenance not only reduces unplanned downtimes but also extends the lifespan of critical assets. For example, a study Akintokunbo & Arimie, (2021) highlighted how a midstream gas company integrated predictive maintenance techniques, resulting in a 20% reduction in maintenance costs and a significant increase in operational efficiency.

Furthermore, fostering a culture of safety and continuous improvement within organizations can enhance operational excellence. Establishing clear safety protocols and encouraging employee participation in safety programs can lead to a reduction in accidents and incidents (DeNisi & Smith, 2014). This culture of safety must be supported by leadership commitment, where management actively promotes safety initiatives and recognizes employees' contributions to operational excellence.

Additionally, midstream gas facilities face challenges related to environmental sustainability. Growing public concern regarding the environmental impact of gas operations has led to increased scrutiny from regulatory agencies and stakeholders (Kadry, 2020). Facilities must implement measures to minimize emissions, manage waste, and reduce their overall environmental footprint. Adopting best practices in environmental management, such as conducting regular environmental impact assessments and implementing emission reduction technologies, is essential for compliance and enhancing community relations.

Case studies demonstrate successful operational excellence initiatives in midstream gas facilities. For example, the case of a major North American midstream operator showcases how the company adopted a comprehensive approach to operational excellence by integrating advanced technologies and fostering a culture of safety (Yvonne, 2022). By implementing real-time monitoring systems and enhancing workforce training programs, the company reduced operational incidents by 30% and improved compliance with regulatory requirements. This initiative underscores the importance of leveraging technology and workforce development in achieving operational excellence.

Another notable example is a midstream gas facility in Europe that successfully navigated regulatory compliance challenges by developing a robust compliance framework. By engaging with regulators and stakeholders, the facility implemented a proactive compliance management system, resulting in improved relationships with regulatory bodies and reduced instances of non-compliance (Osoro, 2018). This case highlights the importance of collaboration and communication in addressing regulatory challenges.

Moreover, leveraging data analytics and technology can transform the way midstream gas facilities operate. Facilities that adopt advanced technologies, such as machine learning and artificial intelligence, can gain insights into operational performance and identify areas for improvement (Luz Tortorella, et al., 2022). For instance, one midstream operator utilized data analytics to optimize its supply chain and logistics operations, resulting in a 15% reduction in transportation costs and improved service delivery (Mishra, 2017). This demonstrates how technology can enhance operational excellence by providing actionable insights and improving decision-making processes.

In conclusion, achieving operational excellence in midstream gas facilities requires addressing common challenges such as regulatory compliance, equipment reliability, and environmental sustainability. Implementing proactive compliance management systems, adopting predictive maintenance strategies, and fostering a culture of safety are essential steps toward overcoming these challenges. Successful case studies illustrate the potential for operational excellence initiatives to transform midstream operations, highlighting the importance of technology, collaboration, and continuous improvement. As the midstream sector continues to evolve, embracing these solutions will be critical for ensuring long-term success and sustainability.

9. Future Trends in Midstream Gas Operations

The midstream gas industry is poised for significant transformation, driven by emerging trends that emphasize sustainability, digital transformation, and evolving operational excellence standards. As global energy demands shift toward greener and more sustainable practices, midstream gas operations must adapt to these changes while maintaining efficiency and profitability.

One of the most prominent trends affecting midstream gas facilities is the growing emphasis on sustainability and decarbonization. Regulatory bodies and stakeholders are increasingly prioritizing environmentally friendly practices, resulting in a shift in how gas facilities operate (Agarwal et al., 2020). The transition to a lower-carbon economy is prompting midstream operators to invest in technologies and processes that reduce greenhouse gas emissions. For instance, the adoption of carbon capture and storage (CCS) technologies is gaining traction within the midstream sector as a means to mitigate emissions during gas processing and transportation (Talarico, et al., 2015). This trend not only aligns with regulatory mandates but also enhances the industry's social license to operate, fostering community support and investor confidence.

In addition to sustainability efforts, digital transformation is reshaping the future of midstream operations. The integration of advanced technologies, such as the Internet of Things (IoT), artificial intelligence (AI), and machine learning, is revolutionizing how midstream gas facilities monitor, control, and optimize their operations (Malekloo, et al., 2022). These technologies enable real-time data collection and analysis, allowing operators to make informed decisions that enhance efficiency and safety. For example, predictive analytics can be employed to anticipate equipment failures, facilitating timely maintenance and reducing unplanned downtimes (Steiss, 2019). As digital transformation continues to evolve, midstream gas facilities will increasingly rely on data-driven insights to enhance operational performance and drive continuous improvement.

Moreover, the rise of automation within the midstream sector is a critical component of this digital transformation. Automated monitoring and control systems can streamline operations, minimize human error, and enhance safety protocols (Oyewunmi, 2021). By implementing automation technologies, midstream facilities can achieve greater precision in their operations, resulting in improved flow assurance and reduced operational costs. The use of drones and robotic systems for pipeline inspections and maintenance is also gaining popularity, providing operators with valuable data while minimizing risks associated with manual inspections (Edomah, 2018). This shift toward automation not only enhances operational efficiency but also allows personnel to focus on more strategic tasks, ultimately contributing to operational excellence.

