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ARTIFICIAL INTELLIGENCE SOLUTION, OIL THEFT REDUCTION, AND CRUDE OIL REVENUE: NIGERIA'S EXPERIENCE

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ABSTRACT: *Purpose-The study aimed to investigate the impact of artificial intelligence (AI) solutions on oil theft and crude oil revenue in Nigeria.* Design/Methodology/Approach- *The study used an ex post facto research design, collecting data from the Nigerian National Petroleum Corporation (NNPC) and the Central Bank Statistical Bulletin from 2020 to 2023. Purposive sampling was employed, and EViews version 12 was used for data analysis. The study used 2020 to 2023 data because the AI solutions were introduced by NNPC in 2020 to monitor oil theft in Nigeria.* Findings-*The findings revealed that AI solutions have a positive and significant effect on crude oil revenue in Nigeria. Additionally, oil theft was found to have a positive and significant impact on crude oil revenue. Limitations and Research Implications- The findings of this study may be limited by the data range and geographical focus. Future research could explore other regions or extend the data range. Practical Implications- The study's recommendations can inform policymakers and stakeholders on how to effectively implement AI solutions, strengthen financial control, and establish an effective legal system to combat oil theft. Originality/Value- This study contributes to the existing literature on AI solutions in the oil industry, highlighting their impact on crude oil revenue in Nigeria. The AI solutions contributed to a reduction in crude oil theft, which improved crude oil revenue for Nigeria.*

KEYWORDS: Artificial intelligence, Crude oil revenue, Nigerian National Petroleum Corporation, Nigeria, Oil theft.

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INTRODUCTION

The dwindling crude oil fortune of Nigeria was prompted by various factors such as oil theft, pipeline vandalism, foreign exchange instability, and unstable international crude oil prices. The crude oil is the mainstay of the Nigerian economy since the 1970s, when Nigeria paid less attention to agriculture, which used to be the main foreign exchange earner for the country. Despite the abundance of oil in Nigeria, its impact has not been felt as it has in other oil-producing countries in Africa and the United Arab Emirates. Crude oil production is a subset of crude oil revenue multiplied by the international oil price to get crude oil revenue. Nigeria's revenue is affected negatively whenever there is pipeline vandalism, oil theft, and a reduction in international oil prices. It usually results in a budget deficit for Nigeria because oil accounts for more than 85% of Nigeria's foreign earnings. The fall in oil revenue as a result of oil theft and pipeline vandalism has caused the country to resort to borrowing to finance its budget deficit. Pipeline vandalism has a negative effect on crude oil production and the eventual revenue of the country (Okorodudu et al., 2018). Crude oil plays a significant role in the economy of Nigeria, considering its financial contribution and effect.

The statistics on oil and gas production in 2013 and 2014 generated by the National Bureau of Statistics in 2016 revealed a comparative figure that the country produced 800,488,102 barrels for the year at a daily rate of 2,193,118.09 in 2013, while the production dropped to 699,486,203 at a daily rate of 1,916,400.56 in 2014 (NBS, 2016). There was a drop of 12.62% in crude oil production in 2014. This would have had a significant effect on the budget for 2014, coupled with a drop in oil prices. Crude oil is very important in the world oil business, but Nigeria has not taken proper advantage of this commodity to develop its economy. It is important to look at what other oil countries have done with their oil fortunes so that Nigeria can take a cue from them. Review of contribution of oil and gas to the GDP of some oil producers showed the following: Nigeria: 5.48%; Saudi Arabia: –50%; Qatar – 40%, Kuwait: –40%; UAE – 27%, Russia – 19%, Norway – 14%, Kazakhstan – 13%, Indonesia – 12%, Canada – 10%, Brazil – 10%, and USA – 8%. Nigeria is the largest oil producer in Africa, followed by Angola, Algeria, Libya, and Egypt.

