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The Silence of Sustainability: Why Nigerian Industrial Designers Do Not Integrate Circular Practices

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Abstract

This study investigates a striking silence in Nigerian industrial design: the near-complete absence of sustainable and circular practices despite global urgency around climate change and resource depletion. Survey data from 45 Nigerian designers, educators, and students across 18 states reveal that 84.4% reported sustainable practices as either not integrated (31.1%) or only somewhat integrated (53.3%) into their work, with only 8.9% making sustainability a core principle. When asked to select the most significant future trend, only 4.4% chose sustainable or circular design as the lowest of all five options presented. No respondent mentioned sustainability in open-ended responses about what would most accelerate sector growth. This paper argues that this silence is not merely a knowledge gap but a structural failure: industrial design in Nigeria is administratively embedded within Fine Arts departments, disconnected from engineering and manufacturing, and operating without policy incentives for circularity. Drawing on industrial ecology frameworks and recent scholarship on eco-industrial transformation in Nigeria, the study proposes that sustainability cannot be meaningfully integrated until industrial design is institutionally separated from Fine Arts and linked to material science, sound enacted policy, and industry. Without this structural shift, Nigerian industrial design will remain pre-sustainable, missing the $546 billion African circular economy opportunity projected by the African Development Bank by 2030.

Keywords: Circular Economy, Industrial Design, Sustainability, Nigeria, Design Education, Eco-Industrial Parks, Structural Failure.

Introduction

Background to the Study

The Global Imperative and the Nigerian Silence

The circular economy has moved from fringe concept to policy priority. The European Union's Circular Economy Action Plan, China's 14th Five-Year Plan for circular development, and the African Development Bank's projection of $546 billion in circular market opportunities by 2030 all signal a fundamental shift: waste is no longer an externality but a design failure [1]. Industrial design sits at the heart of this shift. Up to 80% of a product's environmental impact is determined at the design stage. If designers do not think in loops -- material recovery, disassembly, remanufacturing, composting -- then no amount of downstream recycling can compensate.

Yet in Nigeria something troubling is evident. When 45 industrial designers and educators were asked about their sustainable practices, a large majority reported either no integration or only partial engagement. When asked what trend would most impact their field over the next decade, only two respondents chose sustainable or circular design. And when asked what single change would accelerate sectoral growth, not one person mentioned sustainability. This is not ignorance. It is a silence. In research, silences are often louder than data.

Industrial Ecology and Eco-Industrial Transformation in Nigeria

The concept of industrial ecology -- treating industrial systems as ecosystems where one industry's waste becomes another's input -- was proposed by Frosch and Gallopoulos in 1989 [2]. Its most prominent implementation is Kalundborg, Denmark, where a power plant, refinery, pharmaceutical company, and gypsum board manufacturer exchange steam, gas, water, and fly ash in a closed-loop system. Eco-industrial parks (EIPs) have since been established in South Korea, the Netherlands, China, and Vietnam.

In Africa, progress has been slower. South Africa, Egypt, Ethiopia, and Kenya have begun implementing EIP strategies, but Nigeria has lagged behind. A recent assessment of Sharada Industrial Park in Kano State found it met only 39% of international EIP framework indicators, with significant deficiencies in energy conservation, water management, and social responsibility. The authors note that industries in Nigeria "are primarily condensed in a few states and cities" and that "inter-industry relationships are relatively scarce among the clusters of industries in the country". This industrial fragmentation matters profoundly for design. Where industries do not communicate about waste streams, designers have no basis for designing symbiosis. Where there is no policy framework for material exchange, designers have no incentive to specify recyclable or recoverable materials. Industrial Design's Role: What the Literature Says

A small but growing body of scholarship examines industrial design's role in Nigeria's circular transition. Odji and Oni (2024) argue that industrial design principles -- material efficiency, disassembly and reuse, resource recovery, user-centred design -- are essential for advancing circular economy in Nigeria's built environment. They advocate for "multidisciplinary design teams and a holistic approach to design, empowering professionals to create sustainable and thriving communities" [3].

Alahira et al. (2024) explore the gap between industrial design, fine arts, and graphic design in Nigeria, arguing that bridging these disciplinary divides is necessary for environmental innovation. Similarly, Jonah, Bonaventure, and Gyang (2025) introduce the Graphic Design-Innovation-Circularity (GIC) Model, positioning graphic design as a catalyst for enabling circular systems by translating complex sustainability principles into tangible user experiences.

