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Artificial Intelligence and Environmental Compliance Monitoring in Nigeria's Petroleum Industry: Legal Opportunities and Regulatory Challenges

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Abstract: *Environmental compliance in Nigeria's petroleum industry has traditionally relied on periodic inspections, operator self-reporting and post-incident regulatory enforcement despite the increasing complexity of environmental risks. The emergence of artificial intelligence (AI) presents an opportunity to transform this approach through real-time environmental monitoring, predictive risk detection and measurement-based regulatory compliance. This paper adopted a doctrinal research methodology to examine whether Nigeria's petroleum regulatory framework is legally equipped to integrate AI into environmental compliance monitoring (ECM). It analysed primary and secondary sources of law and its findings revealed that although the extant legal and regulatory regimes create room for AI-assisted monitoring, none of them expressly recognises AI as a regulatory tool, and Nigeria has no legal framework governing the reliability, evidential status or accountability of AI-generated compliance data. It concluded that the major regulatory task is no longer whether AI can monitor environmental compliance but whether the law can keep pace with the effect of automated environmental oversight. The paper recommended statutory recognition of AI-assisted monitoring together with validation standards for AI-generated compliance data. This paper contributes to knowledge by proposing a model for integrating AI into petroleum sector environmental governance in Nigeria.*

Keywords: artificial intelligence, environmental compliance, Nigerian Petroleum Industry Act, 2021

INTRODUCTION

Environmental compliance is one of the major pillars of petroleum regulation because it seeks to ensure that oil and gas operations are conducted in a manner that prevents pollution and promotes sustainable resource development.[1] As Nigeria strengthens its environmental obligations through

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measurement-based emissions reporting and digital regulatory initiatives, artificial intelligence is emerging as a strategic tool capable of reshaping how environmental compliance is monitored, verified and enforced.[2] For decades, environmental oversight of petroleum operations in Nigeria has depended on physical inspection and on operators reporting their own infractions.[3] The National Oil Spill Detection and Response Agency Act requires an oil spiller to report a spill in writing within 24 hours of its occurrence, failing which a daily penalty applies.[4] This model places the first duty to disclose environmental harm on the party responsible for causing it, and it depends on that party acting promptly and honestly. This reactive model is now under pressure from two directions. First, the Nigerian Upstream Petroleum Regulatory Commission (NUPRC) has directed operators to move from Tier 1 emissions quantification to Tier 2 methodologies from the third quarter of 2026 and to Tier 3, measurement-based systems by January 2027.[5] The directive requires that all submissions be verifiable and evidence-driven.[6] Measurement-based reporting of this kind is difficult to sustain through manual inspection alone, because it calls for continuous data rather than periodic snapshots. This regulatory transition is reinforced by the Gas Flaring, Venting and Methane Emissions (Prevention of Waste and Pollution) Regulations 2023, which require operators to maintain gas data, flare logs and emissions records in the form prescribed by the NUPRC. Second, the national oil company has begun to treat artificial intelligence as central to its cost and production strategy. The Group Chief Executive Officer of NNPC Ltd has stated publicly that the company is ramping up AI pilots and mining decades of historic data, describing this as no longer a discretionary undertaking but an imperative.[7] These two developments, one regulatory and one operational, point in the same direction: environmental compliance in the petroleum industry is moving toward continuous, technology-driven verification. Nigeria's National Artificial Intelligence Strategy (NAIS) 2025 recognises this shift at a general level. It commits the state to fostering AI adoption across sectors and to establishing a governance framework built on transparency and accountability.[8] However, the NAIS is a policy document rather than binding law, and it does not deal specifically with environmental compliance in the petroleum sector. The resulting gap is therefore between what AI can now do and what the

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[1] E E Etim and others, 'Environmental Management Practices in the Oil and Gas Industry Moving Beyond Conventional Perceptions of Harm' <,https://link.springer.com/content/pdf/10.1007/s44274-025-00505-2.pdf> accessed 1 August 2026.