The oil theft situation is common with oil-producing nations like Nigeria (Hassan, 2020). Other oil-producing countries that suffer oil theft are Mexico (27,000-54,000 barrels per day), Venezuela (27,000-82,000 barrels per day), Iraq (14,000-27,000 barrels per day), Libya (14,000-27,000 barrels per day), Indonesia (2,700-5,400 barrels per day), Colombia (2,700-5,400 barrels per day), and Ecuador (1,350-2,700 barrels per day) – (Balogun & Adesanya, 2022). Nigeria's oil theft situation was more difficult due to organized crimes, including militant groups and corrupt officials, and pipeline vandalism, resulting in frequent attacks on pipelines and infrastructure. The scale of oil theft is higher in Nigeria compared to other countries. Nigeria loses 200,000 – 400,000 barrels per day to oil theft compared to other countries. The oil theft was of great concern to NNPC, which is why they embarked on the development of AI solutions to track and monitor oil theft in Nigeria. Oil theft is not limited to the destruction of physical facilities of NNPC, but the diversion of crude revenue to personal accounts needs to be critically looked into. The effect of cash diversion might be more gruesome than pipeline vandalism. There was an investigation carried out that indicted some individuals of diverting $69 billion of crude oil revenue (The Punch, 2021). This whopping sum is more than the foreign reserve of the country. This may not be seen as an oil theft, but it should be looked into by the Federal government to stop and discourage the menace in the oil

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industry. The definition of oil theft should not be restricted to oil pipeline vandalism and spillage, but every aspect of the oil business that negatively impacts crude oil revenue. The oil industry should take proactive steps to identify and curb the loopholes that result in losses to our crude revenue (Iqbal et al., 2024).

Oil theft in the form of pipeline vandalism and mismanagement of oil revenue affected oil production in Nigeria. The oil theft figures for 2014–2023 as reported by Nigerian Extractive Industries Transparency Initiative reports are as follows: 2014 -100,000-150,000 barrels per day (bpd), 2015– 120,000-180,000bpd, 2016 – 150,000-200,000bpd, 2017-180,000-220,000bpd, 2018-200,000-240,000bpd, 2019–220,000-260,000bpd, 2020 – 140,000-180,000bpd, 2021 – 120,000-160,000bpd, 2022 – 180,000-200,000bpd, 2023 – 150,000-180,000bpd (NEiTi, 2024). The oil theft in Nigeria has financial implications for the country's oil revenue. The computation of crude theft from 2014 to 2023 amounted to $73.721 billion, while the theft from 2020 to 2023 amounted to $47.979 billion. There was no monitoring system put in place before 2020 to track oil theft in Nigeria (Imouokhome & Onibere, 2018).

This oil theft situation prompted the Nigerian National Petroleum Corporation (NNPC) to devise a monitoring system to reduce the losses resulting from oil theft, which leads to dwindling economic fortunes for the country. Several studies have been carried out on artificial intelligence solutions (AI) and pipeline vandalism, but very few of them put empirical figures to the loss and the quantitative impact of artificial intelligence on oil theft in Nigeria. They identified various monitoring methods of AI solutions that could be used to track oil theft with a view to reducing the impact of theft on our crude revenue (Ayeni & Ayogu, 2020; Hassan, 2020; Henry & Henry, 2019; Imouokhome & Onibere, 2018; Iqbal et al., 2024; Okorodudu et al., 2018; Sadeghioon et al., 2014).

This study set out to bridge the gap in this area by carrying out empirical analysis of AI solutions on oil theft as it impacts the crude oil revenue of Nigeria. The contribution of AI solutions to reducing the impact of crude oil theft in Nigeria made the work unique, as identified in the analysis. The objective of the study is to investigate the effect of the AI solution and oil theft on the crude oil revenue of Nigeria. A null hypothesis was developed from the objective to evaluate the significance of AI solutions and oil theft on crude oil revenue of Nigeria.

LITERATURE REVIEW

Conceptual Review

Oil Revenue

Oil revenue refers to the income generated from the exploration, production, and export of crude oil. As a leading producer of oil in the world, crude oil revenue plays a central role in Nigeria's fiscal landscape. It encompasses various financial resources derived from crude oil sales, including government take, royalties, taxes, and other industry levies that contribute to national coffers (Ogunjobi et al., 2024).