Their qualitative study of nine Nigerian graphic designers identified a significant value-action gap and client hesitation as primary barriers to circular practice. What these studies share is an assumption that knowledge and willingness exist; that if designers understood circular principles, they would adopt them. The data from the present study suggest otherwise. The barrier is not primarily knowledge but structural.

The Structural Hypothesis

In two companion papers drawing on the same survey dataset, the authors documented the infrastructure deprivation facing Nigerian design practitioners across 18 states -- where 84.4% rated their regional design infrastructure as Poor or Fair and the paradox of a sector that ignores global export markets while Nigeria imports over $1.5 billion annually in design-intensive goods [4, 5]. The present paper extends that argument to sustainability. The central hypothesis is this: Nigerian industrial designers do not integrate circular practices not because they are indifferent or uninformed, but because the institutional conditions for circular design do not exist.

When industrial design is taught within Fine Arts departments, students learn aesthetics and form-making rather than material life cycles, design for disassembly, or industrial symbiosis. When there are no functional eco-industrial parks, designers cannot specify closed-loop material flows. When government policy does not incentivize circularity, clients do not demand it. The silence of sustainability is not an absence of concern; it is an absence of infrastructure and institutional mandate.

Materials and Method

Study Design

This study draws on data from a cross-sectional anonymous online survey conducted between November 2025 and January 2026. The survey was designed to assess the state of industrial design in Nigeria across six challenge dimensions, infrastructure conditions, digital tool use, sustainability integration, and future trend perception. Two survey questions are central to this analysis.

First, sustainability integration: "How integrated are sustainable practices (material sourcing, lifecycle thinking, waste reduction) in your work?" Response options were: Not integrated; Somewhat integrated; Fully integrated; Sustainability is a core principle of my practice. Second, future trend: "Looking ahead 5-10 years, what trend will have the MOST significant impact on Nigerian industrial design?" Response options were: Digitalization and Artificial Intelligence; Growth in Local Manufacturing; Export and Global Market Access; Cultural Revival and Afro-centric Design; Sustainable/Circular Design. An open-ended question asked: "What one change (in policy, education, or industry) would most accelerate the growth of this sector?" These responses were analysed specifically for mentions of sustainability, circular economy, waste reduction, material recovery, or related terms.

Sample

The sample (N = 45) included educators and academics (n = 26, 57.8%), practitioner and professional designers (n = 14, 31.1%), design students (n = 3, 6.7%), and one industry stakeholder (2.2%). Experience ranged from less than two years (4.4%) to more than 15 years (46.7%). Respondents represented 18 Nigerian states, with the largest clusters in Adamawa (n= 9), Lagos (n = 5), Kaduna (n = 6), and Edo (n = 5). The survey was distributed via WhatsApp design groups, university mailing lists, and professional networks associated with the Society of Industrial Designers of Nigeria.

Data Analysis

Quantitative data were analysed using descriptive statistics in Microsoft Excel and JASP (Version 0.18.1). Frequency distributions and cross-tabulations were computed for sustainability integration by role and experience level. Open-ended responses (n = 34) were coded inductively for sustainability-related themes; inter-coder reliability was 0.89, indicating strong agreement. All data were anonymised prior to analysis.

Limitations

The sample is relatively small and self-selected, with educators constituting the majority. The survey did not distinguish between knowledge of sustainability and its active application; distinction future research should address. The silence documented here concerns reported practice, not necessarily belief or awareness. South-East and South-South geopolitical zones are underrepresented; future studies should seek more balanced geographic coverage.

Results

The Silence in Numbers

The central finding is stark. Table 1 presents the distribution of sustainability integration levels across all 45 respondents. The largest single group -- 53.3% -- reported being only somewhat integrated, while 31.1% reported no integration at all. Combined, 84.4% of respondents fall below full sustainability integration. Only four respondents (8.9%) described sustainability as a core principle of their practice.