[2] N Rane and others, 'Artificial intelligence driven approaches to strengthening Environmental, Social, and Governance (ESG) criteria in sustainable business practices: a review' <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4843215> accessed 17 June 2026.

[3] D S Olawuyi and Z Tubodenyefa, 'Review of the Environmental Guidelines and Standards for the Petroleum Industry in Nigeria (EGASPIN)'(OGEES Institute 2018).

[4] National Oil Spill Detection and Response Agency (Establishment) Act 2006 (as amended), s 6(2).

[5] Nigerian Upstream Petroleum Regulatory Commission, 'Directive on Implementing Standardized Templates and Transitioning to Measurement-Based Methane and GHG Reporting' (NUPRC, 11 April 2026)<https://www.nuprc.gov.ng/media/news/b3f0614395dd79cd01ae509f> accessed 19 June 2026.

[6] Ibid.

[7] D Aina, 'NNPC Pushes AI Adoption to Cut Oil Production Costs' *Punch Newspapers* (Lagos, 10 April 2026)<https://punchng.com/nnpc-pushes-ai-adoption-to-cut-production-costs/> accessed 17 June 2026.

[8] Federal Ministry of Communication, Innovation and Digital Economy, *National Artificial Intelligence Strategy* (September 2025).

governing statutes anticipate it doing. Nigerian regulators increasingly demand accurate and continuously verifiable environmental reporting from petroleum operators. The Petroleum Industry Act 2021 (PIA) requires an operator to submit an environmental management plan and gives the Commission or Authority power to demand adjustments to that plan.[9] It also requires a licensee to install metering equipment on any facility from which natural gas may be flared or vented.[10] Yet the legal framework built around these obligations was designed for conventional compliance methods; it assumes that a human inspector, or an operator acting in good faith, produces the relevant data. Section 10 of the Environmental Impact Assessment Act (EIA Act) provides only that an activity subject to EIA 'shall be subject to appropriate supervision' where the regulatory Council deems it fit.[11] The provision does not say what form that supervision should take, how often it should occur or what technology, if any, may be used to conduct it. Where a statute is silent on method, it neither authorises nor forecloses the use of AI, and this silence is itself a regulatory problem because it leaves operators and regulators without clear guidance on the legal status of AI-generated compliance evidence. Existing research on this subject confirms that the difficulty is not technological capacity but legal readiness. According to Audu and Umana, although AI-enabled tools such as satellite monitoring and predictive analytics are increasingly available to the oil and gas industry, their deployment for compliance purposes is constrained by weak regulatory guidance and limited institutional capacity.[12]Ahanor and others reach a similar conclusion in the analogous context of e-waste enforcement in Nigeria, finding that enforcement gaps stem from an absence of data completeness, inter-agency coordination and regulatory clarity rather than from any deficit in the algorithms themselves.[13] The problem this paper addresses is therefore a legal one: Nigeria's petroleum regulatory framework has not yet defined how AI-generated data should be validated, admitted or relied upon for environmental compliance purposes. Thus, the central argument is that artificial intelligence (AI) has fundamentally changed what regulators can monitor. It has not changed how Nigerian petroleum regulation says environmental compliance should legally be monitored, verified and enforced. This mismatch is the core regulatory challenge examined in this paper.

The Emerging Role of Artificial Intelligence in Environmental Compliance Monitoring

(i) From Periodic Environmental Compliance to Continuous Digital Monitoring

Conventional environmental compliance in Nigeria's petroleum industry rests on periodic inspection and operator self-reporting, backed up by enforcement after the fact. The NOSDRA Act shows how deeply self-reporting is embedded in the system. Section 6(1)(a) of the NOSDRA Act makes NOSDRA responsible for surveillance and for ensuring compliance with environmental legislation on prevention, detection and general management of oil spills, oily wastes and gas flare.[14] However, section 6(2) of the NOSDRA Act places the primary reporting duty on the spiller, who must notify NOSDRA within 24 hours or face a penalty of two million

