

ARTIFICIAL INTELLIGENCE (AI) AND SUSTAINABLE PRODUCTIVITY IN IMO STATE OIL INDUSTRY

¹Dr. Shaibu, Ogwuche Gabriel (MABEN/0310)
gabbyacademia123@gmail.com

²Dr. Mbaegbu, R.E.V (MABEN/0246)
roseyabymbaegbu@gmail.com

Department of Business Education,
Alvanlko Federal University of Education, Owerri, Imo State.

&

³Zion-Ngoka, Chizomam Kelechi
chizorongoka@yahoo.com

Department of Office Technology and Management,
Federal Polytechnic, Nekede, Imo State

Abstract

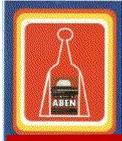
The study was carried out to examine the relationship between Artificial Intelligence (AI) and Sustainable Productivity in Imo State Oil Industry. Specifically, the objectives of the study were to examine how AI enhances quality service delivery and output levels in Imo State oil industry. The study adopted the cross sectional survey research design. The target population for this study comprised 40 managers from 10 oil firms in Imo State, which was purposefully adopted as the sample size. Data were collected through primary (questionnaire). A structured questionnaire designed in a modified four point Likert Scale format was adopted for the collection of data. Spearman Ranking (r) was used for the test of hypotheses via Statistical Package for Social Science (SPSS) Version 25.0. Findings revealed that there is a significant relationship between AI and sustainable productivity in Imo State oil industry. The study concluded that AI enhances sustainable productivity. The study recommended that the management of oil firms in Imo State oil industry should prioritize training programmes that equip employees with the necessary skills to work alongside AI technologies. This includes understanding AI tools, data analysis, and machine learning principles as such would enhance their quality service delivery: Also, management of oil firms in Imo State oil industry should encourage a workplace culture that embraces innovation and can facilitate the acceptance of AI technologies to promote their output levels.

Keywords: Artificial Intelligence, Sustainable Productivity, Quality Service Delivery and Output Level.

Introduction

Unarguably, firms are beginning to seek ways to maintain or enhance their productivity levels while being obliged to ensure that their operations are environmentally responsible, socially equitable and economically viable. The oil industry is one peculiar area of the economy of Imo State in Nigeria and a cornerstone of the global economy with unique challenges and opportunities (Elliot &Damingo, 2024). This peculiarity arises from the industry's inherent dependence on fossil fuels, which are both a significant source of energy and a major contributor to environmental degradation. As the world grapples with climate change and the need for sustainable productivity, the oil industry faces increasing pressure to innovate and adapt (Ben-Naceur, 2019).

Sustainable productivity ensures that oil extraction and processing do not compromise environmental



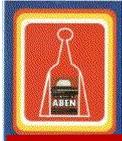
integrity or deplete natural resources, which are critical for future generations. The oil industry in Imo State has faced challenges such as environmental degradation, community displacement, and health hazards linked to pollution. Implementing sustainable practices can mitigate these issues by promoting responsible resource management, reducing carbon footprints, and fostering community engagement in decision-making processes (Waqar et al., 2023). Furthermore, sustainable productivity can enhance the industry's resilience against market fluctuations and regulatory pressures while ensuring compliance with global environmental standards. By investing in cleaner technologies and renewable energy alternatives, Imo State can transition towards a more diversified economy that supports both ecological balance and economic growth (Brooker, 2023). This approach not only benefits local communities, but also positions Imo State as a leader in sustainable oil production within Nigeria. Among others, it is vital to note that the adoption of Artificial Intelligence (AI) is a key to enhancing sustainable productivity in the oil industry.

The oil industry is a key sector of the Nigerian economy, contributing significantly to the country's revenue (Odusote, 2017; Adenikinju, 2019). Imo State, situated in the Niger Delta region, hosts numerous oil companies operating in the upstream and downstream sectors (Iteke, 2020). However, the industry faces pressing challenges, including declining oil reserves, aging infrastructure, and intensifying competition (Ekeocha, 2018; Okoro, 2020). To maintain competitiveness and ensure sustainable growth, oil companies must adopt innovative technologies that optimize operations, reduce costs, and enhance productivity (Al-Sumaiti et al., 2018).