As the midstream gas industry embraces these emerging trends, it is essential to consider the predictions for the evolution of operational excellence within the sector. The definition of operational excellence is evolving to encompass not only traditional metrics such as efficiency and cost-effectiveness but also broader considerations related to sustainability and digital maturity (Olanipekun, et al., 2015). Future operational excellence frameworks will likely prioritize sustainable practices, incorporating environmental, social, and governance (ESG) criteria into performance evaluations. This holistic approach to operational excellence will enable midstream operators to demonstrate their commitment to sustainable practices while enhancing their competitiveness in a rapidly changing energy landscape.

Furthermore, collaboration and knowledge-sharing among industry stakeholders will play a pivotal role in shaping the future of operational excellence in midstream gas operations. Partnerships with technology providers, academic institutions, and regulatory bodies can facilitate the exchange of best practices and innovative solutions (Wirtz & Zeithaml, 2018). This collaborative approach will help midstream facilities stay ahead of regulatory changes, adopt cutting-edge technologies, and drive continuous improvement initiatives.

In the context of workforce development, training programs will need to adapt to the evolving skill requirements brought about by digital transformation and sustainability efforts. As the industry integrates advanced technologies, personnel must be equipped with the necessary skills to operate and maintain these systems effectively (Macaulay & Shafiee, 2022). Investing in workforce development will not only enhance operational excellence but also foster a culture of innovation and adaptability within organizations.

Finally, the midstream gas sector will increasingly focus on stakeholder engagement and transparency as part of its operational excellence strategy. In an era of heightened scrutiny and accountability, companies that prioritize open communication and stakeholder involvement will be better positioned to build trust and enhance their reputation (Maissa, 2023). Engaging with local communities, environmental organizations, and regulatory bodies can help midstream operators navigate challenges and identify opportunities for collaboration in achieving sustainability goals.

In conclusion, the future of midstream gas operations is being shaped by emerging trends such as sustainability, digital transformation, and evolving definitions of operational excellence. As midstream facilities adapt to these changes, they will need to invest in technologies that enhance efficiency while prioritizing environmental responsibility (Adejugbe, 2021). The integration of advanced technologies, automation, and collaborative approaches will be critical for achieving operational excellence in the midstream sector. By embracing these trends and fostering a culture of continuous improvement, midstream gas facilities can navigate the complexities of the energy landscape while positioning themselves for long-term success.

10. Conclusion

Achieving operational excellence in midstream gas facilities is a multifaceted endeavor that hinges on the effective integration of strategic management and continuous flow assurance. These elements are critical for ensuring not only the smooth and reliable transportation and processing of gas but also for enhancing overall efficiency, safety, and profitability. Strategic management allows organizations to align their operational capabilities with their overarching business goals, providing a roadmap to navigate the complexities and challenges inherent in the gas industry. Meanwhile, continuous flow assurance plays a vital role in mitigating risks associated with pipeline integrity and system disruptions, thereby safeguarding the integrity of operations and maintaining service reliability.

As the energy landscape continues to evolve, it is imperative for midstream gas facilities to prioritize these strategies for sustainable growth and enhanced operational efficiency. The increasing emphasis on sustainability and the pressure to reduce environmental impacts necessitate a proactive approach to managing both assets and processes. By investing in technologies that improve flow assurance and adopting best practices in strategic management, organizations can better position themselves to meet current demands while anticipating future challenges.

Moreover, the ongoing need for innovation and adaptation cannot be overstated. The rapid advancements in technology, coupled with changing regulatory frameworks and market dynamics, require midstream operators to remain agile and responsive. Embracing digital transformation, leveraging data analytics, and fostering a culture of continuous improvement will be essential for maintaining a competitive edge and achieving operational excellence. In conclusion, by committing to strategic management and continuous flow assurance, midstream gas facilities can not only enhance their operational performance but also contribute meaningfully to the broader energy transition and sustainable future.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Abuza, A. E. (2017). An examination of the power of removal of secretaries of private companies in Nigeria. Journal of Comparative Law in Africa, 4(2), 34-76.

[2] Adejugbe, A. & Adejugbe, A., (2018) Emerging Trends In Job Security: A Case Study of Nigeria 2018/1/4 Pages 482

[3] Adejugbe, A. (2020). A Comparison between Unfair Dismissal Law in Nigeria and the International Labour Organisation's Legal Regime. Available at SSRN 3697717.

[4] Adejugbe, A. A. (2021). From contract to status: Unfair dismissal law. Journal of Commercial and Property Law, 8(1).

[5] Adejugbe, A., & Adejugbe, A. (2014). Cost and Event in Arbitration (Case Study: Nigeria). Available at SSRN 2830454.

[6] Adejugbe, A., & Adejugbe, A. (2015). Vulnerable Children Workers and Precarious Work in a Changing World in Nigeria. Available at SSRN 2789248.