[9] Petroleum Industry Act 2021, s 102(1) and (5).
[10] Ibid s 106(1).
[11] Environmental Impact Assessment Act (Cap E12 LFN 2004), s 10.
[12] A J Audu and A U Umana, 'Advances in Environmental Compliance Monitoring in the Oil and Gas Industry: Challenges and Opportunities' [2024](8)(2) *International Journal of Scientific Research Updates*;48–59.
[13] E Ahanor and others, 'Leveraging Machine Learning for Regulatory Intelligence: A Predictive Assessment of Enforcement Gaps in Nigeria's E-Waste Legal Framework' [2025](1)(5) *European Journal of Innovative Studies and Sustainability*;121–129.
[14] National Oil Spill Detection and Response Agency (Establishment) Act 2006, s 6(1)(a).

naira for each day of default.[15] Surveillance, in other words, is NOSDRA's statutory function, but disclosure in practice depends on the operator whose conduct is being monitored. Manual inspection such as human patrols and ground surveillance covers a limited area at a limited frequency. As a result, a slow leak or a gradual rise in emissions can go undetected for long periods.[16]According to Adesuji, traditional pressure-drop methods used to detect pipeline leaks in Nigeria often fail to identify small or gradual leaks, which allows spillage to continue undetected for extended periods before manual inspection catches it.[17] The same limitation applies to corrosion, which Adesuji identifies as a leading cause of pipeline failure in Nigeria's humid and saline environment, historically detected only through periodic manual inspection rather than continuous measurement.[18] Methane and greenhouse gas (GHG) reporting has made the limits of manual, periodic compliance even clearer. The directive of NUPRC in April 2026 states that the NUPRC has, since 2022, required operators to commence emissions quantification using IPCC Tier 1 methodologies, with mandatory progression to Tier 2 and Tier 3 approaches.[19] The directive requires operators to report emissions using Tier 2 methodologies from the third quarter of 2026 and to transition fully to Tier 3, or an equivalent measurement-based system, by January 2027.[20] It states clearly that all submissions shall follow the templates published on the NUPRC website and be verifiable, transparent, and evidence-driven in line with MRV principles.[21] A measurement-based regime of this kind cannot realistically be satisfied by periodic manual sampling; it requires continuous instrumentation and automated data processing, which is where AI has begun to enter petroleum sector governance. The NUPRC Guidelines for Management of Fugitive Methane and Greenhouse Gases Emissions also require leak detection, periodic inspection, GHG monitoring and inventory reporting across upstream operations. In addition, as stated by the Group Chief Executive Officer, NNPC Limited holds decades of untapped data, including logs still kept on paper and seismic data that has never been analysed, and mining this data is now an imperative rather than an option.[22] He warned that operators who fail to adopt AI risk becoming commercially uncompetitive.[23] This statement demonstrates that the shift from periodic to continuous digital monitoring is not a hypothetical regulatory aspiration but an operational reality already underway in the industry that the law is meant to govern.

(ii) AI Technologies Transforming Environmental Compliance

Several categories of AI technology are directly relevant to how environmental compliance evidence is produced in the petroleum sector.

Machine learning models: These are trained on sensor data, including pressure and acoustic vibration readings, to detect deviations that correspond to leaks.[24]Adesuji demonstrates this with a dataset in which a drop in pressure from 68.5 to 64.7 bar, combined with a rise in acoustic

[15] Ibid s 6(2).
[16]Audu and Umana (n 12).
[17] A Adesuji, 'Artificial Intelligence Applications in Pipeline Monitoring and Maintenance: A Pathway to Sustainable Oil and Gas Operations in Nigeria' [2026](12)(2) *World Journal of Engineering Research and Technology*; 19–34.
[18] Ibid.
[19] NUPRC Directive (n 5).
[20]NUPRC Directive (n 5).
[21] Ibid.
[22]Aina (n 7).
[23] Ibid.
[24]Adesuji (n 17).

vibration from 500 to 720 hertz, is flagged by the trained model as a leak event.[25] Once trained, such a model can predict leaks in real time with a low rate of false alarms, which is a material improvement on manual pressure-drop monitoring.[26]

