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From Extraction to Value Addition: Engineering Pathways for Bridging Nigeria's Technological Absorptive Capacity Gap in Resource Processing

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ABSTRACT
Nigeria holds 37.01 billion barrels of oil and condensate and 215.19 trillion cubic feet of gas in proven-plus-probable reserves, is the world's largest cassava producer and has documented lithium-bearing pegmatites, yet it captures downstream value unevenly. This critical integrative review argues that, alongside finance, infrastructure and feedstock constraints, the gap reflects an asymmetry in technological absorptive capacity (TAC). The four TAC dimensions (acquisition, assimilation, transformation and exploitation) are articulated as plant level engineering competences and scored using a 0 – 3 rubric for the 7 Nigerian processing cases (NNPC refineries, Dangote refinery, Nigeria LNG, petrochemicals, Ajaokuta Steel, lithium processing and cassava starch).
A case-by-dimension extraction sheet links every score to dated evidence and a confidence grade, and separates verified absence, limited capability and unavailable evidence. Of the 104,976 combinations of scores assessed, Acquisition emerged as the strongest dimension (mean 2.57), while Transformation scored lowest, with only three potential scores and a maximum of 1, placing it in the lowest 95.5% of combinations. Four capability regimes were identified: turnkey-stranded, licensed-operated, foreign-financed nascent, and low-technology fragmented. Of eight headline indicators assessed, three remained unreconciled, one reflected a trend change, and four involved definitional differences. Dangote's crude oil utilisation in early 2025 was approximately 85%, compared with independent auditors' estimates of 54–66%. Priorities include standardising plant performance disclosures, documenting local responsibilities, and independently validating capability assessments. Scores represent single-rater ordinal assessments of observed skills, not quantitative measurements of all domestic engineering capabilities.

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INTRODUCTION

Nigeria has great potential for energy, mineral and agro-industrial development due to its natural endowment. As of 1 January 2026, the Nigerian Upstream Petroleum Regulatory Commission (NUPRC) declared proven-plus-probable (2P) reserves of 37.01 billion barrels of oil and condensate (31.09 billion barrels of crude oil and 5.92 billion barrels of condensate) and 215.19 trillion cubic feet (TCF) of gas (Channels Television, 2026; NUPRC, 2026). Nigeria is also the world's largest cassava producer, with output rising from 56.96 million tonnes in 2019 to 62.69 million tonnes in 2023 (BusinessDay, 2025b), and lithium-bearing pegmatites have been documented in Nigerian geology (Olajuyi et al., 2025).
Even with this endowment, resources have not necessarily been translated into dependable processing power and domestic technological capacity. All four refineries owned by the Nigerian National Petroleum Company Limited (NNPC), with a combined capacity of 445,000 barrels per day (b/d), remained closed in May 2026 (Reuters, 2026). The privately-owned Dangote refinery, on the other hand, was recorded by the downstream regulator to have operated at 105.21% utilisation in August 2026, with 736,470 b/d against a 700,000 b/d basis (Billionaires Africa, 2026; allAfrica, 2026a). In 2025, Nigeria LNG exported 14.78 million tonnes of LNG, compared with 13.78 million tonnes in 2024 (Leadership, 2026b). These contrasts show that endowment does not determine industrial outcomes. More importantly, an operating plant is no guarantee that domestic engineers can troubleshoot, modify, optimise and replicate its technology. The issue is not just whether a plant is in operation but who has the engineering skills and authority to run, modify, and replicate the plant.
Domestic capability in this review is defined as the demonstrated competence of the engineering teams in Nigeria, along with documented decision authority, in selection of process technology, operation, maintenance, modification and replication. It is about the location of the engineering activity, not the ownership of the plant or the nationality of the plant staff: it's also about a foreign-owned plant that develops domestic capability and a state-owned plant that relies entirely on foreign engineering. Workforce competence is therefore not enough but essential and ownership considered in isolation (P2 below). Capability is also one of a number of interacting constraints. Finance,

infrastructure (gas, power and pipelines), feedstock security and capability constrain one another: a refinery without reliable crude supply cannot demonstrate sustained operation, and a plant without maintenance funding struggles to retain skilled staff. The scores reported here therefore describe demonstrated capability under these constraints, and Section 5.7 weighs the competing explanations explicitly.

The lens that can be used for this question is the technological absorptive capacity (TAC). Cohen and Levinthal (1990) define absorptive capacity as the capacity to recognise the value of external knowledge, assimilate it and use it for commercial purposes. It is reconceptualised by Zahra and George (2002) in four ways (acquisition, assimilation, transformation and exploitation), which are categorised into potential and realised capacity. A meta-analysis of 19 studies covering more than 6,000 firms finds a positive but heterogeneous relationship between technological capability and performance in developing countries (Tello-Gamarra & Fitz-Oliveira, 2023). Because learning in process industries involves licensors, contractors, suppliers, regulators and training institutions as well as operators, we follow the multi-level view of absorptive capacity proposed by Volberda et al. (2010) and adopt the plant ecosystem as the unit of analysis.

Three gaps motivate the review. First, Nigerian studies of processing industries tend to be sector-bound: expert surveys of state-refinery performance (Iheukwumere et al., 2021), a survey of technology adoption among cassava starch processors (Adejumo et al., 2025), a comparative study of upstream local content (Heum et al., 2003) and a review of lithium ores (Olajuyi et al., 2025). None applies a common engineering-based assessment across sectors. Secondly, there is little differentiation between the requirement to operate the acquired technology and to have the capability and authority to modify and develop the technology, meaning that investment, capacity, output and local procurement could be interpreted as evidence of a pool of accumulated capabilities. Third, performance evidence is from different time spans, definitions and degrees of independence, compromising the ability to make comparisons between plants. This review extends those sector studies in three ways: it applies one rubric to seven cases across hydrocarbons, gas, petrochemicals, steel, lithium and agro-processing; it separates demonstrated, locally controlled engineering capability from operating output; and it tests how far the public evidence can support such comparisons.

The study addresses four research questions. (RQ1) How can the four TAC dimensions be translated into observable plant-level engineering competences and scored consistently across sectors? (RQ2) What are the biggest capability gaps in the seven cases, and what capability profiles are revealed, and how much do competing explanations (plant age, feedstock, finance and licensor dependence) explain these capability gaps? (RQ3) What is the reliability and comparability of the public evidence of plant performance? (RQ4): What are the engineering, institutional and policy avenues to facilitate domestic learning and what do comparator countries bring to the table for these? Four propositions are tested and not assumed: P1: acquisition is more developed than assimilation and exploitation, and transformation is the least developed; P2: differences in operating performance (assimilation and exploitation) are not explained solely by ownership; P3: weak transformation weakens progress towards process modification and towards higher value activity; and P4: inconsistent performance reporting weakens capability assessment across sectors. Design implications are used to answer RQ4, since there is not enough evidence to prove the effectiveness of the policies in Nigeria.

The review provides (a) an engineering translation of the four TAC dimensions into plant-level competences; (b) a common scoring protocol, with a case-by-dimension extraction sheet, for all seven cases; (c) a clear distinction between operational performance and locally controlled capability; (d) an audit of the evidence on which the scores rest; and (e) capability-conditioned policy pathways. To our knowledge, this combination has not been presented in an equivalent review within the literature retrieved for this study; the claim is limited to the documented search and does not imply that work on individual components is absent.