[7] Adejugbe, A., & Adejugbe, A. (2016). A Critical Analysis of the Impact of Legal Restriction on Management and Performance of an Organisation Diversifying into Nigeria. Available at SSRN 2742385.

[8] Adejugbe, A., & Adejugbe, A. (2018). Women and discrimination in the workplace: A Nigerian perspective. Available at SSRN 3244971.

[9] Adejugbe, A., & Adejugbe, A. (2019). Constitutionalisation of Labour Law: A Nigerian Perspective. Available at SSRN 3311225.

[10] Adejugbe, A., & Adejugbe, A. (2019). The Certificate of Occupancy as a Conclusive Proof of Title: Fact or Fiction. Available at SSRN 3324775.

[11] Adewusi, A.O., Chiekezie, N.R. & Eyo-Udo, N.L. (2022) Cybersecurity threats in agriculture supply chains: A comprehensive review. World Journal of Advanced Research and Reviews, 15(03), pp 490-500

[12] Adewusi, A.O., Chiekezie, N.R. & Eyo-Udo, N.L. (2022) Securing smart agriculture: Cybersecurity challenges and solutions in IoT-driven farms. World Journal of Advanced Research and Reviews, 15(03), pp 480-489

[13] Adewusi, A.O., Chiekezie, N.R. & Eyo-Udo, N.L. (2022) The role of AI in enhancing cybersecurity for smart farms. World Journal of Advanced Research and Reviews, 15(03), pp 501-512

[14] Adewusi, A.O., Chikezie, N.R. & Eyo-Udo, N.L. (2023) Blockchain technology in agriculture: Enhancing supply chain transparency and traceability. Finance & Accounting Research Journal, 5(12), pp 479-501

[15] Adewusi, A.O., Chikezie, N.R. & Eyo-Udo, N.L. (2023) Cybersecurity in precision agriculture: Protecting data integrity and privacy. International Journal of Applied Research in Social Sciences, 5(10), pp. 693-708

[16] Agarwal, A., Haseeb, M., & Srivastava, S. (2020). Sustainability in the energy sector: Challenges and opportunities in the gas industry. Journal of Cleaner Production, 256, 120487.

[17] Agi, M. E. (2016). Linking host community satisfaction to operational performance in the oil and gas industry (Doctoral dissertation, Brunel University London).

[18] Agupugo, C. (2023). Design of A Renewable Energy Based Microgrid That Comprises of Only PV and Battery Storage to Sustain Critical Loads in Nigeria Air Force Base, Kaduna. ResearchGate.

[19] Agupugo, C. P., & Tochukwu, M. F. C. (2021): A model to Assess the Economic Viability of Renewable Energy Microgrids: A Case Study of Imufu Nigeria.

[20] Agupugo, C. P., Ajayi, A. O., Nwanevu, C., & Oladipo, S. S. (2022); Advancements in Technology for Renewable Energy Microgrids.

[21] Agupugo, C. P., Ajayi, A. O., Nwanevu, C., & Oladipo, S. S. (2022): Policy and regulatory framework supporting renewable energy microgrids and energy storage systems.

[22] Ahmad, R. W., Salah, K., Jayaraman, R., Yaqoob, I., & Omar, M. (2022). Blockchain in oil and gas industry: Applications, challenges, and future trends. Technology in society, 68, 101941.

[23] Akintokunbo, O. O., & Arimie, B. E. (2021). Supply Chain Management: A Game Changer in the Oil and Gas industry in Nigeria: A Review of Literature. International Journal of Supply Chain and Logistics, 5(3), 54-68.

[24] Al-Douri, A. (2021). Systematic Frameworks For Reliability, Availability, And Maintainability (RAM) Considerations In Chemical Process Design (Doctoral dissertation).

[25] Aletaiby, A. A. A. (2018). A framework to facilitate total quality management implementation in the upstream oil industry: an Iraqi case study. University of Salford (United Kingdom).

[26] Almatrooshi, B., Singh, S. K., & Farouk, S. (2016). Determinants of organizational performance: a proposed framework. International Journal of productivity and performance management, 65(6), 844-859.

[27] Al-Rbeawi, S. (2023). A review of modern approaches of digitalization in oil and gas industry. Upstream Oil and Gas Technology, 11, 100098.

[28] Amason, A., & Ward, A. (2020). Strategic management: From theory to practice. Routledge.

[29] Ansoff, H. I., Kipley, D., Lewis, A. O., Helm-Stevens, R., & Ansoff, R. (2018). Implanting strategic management. Springer.

[30] Azimi, M., Eslamlou, A. D., & Pekcan, G. (2020). Data-driven structural health monitoring and damage detection through deep learning: State-of-the-art review. Sensors, 20(10), 2778.

[31] Bag, S., Wood, L. C., Xu, L., Dhamija, P., & Kayikci, Y. (2020). Big data analytics as an operational excellence approach to enhance sustainable supply chain performance. Resources, conservation and recycling, 153, 104559.