Artificial Intelligence (AI) has emerged as a transformative force in the oil and gas industry, offering unprecedented opportunities for improvement (Kamal et al., 2019; Bera et al., 2020). AI can optimize drilling and extraction processes (Shi et al., 2018), predict equipment failures (Li et al., 2019), enhance energy efficiency (Wang et al., 2020), and inform decision-making through advanced data analytics (Hartono et al., 2020). Despite these benefits, AI adoption in the Nigerian oil and gas industry remains limited (Akinwale et al., 2020). Artificial Intelligence (AI) is the process of simulating human intellect in computers through steps such as job definition, data collection and processing, model selection, and system integration (Birhan, 2024). Artificial intelligence (AI) is widely regarded as a unique general-purpose technology that is being employed swiftly, thoroughly and broadly. It has applications in many different industrial areas. Previous research found a high positive association between the adoption of AI and sustainable productivity, as measured by both value-added and sales-based productivity indicators (Birhan, 2024). However, among others, quality service delivery and output levels are pointers to sustainable productivity in the oil industry.

Quality service delivery in this study refers to the consistent provision of services that meet or exceed customer expectations, while adhering to safety, regulatory and environmental standards (Lettenmeier et al., 2009; Izionworu & Maxwell, 2017). It is important to note that understanding and fulfilling the needs of customers, whether they are consumers, businesses, or governments is paramount. This includes timely delivery of products, reliability of supply chains, and responsiveness to inquiries and issues. Efficient operations minimize waste and reduce costs, while also maximizing output. These include optimizing drilling processes, refining operations, transportation logistics, and maintenance schedules. The oil industry is inherently hazardous; thus, maintaining high safety standards is crucial for quality service delivery. These include training personnel adequately, implementing rigorous safety protocols, and investing in technology that enhances safety (IEA, 2020). Adhering to local and international regulations ensures that companies operate within legal frameworks while promoting environmental sustainability. Continuous improvement through technological advancements can enhance service quality by increasing efficiency and reducing environmental impact.

On the other hand, output levels refer to the quantity of oil produced relative to inputs such as labor, capital investment, technology, and natural resources. Sustainable productivity emphasizes not just maximizing output but doing so in a way that preserves resources for future generations. The above implies that sustainable practices involve careful management of natural resources to prevent depletion, which also include enhanced oil recovery techniques that maximize extraction without compromising future reserves. Companies must assess their ecological footprint by minimizing emissions, managing waste effectively, and protecting biodiversity around extraction sites (Crăciu, 2003; Izionworu & Maxwell, 2017). Sustainable



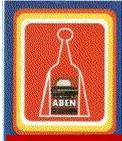
productivity also implies ensuring profitability over the long term without sacrificing ethical considerations or environmental health. Engaging with local communities affected by oil extraction activities fosters goodwill and supports sustainable development initiatives. Utilizing advanced technologies such as data analytics for predictive maintenance or renewable energy sources can enhance productivity sustainably. However, the focus of this study is on the adoption of artificial intelligence to enhancing sustainable productivity in the oil industry.

Drawing from the above, artificial intelligence (AI) is presumed to optimize various operational processes and minimizing environmental impacts in the oil industry (Srivastava, 2024). The Organization for Economic Cooperation and Development (OECD) (2019) defines an AI system as a machine-based system that can, for a given set of human-defined objectives, make predictions, recommendations, or decisions influencing real or virtual environments. AI systems are designed to operate with varying levels of autonomy (Saam, 2024). By employing AI-driven predictive analytics, companies can forecast equipment failures and maintenance needs, thereby reducing downtime and extending the lifespan of machinery. Machine learning algorithms can analyze geological data to identify potential drilling sites more accurately, leading to more efficient resource extraction while minimizing ecological disruption (Waqar et al., 2023; Anand, 2023). Furthermore, AI can optimize supply chain logistics, ensuring that resources are allocated efficiently and waste is minimized throughout the production cycle. In addition, AI technologies such as remote sensing and drones can monitor environmental conditions and detect leaks or spills in real-time, allowing for immediate response actions that protect local ecosystems. Implementing AI solutions also facilitates compliance with regulatory standards by automating reporting processes and ensuring adherence to environmental guidelines. Moreover, AI can support workforce training through virtual simulations, enhancing skill development while promoting safety protocols in hazardous environments (Czarnitzki, 2023). In the long run, leveraging AI in these ways will not only boosts productivity, but also aligns with sustainable practices crucial for the long-term viability of the oil industry.