The systemic influence of oil revenue on Nigeria's economy is profound and multifaceted. Representing a significant portion of the country's foreign earnings, oil revenue is a critical

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driver of the country's budget and public finances. Its central role in the economy is highlighted through its contribution to government expenditures, as it provides the financial capacity for infrastructure development, public services, and social welfare programs policy (Aregbeyen & Kolawole, 2015). However, this dependency also subjects the nation to vulnerabilities, as highlighted by economic assessments that point out potential instabilities due to oil price volatility. Despite its benefits, the reliance on oil revenue entails significant economic challenges. Price fluctuations in the global oil market often lead to economic uncertainty, affecting growth projections and fiscal stability (Kutu & Ohonba, 2024). These economic dynamics prompt comprehensive strategies aiming to diversify revenue sources, which is vital for reducing Nigeria's economic susceptibility to such global impacts.

Oil Theft

Oil theft, referred to as oil bunkering, is the illegal act of stealing or diverting crude oil or refined petroleum products from pipelines, tanks, or other storage facilities (Adelowo, E. & Oladele, 2022). According to Soremi (2020), it involves the unauthorized tapping of pipelines, siphoning of oil from storage tanks, or hijacking of oil tankers. Oil theft occurs at various stages of the oil supply chain, including production, transportation, and storage (Dimkpa et al., 2023). According to the investigation, the common scenarios in which oil theft occurs include:

1. Pipeline tampering: This involves the deliberate breaking of oil pipelines to access and steal crude oil or petroleum products. Vandalism can occur through tampering with pipelines, such as drilling holes or making illegal connections (Soremi, 2020).

2. Hijacking of oil tankers: Oil tankers can be hijacked, and oil can be stolen or diverted during transportation (Soremi, 2020).

3. Leakage and tapping: Vandalism can occur through leakage and tapping of pipelines, often through deliberate damage or manipulation of pipeline infrastructure (Dimkpa et al., 2023).

4. Manipulation of metering systems: Oil vandalism can occur through the manipulation of metering systems, allowing thieves to steal oil without detection (Adelowo & Oladele, 2022).

Artificial Intelligence Solutions

Artificial Intelligence refers to the use of computer systems to perform tasks that would typically require human intelligence, such as image recognition, decision-making, and speech recognition (Ahmed et al., 2017). Artificial Intelligence solutions (AI) have emerged as a transformative tool in the fight against oil theft, offering innovative solutions to enhance monitoring and security within the oil industry. By integrating AI technologies such as satellite imagery, sensors, and Machine Learning algorithms, stakeholders can achieve real-time surveillance of oil pipelines, significantly improving the detection of unauthorized activities. For instance, AI solutions can analyze vast amounts of data from various sources to identify patterns indicative of oil theft, allowing for quicker responses from security personnel. This proactive approach not only helps in mitigating losses but also strengthens the overall integrity of the oil supply chain, which is vital for maintaining crude oil revenues that constitute a significant portion of any oil-producing economy (Hanga & Kovalchuk, 2019; Sircar et al., 2021). AI solutions can monitor real-time data on pressure and flow rates, allowing for

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immediate alerts when discrepancies arise, thus enabling rapid intervention to mitigate losses (Hanga & Kovalchuk, 2019). The approach not only enhances the security of oil infrastructure but also contributes to more efficient resource management. AI solutions include the following: Intelligent pipeline surveillance & monitoring, Aerial & maritime surveillance (drones and satellites), Data-driven operational monitoring.