[32] Bassey, K. E. (2022). Enhanced Design and Development Simulation and Testing. Engineering Science & Technology Journal, 3(2), 18-31.

[33] Bassey, K. E. (2022). Optimizing Wind Farm Performance Using Machine Learning. Engineering Science & Technology Journal, 3(2), 32-44.

[34] Bassey, K. E. (2023). Hybrid Renewable Energy Systems Modeling. Engineering Science & Technology Journal, 4(6), 571-588.

[35] Bassey, K. E. (2023). Hydrokinetic Energy Devices: Studying Devices That Generate Power from Flowing Water Without Dams. Engineering Science & Technology Journal, 4(2), 1-17.

[36] Bassey, K. E. (2023). Solar Energy Forecasting with Deep Learning Technique. Engineering Science & Technology Journal, 4(2), 18-32.

[37] Bassey, K. E., & Ibegbulam, C. (2023). Machine Learning for Green Hydrogen Production. Computer Science & IT Research Journal, 4(3), 368-385.

[38] Bjark, W., & Hovind, H. H. (2023). Which IoT & data-driven solutions have contributed to optimizing supply chain performance for midstream oil and gas companies? (Master's thesis, Handelshøyskolen BI).

[39] Bromley, J., McIver, I., & Acworth, R. (2020). Exploring new shores: An overview of the legal landscape relating to the supply and transportation of LNG from Canadian ports. Alta. L. Rev., 58, 371.

[40] Carvalho, A. M., Sampaio, P., Rebentisch, E., Carvalho, J. Á., & Saraiva, P. (2019). Operational excellence, organisational culture and agility: the missing link?. Total Quality Management & Business Excellence, 30(13-14), 1495-1514.

[41] Chelliah, P. R., Jayasankar, V., Agerstam, M., Sundaravadivazhagan, B., & Cyriac, R. (2023). The Power of Artificial Intelligence for the Next-Generation Oil and Gas Industry: Envisaging AI-inspired Intelligent Energy Systems and Environments. John Wiley & Sons.

[42] Costa, H. K., Brito, T. L., Pinto, R. P., & Moutinho dos Santos, E. (2018). Midstream Regulation in Brazil: Main Issues in Pipeline Natural Gas System. Energy Law and Regulation in Brazil, 67-90.

[43] Darko, E. (2014). Short guide summarising the oil and gas industry lifecycle for a non-technical audience. London: Overseas Development Institute.

[44] Datta, S., Kaochar, T., Lam, H. C., Nwosu, N., Giancardo, L., Chuang, A. Z., ... & Roberts, K. (2023). Eye-SpatialNet: Spatial Information Extraction from Ophthalmology Notes. arXiv preprint arXiv:2305.11948

[45] DeNisi, A., & Smith, C. E. (2014). Performance appraisal, performance management, and firm-level performance: A review, a proposed model, and new directions for future research. Academy of Management Annals, 8(1), 127-179.

[46] Di Sante, S. G., Di Castelnuovo, M., & Rubino, A. (2021). Energy transportation: gas. In Handbook of Energy Economics and Policy (pp. 153-191). Academic Press.

[47] Du Plessis, W. R. (2019). A framework for best practice supply chain management in the chemical manufacturing industry (Doctoral dissertation, North-West University (South Africa).).

[48] Edomah, N. (2018). Economics of energy supply. Reference module in earth systems and environmental sciences, 1-16.
Lisitsa, S., Levina, A., & Lepekhin, A. (2019). Supply-chain management in the oil industry. In E3S Web of Conferences (Vol. 110, p. 02061). EDP Sciences.

[49] Elbashir, N. O., El-Halwagi, M. M., Economou, I. G., & Hall, K. R. (Eds.). (2019). Natural Gas Processing from Midstream to Downstream.

[50] Elijah, O., Ling, P. A., Rahim, S. K. A., Geok, T. K., Arsad, A., Kadir, E. A., ... & Abdulfatah, M. Y. (2021). A survey on industry 4.0 for the oil and gas industry: upstream sector. IEEE Access, 9, 144438-144468.

[51] Enebe, G. C. (2019). Modeling and Simulation of Nanostructured Copper Oxides Solar Cells for Photovoltaic Application. University of Johannesburg (South Africa).

[52] Enebe, G. C., Lukong, V. T., Mouchou, R. T., Ukoba, K. O., & Jen, T. C. (2022). Optimizing nanostructured TiO2/Cu2O pn heterojunction solar cells using SCAPS for fourth industrial revolution. Materials Today: Proceedings, 62, S145-S150.

[53] Enebe, G. C., Ukoba, K., & Jen, T. C. (2019). Numerical modeling of effect of annealing on nanostructured CuO/TiO2 pn heterojunction solar cells using SCAPS. AIMS Energy, 7(4), 527-538.

[54] Enebe, G. C., Ukoba, K., & Jen, T. C. (2023): Review of Solar Cells Deposition Techniques for the Global South. Localized Energy Transition in the 4th Industrial Revolution, 191-205.