Statement of the Problem

The adoption of artificial intelligence (AI) in the oil industry in Nigeria has been characterized by several challenges that contribute to its poor implementation. Despite the potential benefits that AI can bring to the sector, including enhanced operational efficiency, predictive maintenance, improved safety measures, optimized resource management and sustainable productivity, the uptake of these technologies remains limited. It is important to note that the oil industry in Nigeria often grapples with inadequate infrastructure, which hinders the effective deployment of AI technologies (Oladipo, 2022). Many facilities lack the necessary hardware and software capabilities to support advanced AI systems. This includes insufficient data storage solutions and unreliable internet connectivity, which are essential for real-time data processing and analysis. Also, there is a significant shortage of skilled personnel who are trained in both AI technologies and their applications within the oil sector. The workforce often lacks expertise in data science, machine learning, and other relevant fields that are crucial for implementing AI solutions effectively. The initial investment required for adopting AI technologies can be prohibitively high for many companies operating in Nigeria's oil industry. These include costs associated with technology acquisition, training personnel, and integrating new systems into existing operations. The regulatory framework governing the oil industry in Nigeria can be complex and may not always support innovation or technological advancement.

Companies sometimes face bureaucratic hurdles that slow down decision-making processes related to technology adoption (Mobayo et al., 2021). There is often a cultural resistance to change within organizations in the oil sector. Employees may be hesitant to adopt new technologies due to fear of job displacement or skepticism about the effectiveness of AI solutions compared to traditional methods. Effective AI systems rely on high-quality data for training algorithms and making accurate predictions. In Nigeria's oil industry, data collection practices may be inconsistent or unreliable, leading to challenges in developing robust AI models. Many stakeholders within the Nigerian oil industry seem to have limited awareness or understanding of what AI entails and how it can be applied effectively within their operations. This dearth in knowledge can lead to reluctance in investing time and resources into exploring AI solutions which negatively



affect their productivity levels.

Purpose of the Study

The major aim of the study was to examine the relationship between artificial intelligence and sustainable productivity in Imo State Oil Industry. Specifically, the study was out to:

1. Ascertain the relationship between artificial intelligence and quality service delivery in Imo State Oil Industry.
2. Examine the relationship between artificial intelligence and output level in Imo State Oil Industry.

Research Questions

The following research questions were raised to guide the study:

1. What is the relationship between artificial intelligence and quality service delivery in Imo State Oil Industry?
2. What is the relationship between artificial intelligence and output level in Imo State Oil Industry?

Hypotheses

In the course of carrying out this study, two null hypotheses were tested which were stated thus:

- Ho₁: There is no significant relationship between artificial intelligence and quality service delivery in Imo State Oil Industry.
- Ho₂: There is no significant relationship between artificial intelligence and output level in Imo State Oil Industry.

Method

The study adopted the cross sectional survey research design. The population of the study was 40 respondents, drawn from ten (10) oil servicing firms in Imo State. The sampling for this study was arrived using purposive sampling so as to reach out to those organizations where data could be easily assessed. Four (4) respondents comprising general manager, human resource manager, operations managers and service manager were selected from each firm, totaling 40 managers as sample for the study. Data were collected using the questionnaire, where a structured questionnaire titled "Artificial Intelligence and Sustainable Productivity Index (AISPI)" was used. The questionnaire was designed in a modified four point Likert Scale with response options: Strongly Agree (SA) 4, Agree (A) 3, Disagree (D) 2, and Strongly Disagree (SD) 1. The instrument was face ad content validated by experts. The reliability coefficient of the instrument (0.73) was elicited using Crombach Alpha. 36(90%) out of 40 copies of the questionnaire were retrieved during its administration. Spearman Ranking (r) was used for the test of hypotheses in a bivariate format, using the Statistical Package for Social Science (SPSS) Version 23 at 0.05 level of significance.