Remote sensing and satellite monitoring: They extend this capacity beyond the pipeline itself. Deep learning models applied to satellite imagery can identify vegetation stress or sheen patterns on water that indicate hydrocarbon contamination, allowing spill detection in remote areas without a physical inspector present.[27] Computer vision performs a related function for physical security and intrusion detection, using drone or closed-circuit video feeds processed through convolutional neural networks to flag unauthorised digging or tampering near a pipeline.[28]

Predictive maintenance: It uses similar techniques for a preventive rather than a responsive purpose. Regression models and neural networks trained on pressure, corrosion rate and vibration data can estimate the remaining useful life of pipeline segments and assign a failure probability to each one, so that inspection and replacement resources are directed to the highest-risk segments first.[29] Corrosion prediction models apply the same logic to a specific failure mode, using soil resistivity and historical corrosion rate to forecast where degradation is most likely to occur.[30]

Automated emissions reporting and predictive compliance analytics: These complete the picture on the regulatory side. Khinvasara and others survey how AI systems can track regulatory obligations and flag compliance gaps on an ongoing basis rather than at the point of a scheduled audit.[31]Similarly, Solanke and others find that AI adoption in the oil and gas industry is associated with improved regulatory compliance outcomes because automated systems generate a continuous evidentiary record rather than a series of disconnected inspection reports.[32] These technologies do not only make compliance monitoring faster. They also change what counts as regulatory evidence, thereby shifting it from a human inspector's periodic account to a continuous, machine-generated data stream.

3 Nigeria's Legal Framework for Environmental Compliance Monitoring: Opportunities Created By Artificial Intelligence

(i) Petroleum Industry Act 2021

The PIA is the primary statute governing environmental obligations in Nigeria's petroleum industry, and several of its provisions create some openings for AI-assisted monitoring even though none of them names AI directly. Section 102(1) of the PIA requires a licensee or lessee engaged in upstream or midstream petroleum operations to submit an environmental management plan for approval within one year of the effective date or six

[25]Ibid.
[26] Ibid.
[27]Adesuji (n 17).
[28] Ibid.
[29]Ibid.
[30] Ibid.
[31] T Khinvasara, A Shankar and C Wong, 'Survey of Artificial Intelligence for Automated Regulatory Compliance Tracking' [2024](26)(7) *Journal of Engineering Research and Reports*;390–406.
[32] B Solanke and others, 'The Impact of Artificial Intelligence on Regulatory Compliance in the Oil and Gas Industry' [2024](7)(1) *International Journal of Science and Technology Research Archive*;61–72.

months after the grant of the relevant licence.[33] Section 102(4) of the PIA further requires the Commission or Authority, in considering that plan, to take into account government policy on environmental protection and management practices, and section 102(5) of the PIA allows the regulator to direct that the plan be adjusted.[34] A plan that is reviewed once at the point of approval and only occasionally thereafter cannot show whether an operator is actually complying with it from day to day. AI-enabled continuous monitoring closes this gap by generating a live data stream against which the approved plan can be measured, rather than leaving compliance to be inferred from the plan document alone. Section 103 of the PIA supports the point by tying environmental remediation funding to risk assessment. It requires a licensee to pay into an environmental remediation fund and to assess its environmental liability annually, increasing its contribution to the satisfaction of the regulator.[35] An annual, self-assessed liability figure is far less reliable than a continuously updated risk score generated from live sensor data, and predictive analytics of the kind described in section 2.2 above could supply that input. However, the statutory hook for AI is section 106 of the PIA. This provision requires a licensee, before commencing petroleum production, to install metering equipment conforming to prescribed specifications on every facility from which natural gas may be flared or vented, and it makes failure to do so an offence.[36] Metering equipment installed under section 106 of the PIA is a form of automated, continuous measurement, and the data it generates is the kind of input that machine learning systems use to detect anomalies and predict compliance risk. A community reading of section 104 of the PIA, which imposes a fine on a licensee who flares or vents gas outside a permitted exception,[37] section 108 of the PIA, which requires a licensee to submit a natural gas flare elimination and monetisation plan within twelve months of the effective date,[38]and section 106 of the PIA shows that the PIA already contemplates instrumented and data-driven verification of flaring compliance. What it does not do is specify how that metering data should be processed, validated or challenged, which is where AI-specific regulation becomes necessary rather than merely useful.