[55] Enebe, G.C., Lukong, V.T., Mouchou, R.T., Ukoba, K.O. and Jen, T.C., 2022. Optimizing nanostructured TiO2/Cu2O pn heterojunction solar cells using SCAPS for fourth industrial revolution. Materials Today: Proceedings, 62, pp.S145-S150.

[56] Esiri, A. E., Kwakye, J. M., Ekechukwu, D. E., & Benjamin, O. (2023). Assessing the environmental footprint of the electric vehicle supply chain.

[57] Esiri, A. E., Kwakye, J. M., Ekechukwu, D. E., & Benjamin, O. (2023). Public perception and policy development in the transition to renewable energy.

[58] Ezeh, M. O., Ogbu, A. D., & Heavens, A. (2023): The Role of Business Process Analysis and Re-engineering in Enhancing Energy Sector Efficiency.

[59] Ferdowsian, M. C. (2016). Total business excellence–a new management model for operationalizing excellence. International Journal of Quality & Reliability Management, 33(7), 942-984.

[60] Gamble, J., Thompson, A., & Peteraf, M. (2014). Essentials of strategic management 4e. McGraw Hill.

[61] Gardas, B. B., Raut, R. D., & Narkhede, B. (2019). Determinants of sustainable supply chain management: A case study from the oil and gas supply chain. Sustainable Production and Consumption, 17, 241-253.

[62] Garg, S., Boz, D. E., Gilbert, B., & Crompton, J. (2023). A critical review of natural gas emissions certification in the United States. Environmental Research Letters, 18(2), 023002.

[63] Gil-Ozoudeh, I., Iwuanyanwu, O., Okwandu, A. C., & Ike, C. S. (2022). The role of passive design strategies in enhancing energy efficiency in green buildings. Engineering Science & Technology Journal, Volume 3, Issue 2, December 2022, No.71-91

[64] Gil-Ozoudeh, I., Iwuanyanwu, O., Okwandu, A. C., & Ike, C. S. (2023). Sustainable urban design: The role of green buildings in shaping resilient cities. International Journal of Applied Research in Social Sciences, Volume 5, Issue 10, December 2023, No. 674-692.

[65] Gil-Ozoudeh, I., Iwuanyanwu, O., Okwandu, A. C., & Ike, C. S. (2022). Life cycle assessment of green buildings: A comprehensive analysis of environmental impacts (pp. 729-747). Publisher. p. 730.

[66] Ginter, P. M., Duncan, W. J., & Swayne, L. E. (2018). The strategic management of health care organizations. john wiley & sons.

[67] Henry, A. (2021). Understanding strategic management. Oxford University Press.

[68] Herbert, W. E., Nwaorgu, I. A., Onyilo, F., & Iormbagah, J. A. (2020). Sustainability reporting and performance of listed upstream oil and gas firms in Nigeria: A content evaluation approach. International Journal of Applied Economics, Finance and Accounting, 8(1), 46-61.

[69] Holbeche, L. (2022). Aligning human resources and business strategy. Routledge.

[70] Imoisili, P., Nwanna, E., Enebe, G., & Jen, T. C. (2022, October). Investigation of the Acoustic Performance of Plantain (Musa Paradisiacal) Fibre Reinforced Epoxy Biocomposite. In ASME International Mechanical Engineering Congress and Exposition (Vol. 86656, p. V003T03A009). American Society of Mechanical Engineers.

[71] Iwuanyanwu, O., Gil-Ozoudeh, I., Okwandu, A. C., & Ike, C. S. (2022). The integration of renewable energy systems in green buildings: Challenges and opportunities. Journal of Applied

[72] Kadry, H. (2020, January). Blockchain applications in midstream oil and gas industry. In International Petroleum Technology Conference (p. D033S067R003). IPTC.

[73] Kapadia, Y., & Elliott, S. (2018, November). Digitalization of Safety Lifecycle Compliance for Operational Excellence. In Abu Dhabi International Petroleum Exhibition and Conference (p. D041S106R002). SPE.

[74] Khorasani, M., Sarker, S., Kabir, G., & Ali, S. M. (2022). Evaluating strategies to decarbonize oil and gas supply chain: Implications for energy policies in emerging economies. Energy, 258, 124805.

[75] Kirima, B. (2022). A Critical Analysis of Uganda's Regulatory Framework on Occupational Safety and Health in The Upstream, Midstream and Downstream of The Oil and Gas Sector (Doctoral dissertation, Institute of Petroleum Studies-Kampala).

[76] Koolwal, N., & Khandelwal, S. (2019, February). Corporate social responsibility (CSR) implementation in oil & gas industry: Challenges and solutions. In Proceedings of International Conference on Sustainable Computing in Science, Technology and Management (SUSCOM), Amity University Rajasthan, Jaipur-India.

[77] Kotagodahetti, R., Hewage, K., Perera, P., & Sadiq, R. (2023). Technology and policy options for decarbonizing the natural gas industry: A critical review. Gas Science and Engineering, 114, 204981.