Theoretical Review

Institutional Theory

The key proponents of Institutional Theory include Sutton & Selznick (1958), who developed the concept of institutionalization and the role of leadership in shaping organizations. Also, Jepperson and Meyer (2021) contributed to the development of neo-institutional theory, focusing on the impact of social and cultural norms on organizations, among many others. The assumptions of the theory include Social Construction of Reality, Institutionalization, Isomorphism, Legitimacy, Power and Politics, Cultural and Historical Context, Path Dependence, and Embeddedness. A supporter of the institutional theory is John Meyer, who developed neo-institutional theory, emphasizing the role of institutions in shaping organizational behavior. Also, Paul DiMaggio supported the theory in developing the concept of institutional entrepreneurship, highlighting the role of actors in shaping institutions. While some critics, such as Richard Scott, argued that institutional theory oversimplifies the complexity of organizational behavior, Stewart Clegg criticized the theory for neglecting power dynamics and conflict. Other critics include Michael Reed, Royston Greenwood, Bob Hinings, David Levy, and Frank Dobbins. The Relevance of Institutional Theory to oil theft includes:

- **Institutional Framework**: Oil theft occurs within a complex institutional framework, involving government regulations, industry standards, and social norms.
- **Institutional Weaknesses**: Weak institutions, such as inadequate regulation and poor law enforcement, enable oil theft.
- **Institutional Legitimacy**: Oil thieves often exploit institutional legitimacy, disguising their activities as legitimate business.
- **Institutional Isomorphism**: Oil companies and government agencies may adopt similar practices and procedures, facilitating oil theft.
- **Power Dynamics**: Institutional theory highlights the role of power dynamics, such as corruption and collusion, in enabling oil theft.
- **Cultural and Historical Context**: Oil theft is shaped by cultural and historical contexts, such as patronage networks and historical grievances.
- **Institutional Change**: Institutional theory can inform strategies for changing institutions to prevent oil theft, such as strengthening regulations and improving law enforcement.

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Empirical Review

Empirical studies highlight the effectiveness of AI solutions in reducing oil theft and its impact on crude revenue:

According to Hanga and Kovalchuk (2019), who surveyed Machine Learning (ML) and Multi-agent Systems (MAS) in Oil and Gas Industry applications. An exploratory review was used in which several studies were reviewed. The findings showed that MAS and ML were found to be useful for the reduction in oil theft. AI technologies, particularly machine learning algorithms, can analyze vast amounts of data from various sources, such as sensors and satellite imagery. To identify patterns indicative of oil theft as discussed by Adelowo, E. and Oladele (2022), Artificial Intelligence and Internet of Things (IOT) could be used in the oil industry to curb oil theft and reduce revenue loss by incorporating Machine Learning algorithms with technologies such as satellites, communication devices and sensors to provide real-time monitoring to ensure fast response of security officials in cases of oil theft and pipeline vandalism, using exploratory review to complete the study. In the same vein, Ahmed et al. (2017) also investigated how Multi-Agent Systems (MAS) could facilitate real-time monitoring of pipelines, allowing for quicker responses to potential theft and pipeline vandalism in Nigeria, with the use of Multi-Agent Systems Engineering to analyze and design the system. The system was designed to monitor the pressure flow of the pipeline, avoiding leakage and signaling abnormal flow, and to detect the movement of metallic objects meters away from the pipeline.

Predictive analytics involves using historical data and machine learning models to forecast potential theft hotspots. Ogbise (2025) explained that, by analyzing patterns in previous theft incidents, AI solutions could predict future risks and optimize surveillance efforts. This would help in allocating resources more efficiently and reducing theft-related losses. Their study found that AI-driven predictive analytics reduced theft-related losses (approximately 20%) by enabling targeted interventions in high-risk areas. Their study emphasized the role of machine learning in identifying patterns and predicting theft incidents before they occur. Okorodudu et al. (2018) investigated a monitoring system for petroleum pipeline vandalism in the Niger Delta region of Nigeria. He posited that Nigeria suffered from several successive governments that had suffered $12 billion annually from pipeline vandalism-related activities. The methodology used was the simulation of subsystems in conjunction with the procedural programming application Proteus 8. The findings revealed that the overall system was able to monitor the petroleum pipeline and reduce acts of vandalism on the nation's pipeline topology.