Results

- Ho₁: There is no significant relationship between artificial intelligence and quality service delivery in Imo State Oil Industry.

Table 1: Relationship between Artificial Intelligence and Quality Service Delivery

		Artificial Intelligence	Quality Service Delivery
Artificial Intelligence	Correlation Coefficient	1.000	.340**
	Sig. (2-tailed)	.	.000
	N	36	36
Quality Service Delivery	Correlation Coefficient	.340**	1.000
	Sig. (2-tailed)	.000	.
	N	36	36

** . Correlation is significant at the 0.01 level (2-tailed).

Source: Survey Data, 2024.

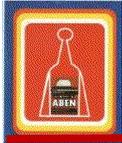


Table 1 above shows r value of 0.340 at a significance level of 0.00 which is less than the chosen alpha level of 0.05. Since the significance value 0.000 is less than the alpha level of 0.05, the null hypothesis (Ho₁) which states that there is no significant relationship between artificial intelligence and quality service delivery in Imo State Oil Industry was rejected and the alternate hypothesis was accepted. This implies that there is a significant relationship between artificial intelligence and quality service delivery in Imo State Oil Industry.

Ho₂: There is no significant relationship between artificial intelligence and output level in Imo State Oil Industry.

Table 2: Relationship between Artificial Intelligence and Output Level

		Artificial Intelligence	Output Level
Artificial Intelligence	Correlation Coefficient	1.000	.602**
	Sig. (2-tailed)	.	.000
	N	36	36
	Correlation Coefficient	.602**	1.000
Output Level	Sig. (2-tailed)	.000	.
	N	36	36

** . Correlation is significant at the 0.01 level (2-tailed).

Source: Survey Data, 2024.

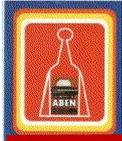
Table 2 above shows r value of 0.602 at a significance level of 0.00 which is less than the chosen alpha level of 0.05. Since the significance value 0.000 is less than the alpha level of 0.05, the null hypothesis (Ho₂) which states that there is no significant relationship between artificial intelligence and output level in Imo State Oil Industry was rejected and the alternate hypothesis was accepted. This implies that there is a significant relationship between artificial intelligence and output level in Imo State Oil Industry.

Discussion of Findings

The test of analyses revealed that there is a significant relationship between artificial intelligence and sustainable productivity (quality service delivery and output level) in Imo State Oil Industry. These findings are tandem with the findings of Birhan (2024) and Garg et al. (2024) which asserted that AI enhances quality on the productivity of a company. The above implies that AI enhances sustainable productivity in the oil industry through various applications that optimize operations, reduce waste, and improve decision-making processes. AI technologies such as machine learning, predictive analytics, and automation contribute to more efficient resource management, enhanced safety protocols, and reduced environmental impact (Waqar et al., 2023). For instance, AI can analyze vast amounts of geological data to identify potential drilling sites with greater accuracy, minimizing unnecessary exploration and associated environmental disruption. Additionally, AI-driven monitoring systems can predict equipment failures before they occur leading to less downtime and more efficient maintenance schedules (Elliot &Damingo, 2024).

The study revealed that AI-driven predictive maintenance can reduce downtime and extend equipment lifespan. This aligns with Li et al. (2019), who found that machine learning algorithms can predict equipment failures with accuracy. AI analytics can provide real-time insights, enabling informed decision-making. Hartono et al. (2020) similarly found that data analytics can improve decision-making accuracy.