Conceptual Framework

Absorptive Capacity: From the Firm to the Plant Ecosystem

Zahra and George's (2002) distinction between potential absorptive capacity (acquisition and assimilation) and realised absorptive capacity (transformation and exploitation) explains how organisations convert external knowledge into operational and commercial outcomes. Resource-processing industries require a broader frame because technological learning is distributed across plant operators, technology licensors, engineering contractors, suppliers, regulators and technical institutions. Thus, this review adopts the plant ecosystem as the unit of analysis, as advocated in Volberda et al. (2010) who argues that absorptive capacity is the result of individual, organisational and inter-organisational influences.

Capability Accumulation and Learning Intensity

Technological capability is not simply the purchasing of equipment, but a process of learning, which is cumulative. Lall (1992) refers to the interdependence of incentives, capabilities and institutions to achieve technological development and Kim (1998) highlights the contribution of performance crises to the learning and development process from imitation to innovation. In Nigeria, where several state-owned processing plants have long been idle, failure of operation becomes an opportunity to learn only when problems are investigated systematically, technical knowledge is preserved and the authority to make changes is retained. Hardship does not create ability.

Resource Linkages and Local Content

Resource sector linkages can be used to improve local technology development by involving local participation in engineering, manufacturing, equipment supply and services (Morris et al., 2012). Research on mining value chains in Latin America highlights the significance of knowledge sharing and of technical interaction and learning (Figueiredo & Piana, 2016; Pietrobelli et al., 2018; Stubrin, 2017). Local content policies in oil and gas-producing countries have had mixed impacts with backward linkages in Nigeria being constrained (Adewuyi & Oyejide, 2012) and in other countries, (Acheampong et al., 2016; Ayentimi et al., 2016) reported mixed results for local content policies. Hilson and Ovadia (2020) state that the development of an indigenous technical base is dependent on the state enterprises and agencies. Local content is therefore considered here as a means to capability development rather than proof of development, and the review questions whether local participation takes place from simple procurement to design, fabrication, maintenance and process modification.

The Engineering-Based TAC Framework and Scoring Method

Table 1 defines four distinct TAC dimensions. Acquisition is access to technology and participation in its selection, contracting and commissioning; assimilation is the ability to

operate and maintain it; transformation is the ability to modify and adapt it; and exploitation is the ability to use it for sustained commercial output, upgrading or replication. Operational performance is not used as an indicator of technological autonomy, as a plant could achieve high output while relying on external specialists for major changes.

Table 1: Engineering-Based Technological Absorptive Capacity Framework

Dimension	Engineering competence	Key indicators
Acquisition	Technology selection, contracting and engineering participation	Technology source; domestic engineering involvement; commissioning and knowledge-transfer arrangements
Assimilation	Operation, maintenance and reliability management	Capacity utilisation; downtime; locally led maintenance; operator competence
Transformation	Process modification and technological adaptation	Locally led debottlenecking, feedstock adaptation, fabrication and process improvement
Exploitation	Sustained commercial operation and upgrading	Operating performance; product quality; commercial output; technological replication

Every case is scored against each of the criteria using the 0-3 ordinal scale shown in Table 2. Three distinct questions are addressed in this scoring framework: Acquisition refers to whether and when industrial-scale technologies were ever acquired and commissioned by the plant. Assimilation and Exploitation refer to the technological capabilities currently present within a specified timeframe (November 2024 to October 2026). Evidence strength is graded between A, B and C. A = Regulatory/Technical/Evidence peer reviewed. B = Information provided by the company or specific information reported at a particular time by reputable sources. C = Indirect, incomplete, no dates or inferred. All cells have an evidence status. A score of 0 indicates there is evidence that the capability is not present. This can only be assigned if it can be proven that there is no evidence of the competence being present (e.g. Core process never operational). A score of 1 indicates there is some capability. If there is no dated evidence available in the public domain then this cell will have a status of NE. These cells have not been included in the mean scores for each criterion and are constrained in the sensitivity analysis (Section 3.5). The scores are subjective and do not rely on validation through surveys.

Table 2: Scoring Rubric (0–3 Ordinal Scale), Assessment Windows and Treatment of Missing Evidence

Dimension	0 (verified absence)	1	2	3
Acquisition (plant history)	No verified technology access	Technology contracted or partly installed; core process not commissioned	Technology largely installed but core process not fully commissioned; or commissioned within 12 months of the evidence cut-off; or industrial-scale technology confined to a minority of case capacity	Industrial-scale technology acquired and commissioned into operation at any point in the plant's life
Assimilation (Nov 2024–Oct 2026)	No operation in the assessment window	Commissioning, intermittent operation or recurrent failure	Sustained operation, but below design performance or near design for fewer than 12 consecutive months	Operation near design performance for at least 12 consecutive months, with locally led routine maintenance documented
Transformation (plant history)	Positive evidence that no process modification was undertaken or was possible	Modification reported; local leadership unverified	Documented local-led adaptation or modification	Repeated, independently verified local-led redesign
Exploitation (Nov 2024–Oct 2026)	No commercial output in the assessment window	Limited, intermittent or early commercial output	Sustained commercial output; upgrading or replication unverified	Sustained performance near design capacity with upgrading or replication

Note. NE (not evidenced) is recorded where no dated public evidence exists either way; it is not a score and is excluded from means. Confidence grades (A–C) are recorded separately for every case–dimension cell in Appendix Table A1.

MATERIALS AND METHODS

Review Design and Literature Search

This is a critical integrative review that combines conceptual and empirical literature with plant, regulatory, company and press evidence for seven Nigerian cases. Literature searches were run in Dimensions on 23 October 2026 using five predefined strings: S1 (technological capability and resource processing), S2 (operational capability and technology transfer), S3 (resource-sector linkages in comparator countries), S4 (absorptive capacity in developing economies) and S5 (engineering education and skills). They covered English-language publications from 1990 to 2026 and returned 8, 0, 1,076, 326 and 30 records respectively (1,440 before de-duplication by Dimensions identifiers and DOIs). The full search strings are available from the authors. Searches of regulator, company and international-organisation sources were conducted separately and are not included in these counts.

Case Selection

The seven cases were selected purposively to span the main resource classes (crude oil, natural gas, petrochemicals, iron and steel, lithium and cassava) and to vary ownership (state, private domestic, joint venture and foreign-financed), technology source and stage of development (idle, commissioning and sustained operation). Five cases are single plants or a single operator's complexes (NNPC refineries, Dangote refinery, Nigeria LNG, Ajaokuta Steel

and the Endo lithium plant); two are composite cases (petrochemicals, combining the Eleme and Dangote polypropylene complexes, and cassava starch, a population of small and medium processors). Because composite and plant-level cases are not like-for-like, results are also reported for the plant-level subset (Table 4).

Evidence Extraction and Confidence Grading

Sources were selected for relevance to technological capability, engineering learning, resource linkages and industrial upgrading. For every case we extracted installed capacity, utilisation, technology source, ownership, local engineering participation and operating history, and recorded the result in a case-by-dimension extraction sheet (Appendix Table A1). Each of the 28 cells records the score, its evidence status (demonstrated, limited, verified absence or not evidenced), the dated evidence relied on, the sources and a confidence grade (A–C; Section 2.4). The grade is that of the strongest source supporting the score. The evidence cut-off was 31 October 2026. Each figure and source quoted in this article was checked against the original document or a primary reproduction, and statements that could not be confirmed were removed.