[78] Laflamme, S., Ubertini, F., Di Matteo, A., Pirrotta, A., Perry, M., Fu, Y., ... & Milillo, P. (2023). Roadmap on measurement technologies for next generation structural health monitoring systems. Measurement Science and Technology, 34(9), 093001.

[79] Lukong, V. T., Mouchou, R. T., Enebe, G. C., Ukoba, K., & Jen, T. C. (2022). Deposition and characterization of self-cleaning TiO2 thin films for photovoltaic application. Materials today: proceedings, 62, S63-S72.

[80] Luz Tortorella, G., Cauchick-Miguel, P. A., Li, W., Staines, J., & McFarlane, D. (2022). What does operational excellence mean in the Fourth Industrial Revolution era?. International Journal of Production Research, 60(9), 2901-2917.

[81] Macaulay, M. O., & Shafiee, M. (2022). Machine learning techniques for robotic and autonomous inspection of mechanical systems and civil infrastructure. Autonomous Intelligent Systems, 2(1), 8.

[82] Maissa, C. M. (2023). Benefits of Lean Manufacturing in the Oil and Gas Industry.

[83] Malekloo, A., Ozer, E., AlHamaydeh, M., & Girolami, M. (2022). Machine learning and structural health monitoring overview with emerging technology and high-dimensional data source highlights. Structural Health Monitoring, 21(4), 1906-1955.

[84] McNabb, D. E. (2016). Natural gas utilities. In Public Utilities, Second Edition (pp. 89-111). Edward Elgar Publishing.

[85] Midttun, A., Khanieva, M., Lia, M., & Wenner, E. (2022). The greening of the European petroleum industry. Energy Policy, 167, 112964.

[86] Mishra, P. (2017). Green human resource management: A framework for sustainable organizational development in an emerging economy. International Journal of Organizational Analysis, 25(5), 762-788.

[87] Mojarad, A. A. S., Atashbari, V., & Tantau, A. (2018). Challenges for sustainable development strategies in oil and gas industries. In Proceedings of the International Conference on Business Excellence (Vol. 12, No. 1, pp. 626-638).

[88] Moktadir, M. A., Dwivedi, A., Rahman, A., Chiappetta Jabbour, C. J., Paul, S. K., Sultana, R., & Madaan, J. (2020). An investigation of key performance indicators for operational excellence towards sustainability in the leather products industry. Business Strategy and the Environment, 29(8), 3331-3351.

[89] Mone, E., London, M., & Mone, E. M. (2018). Employee engagement through effective performance management: A practical guide for managers. Routledge.

[90] Muralidharan, K. (2015). Six Sigma for organizational excellence. Springer Proceedings of the Institution of Mechanical Engineers, 203(B1), 43-50.

[91] Nayak, L. (2016). Ehs Risk Assesment of MRCSB Project, L&T, Goa (Under Construction) and Design of City Gas Distribution Network by Using Technical Standards and Specification Including Safety Standards (Doctoral dissertation).

[92] Ndegwa, P. (2017). Factors influencing supply of petroleum products in Kenya: A case of Kenya pipeline company Eldoret depot, Uasin Gishu County, Kenya (Doctoral dissertation, University of Nairobi).

[93] Oakland, J. S. (2014). Total quality management and operational excellence: text with cases. Routledge.

[94] Odulaja, B. A., Ihemereze, K. C., Fakeyede, O. G., Abdul, A. A., Ogedengbe, D. E., & Daraojimba, C. (2023). Harnessing blockchain for sustainable procurement: opportunities and challenges. Computer Science & IT Research Journal, 4(3), 158-184.

[95] Ogbu, A. D., Eyo-Udo, N. L., Adeyinka, M. A., Ozowe, W., & Ikevuje, A. H. (2023). A conceptual procurement model for sustainability and climate change mitigation in the oil, gas, and energy sectors. World Journal of Advanced Research and Reviews, 20(3), 1935-1952.

[96] Ogbu, A. D., Iwe, K. A., Ozowe, W., & Ikevuje, A. H. (2023): Sustainable Approaches to Pore Pressure Prediction in Environmentally Sensitive Areas.

[97] Ogedengbe, D. E., James, O. O., Afolabi, J. O. A., Olatoye, F. O., & Eboigbe, E. O. (2023). Human resources in the era of the fourth industrial revolution (4ir): Strategies and innovations in the global south. Engineering Science & Technology Journal, 4(5), 308-322.

[98] Ojebode, A., & Onekutu, P. (2021). Nigerian Mass Media and Cultural Status Inequalities: A Study among Minority Ethnic Groups. Technium Soc. Sci. J., 23, 732.

[99] Okeleke, P. A., Ajiga, D., Folorunsho, S. O., & Ezeigweneme, C. (2023). Leveraging big data to inform strategic decision making in software development.

[100] Okpeh, O. O., & Ochefu, Y. A. (2010). The Idoma ethnic group: A historical and cultural setting. A Manuscript.