AI can optimize energy consumption, reducing energy waste. Wang et al. (2020) reported similar results, with AI-driven energy efficiency optimization reducing energy consumption. AI can optimize supply chain logistics, reducing delivery times and costs. This supports Bera et al. (2020), who found that AI-driven supply chain optimization can reduce costs. AI can also enhance talent acquisition and retention, as it helps



identify top candidates and predict employee turnover. Akinwale et al. (2020) similarly found that AI-driven HR analytics can improve talent management. AI-powered cybersecurity systems can detect threats faster and reduce false positives. Kamal et al. (2019) reported similar results, with AI-driven cybersecurity systems reducing threat detection time. AI can optimize drilling and extraction processes, reducing environmental impact by to a great extent. Shi et al. (2018) similarly found that AI-driven process optimization can reduce environmental impact.

Moreover, AI facilitates better energy management by optimizing production processes and reducing emissions through real-time data analysis (Liao et al., 2023). This not only improves operational efficiency, but also aligns with sustainability goals by lowering the carbon footprint of oil extraction and processing activities. Overall, the integration of AI in the oil industry supports a transition towards more sustainable practices, while maintaining productivity levels (quality service delivery and output).

Conclusion

The study concluded that artificial intelligence greatly influences sustainable productivity through quality service delivery and output level in Imo State Oil Industry. To maintain competitiveness and ensure sustainable growth, oil companies must adopt innovative technologies that optimize operations, reduce costs, and enhance productivity.

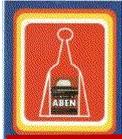
Recommendations

The following recommendations were made by the authors based on the results and findings of the study:

1. Management of oil firms in Imo State oil industry should prioritize training programmes that equip employees with the necessary skills to work alongside AI technologies. This includes understanding AI tools, data analysis, and machine learning principles as such would enhance their quality service delivery.
2. Management of oil firms in Imo State oil industry should encourage a workplace culture that embraces innovation that facilitates the acceptance of AI technologies to promote their output levels.

References

- Adenikinju, A.A. (2019). The Nigerian oil and gas industry: An overview. *Journal of Energy and Natural Resources*, 8(2), 1-12.
- Akinwale, A. O., Oyeleke, O.O., Oyeleran. A. & Charles, O.S. (2020). Artificial intelligence in the Nigerian oil and gas industry: Challenges and opportunities. *Journal of Petroleum Science and Engineering*, 195, 107624.
- Al-Sumaiti, A. S., Abdullah, S.A., Abdulrahma, A.A. & Bader, M.A. (2018). Artificial intelligence in the oil and gas industry: A review. *Journal of Artificial Intelligence Research*, 63, 511-534.
- Anand, V. (2023). *How AI can revolutionize the oil and gas industry*. <https://www.linkedin.com/pulse/how-ai-can-revolutionize-oil-gas-industry-vikram-anand>
- Ben-Naceur, K. (2019). *How the oil and gas industry is contributing to sustainability*. <https://jpt.spe.org/how-oil-and-gas-industry-contributing-sustainability>
- Bera, S., Sa, B., Srimanta, S. & Das, A.K. (2020). Application of artificial intelligence in oil and gas industry: A review. *Journal of Intelligent Information Systems*, 57(2), 247-265.
- Birhan, M. (2024). Artificial intelligence's effects on enhancing productivity. *Acta Scientific Computer Sciences*, 6(2), 15-19
- Brooker, J. (2023). *Transforming operations and enhancing sustainability in oil and gas*. <https://energy-oil-gas.com/news/transforming-operations-and-enhancing-sustainability-in-oil-and-gas/>
- Craciu, C. (2003). The improvement of services quality. *International Journal of Academic Research in Business and Social Sciences*, 3, 408 – 414
- Ekeocha, C. N. (2018). Challenges facing the Nigerian oil and gas industry. *Journal of Business and Economic Research*, 16(2), 1-10.