Conflicting Reports, Syndicated Sources and Missing Data

Three rules governed difficult evidence. First, conflicting figures were neither averaged nor reconciled arbitrarily. Where two sources reported the same quantity differently, both were recorded, the score was based on the more independent source (in the order regulator, independent market analytics, company and general press), and the conflict was logged in the measurement-integrity audit (Table 6). Where a difference arose from definitions (for example, receipts versus throughput, or different capacity denominators), the figures were restated on a common, explicit basis rather than treated as contradictory. Second, syndicated items were treated as a single source. Press reports reproducing the same regulator factsheet (for example, the NMDPRA August 2026 factsheet reported by allAfrica and Nairametrics) or the same wire story (Reuters via TimesLIVE) were not counted as independent corroboration; where syndicated versions of one release disagreed, the disagreement was itself logged (Table 6, item 4). Third, missing data were recorded as not evidenced (NE), never as zero.

Sensitivity Analysis and Rater Design

Two kinds of uncertainty were tested. Scores resting on grade-C evidence were allowed to move one point down or up within the 0–3 range, and NE cells were imputed at 0 (verified absence) or 1 (limited capability). Two uniform scenarios moved all uncertain cells together to their lower and upper values. Because uniform scenarios cannot show whether an ordering survives mixed combinations, we also enumerated every combination of the eight grade-C cells (three values each) and the four NE cells (two values each), giving $3^8 \times 2^4 = 104{,}976$ combinations, and recorded how often each pairwise ordering of the dimension means held. A stress test allowed NE cells to take the value 2. The scoring was done by one rater, and inter-rater reliability has not been determined; the extraction sheet is provided so that the scores can be independently re-rated.

RESULTS AND DISCUSSION

Case Evidence I: Resource Base and Value-Chain Position (RQ2)

Sections 4 to 8 follow the research questions. Sections 4 and 5 present the case evidence and capability profiles (RQ2), applying the rubric developed for RQ1 in Section 2.4; Section 6 examines measurement limitations (RQ3); and Sections 7 and 8 set out policy implications (RQ4). Section 9 assesses the propositions.

Hydrocarbons and Petrochemicals

The reserve base is gas-weighted: 2P gas reserves rose from 210.54 TCF to 215.19 TCF between January 2025 and January 2026, while oil and condensate reserves fell slightly (Channels Television, 2026). The four state refineries total 445,000 barrels per stream day (Iheukwumere et al., 2021). Port Harcourt had been shut since 2020 after several years of low utilisation (Argus Media, 2024); its old unit restarted on 26 November 2024 and halted again on 24 May 2025 (Sweet Crude Reports, 2025). Port Harcourt's two units are managed as a single complex, so non-producing status for "Port Harcourt, Warri and Kaduna" refers to three complexes and four installations. The Dangote refinery began commissioning in January 2024 (BusinessDay, 2025a). NMDPRA's August 2026 factsheet reports domestic refinery crude receipts of 683,000 b/d and no production at the three NNPC complexes (allAfrica, 2026a; Nairametrics, 2026c).

Nigeria LNG (NLNG) began producing in August 1999 and, after Train 6 in 2007, had capacity of 22 million tonnes per annum (mtpa) of LNG plus about 5 mtpa of liquefied petroleum gas and condensates; Train 7 is to raise liquefaction capacity to 30 mtpa, with start-up targeted for the end of 2027 (Leadership, 2026a, 2026b). In petrochemicals, Indorama Eleme's complex comprises an olefins cracker with M. W. Kellogg technology, a polyethylene plant licensed from Nova Chemicals and a polypropylene plant licensed from Basell, with stated capacities of 360 kt per year of ethylene and 120 kt per year of propylene from the olefins plant and 360 kt per year for the polyethylene unit (Indorama Eleme Petrochemicals Limited, n.d.). Dangote polypropylene began production in March 2025 (S&P Global, 2025b) and is described as a 900,000 t per year, 77-grade plant (BusinessDay, 2025a).

Solid Minerals

The Diamond New Energy lithium plant at Endo, Nasarawa State, was commissioned on 2 July 2026. It has a reported processing capacity of 6,000 tonnes of ore per day on an investment of about USD 250 million, with Chinese firms Jiuling and Canmax involved (Energy News Network, 2026; Nairametrics, 2026b). Several reports equate this with about three million tonnes per year, but that figure would require roughly 500 operating days; at 365 operating days the stated daily rate gives 2.19 million tonnes per year, and no source states the annual operating basis. Only the daily figure is therefore used here. Domestic geoscience work is meanwhile extending the resource base: lithium ores from Birnin Gwari, Kaduna State, were recently characterised at about 1.17–1.34 wt% Li (Goje et al., 2026). This is evidence of foreign-backed acquisition and installed ore-processing capacity, not yet of sustained commercial output, domestic process-design authority or local control of chemical conversion. Ajaokuta Steel Company was established in 1979, has not produced liquid steel since inception, and was designed to produce 1.3 million tonnes of liquid steel per year in its first phase (Adekoya, 2023; Nairametrics, 2026a).

Agricultural Resources

Nigeria's cassava output of 62.69 million tonnes in 2023 coexists with limited industrial use: BusinessDay (2025b) reported that less than 5% of the crop goes to industrial processing. The survey of 570 cassava starch processors revealed that the adoption of the use of automated technology was very low (18%) and that a gradient of profitability was experienced among the processors from conventional to semi-automated to automated (Adejumo et al., 2025). These sources show the difference between agricultural production and industrial processing, but they do not show an independently audited supply–demand balance of starch at the national level. Evidence from palm oil, another agro-processing chain, points the same way. Among palm oil processors in Ogun State, adoption of an improved oil clarifier significantly affected technical inefficiency, and the authors recommended training in the use of improved technology to build capacity (Ogunmola et al., 2019). A review of Nigerian crude palm oil likewise attributes quality and safety problems partly to inadequate processing know-how, alongside poor raw materials, packaging, handling and adulteration (Abdullahi et al., 2023). In both chains, the binding constraint lies in operating and process know-how as much as in access to equipment.

The value-capture gap is thus a collection of sector-specific bottlenecks (Table 3). Refining has advanced the most toward domestic processing, but the evidence is not definitive and does not prove that the whole refining process is 100 percent domestically controlled or that domestic processing has replaced imports. LNG demonstrates a sustained export capability, this is not enough to develop gas-based manufacturing capability. At Ajaokuta, steelmaking remains stalled before production, lithium has been moved to an initial ore-processing stage, and cassava is still at the agricultural level with some industrial applications. It is a comparison and not a like for like productivity ranking.