AI-powered anomaly detection systems analyze real-time data from pipeline sensors to identify deviations that may signify theft or pipeline breaches. Aljameel et al. (2022) proposed that using a technique such as deep learning can enhance the accuracy of detecting irregularities that could be missed by traditional methods. This technology enables rapid response to potential theft incidents, minimizing financial losses.

Imouokhome and Onibere (2018) carried out a study on Unified Modeling Language-adaptive neuro-fuzzy inference system models for understanding the design complexity of oil/gas pipeline intrusion and detection systems. The methodology used is Unified Modeling Language, which describes a real-time, intelligent, but complex system that detects, discriminates between varied vibration signatures of oil and gas distribution pipelines and identifies the signatures due to intrusions on the pipes by vandals. By the use of hierarchical

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activity and state transition diagrams from the Unified Modeling Language domain, the system understudy was modeled. The finding shows that the implementation of the system modeled in this study will significantly reduce oil theft/spillage, destruction of properties, and loss of human lives, as encountered in the oil production of Nigeria.

Ayeni & Ayogu, 2020 examined the intelligent pipeline monitoring system based on internet of Things (IoT). The motivation for this study was a result of pipeline vandalism in Nigeria, which has caused the nation to lose billions of dollars annually and has hurt the nation's economy. The exploratory review was adopted for the study, and the author came to the conclusion that IoT could be used to monitor pipeline flops in advance. According to Vegesna (2023), AI solutions streamline the reporting process by automating data collection and analysis, providing real-time insights into potential theft activities. These systems support decision-making by generating actionable intelligence and facilitating timely interventions.

Gonzales, 2023 carried out a panel data study on the implication of AI innovations on economic growth. The study dwelt on the application of Artificial Intelligence solutions (AI) across firms and industries, which warranted a line of research focused on determining its overall effect on economic variables. The study used an ex post facto research design, which made use of secondary data of a panel data set of countries from 1970 to 2019, and the number of AI patents as a measure of AI solutions. A text search query was performed to distinguish AI patents from other types of innovations in a public database. The findings revealed a positive relationship between AI and economic growth, which is higher than the effect of the total population of patents on growth.

Hypothesis Development

Stemming from conceptual review and theoretical review of this study, the following hypothesis is formulated to be tested:

Artificial intelligence and oil theft reduction have no positive significant effect on crude oil revenue in Nigeria.

METHODOLOGY

Research design

The study examined the effect of an AI solution on crude oil theft and crude oil revenue in Nigeria. An ex post facto research design was adopted for the study because data were obtained from the reports of NNPC.

Population

The population data for the study covered from 1960 to date, which affected oil theft and crude oil revenue, while the AI solution started from 2020 when it was introduced by the NNPC to monitor oil theft.

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Sample and sampling technique

The sample for the study was determined by the time the AI solution was introduced by the NNPC in Nigeria. Purposive sampling was used to select the period used for the study. The period of the sample is 2020 through 2023, that is, a period of four years. The year 2020 was chosen because it was the period in which the AI solution was introduced by the NNPC.

Method of data collection

The study made use of secondary data on AI solutions, oil theft, and crude oil revenue obtained from NNPC reports. The data used for the study were from 2020 through 2023. The data obtained were on AI solutions, Oil theft, and Crude oil revenue for the period of the sample. Daily oil production, oil theft, and AI solution data were translated to monthly figures. The monthly crude price in dollars was also obtained.

Method of data analysis.

Descriptive and inferential statistics were used for the data analysis. The regression analysis was carried out using E-views version 12.0 software package to test the model for the period 2020-2023. The variance inflation factor was used to test the multicollinearity.