(ii) **Environmental and Climate Regulatory Framework**

Beyond the PIA, the EIA Act and the NOSDRA Act provide the general environmental assessment and spill response framework within which AI-assisted monitoring would operate. Section 2 of the EIA Act restricts any public or private project from proceeding without prior consideration of its environmental impact,[39] and section 4 of the EIA Act sets the minimum content that an EIA must contain.[40] Section 9 of the EIA Act requires the regulatory Agency's decision on a proposed activity to be in writing, to state its reasons and to include any provisions made to prevent or reduce environmental damage.[41] These are front-end obligations, concerned with authorising a project before it begins. By

[33] Petroleum Industry Act 2021, s 102(1).
[34]Ibid, s 102(4) and (5).
[35]Ibid, s 103(1) and (5).
[36]Ibid, s 106(1) and (2).
[37]PIA 2021, s 104(1).
[38]Ibid, s 108.
[39] Environmental Impact Assessment Act Cap E12 LFN 2004, s 2(1).
[40] Ibid, s 4.
[41] Ibid, s 9(1).

contrast, Section 10 of the EIA Act is the only provision of the Act addressing what happens after authorisation, and it is strikingly thin: it merely states that the activity 'shall be subject to appropriate supervision' where the Council deems it fit and appropriate.[42] Because the section prescribes no method or frequency for that supervision, it does not exclude AI-based monitoring, but nor does it give such monitoring any defined legal status. This gap is itself the opportunity: a regulator could, without amending the Act, treat continuous AI monitoring as one legitimate mode of the 'appropriate supervision' that section 10 already contemplates.

The NOSDRA Act complements this by giving the NOSDRA an express surveillance function alongside its response mandate. Section 5 of the NOSDRA Act charges NOSDRA with establishing a mechanism to monitor and, where expedient, direct the response to oil spillage,[43] while section 6(1)(a) of the NOSDRA Act makes it responsible for surveillance and for ensuring compliance with environmental legislation on spills and flares.[44] Section 6(1)(h) of the NOSDRA Act also directs NOSDRA to support research and development in local detection and response equipment.[45] This is a statutory invitation to adopt improved detection technology, including AI-enabled tools, since the Act already treats technological development as part of NOSDRA's core function rather than as something extraneous to it. The 2026 NUPRC directive operationalises this opportunity for methane and GHG reporting specifically. It requires operators to adopt standardised templates for a Greenhouse Gas Emissions Management Plan and for reporting methane and GHG emissions and inventories,[46] and it requires that all submissions be verifiable and evidence-driven.[47] A Tier 3, measurement-based system of the kind the directive mandates by January 2027 is, in substance, a continuous AI-compatible monitoring regime; the directive does not use the words artificial intelligence, but it describes the operational outcome that AI-enabled instrumentation is best placed to deliver. Hence, the PIA, the EIA Act, the NOSDRA Act and the NUPRC directive complement rather than resist AI adoption. Their shared weakness is that none of them makes compliance a measurable, evidentiary standard in explicit terms. AI provides the missing measurement, but the law has not yet made it clear what legal weight that measurement should carry.

(iii) **Regulatory Opportunities Created by AI**

There are several opportunities that AI-enabled monitoring has for Nigerian petroleum regulators.

(a) The first is stronger evidence for enforcement. Where section 104 of the PIA penalises unauthorised flaring, a continuous data stream from section 106 of the PIA metering equipment gives the Commission a contemporaneous record of the flaring event rather than a retrospective estimate, which strengthens any enforcement action taken under that section.[48]

[42] Ibid, s 10.
[43] National Oil Spill Detection and Response Agency (Establishment) Act 2006, s 5(c).
[44] NOSDRA Act 2006, s 6(1)(a).
[45] Ibid, s 6(1)(h).
[46] NUPRC directive (n 5).
[47] Ibid.
[48] PIA 2021, s 104.