Table 3: Resource Base, Processing Status and Value-Capture Gap, October 2026

Resource	Verified indicator	Domestic processing status	Gap
Oil and condensate	37.01 billion bbl, 2P (NUPRC, 2026)	State refineries (445,000 bpsd) shut in May 2026; Dangote reported at 105.21% in August 2026	Refining advanced in private hands; state assets idle
Natural gas	215.19 TCF, 2P (NUPRC, 2026)	NLNG 22 mtpa LNG; Train 7 to 30 mtpa (end-2027 target)	Value concentrated in LNG exports
Iron ore and steel	Ajaokuta designed for 1.3 Mt/y (Adekoya, 2023)	No liquid steel produced since 1979 (Nairametrics, 2026a)	No liquid-steel output at Ajaokuta (plant-specific)
Lithium	Pegmatites documented (Olajuyi et al., 2025)	Endo plant commissioned 2 July 2026; 6,000 t ore/day	Chemical conversion not evidenced
Cassava	62.69 Mt in 2023 (BusinessDay, 2025b)	Under 5% used industrially; 18% of surveyed processors automated	Large agricultural base; limited industrial use

Note. 2P = proven plus probable; bpsd = barrels per stream day; mtpa = million tonnes per annum.

Case Evidence II and Capability Profiles (RQ2)

Acquisition: Strong on Capital, Ambiguous on Engineering Authority

Nigeria has shown that it has the capacity to acquire large-scale process technologies if sufficient capital is available. NLNG has been operating since 1999 (Leadership, 2026a), the Dangote complex has been in operation since 2024 (BusinessDay, 2025a) and the processing units of Indorama Eleme Petrochemicals Limited operate under foreign technology concessions. However, the acquisition and operation of advanced equipment does not necessarily give the right to design, change or optimise their technology independently. Local content statistics illustrates this difference. The Nigerian Content Development and Monitoring Board (NCDMB) reports that Nigerian content in the oil and gas sector has increased from less than 5 percent before the 2010 Act to 26 percent in 2017, compared to the 70 percent target set for 2027 (NCDMB, 2017), and reached 42 percent by December 2021 (Sweet Crude Reports, 2022a). However, expenditure-based indicators do not necessarily reflect domestic technical capacity. A 2003 study of 447 large suppliers found that, although 256 were majority owned by Nigerians, many of them were mainly active as import agents; only 79 (less than 20 percent) had a significant part of their value-added activities located in Nigeria. Differences in measurement of local content have also led to estimates of 5-30 percent (Heum et al., 2003). Consequently, two perspectives emerge. The traditional local content approach emphasizes domestic spending, employment and procurement, while the engineering capability approach assesses whether these activities develop domestic design expertise, process control, maintenance independence and supplier innovation. Although available statistics show an increase in domestic participation, they provide only limited evidence of a corresponding improvement in the independent technical capability. The performance of local content should therefore be assessed not only on the basis of the expenditure retained at home, but also on its contribution to technological learning, adaptation and domestic innovation.

Assimilation: Operating What Is Acquired

The disparity between having process assets and sustaining operations is clearly illustrated in the state refineries. Iheukwumere et al. (2021) conducted an expert survey to determine the factors that affect the performance of refinery plant but the result did not show direct plant performance, rather it showed experts perception on the various factors that affect the performance of refinery plant, which includes government interference, funding, political indecision, theft, pipeline attack, cost of spare part, maintenance, operating capital, supply of feedstock and competence and training of staff. The old Port Harcourt unit restarted on 26 November 2024 but was halted on 24 May 2025 (Sweet Crude Reports, 2025). All four state refineries remained closed in May 2026 (Reuters, 2026) while in August 2026 the regulator reported no production at the Port Harcourt, Warri or Kaduna refineries (allAfrica, 2026a). Under the rubric, this record of intermittent operation within the assessment window gives an assimilation score of 1. The acquisition score, by contrast, reflects the plants' history: industrial-scale refining technology was acquired, commissioned and operated for decades, so the case scores 3 on acquisition. Its weakness lies in current functionality, not in historical access to technology. An operating case that contrasts with the Dangote refinery is also unevenly ramped up. Company sources indicated that by the end of January the plant had achieved 85% of its 650,000 b/d nameplate, while data from the market analytics firms Argus and Kpler and Vortexa suggested crude receipts of

350,000–400,000 b/d (54–62%) in January, and 61–66% in early February (Argus Media, 2025a). The regulator said that domestic refineries' average utilisation stood at 99.12% by April 2026, and Dangote refinery was at its full capacity for most days by 2026 (allAfrica, 2026b; Reuters, 2026); while in August 2026, Dangote refinery utilisation was reported at 105.21% (allAfrica, 2026a). Applying the rubric, the Dangote refinery scores 2 on assimilation because operation near design performance is documented only from 2026, fewer than 12 consecutive months before the evidence cut-off, after an uneven ramp-up in 2025. The score rests on operating and reliability evidence, not on transparency; gaps in disclosure are reflected instead in the confidence grade (B). The record shows operation, but not independent Nigerian control over commissioning, process design or major modification.

The difference between NNPC and Dangote should not be narrowed down to public vs private ownership. As reported by the regulators in August 2026, the private operators vary widely, ranging from Edo refinery at 90.43% to WalterSmith at 64.77%, to Aradel at 58.77% and to OPAC at 16.97%, with Duport being closed (allAfrica, 2026a). Private ownership alone is not enough, therefore, to ensure high utilisation and the sources do not discriminate between the reasons for differences in performance. The evidence sits at a qualified institutional level, not a clean ownership level; a causal claim would need similar plant-level information on feedstock, downtime, maintenance spending, staffing, and turnaround execution. Product-quality evidence is also emerging for this segment: diesel from a Nigerian modular refinery met most national fuel specifications in ASTM tests (Abdulrahman et al., 2026), although such tests demonstrate product quality rather than plant-level utilisation or local engineering authority. Plant age, feedstock supply and financing also differ between the state and private plants (Section 5.7).

Transformation: The Least Evidenced Capability

Transformation is the least documented dimension. Oil sector firms have very low linkages with local firms, which limits the domestic firms' capacity to provide technologies for the upstream industry (Adewuyi & Oyejide, 2012), while the 2003 technology assessment placed Nigeria at very low level compared to the technology leaders in the upstream oil industry sector (Heum et al., 2003). One development may be regarded as a sign of transformation but is currently not considered to be led by the local engineer; Dangote's plan to increase the nameplate capacity from 650,000 b/d to 700,000 b/d to eliminate constraints that held the plant back from its potential (Argus Media, 2025b). Capacity expansion can be provided by a licensor or contractor, and, if no evidence is available showing engineering lead and local problem-solving contributions, it cannot be scored as demonstrated local transformation. Under the revised rubric, transformation could be scored in only three cases: the Dangote refinery and NLNG score 1 (expansion reported, but local engineering leadership unverified), and Ajaokuta scores 0 because its core steelmaking process has never operated. For the NNPC refineries, petrochemicals, lithium and cassava starch, no dated public evidence either way was found, and these cells are recorded as not evidenced rather than as zero.

A low score may indicate lower ability, lack of evidence of ability, or a combination of the above. Public reporting rarely singles out the leader of engineering change or approval of design changes. The review scores demonstrated and attributable transformation, not presumed competence. This conservative rule does not recognize capability based on capacity building alone, but may underestimate undocumented learning. The takeaway is not that Nigerian engineers are incapable of doing this, but that it is the least demonstrated and least documented dimension.