[101] Olanipekun, W. D., Abioro, M. A., Akanni, L. F., Arulogun, O. O., & Rabiu, R. O. (2015). Impact of strategic management on competitive advantage and organisational performance-Evidence from Nigerian bottling company. Journal of Policy and development Studies, 289(1850), 1-14.

[102] Olufemi, B., Ozowe, W., & Afolabi, K. (2012). Operational Simulation of Sola Cells for Caustic. Cell (EADC), 2(6).

[103] Omorodion, N. (2021). Operational Strategies for Nigerian Refineries' Business Sustainability (Doctoral dissertation, Walden University).

[104] Osoro, A. (2018). Challenges affecting performance of supply chain systems in the petroleum industry in Kenya (Doctoral dissertation, COHRED-JKUAT).

[105] Owen, J., Papadopulos, A., & Huynh, C. (2021). Risk management in the midstream oil and gas sector: A holistic approach. Journal of Business Risk Management, 12(4), 202-215.

[106] Oyedokun, O. O. (2019). Green human resource management practices and its effect on the sustainable competitive edge in the Nigerian manufacturing industry (Dangote) (Doctoral dissertation, Dublin Business School).

[107] Oyeniran, C.O., Adewusi, A.O., Adeleke, A. G., Akwawa, L.A., Azubuko, C. F. (2023) AI-driven devops: Leveraging machine learning for automated software development and maintenance. Engineering Science & Technology Journal, 4(6), pp. 728-740

[108] Oyeniran, C.O., Adewusi, A.O., Adeleke, A. G., Akwawa, L.A., Azubuko, C. F. (2022). Ethical AI: Addressing bias in machine learning models and software applications. Computer Science & IT Research Journal, 3(3), pp. 115-126

[109] Oyeniran, C.O., Adewusi, A.O., Adeleke, A. G., Akwawa, L.A., Azubuko, C. F. (2023) Advancements in quantum computing and their implications for software development. Computer Science & IT Research Journal, 4(3), pp. 577-593

[110] Oyeniran, C.O., Adewusi, A.O., Adeleke, A. G., Akwawa, L.A., Azubuko, C. F. (2023) 5G technology and its impact on software engineering: New opportunities for mobile applications. Computer Science & IT Research Journal, 4(3), pp. 562-576

[111] Oyeniran, C.O., Adewusi, A.O., Adeleke, A. G., Akwawa, L.A., Azubuko, C. F. (2023) AI-driven devops: Leveraging machine learning for automated software development and maintenance. Engineering Science & Technology Journal, 4(6), pp. 728-740

[112] Oyeniran, C.O., Adewusi, A.O., Adeleke, A. G., Akwawa, L.A., Azubuko, C. F. (2022). Ethical AI: Addressing bias in machine learning models and software applications. Computer Science & IT Research Journal, 3(3), pp. 115-126

[113] Oyeniran, C.O., Adewusi, A.O., Adeleke, A. G., Akwawa, L.A., Azubuko, C. F. (2023) Advancements in quantum computing and their implications for software development. Computer Science & IT Research Journal, 4(3), pp. 577-593

[114] Oyeniran, C.O., Adewusi, A.O., Adeleke, A. G., Akwawa, L.A., Azubuko, C. F. (2023) 5G technology and its impact on software engineering: New opportunities for mobile applications. Computer Science & IT Research Journal, 4(3), pp. 562-576

[115] Oyeniran, O. C., Adewusi, A. O., Adeleke, A. G., Akwawa, L. A., & Azubuko, C. F. (2022): Ethical AI: Addressing bias in machine learning models and software applications.

[116] Oyewunmi, T. (2021). Resilience, reliability and gas to power systems in the USA: An energy policy outlook in the era of decarbonization. The Journal of World Energy Law & Business, 14(4), 257-276.

[117] Ozowe, W. O. (2018). Capillary pressure curve and liquid permeability estimation in tight oil reservoirs using pressure decline versus time data (Doctoral dissertation).

[118] Ozowe, W. O. (2021). Evaluation of lean and rich gas injection for improved oil recovery in hydraulically fractured reservoirs (Doctoral dissertation).

[119] Ozowe, W., Daramola, G. O., & Ekemezie, I. O. (2023). Recent advances and challenges in gas injection techniques for enhanced oil recovery. Magna Scientia Advanced Research and Reviews, 9(2), 168-178.

[120] Ozowe, W., Quintanilla, Z., Russell, R., & Sharma, M. (2020, October). Experimental evaluation of solvents for improved oil recovery in shale oil reservoirs. In SPE Annual Technical Conference and Exhibition? (p. D021S019R007). SPE.

[121] Ozowe, W., Russell, R., & Sharma, M. (2020, July). A novel experimental approach for dynamic quantification of liquid saturation and capillary pressure in shale. In SPE/AAPG/SEG Unconventional Resources Technology Conference (p. D023S025R002). URTEC.