- Elliot, K. N. & Damingo, L. A. (2024). Application of artificial intelligence in the oil and gas industry. *International Research Journal of Modernization in Engineering, Technology and Science*, 6(5), 9244-9250
- Garg, S., Haralayya, B., AL Qudah, M., Maguluri, L. P. & Szeberényi, A. (2024). The impact of artificial intelligence on management productivity and efficiency. *Business, Management and Economics Engineering*, 22(1), 424-434
- Hartono, R., Rudi, H., Mohammad, N.K. & Indra, S. (2020). Data analytics in oil and gas industry: A review. *Journal of Data Science and Analytics*, 5(1), 1-14.
- Heylighen, F. & Joslyn, C. (1992). *What is systems theory?* <http://pespmc1.vub.ac.be/SYSTHEOR.html>
- IEA (2020). *The Oil and Gas Industry in Energy Transitions*, IEA, Paris <https://www.iea.org/reports/the-oil-and-gas-industry-in-energy-transitions>, Licence: CC BY 4.0
- Iteke, O. (2020). Imo State oil and gas industry: An overview. *Journal of Environmental Science and Health, Part C*, 38, 115-126.
- Izionworu, I. Z. & Maxwell, O. U. (2017). Effective service delivery through quality management system (QMS) in oil and gas servicing companies, a case study of selected firms, Port Harcourt. *Chemistry International* 3(2), 106-113
- Kamal, M., Amar, W., Mohammed, A. & Hisham, K. (2019). Artificial intelligence in oil and gas industry: Applications and challenges. *Journal of Petroleum Exploration and Production Technology*, 9(3), 1537-1546.
- Lettenmeier, M., Rohn, H., Liedtke, C., Schmidt-Bleek, F., Bienge, K., Urbaneja, D. M. & Buddenberg, J. (2009). *Resource productivity in 7 steps: How to develop eco-innovative products and services and improve their material footprint*. Wuppertal Institute for Climate, Environment and Energy
- Li, Z., Li, Y., Wang, J. & Li, Q. (2019). Predictive maintenance in oil and gas industry using machine learning. *Journal of Intelligent Manufacturing*, 30(4), 1537-1546.
- Liao, Q., Li, D., Zhang, K & Chang, H. (2023). Applications of artificial intelligence in the oil and gas industry. *Frontiers in Earth Science*, 11(1), 34-45, 2023.
- Mobayo, J. O., Aribisala, A. F., Yusuf, S. O. & Belgore, U. (2021). Artificial intelligence: Awareness and adoption for effective facilities management in the energy sector. *Journal of Digital Food, Energy & Water Systems*, 2(2), 1-18.
- Mohammed, K. & Shehu, A. (2023). A review of artificial intelligence (AI) challenges and future prospects of explainable ai in major fields: A case study of Nigeria. *Open Journal of Physical Science*, 4(1), 01-18
- Oduote, O. (2017). The Nigerian oil and gas industry: A review. *Journal of Energy and Natural Resources*, 6(1), 1-15.
- Okoro, E. (2020). Challenges facing the Nigerian oil and gas industry. *Journal of Business and Economic Research*, 18(1), 1-12.
- Oladipo, O. (2022). *Nigeria's oil sector looks on as robotics adoption picks up*. <https://businessday.ng/energy/oilandgas/article/nigerias-oil-sector-looks-as-robotics-adoption-picks-up/>
- Saam, M. (2024). The impact of artificial intelligence on productivity and employment: How can we assess it and what can we observe? *Intereconomics: Review of European Economic Policy*, 59(1), 22-27
- Shi, X., Mens, W., Li, J. & Li, Q. (2018). Optimization of drilling and extraction processes using artificial intelligence. *Journal of Petroleum Science and Engineering*, 165, 457-466.
- Srivastava, S. (2024). *Unleashing the potential of artificial intelligence in the oil and gas industry – 10 use cases, benefits, examples*. <https://appinventiv.com/blog/artificial-intelligence-in-oil-and-gas-industry/>
- Wang, Y., Wang, J. & Li, Y. (2020). Energy efficiency optimization in oil and gas industry using artificial intelligence. *Journal of Cleaner Production*, 287, 121745.
- Waqar, A., Othman, I., Shafiq, N., & Mansoor, M. S. (2023). Applications of AI in oil and gas projects towards sustainable development: a systematic literature review. *Artificial intelligence review*, 1-28. Advance online publication. <https://doi.org/10.1007/s10462-023-10467-7>