Exploitation: From Commissioning to Sustained Output

There is a wide variation in the degree of exploitation among cases. Ajaokuta, established in 1979, has produced no liquid steel – the Minister of Steel Development stated in July 2026 that a technical audit was being undertaken, and that an agreement with a Chinese investor would be finalized before the end of 2026; also, the 2026 budget proposal provided N6.69 billion to the company (Nairametrics, 2026a). These are only planning, not results of operation. The NNPC refineries produced only limited and contested volumes during the 2024–25 restart, which supports an exploitation score of 1 with grade-C confidence (Sweet Crude Reports, 2025). NLNG has since 1999 exported continuously and in 2025, the 14.78 million tonnes of exports is approximately 67% of its nameplate capacity in 22mtpa, purely by numbers, which represents a combination of exported volumes and capacity and should not be interpreted as a utilisation rate. The lithium plant is a newly commissioned plant and the survey of the cassava business does not set the level of performance of an integrated starch sector (Adejumo et al., 2025). Exploitation should not be read as a proxy for national technological independence.

Scored Results

Table 4 and Appendix Table A1 report the rescored results. Using evidenced cells only, the dimension means are 2.57 for acquisition (n = 7), 1.43 for assimilation (n = 7), 1.14 for exploitation (n = 7) and 0.67 for transformation (n = 3). Under the lower uniform scenario (grade-C scores −1; NE = 0) the means are 2.57, 1.00, 0.57 and 0.14 respectively; under the upper scenario (grade-C scores +1; NE = 1) they are 2.57, 1.86, 1.71 and 1.00 (Figure 1). Across all 104,976 mixed combinations, acquisition has the highest mean in every combination, and transformation has the lowest mean in 95.5% of them; in the remainder it ties with or exceeds exploitation. Assimilation exceeds exploitation in only 75.3% of combinations, so the order of the two middle dimensions is not a robust finding. When NE cells are allowed to reach 2, transformation remains lowest in 71.1% of combinations. The robust findings are therefore limited to two: acquisition is the strongest demonstrated dimension, and transformation is the least evidenced and, in most combinations, the weakest. For the five plant-level cases alone, the means are 2.60, 1.20, 0.67 (n = 3) and 1.20. These are descriptions of an ordinal rubric, not interval-scale measurements; the cases are purposive and not statistically representative, and the analysis does not correct for the single-rater design. No case scores above 1 on transformation, which reflects the absence of documented, attributable local modification rather than proof that it does not occur.

Table 4: Rescored TAC Diagnostic with Confidence Grades (0–3 Scale; Seven Cases)

Case	Acquisition	Assimilation	Transformation	Exploitation	Mean (evidenced cells)
NNPC refineries	3 (A)	1 (B)	NE	1 (C)	1.67
Dangote refinery	3 (B)	2 (B)	1 (B)	2 (B)	2.00
Nigeria LNG	3 (B)	2 (C)	1 (C)	2 (B)	2.00
Petrochemicals (Eleme; Dangote PP)†	3 (B)	2 (C)	NE	1 (C)	2.00
Ajaokuta Steel	2 (B)	0 (B)	0 (B)	0 (B)	0.50
Lithium processing	2 (B)	1 (B)	NE	1 (C)	1.33
Cassava starch†	2 (A)	2 (C)	NE	1 (C)	1.67
Dimension mean, evidenced cells (n)	2.57 (7)	1.43 (7)	0.67 (3)	1.14 (7)	1.45
Lower uniform scenario (grade C −1; NE = 0)	2.57	1.00	0.14	0.57	1.07
Upper uniform scenario (grade C +1; NE = 1)	2.57	1.86	1.00	1.71	1.79
Range across all 104,976 mixed combinations	2.57	1.00–1.86	0.14–1.00	0.57–1.71	–
Plant-level cases only (5 cases)	2.60	1.20	0.67 (3)	1.20	1.42

Note. Scores are ordinal judgements by a single rater; letters in brackets are confidence grades (A–C). NE = not evidenced (no dated public evidence either way); NE cells are excluded from evidenced means and row means, so row means based on three cells are not directly comparable with those based on four. † Composite case (two complexes, or a population of processors); plant-level means are reported separately. Scenario rows move all grade-C scores by one point within 0–3 and impute NE cells at 0 or 1; the range row covers every mixed combination. The evidence for each cell is given in Appendix Table A1.

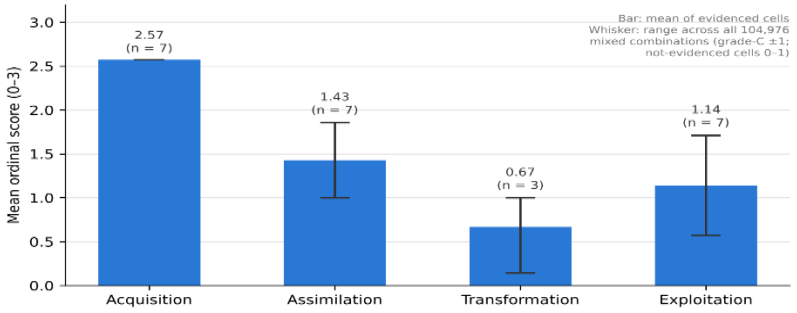

Figure 1: Mean TAC Score by Dimension, With the Range across All Mixed Uncertainty Combinations

Note. Bars show means of evidenced cells (n in brackets); whiskers show the minimum and maximum across all 104,976 combinations of grade-C (±1) and NE (0–1) values (Table 4; authors' calculation).

Four Regimes of Capability

The cases fall into four ideal-typical regimes (Table 5). The turnkey-stranded regime combines high historical acquisition with little or no current operation. The licensed-operated regime combines high acquisition scores with commercial operation while transformation is at most 1 or not evidenced: plants operate at scale without public evidence that local teams hold design and modification authority. Regimes are analytical, not permanent, units; a plant can shift between regimes as its operating history, ownership, feedstock availability, labour availability and typology evolve; support for these regimes should be assessed longitudinally.

Table 5: Capability Regimes, Signatures and Binding Constraints

Regime	Cases	Score signature (Acq/Assim/Transf/Expl)	Binding constraint	Primary policy lever
Turnkey-stranded	NNPC refineries; Ajaokuta Steel	2–3 / 0–1 / NE–0 / 0–1	Operability, continuity, governance, enabling infrastructure	Performance-based operating contracts; independent verification; gas and power first
Licensed-operated	Dangote; Nigeria LNG; petrochemicals	3 / 2 / NE–1 / 1–2	Local engineering authority; licence terms	Engineering-share and knowledge-transfer clauses; pilot facilities
Foreign-financed nascent	Lithium processing	2 / 1 / NE / 1	Assimilation; stage of the product	Capability gates on export restrictions; conversion milestones
Low-technology fragmented	Cassava starch	2 / 2 / NE / 1	Feedstock yield, aggregation, scale	Extension and aggregation; offtake and quality standards

Note. NE = not evidenced (Table 2). Signatures are taken from Table 4.