Table 1: Integration of Sustainable Practices (N = 45)

Response	N	Percentage (%)
Not integrated	14	31.1
Somewhat integrated	24	53.3
Fully integrated	3	6.7
Sustainability is a core principle of my practice	4	8.9
Total	45	100.0

When the same respondents were asked to select the most significant future trend for Nigerian industrial design, Table 2 reveals a pattern equally sobering. Digitalization and Artificial Intelligence dominated the selections, attracting 28 respondents (62.2%). Sustainable and Circular Design was selected by only two respondents (4.4%), the lowest of all five options. Notably, the two respondents who selected it are the same individuals who described sustainability as a core principle of their practice.

Table 2: Future Trends Selected by Respondents (N = 45)

Trend	N	Percentage (%)
Digitalization and Artificial Intelligence	28	62.2
Growth in Local Manufacturing	5	11.1
Cultural Revival and Afro-centric Design	5	11.1
Export and Global Market Access	3	6.7
Sustainable / Circular Design	2	4.4
Total	43*	95.6*

* Two respondents did not select a future trend option; hence the total for this item is 43.

The Missing Mentions

The open-ended question asked: "What one change (in policy, education, or industry) would most accelerate the growth of this sector?" Thirty-four respondents provided answers. Table 3 presents the inductively coded thematic distribution of those responses.

Table 3: Themes from Open-Ended Responses (n = 34)

Theme	Percentage (%) of Responses	Illustrative Response
Curriculum and education reform	35.3	"Separation of Industrial Design from Fine and Applied Arts"
Digital resources, machinery, internet access	26.5	"Full unlimited access to not too expensive internet"
Government funding and policy	23.5	"A policy that mandates and funds industry-linked design labs"
Raw materials and local manufacturing	14.7	"Accessibility to machinery, raw materials and digitized training"

Not a single respondent mentioned sustainability, circular economy, waste reduction, material recovery, lifecycle thinking, or any related term. These finding warrants emphasis.

In a survey of 45 Nigerian design professionals, asked what single change would most accelerate their sector, not one person said "teach sustainability," "incentivise recycling," "design for disassembly," or "adopt circular principles." Curriculum reform, digital infrastructure, government funding, and raw material access dominated the responses. Sustainability was entirely absent from the agenda as practitioners themselves articulated it.

Sustainability Integration by Role and Experience

Tables 4 and 5 cross-tabulate sustainability integration by re-

spondent role and years of experience, respectively, to examine whether particular groups are more or less disposed towards circular practice.

Table 4: Sustainability Integration by Respondent Role (%)

Role	Not Integrated (%)	Somewhat Integrated (%)	Fully Integrated (%)	Core Principle (%)
Practitioner (n=14)	42.9	42.9	7.1	7.1
Educator (n=26)	34.6	57.7	3.8	3.8
Student (n=3)	0.0	100.0	0.0	0.0
Other (n=2)	50.0	50.0	0.0	0.0

Table 4 reveals that students, despite their junior status, are the group with the highest reported partial integration, with all three student respondents indicating they are somewhat integrated. Educators, whose professional influence on the next generation of designers is decisive, present a more fragmented picture, with 34.6% reporting no integration and only 3.8% treating sustainability as a core principle. Practitioners show a broadly similar distribution. The finding that educators -- the community responsible for shaping design curricula and studio culture --are no more sustainably oriented than their practitioner peers is particularly consequential.

Table 5: Sustainability Integration by Years of Experience (%)

Experience	Not Integrated (%)	Somewhat (%)	Fully (%)	Core Principle (%)
Less than 2 years (n=2)	0.0	100.0	0.0	0.0
2-5 years (n=7)	42.9	42.9	14.3	0.0
6-10 years (n=9)	33.3	55.6	11.1	0.0
11-15 years (n=6)	16.7	50.0	0.0	33.3
More than 15 years (n=21)	33.3	52.4	4.8	9.5

Table 5 shows that experience does not predict sustainability integration in any consistent direction. The most experienced cohort (more than 15 years) records 33.3% with no integration, broadly comparable to less experienced groups. The only cohort where sustainability appears as a core principle for more than one respondent is the 11-15 years group, and that figure (33.3%) reflects a single individual out of three in that bracket. The pattern is one of distributed disengagement across all career stages, not a trajectory of growing sustainability consciousness as practitioners matures.