Model specification

The functional relationship between the AI solution, oil theft, and crude oil revenue is expressed as follows:

$Y = f(X)$

Y = dependent variable

X = independent variable

$y_1 = \beta_0+\beta_1 x_1+\beta_2 x_{2+}\mu$,,,equation 1

y_1 = crude oil revenue

x_1 = AI solution

x_2 = oil theft reduction

β_0 = coefficient

$\beta_{1-}\ \beta_2$ = constant or intercept

μ = error term

$C\_V = \beta_0+\beta_1 C\_TR+\beta_2 AI\_D_{+}\mu$,,,Model 1

C_V = crude oil revenue

C_TR = oil theft reduction

AI_D = AI solution

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RESULTS AND DISCUSSION

Descriptive statistics

Table 1: Descriptive analysis of variables

Descr.	AI_D	C_TR	C_V
Mean	0.3712	0.9996	3.3769
Median	0.3799	1.0177	3.5391
Maximum	0.6543	1.6356	5.3722
Minimum	0.0772	0.2573	0.8486
Std. Dev.	0.1654	0.3093	1.0264
Skewness	0.0131	-0.1372	-0.3718
Kurtosis	1.5584	2.8442	2.8149
Jarque-Bera	4.1577	0.1992	1.1745
Probability	0.1251	0.9052	0.5559
Sum	17.8159	47.9786	162.0916
Sum sq. Dev	1.2856	4.4963	49.5134
Observations	48	48	48

Source: *Researcher's computation (2024) – EViews 12.0*

Descriptive analysis

Table 1 shows the summary statistics of all the variables obtained from the sampled figures of AI solutions, oil theft, and crude oil revenue in Nigeria. The study used C_V to represent crude oil revenue. AI_D represents the AI solution, while C_TR represents oil theft reduction. Table 1 shows the descriptive statistics of the variables used in this study, as stated earlier. The mean values of C_V, AI_D, and C_TR revealed 3.377, 0.371, and 0.999 with standard deviations of 1.026, 0.165, and 0.309, respectively. The standard deviation (SD) reveals some degree of data variation by measuring the degree of dispersion from the mean. The data points appear to be extremely close to the mean when the standard deviation is low, whereas a high standard deviation shows that the data points are dispersed throughout a wide range of values. The difference between the minimum value of 0.077 ($77.196m) and the maximum value of 0.654 ($654.255m) for the AI solution (AI_D) revealed the extent to which the AI solution varied from month to month within the review period of four years. Oil theft reduction (C_TR) showed a minimum of 0.257 ($257.32m) and a maximum of 1.6356 ($1.6356b). Crude oil revenue (C_V) had a minimum of 0.848 ($848m) and a maximum of 5.372 ($5.372b).

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Correlation matrix of variables

Table 2: Correlation matrix and VIF

Variable	AI_D	C_TR	VIF
AI_D	**1.0000**	**0.8238**	**3.112**
C_TR	**0.8238**	**1.0000**	**3.112**
		Mean	**3112**

Source: *Researcher's computation (2024) – EViews 12.0*

Hair et al., 2011 postulated that 0.86 and below was an appropriate and acceptable level of correlation. It was further stated that any variable above this threshold shows the presence of multicollinearity. The relationship between the AI solution and oil theft is high, but it is below the threshold of 0.86. The variance inflation factor (VIF) test was carried out to confirm the presence of multicollinearity. A VIF below 10 shows the absence of multicollinearity. The result above showed a mean result of 3.112, which indicates the absence of multicollinearity problems among the variable data series for both variables, meaning that there was an absence of multicollinearity in the study. To ensure that the estimated parameters are not biased and inefficient, the study used the variance inflation factor for each of the explanatory variables by examining the possibility of multicollinearity among the explanatory variables. The results of the VIF are less than 10 for each of the variables. The variables have a VIF of 3.112 (AI_D) and 3.112 (C_TR). The results revealed that AI_D and C_TR have a positive association with the performance of C_V in Nigeria, with correlational values of 0.8238 and 0.8238, respectively.