Competing Explanations: Plant Age, Feedstock, Finance and Licensor Dependence

The capability profiles are not the only explanation for differences in plant performance, and the scores cannot by themselves separate capability from four competing explanations. The age of the plants differs significantly. The state refineries are old facilities, with Port Harcourt closed since 2020 due to many years of low utilisation (Argus Media, 2024). In comparison, the Dangote refinery started commissioning in 2024 (BusinessDay, 2025a). Even if the personnel run the plants with high competence, there will still be issues of the plants being aged, with old spares and lack of maintenance causing low assimilation. This is also confusing as the Dangote refinery is owned by the NNPC, but it is a new plant. Feedstock issues can also cause low utilisation. Theft, sabotage and variable feedstock are cited as reasons for poor performance in state refineries by experts (Iheukwumere et al., 2021). The difference in crude received and throughput at Dangote (Section 6.1) shows how crude availability can affect utilisation. In regards to NLNG, without knowing how much gas is available, we cannot say the reason for not exporting at nameplate capacity is due to plant reliability. With cassava starch, feedstock availability and clumping will affect the plant.

Finance can be an issue. Funding, working capital and spare parts are cited as issues in state refineries (Iheukwumere et al., 2021). Ajaokuta is reliant on an agreement with investors and budget allocation (Nairametrics, 2026a). Foreign investment was used to fund the Endo lithium plant (Nairametrics, 2026b). Licensors are also an issue. Eleme has units licenced by KBR, Nova Chemicals and Basell (Indorama Eleme Petrochemicals Limited, n.d.). The lithium plant has been built with the help of Chinese partners (Energy News Network, 2026). The Dangote expansion may be designed by licensor or contractor (Argus Media, 2025b). Licenses can cause issues as they will have set terms on how much can be changed locally. Therefore, a low transformation score may be due to the license. However, finance and feedstock will determine whether the plant will be operational for a long period of time to allow learning to take place. Licenses will also determine whether learning can happen. The TAC scores demonstrate the capability of the plants under these constraints however this does not mean capability is the main or only reason for the difference in performance.

Measurement Limitations: Plant-Level Evidence and Data Audit (RQ3)

Refining

Figure 2 separates the four kinds of evidence available on Dangote refinery performance: company-linked statements, independent estimates of crude receipts, regulator-based throughput for the Dangote plant and the regulator's average utilisation for all domestic refineries. These are different indicators, and they are shown in separate panels so that the figure does not imply equivalence between receipts, throughput and aggregate utilisation. In early 2025, company-linked statements were 20–30 percentage points higher than independent receipt-based estimates (Argus Media, 2025a; S&P Global, 2025a), which shows why company statements and independent measures should not be used interchangeably. Utilisation also depends on the numerator, the denominator and the averaging period. The regulator-based figure of 105.21% is the August 2026 throughput divided by the re-rated capacity: 736,470 ÷ 700,000 × 100 = 105.21%. Against the original nameplate of 650,000 b/d (Reuters, 2026), the same throughput gives 736,470 ÷ 650,000 × 100 ≈ 113.30% (authors' calculation). Moreover, the 736,470 b/d of Dangote throughput exceeds the regulator's August total of crude receipts for all domestic refineries (683,000 b/d; allAfrica, 2026a), indicating that receipts and throughput are different quantities; throughput can, for example, draw on stored crude. For this reason, regulator and company series are treated as complementary and are not spliced into a single record.

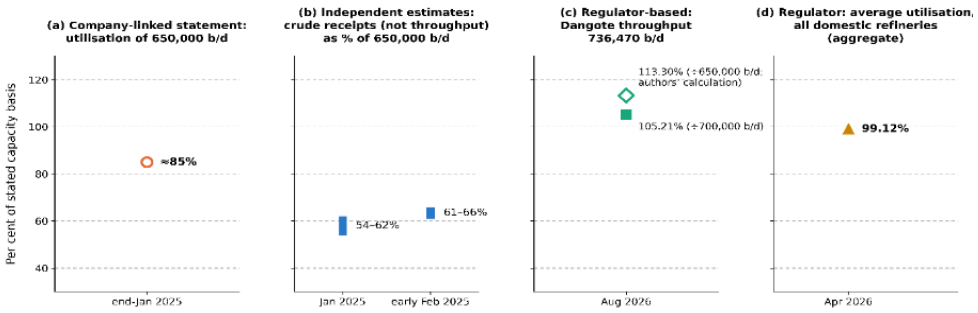

Figure 2: Dangote Refinery Performance Indicators by Evidence Category: Company-Linked Utilisation, Independent Crude-Receipt Estimates, Regulator-Based Throughput and the National Refinery Average

Note: Sources: Argus Media (2025a), S&P Global (2025a), allAfrica (2026a, 2026b), Billionaires Africa (2026), Reuters (2026). Panel (a) is a company-linked utilisation statement. Panel (b) shows independent estimates of crude receipts (crude delivered to the refinery), not refinery throughput, expressed against the 650,000 b/d nameplate. Panel (c) shows regulator-based throughput for the Dangote refinery against two capacity bases; the 113.30% value is the authors' calculation. Panel (d) is the regulator's April 2026 average utilisation for all domestic refineries and is not a Dangote-specific figure. Reporting dates are irregular, and the panels should not be read as one time series.

Gas, Petrochemicals and Minerals

Sustained commercial operation has been shown by NLNG's exports, but the three measures available (export tonnage, production and nameplate capacity) are different quantities. No data on utilisation at the unit level was retrieved for petrochemicals in the Eleme and Dangote complex, and hence claims of capacity and market entry should not be taken as evidence of sustained performance. Moreover, the high acquisition scores for licensed facilities do not necessarily mean that they have access to complex process technology; the exploitation score for the combined Eleme–Dangote case is conservative and should not be used to compare the two facilities. The Endo lithium plant is a first stage of ore processing, and not a battery-materials chain; the second step

is chemical conversion, which is a different hydrometallurgical skill than ore beneficiation. Its reported annual throughput (about three million tonnes) is also inconsistent with the stated daily rate at 365 operating days (Section 4.2).

Measurement-Integrity Audit

Table 6 lists eight measurement issues in selected headline indicators. They are not all reporting errors: each is classified as an unreconciled discrepancy, a temporal change or a definitional difference. Three items are unreconciled discrepancies (items 1, 4 and 7), one is a temporal change (item 5) and four are definitional differences (items 2, 3, 6 and 8). There were three consistencies found. Firstly, there was some overlap in terms. Secondly there were different ways of describing capacity. Thirdly there were often no independent figures reported. These results support the hypothesis P4 for the indicators investigated. This justifies the need for the disclosure standard in section 8.2. The audit was not a full census of the Nigerian industrial data set but was concentrated.