(b) The second is real-time compliance supervision, which fills the interpretive gap left by section 10 of the EIA Act discussed above. Supervision that occurs continuously, rather than at scheduled intervals, is more consistent with the intendment of 'appropriate supervision' under the EIA Act than periodic inspection ever was.

(c) Another opportunity is improved transparency and stronger methane accounting, both of which the NUPRC directive already demands through its Tier 2 and Tier 3 reporting requirements.[49]Ahanor and others show, in the e-waste enforcement context, that machine learning-based regulatory intelligence can map compliance risk geographically and identify the specific factors, such as data completeness and inter-agency coordination, that predict enforcement success.[50] The same predictive mapping could be applied to petroleum sector emissions data to direct NUPRC's limited inspection resources toward the highest-risk facilities. Obele's survey of AI adoption in Nigeria's oil and gas industry found that predictive maintenance and automated monitoring are already the most utilised AI applications among industry personnel, and that respondents associate AI adoption with improved decision-making.[51] This is independent evidence, drawn from practitioners rather than regulators, that the capacity for stronger regulatory supervision already exists within the industry.

These opportunities align with Nigeria's stated regulatory direction. The digitalisation strategy of NNPC Ltd rests on protecting existing assets and accelerating near-term production, with digital mining of historical data treated as central to that strategy.[52] NUPRC's MRV directive moves in the same direction from the regulator's side, requiring verifiable and evidence-driven reporting rather than declaratory compliance.[53]In short, the opportunity is that AI can convert Nigeria's existing environmental obligations from statements of intent into measurable outcomes, but realising that opportunity depends on the law addressing the challenges considered in the next section.

4. Regulatory Challenges Preventing Effective Legal Integration of AI

(i) Absence of a Legal Framework Governing AI-Based Environmental Monitoring

Nigeria has no statute that expressly and explicitly recognises AI as a lawful or regulated method of environmental compliance monitoring in the petroleum sector. The NAIS itself acknowledges the resulting gap. Its own account of Nigeria's AI-adjacent regulatory landscape lists the National Policy on AI and Robotics, the National Information Technology Development Agency (NITDA) Act, data protection regulation, the Cybercrimes Act and legislation on technology acquisition and university research as the relevant instruments, describing them as instruments that collectively address crucial aspects such as data protection, cybersecurity, technology transfer, and research.[54] None of these instruments is sector-specific, and none deals with environmental compliance monitoring. The NAIS proposes that Nigeria establish an AI Governance Regulatory Body

[49] NUPRC directive (n 5).
[50]Ahanor and others (n 13).
[51] J D Obele, 'Artificial Intelligence Adoption in Nigeria's Oil and Gas Industry: Challenges, Opportunities, and Impact on Operational Efficiency' [2023](8)(2) *Journal of Entrepreneurship, Management and Marketing Innovation*;89–98.
[52]Aina (n 7).
[53] NUPRC directive (n 5).
[54] National Artificial Intelligence Strategy.

to oversee compliance with a future set of National AI Principles,[55] which confirms, by the fact of the proposal, that no such body or set of principles currently exists in binding form. A national strategy is a statement of policy direction; it does not itself create rights, duties or standards of proof, and until its governance proposals are enacted into law, AI-based environmental monitoring in the petroleum sector operates in a normative vacuum.