Hypothesis testing

Table 3: Regression analysis

Variable	Coefficient	Std.-Error	t-Statistics	Prob.
C	0.1595	0.0484	3.2933	0.0019
AI_D	1.0265	0.1494	6.8718	0.0000
C_TR	2.8376	0.0799	35.5268	0.0000
R-squared	0.9916	Mean dependent var.	3.3769	
Adjusted R-squared	0.9912	SD dependent var.	1.0264	
S.E. of regression	0.0906	Akaike info criterion	1.7884	
Sum squared resid.	0.4148	Schwarz criterion	1.6714	
Log likelihood	45.9210	Hannan-Quinn criterion	1.7442	
F-statistic	2663.51	Durbin-Watson Stat	0.2776	
Prob (F-statistic)	0.0000			

Source: *Researcher's computation (2024) – E-views version 12*

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The hypothesis for the study was tested using inferential statistics. The results are shown using regression in Table 3.

H_{o1} – AI solution and oil theft have no significant effect on crude oil revenue.

Table 3 revealed that the AI solution had a positive and significant effect on crude oil revenue of Nigeria with a coefficient of 0.1595 and a p-value of 0.0000. This shows that the introduction of every unit of AI solution brings about an increase of 1.03 percent of crude oil revenue. In the same vein, oil theft showed a positive and significant effect on crude oil revenue of Nigeria with a coefficient of 2.838 and a p-value of 0.0000. This implied that the application of artificial intelligence in the discovery of crude oil theft led to an increase in crude oil revenue for Nigeria. Every unit of oil theft introduced brought about 2.838 percent of crude oil revenue in Nigeria. The value of the coefficient of multiple determination (Adjusted R^2) of 0.9913 means that all the proxies of the independent variables are jointly responsible for 99.13% changes in C_V, while the remaining changes in C_V (0.87%) are caused by other factors outside the scope of this model. The high R-squared explained the impact of the AI solution on crude oil theft, which resulted in a positive and significant impact on crude revenue. The low Durbin-Watson of 0.2776 (positive autocorrelation) may affect inference.

Decision

At a level of significance 0.05, degree of freedom of 1 with F-statistics = 2663.305 and p-value = 0.0000, which is less than the adopted level of significance. Therefore, the study rejected the null hypothesis while alternate hypothesis was accepted, which shows that the AI solution with oil theft has a significant effect on crude oil revenue of Nigeria.

DISCUSSION OF FINDINGS

The results investigated the effect of the AI solution and crude oil theft on the crude revenue of Nigeria. The results revealed that AI solutions and oil theft had a positive and significant effect on crude revenue in Nigeria since their introduction in 2020. This was supported by Ahmed et al. (2017) and Hanga and Kovalchuk (2019), whose findings showed that machine learning and multi-agent systems in oil and gas industry applications were useful in reducing oil theft. The findings of Adelowo and Oladele (2022) also supported the results of this study through their study on how artificial intelligence and the Internet of Things (IOT) were used to curb oil theft and reduce revenue loss. This provided real-time monitoring to ensure fast responses of security officials in cases of oil theft and pipeline vandalism. This was also supported by Aljameel et al. (2022). The result of Ogbise (2025) was in tandem with the result of this study, which showed an improvement in crude oil revenue through the application of an AI solution. In his study, it was found that AI-driven predictive analytics reduced theft-related losses by 20% in high-risk areas. Okorodudu et al. (2018) investigated a monitoring system for petroleum pipeline vandalism in the Niger Delta region of Nigeria. The findings showed that the monitoring system was effective in reducing acts of vandalism in the region, which is in tandem with the results of this study.

The study contributes to a body of knowledge that can be referenced by future researchers in this area. The study is a novel one that will attract more attention from researchers with more years to cover in the scope of the study. Previous researchers adopted an exploratory and survey

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design, but this study adopted an ex post facto research design to identify the specific impact of AI solutions and crude oil theft on crude oil revenue of Nigeria. The study has shown that an AI solution is an appropriate strategy to reduce oil theft and increase crude oil revenue in Nigeria. Since the introduction of the AI solution, the Niger Delta has experienced relative peace, and oil production has also witnessed increases.

Implication of the findings

The analysis carried out from the study's model showed a positive result, which has implications for various stakeholders in the oil industry, specifically, and the country in general. The stakeholders may include the Federal government, investors and shareholders, policymakers/regulators, professionals, scholars, industry managers, and the general public.