Table 6: Measurement-Integrity Audit of Headline Figures

#	Item	Statement A	Statement B or check	Classification and implication
1	Dangote utilisation, early 2025	About 85% of nameplate at end-January, per company sources (Argus Media, 2025a; S&P Global, 2025a)	54–62% in January and 61–66% in early February implied by Argus, Kpler and Vortexa data (Argus Media, 2025a)	Unreconciled discrepancy (partly definitional: utilisation vs receipts). Company statements need independent corroboration
2	Dangote denominator, Aug 2026	105.21% = 736,470 ÷ 700,000 b/d (Billionaires Africa, 2026)	113.30% = 736,470 ÷ 650,000 b/d (Reuters, 2026; authors' calculation)	Definitional difference. Report against both capacities
3	Throughput versus receipts, Aug 2026	Dangote 736,470 b/d (Billionaires Africa, 2026)	All domestic refineries' crude receipts 683,000 b/d (allAfrica, 2026a)	Definitional difference. Different quantities; raw tables needed
4	Petrol imports, Aug 2026	Rose to 20.6 Ml/d; domestic refinery supply 29.7 Ml/d (allAfrica, 2026a)	Fell 26% to 14.6 Ml/d; domestic supply 35.9 Ml/d (Nairametrics, 2026c)	Unreconciled discrepancy. Reports of the same factsheet disagree on direction
5	Local content	42% by December 2021 (Sweet Crude Reports, 2022a)	47% by September 2022, same agency head (Sweet Crude Reports, 2022b); spend versus value added disputed (Heum et al., 2003)	Temporal change (2021 vs 2022), not a contradiction. Spend share is not engineering authority
6	NLNG utilisation	14.78 Mt exported in 2025 (Leadership, 2026b)	About 67% of 22 mtpa (authors' calculation)	Definitional difference. Exports are not utilisation
7	Dangote PP capacity	900,000 t/y, 77 grades (BusinessDay, 2025a)	830,000 t/y (S&P Global, 2025b)	Unreconciled discrepancy. Design basis must be stated
8	Eleme capacity	Ethylene 360 kt/y (Indorama Eleme Petrochemicals Limited, n.d.)	Olefins unit 440 kt/y, same page	Definitional difference (ethylene output vs total olefins-unit capacity). Product and unit definitions differ

Policy Implications I: Comparative Lessons for Design (RQ4)

Comparators are selected based on their relevance to the Nigerian sectors and the evidence available. The petroleum comparisons are of a 2003 study commissioned by the Norwegian development agency, which compares Nigeria with Brazil, Indonesia, Malaysia, Mexico and Norway; it is two decades old and is not a benchmark, but rather a lesson in design (Heum et al., 2003). Norway had no statutory local content target: a 1972 Royal Decree favoured competitive Norwegian suppliers, early operators had to agree to capacity-building contracts with Norwegian suppliers, some contracts above NOK 1,000,000 were reported and some licences had their operator changed to Statoil, though the requirement was modified to be compatible with European trade rules later on. Malaysia placed exclusive resource rights in the hands of Petronas (1973), included technology transfer clauses in joint operation agreements and expanded definition of local content to value added in Malaysia, regardless of ownership to about 70%. Brazil had adopted import substitution, reaching more than 90 per cent of Brazil's local content in the late 1980s and 80 per cent in the early 1990s in mature technologies, and much less in deep offshore. The target set by Indonesia was 35% and achieved approximately 25% (Heum et al., 2003).

More recent work adds nuance. Lebdioui (2022) examines how Malaysia added value to its natural resources through industrial policy, and Camba et al. (2022) compare how Indonesia and Malaysia mobilised Chinese capital in mineral processing. Indonesia's ban on nickel ore exports, effective 2020, is associated with a rise in nickel export values from USD 4 billion in 2017 to USD 34 billion in 2022, but the source of this estimate is an advocacy study that also reports environmental and health costs (Centre for Research on Energy and Clean Air [CREA] & Center of Economic and Law Studies [CELIOS], 2024). Studies of Chile (Atienza et al., 2020), Brazil (Azevedo Filho et al., 2019; Lima-de-Oliveira, 2020) and the Agder oil and gas cluster in Norway (Isaksen & Karlsen, 2012) emphasise regional dimensions, policy design and political shocks.

Three lessons survive scrutiny. First, outcomes are organized around obligations and not the headline target: Norway and Malaysia linked local content with capacity building, technology transfer and monitoring, while the capacity-building part of the target in Indonesia was left unfulfilled. Second, technological gaps at the frontier can coexist with a high local-content percentage; as demonstrated by the lower deep-offshore local-content percentage in Brazil. Third, export restrictions can rapidly mobilise investment, as with Indonesian nickel, but they do not on their own transfer capability where technology and finance are foreign; the Chinese-backed lithium plant in Nigeria faces the same risk. There are three cautions. First, Norway was industrialised before oil. Second, reported percentages of local content are

not comparable across definitions. Third, international cases can inform policy design, but they do not demonstrate that any instrument would be effective in Nigeria, where finance, infrastructure and feedstock conditions differ. The lessons are summarised in table 7.

Table 7: Comparative Evidence and Transferable Lessons

Case	Instrument	Outcome	Design lesson (not evidence of effectiveness in Nigeria)
Norway (petroleum)	Supplier preference; capacity-building agreements; operatorship transfer; contract reporting	About 50% (2003); clause later amended (Heum et al., 2003)	Link licences to capability building and monitor awards
Malaysia (petroleum)	National oil company; technology-transfer clauses; value-added definition	About 70% (2003) (Heum et al., 2003)	Contractual transfer under stable macro conditions
Brazil (petroleum)	Import substitution; later licence-round strategies	Above 90% (late 1980s) to about 80% (early 1990s); lower in deep offshore (Heum et al., 2003)	Mature-technology content can coexist with frontier gaps
Indonesia (upstream oil)	35% target	About 25% (Heum et al., 2003)	Targets without capacity do not deliver
Indonesia (nickel)	Ore export ban (2020)	USD 4 bn (2017) to USD 34 bn (2022); reported environmental and health costs (CREA & CELIOS, 2024)	Pair bans with capability and emissions conditions

Note. Percentages reflect different definitions and are not directly comparable. CREA = Centre for Research on Energy and Clean Air; CELIOS = Center of Economic and Law Studies. Comparators inform design; they do not demonstrate policy effectiveness in Nigeria.

Policy Implications II: Integrated Framework and Roadmap (RQ4)

Capability Gates

The diagnosis implies a different logic from target-based policy. We propose capability gates: a tightening of policy (an export restriction, a concession extension, a step-up in a local-content target or the release of an incentive) is released only after verified capability indicators from Table 1 are met. Gates can be used to prevent two failure modes that are apparent in the evidence: expanding processing capacity without transferring capability (the pattern reported for Chinese-financed nickel processing in Indonesia, and a risk for the Chinese-backed lithium plant in Nigeria; Camba et al., 2022; CREA & CELIOS, 2024); and rehabilitation or concession cycles that repeat without evidence of operation (state refineries, Ajaokuta). The framework is shown in Figure 3, consisting of four TAC dimensions as a learning loop driven by the engineering enablers and institutional foundations, and controlled by gates and disclosure. These are ideas for implementing and evaluating, not effects found as a result of this review.

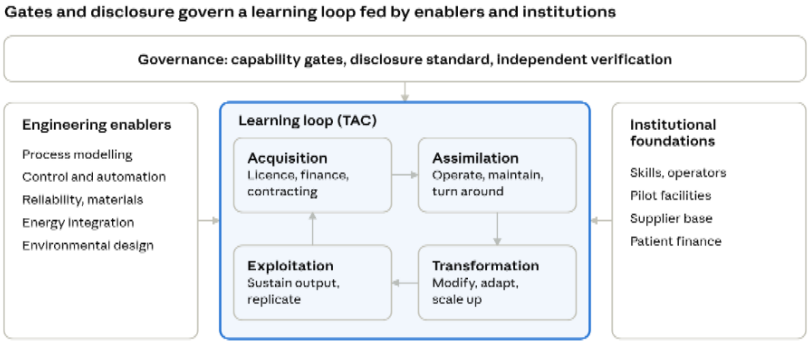

Figure 3: Integrated Framework: The TAC Learning Loop, Its Enablers and Institutions, and the Governance That Gates It (*Note. Authors' conceptual synthesis)*

Minimum Plant-Performance Disclosure Standard

As can be seen in Table 6, headline figures do not agree due to lack of definitions. We believe all plants supported by public funding or regulated should publish monthly on regulator hosted tables: nameplate capacity and date of and basis for re-rating; crude or feed intake and product output under defined terms (production, receipts, sales); planned and unplanned downtime and turnaround scope with the local led share; licensors and terms for knowledge transfer; engineering man-hours by location, and the organisation holding engineering responsibility, for projects and in-plant modifications; and independent verification of utilisation. The numerical gate thresholds should be set based on this disclosure and not specified beforehand.