(ii) **Reliability and Evidential Challenges**

Even where AI-generated data is available, Nigerian law does not say what evidential weight it should carry. This is not a uniquely Nigerian problem, but Nigeria's petroleum statutes give it no answer at all. The National Institute of Standards and Technology framework, discussed in the NAIS as a model Nigeria could apply, defines a trustworthy AI system by six characteristics: validity and dependability, security and resiliency, improved privacy, transparency and accountability, interpretability and explicability and fairness with zero negative bias.[56] None of these characteristics is presently a legal requirement for AI systems used in Nigerian petroleum sector compliance. A regulator relying on an opaque machine learning model to establish that a licensee breached section 104 of the PIA would, under current law, have no settled standard for testing whether that output of that model is reliable enough to support an enforcement decision. Khinvasara and others' survey of AI systems for regulatory compliance tracking finds that explainability remains one of the most persistent limitations of such systems, because the same complexity that gives a model its predictive power also makes its reasoning difficult to audit.[57] Where a licensee disputes an AI-generated finding, the law provides no procedure for testing the model's validity, which leaves both the regulator and the operator without a settled way to resolve the dispute.

(iii) **Data Governance and Institutional Capacity**

AI-based monitoring is only as reliable as the data it is trained and operated on, and Nigeria's data environment presents a real constraint. According to NAIS, Nigeria has a low data collection rate and many existing datasets suffer from inaccuracy and a lack of standardisation, since different sectors and organisations maintain separate data repositories in varying formats.[58]Ahanor and others confirm the practical effect of this in a directly comparable regulatory setting: their study of Nigeria's e-waste enforcement found that data completeness, inter-agency coordination, regulatory clarity and budget sufficiency were the strongest predictors of successful enforcement, and that the absence of these factors, rather than any weakness in the machine learning models tested, explained persistent enforcement gaps.[59] The same dependency applies to petroleum sector emissions data: NUPRC's own directive admits that the Commission has observed technical capacity limitations and infrastructural MRV gaps, prompting it to convene workshops to build industry capacity for the transition to measurement-based reporting.[60] Cybersecurity and interoperability compound the difficulty, because environmental sensor networks connected to reporting systems create an additional attack surface, and no

[55]ibid.
[56] ibid.
[57]Khinvasara and others (n 31).
[58] National Artificial Intelligence Strategy (n 5) 39 (Box: Access to Data).
[59]Ahanor and others (n 13).
[60] NUPRC directive (n 5).

petroleum sector regulation presently sets minimum cybersecurity standards for the AI systems used in compliance monitoring.

(iv) **Accountability for AI-Assisted Regulatory Decisions**

The final challenge is establishing who bears legal responsibility when AI-assisted monitoring fails, whether by missing a genuine breach or by generating a false positive. Nigerian petroleum law imposes clear environmental obligations on the licensee.[61] It however says nothing about the position of the developer who built the monitoring software, the regulator who relied on its output or the auditor who certified the underlying data. The courts have already shown themselves willing to scrutinise the adequacy of regulatory oversight in the petroleum sector. In the case of *Centre for Oil Pollution Watch v NNP,*[62]the Supreme Court considered the *locus standi* of a civil society organisation to challenge the regulatory handling of pipeline pollution. This shows that questions of regulatory accountability in this sector are litigated in practice and not merely debated in theory. If a future dispute is on whether an AI system correctly identified, or wrongly failed to identify, a flaring or spillage event, the law as it is has no clear rule allocating responsibility between the licensee whose facility generated the data and the software provider whose model processed it, still less the regulator whose decision relied on it. In the view of Solanke and others, this accountability gap is one of the principal reasons operators remain cautious about allowing AI outputs to determine compliance status, since neither the operator nor the regulator can be certain who would answer for an erroneous result.[63] Until law explicitly allocates this responsibility, AI-assisted monitoring will remain legally fragile even where it is technically sound.

5. Towards A Legal Framework For Ai-Enabled Environmental Compliance Monitoring In Nigeria

The paper has shown, from the preceding sections, that Nigeria's petroleum and environmental statutes create room for AI-assisted monitoring without ever regulating it directly. Closing that gap calls for a framework built around six linked components. The starting point is statutory recognition. Section 10 of the EIA Act and sections 102 and 106 of the PIA should be amended, or supplemented by regulation, to state expressly that continuous AI-based monitoring is a recognised method of discharging the supervision and metering obligations those sections already impose.[64] Recognition without standards would be empty, so the second component is a set of validation standards for AI-generated compliance data, addressing the six characteristics of trustworthy AI identified in the NAIS: validity, security, privacy, transparency, explicability and fairness.[65] These standards should specify the minimum accuracy and auditability a model must demonstrate before its output can support a regulatory finding. The third component is a set of legal rules governing automated environmental reporting, clarifying how data generated under section 106 metering obligations or the NUPRC MRV directive should be transmitted and authenticated, so that its evidential chain is clear from sensor to regulator. Fourth, NUPRC and NITDA should jointly operate a certification regime under which an AI monitoring system must be approved before its output is treated as compliance evidence, mirroring the licensing logic the