The Government: The result showed that the AI solution had a positive and significant effect on the crude oil revenue of Nigeria. The oil theft in Nigeria, compared with other oil-producing countries, showed that Nigeria's loss was massive and affected the country's budget. This has caused the government to source a loan to support its budget. The oil theft situation affects all the tiers of government in Nigeria. The oil revenue goes into the federation account, from which allocation is shared among the three tiers of government. The introduction of an AI solution and oil theft recovery has a positive effect on oil revenue that accrues to the government, as losses from crude oil theft are reduced. With the currency devaluation, more Naira revenue is received by the government to execute developmental projects. The AI solution should be encouraged by the government to drive towards zero tolerance for crude oil theft. The AI solution should also include financial control that can trace stolen oil money from the country's crude oil revenue.

Scholars: The study is a novel one in the sense that there has not been any study that provided empirical analysis of this nature. Most studies were involved in literature review and exploratory studies on the monitoring system of the AI solution. The study will serve as an empirical material for researchers who may want to engage in this area in the future. The study will pave the way for more researchers to look at other challenges in the study.

Policy makers/Regulators: The study will encourage policymakers to review their policies to further reduce the oil theft situation in Nigeria. A review of oil theft in Nigeria, with other countries, can help them to set a threshold of losses from oil theft in Nigeria. The policymakers may need to include more aspects of AI solutions in the policy to enhance its effectiveness in curbing oil theft. NNPC, as a regulator, should engage other stakeholders to curb oil theft and pipeline vandalism. The oil theft in the area of cash diversion should be looked into by the NNPC by instituting sound financial control that will eliminate fraud from the system.

Professionals: The professionals in the oil field will find the study useful to know the benefits they can derive from the application of an AI solution. The oil industry managers require an AI solution to monitor oil spillage or pipeline vandalism and quantify its effects. It is not enough to know the capability of an AI solution, but figures must be provided to support the literature.

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CONCLUSION AND RECOMMENDATION

The study empirically investigated the effect of the AI solution and oil theft recovery on the crude oil revenue of Nigeria. The findings revealed that the AI solution and oil theft jointly had a positive and significant effect on crude oil revenue of Nigeria (F-statistic = 2663.305, p-value = 0.000). This is in tandem with the institutional theory, which states that citizens' behavior is influenced by the institutions. This suggests that values and norms established by the institution go a long way to dissuade citizens from oil theft and corruption.

Recommendation

In line with the results and findings in the hypothesis, the following recommendations were made, which might be useful to the government, management, investors, policymakers/regulators, and other stakeholders:

1. The Government: The government should pay attention to the financial control system to reduce cash diversion from crude revenue. A sound financial control system with a strong legal system should be established to forestall fraud and corruption in the oil industry. Considering the importance of crude oil revenue to the government's budget

2. Researchers: The study, being a novel one, will serve as a useful empirical study for other researchers who want to delve into this area in the future. It provides a basis for information that will be needed by other researchers who want to investigate oil theft and crude oil revenue with the help of an AI solution.

3. Policy makers/regulators: The policy makers and regulators should look for a way to monitor the success of the AI solution being used so that they can identify the effectiveness of the solution and its contribution to oil theft prevention on crude oil revenue. The regulator (NNPC) should devise a strong AI solution for a financial control system that will track stolen oil money and establish an effective legal system to prosecute the people involved in stolen crude oil money.

Contributions to knowledge

This study will contribute to knowledge in the following areas:

- The study is a novel one that will serve as an example for other researchers and analysts who want to do more work and cover the identified gap.
- The study will elicit further research into this area, as no empirical analysis has been carried out before now. Previous studies had been on an exploratory research design describing various monitoring methods of an AI solution.
- The study can be applied to other industries that require an AI solution to uncover theft situations.

Conflicts of interest

The writers affirm that there is no conflict of interest in carrying out the study. The interest in carrying out the study was purely academic and in the public interest.

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