Engineering Pathways and Phased Roadmap

For the private refinery, the pathway is to match operated capability with owned capability through crude-slate matching, reliability programmes for rotating equipment and catalytic units, scope definition and planning for turnaround under local leadership, and documented process changes. For the state refineries, the evidence is against further rounds of rehabilitation contracts unless the operating model changes: owner's engineering should be retained by the state, operator payment tied to verified utilisation, and contract exit triggered

by sustained under-performance. Rehabilitation without secure crude supply and maintenance funding is unlikely to succeed, whoever operates the plant. In the case of gas, the Nigerian component of the engineering of projects like Train 7 will make it a transformation test. In the case of lithium, the assimilation and transformation would be tested in the conversion of concentrate to chemicals. For steel, staging occurs: securing gas and power first, starting with unit operations that train a metallurgical workforce, and linking each expansion to proven operation of the preceding step. For cassava, the binding capabilities are feedstock supply, drying energy and line maintenance, that is, aggregation and pilot starch lines first.

There are three phases that occur (Table 8). Phase 1 (0-3 years) consolidates: disclosure, performance-based partnerships and knowledge transfer clauses. Shared pilot centres, local fabrication and spares, capability-based local-content metrics in addition to spend-based, and a gated progression towards lithium conversion are all part of Phase 2 (3-10 years). Phase 3 (10+ years) upgrades: replication of plants under Nigerian lead engineering and development of a local capacity for engineering services.

Table 8: Roadmap, Capability Gates and Indicators

Phase	Priority actions	Gate to proceed	Indicators
1 (0–3 yrs)	Disclosure standard; performance-based partnerships; knowledge-transfer clauses; turnaround localisation	Plant-level disclosure live and independently verified	Share of supported plants disclosing; verified utilisation; share of contracts with transfer clauses; locally led turnaround scope
2 (3–10 yrs)	Pilot centres; local fabrication and spares; capability-based local-content metrics; lithium conversion	Verified sustained operation and minimum local-led scope in Phase 1 plants	Local share of spares and fabrication; pilot-to-plant scale-ups; conversion yield
3 (10+ yrs)	Replication; intermediate products; technology services	Documented local design or modification authority	New plants with Nigerian lead engineering; domestic intellectual property on adapted processes

Discussion

Table 9 summarises the propositions. Within the purposive sample, P1 is supported for acquisition, which has the highest mean in every tested combination, and partly supported for transformation, which is lowest in 95.5% of combinations but could be scored in only three cases. P2 is supported: the state-owned complexes have been less reliable than the private licensed facilities, but private modular refineries vary widely, and plant age, feedstock supply and financing differ systematically between the state and private plants, so ownership alone does not explain performance. P3 is plausible but not tested, because there is too little evidence on local modification authority to link weak transformation to stalled upgrading. P4 is supported for the indicators audited. Policy design (RQ4) is not treated as a tested proposition: the comparator evidence informs the design of instruments but does not show that they would work in Nigeria.

Table 9: Assessment of Propositions

Proposition	Result	Basis	Confidence
P1 asymmetry	Supported; partly for transformation	Evidenced means 2.57 / 1.43 / 0.67 (n = 3) / 1.14; acquisition highest in 100% and transformation lowest in 95.5% of 104,976 combinations	Moderate; low to moderate for transformation
P2 ownership–performance	Supported	State complexes non-producing; private modular refineries vary 17–90% (allAfrica, 2026a); plant age, feedstock and finance confound the state–private contrast	Moderate
P3 upgrading	Plausible; not tested	Lithium at early processing stage; no locally led modification documented	Low
P4 measurement	Supported for audited indicators	Three unreconciled discrepancies, one temporal change and four definitional differences (Table 6)	Moderate to high

These results support four key narratives. First, spending on local content does not guarantee engineering capability. Second, private ownership does not guarantee high utilisation. Third, export bans can drive investment, however, they do not guarantee broad technology control. Fourth, proxies at firm level do not guarantee which firms will have problem solving, adapting and scaling capabilities. This does not mean these policy tools are not effective; however none guarantee capability. The examples illustrate how projects can often be large scale and quick to deliver, with large amounts of knowledge retained by the licensor. However, if the local engineering requirement is badly designed it can cause increased costs. The correct approach is to ensure that capabilities exist to make sure that processes can be made to work. Then increase local accountability through contracting. Finally enforce standards only when they can be delivered with capabilities in place. Engineers need to design processes to be operable and adaptable from the outset. Regulators need to measure capabilities. And financiers need to invest in pilots and early operations. International examples can help design this approach, however we need to see if this will work in Nigeria.

Limitations and Research Agenda

The seven cases are purposively selected and not representative. The TAC scores are ordinal judgments from one evaluator only, and there is no independent scoring nor interrater reliability data, and the sensitivity analysis covers grade-C and missing-evidence uncertainty but not rater bias. Four of the 28 case–dimension cells, all in transformation, are not evidenced, so conclusions about that dimension rest on three cases. Database coverage and indexing influence the Dimensions search and literature was chosen for explanatory contribution; it should not be assumed that every record retrieved from a database has been subjected to full-text assessment. The plant evidence has been drawn from a variety of sources including regulator, company, peer-reviewed, press etc, and with differing definitions and independence, and much recent reporting is secondary. Evidence in the workforce and education was not systematically evaluated. Statements that were not confirmed against a source were

omitted, possibly underreporting capabilities that do exist but have not been documented. The plant level utilisation, downtime, and local-engineering-share data should be requested from the regulators and gathered via plant surveys in future work efforts; independent utilisation data for major facilities should be obtained; capability-based local-content measures should be developed; and the scoring should be independently re-evaluated and compared with other energy resource processing systems.

CONCLUSION

The downstream gap cannot be attributed solely to a lack of resources and investment. Within the seven strategically selected cases, there have been repeated instances of significant process technologies being sourced from Nigeria; however there has been little evidence of local technology modification. The highest performing dimension was sourcing technology, this was evident in all the combinations of uncertain scores. Technology modification was the lowest performing dimension in all but one combination. The results were affected by finance, feedstock availability, plant age and licence duration. It is important to note that these scores are reflective of the ability to modify technology and not all engineering skills available in the local market. From these three actions can be identified. Firstly, publically funded or regulated plants should provide monthly information about their capacity, throughput, income and downtime, using defined terminology. This will ensure headline information can be verified. Secondly, within contracts, licences and turnarounds it should be noted who is responsible for the engineering modifications. Finally, capability assessments should be independently validated using multiple scorers, plant surveys and workforce data over time.

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