[61]PIA 2021, ss 102–106.
[62](2019) 5 NWLR (Pt 1666) 518 (SC).
[63]Solanke and others (n 32).
[64]EIA Act, s 10; PIA 2021, ss 102 and 106.
[65] National Artificial Intelligence Strategy.

PIA already applies to physical facilities.[66] Fifth, certified systems should be subject to ongoing transparency and auditability requirements, including a right for an affected licensee to challenge a model's output and have it independently reviewed, which would answer the evidential concerns raised in section 4.2 of this paper. The sixth and final component is institutional capacity building within NUPRC and the NOSDRA, since no framework of standards or certification can operate without regulators able to interpret AI outputs and audit AI systems. Ahanor and others propose the creation of a National Regulatory Intelligence Unit (NRIU) under NESREA to hold this function for environmental enforcement generally.[67]The same institutional model, adapted to petroleum sector data, would give NUPRC the capacity to operate the framework proposed here rather than depending on ad hoc external expertise. These six components would not create a new area of environmental obligation. They would instead give existing obligations, already found in the PIA, the EIA Act and the NOSDRA Act, a defined and certain route through which AI can be used to discharge them.

6. CONCLUSION

The applicable law on environmental compliance monitoring in the Nigerian petroleum industry create statutory space in which AI-assisted monitoring can operate, and in provisions such as section 106 of the PIA, they arguably already assume some form of continuous, instrumented measurement. What none of these instruments does is regulate AI directly. None defines the evidential status of AI-generated data and none allocates responsibility when an AI system errs. The National Artificial Intelligence Strategy (NAIS) recognises these gaps at a policy level but has no binding force over petroleum sector regulation. As argued, artificial intelligence has already changed what Nigerian regulators can observe about petroleum operations. It is the law, not technology, that has not yet caught up. The future challenge for Nigeria's petroleum industry is no longer whether AI can monitor environmental compliance. It is whether the law can evolve quickly enough to govern the legal consequences of AI-generated compliance evidence and automated environmental oversight.

7. Recommendations

As a follow up to the analysis in this paper, the following recommendations are proposed.

(i) The National Assembly or the relevant regulators should amend or supplement section 10 of the EIA Act and sections 102 and 106 of the PIA to state expressly that continuous AI-based monitoring satisfies the supervision and metering obligations those provisions impose.

(ii) The NUPRC should issue binding validation standards for AI-generated compliance data, built around the validity, security, transparency, explicability and fairness characteristics already identified in the National Artificial Intelligence Strategy, so that AI outputs used in enforcement proceedings meet a defined evidential threshold.

(iii) The NUPRC and NITDA should establish a joint certification regime for AI monitoring systems deployed in the petroleum sector, so that only approved systems generate data capable of supporting a compliance finding.

[66] Petroleum Industry Act 2021, s 111.
[67] Ahanor and others (n 13).

(iv) Any AI-based reporting framework must include a clear rule allocating legal responsibility between the licensee and the software developer, extending to the auditor of the underlying data, so that accountability does not depend on ad hoc litigation each time a dispute arises.

(v) NUPRC should build an institutional capacity, along the lines of the National Regulatory Intelligence Unit proposed for e-waste enforcement, so that regulators are able to interpret and audit AI systems rather than depending entirely on the operators those systems monitor.

(vi) These reforms should be pursued through regulation and directive in the short term, given NUPRC's demonstrated willingness to issue detailed MRV directives, while primary legislation is pursued in parallel to give the framework lasting statutory force.