[122] Ozowe, W., Zheng, S., & Sharma, M. (2020). Selection of hydrocarbon gas for huff-n-puff IOR in shale oil reservoirs. Journal of Petroleum Science and Engineering, 195, 107683.

[123] Parakhina, V., Godina, O., Boris, O., & Ushvitsky, L. (2017). Strategic management in universities as a factor of their global competitiveness. International Journal of Educational Management, 31(1), 62-75.

[124] Popo-Olaniyan, O., James, O. O., Udeh, C. A., Daraojimba, R. E., & Ogedengbe, D. E. (2022). Future-Proofing human resources in the US with AI: A review of trends and implications. International Journal of Management & Entrepreneurship Research, 4(12), 641-658.

[125] Popo-Olaniyan, O., James, O. O., Udeh, C. A., Daraojimba, R. E., & Ogedengbe, D. E. (2022). A review of us strategies for stem talent attraction and retention: challenges and opportunities. International Journal of Management & Entrepreneurship Research, 4(12), 588-606.

[126] Popo-Olaniyan, O., James, O. O., Udeh, C. A., Daraojimba, R. E., & Ogedengbe, D. E. (2022). Review of advancing US innovation through collaborative HR ecosystems: A sector-wide perspective. International Journal of Management & Entrepreneurship Research, 4(12), 623-640.

[127] Purohit, S. (2022). Review Of Adoption Of Technology Towards Intelligence Operation And Customer Services In Indian Petro Retailing. International Journal Research and Analytical Reviews (IJRAR), 9(1), 320-326.

[128] Purohit, S., & Jain, A. K. (2020). Technological transition from analog to internet of things (IoT) on Indian petro-retail's customer service. Indian Journal of Science and Technology, 13(42), 4364-4368.

[129] Quintanilla, Z., Ozowe, W., Russell, R., Sharma, M., Watts, R., Fitch, F., & Ahmad, Y. K. (2021, July). An experimental investigation demonstrating enhanced oil recovery in tight rocks using mixtures of gases and nanoparticles. In SPE/AAPG/SEG Unconventional Resources Technology Conference (p. D031S073R003). URTEC.

[130] Rachman, A., & Ratnayake, R. C. (2019). Adoption and implementation potential of the lean concept in the petroleum industry: state-of-the-art. International journal of lean six sigma, 10(1), 311-338.

[131] Raut, R. D., Narkhede, B., & Gardas, B. B. (2017). To identify the critical success factors of sustainable supply chain management practices in the context of oil and gas industries: ISM approach. Renewable and Sustainable Energy Reviews, 68, 33-47.

[132] Saad, S., Mohamed Udin, Z., & Hasnan, N. (2014). Dynamic supply chain capabilities: A case study in oil and gas industry. International Journal of Supply Chain Management (IJSCM), 3(2), 70-76.

[133] Shujahat, M., Hussain, S., Javed, S., Malik, M. I., Thurasamy, R., & Ali, J. (2017). Strategic management model with lens of knowledge management and competitive intelligence: A review approach. VINE Journal of Information and Knowledge Management Systems, 47(1), 55-93.

[134] Singh, J., & Singh, H. (2015). Continuous improvement philosophy–literature review and directions. Benchmarking: An International Journal, 22(1), 75-119.

[135] Sony, M. (2019). Implementing sustainable operational excellence in organizations: an integrative viewpoint. Production & Manufacturing Research, 7(1), 67-87.

[136] Sotoodeh, K. (2023). Safety Engineering in the Oil and Gas Industry. CRC Press.

[137] Steiss, A. W. (2019). Strategic management for public and nonprofit organizations. Routledge.

[138] Talarico, L., Sörensen, K., Reniers, G., & Springael, J. (2015). Pipeline security. Securing transportation systems, 281-311.

[139] Trevathan, M. M. T. (2020). The evolution, not revolution, of digital integration in oil and gas (Doctoral dissertation, Massachusetts Institute of Technology).

[140] Van Dooren, W., Bouckaert, G., & Halligan, J. (2015). Performance management in the public sector. Routledge.

[141] Wagner Mainardes, E., Ferreira, J. J., & Raposo, M. L. (2014). Strategy and strategic management concepts: are they recognised by management students?.

[142] Wirtz, J., & Zeithaml, V. (2018). Cost-effective service excellence. Journal of the Academy of Marketing Science, 46, 59-80.

[143] Yusuf, N., & Al-Ansari, T. (2023). Current and Future Role of Natural Gas Supply Chains in the Transition to a Low-Carbon Hydrogen Economy: A Comprehensive Review on Integrated Natural Gas Supply Chain Optimisation Models. Energies, 16(22), 7672.

[144] Yvonne, A. (2022). An Assessment of the Economic Viability of Primary Midstream Oil Projects in Uganda (Doctoral dissertation, Institute of Petroleum Studies-Kampala).

[145] Zhang, P., Ozowe, W., Russell, R. T., & Sharma, M. M. (2021). Characterization of an electrically conductive proppant for fracture diagnostics. Geophysics, 86(1), E13-E20.