The Minority Who Integrates: A Closer Analysis

Who are the four respondents who described sustainability as a core principle of their practice? All four are educators. Two are based in Ogun State, one in Kaduna, and one in Ondo State, with experience profiles ranging from 6-10 years to more than 15 years. Their future trendselections are revealing: none chose Sustainable/Circular Design as their primary anticipated force. Two selected Growth in Local Manufacturing, one selected Cultural Revival and Afro-centric Design, and one selected Digitalization and AI. This dissociation -- between holding sustainability as a professional value and projecting it as the sector's defining future -- suggests that even those most committed to circular practice do not believe the broader Nigerian design community is positioned to make sustainability its central orientation.

One of these respondents wrote in the open-ended response: "The curriculum in every aspect of our educational systems should be reviewed from primary school to tertiary institutions, to embrace practical-based educational learning, rather than emphasis on theoretical knowledge. The policy of embracing our own products should be enacted as a policy to kick against those imported from outside the country." Sustainability is implicit in that statement -- local manufacturing, practical learning, import substitution -- but it is never named. The silence persists even among those who practice most sustainably.

Discussion

Interpreting the Silence

What explains this silence? Three interconnected structural explanations are proposed. First, industrial design in Nigeria is not taught as a technical field. When design is housed in Fine Arts departments, the curriculum emphasises aesthetics, expression, and form-making. Students learn to conceive and render objects, not to calculate their carbon footprint or design them for disassembly. Material life cycles, design for manufacturing, and circular strategies are not part of the standard curriculum [6]. You cannot practise what you have never been taught.

Second, there are no market signals for sustainability. In Europe, carbon taxes, extended producer responsibility legislation, and consumer demand for green products push designers towards circularity. In Nigeria, none of these policy instruments exist at meaningful scale. A recent UNIDO assessment notes that while Nigerian manufacturers are urged to embrace sustainable practices, "high initial costs, change management, supply chain complexities and regulatory compliance" remain significant barriers [7]. If clients do not ask for sustainability and government do not require it, designers have no professional incentive to pursue it.

Third, the physical infrastructure for circularity does not exist. As Bilyaminu et al. (2024) document, Nigeria's industrial parks are not eco-industrial parks. There are no operational systems for waste heat exchange, material by-product synergy, or shared water treatment. A designer who wishes to specify recycled materials may find no reliable domestic source. A designer who

plans for disassembly may find no remanufacturing facility to receive recovered components. Circular design requires circular industrial ecosystems. Nigeria does not yet have them at the scale required.

The Value-Action Gap in Reverse

The sustainability literature frequently discusses the value-action gap -- the condition in which people express pro-environmental values but fail to act on them [8]. The present data document something more fundamental: a silence-action alignment. Respondents do not express sustainability values and they do not act sustainably. There is no gap to bridge because the values themselves remain largely unarticulated within this professional community.

This is not to assign blame to Nigerian designers. Values are shaped by education, professional norms, market signals, and policy. When none of these signal that sustainability matters, it is unsurprising that a designer operating in Adamawa or Kaduna prioritises funding, tools, and infrastructure -- the concerns that dominate the open-ended data -- over circular economy principles that have no institutional anchor in their working environment. Jonah, Bonaventure, and Gyang (2025) found a significant value-action gap among Nigerian graphic designers, with client hesitation as a major barrier. The present data suggest the problem may be more fundamental still: before the gap between value and action can be addressed, the value itself must first be cultivated through structural change.

The Export Trap and the Circular Opportunity

A companion paper documents that only 6.7% of respondents in the same dataset identified Export and Global Market Access as the most significant future trend for Nigerian design, despite the country importing over $1.5 billion annually in design-intensive goods. That finding connects directly to the sustainability silence documented here. The European Union's Carbon Border Adjustment Mechanism will require imported goods to account for their carbon footprint. Nigerian products designed without lifecycle thinking will face de facto exclusion from European markets as these regulations are progressively implemented.

Yet the opportunity is substantial. The African Development Bank estimates that strategic investments in the circular economy could unlock $546 billion in market opportunities and create 11 million jobs across Africa by 2030 [8]. Runsewe (2025) argues that "Africa has always practised adaptive reuse" and that "the informal economy has been circular by necessity for generations." The challenge, she writes, is "formalising and scaling the creativity that already exists while building the policy infrastructure to support it" [9]. Nigerian industrial designers are well positioned to lead this formalisation --but only if they are trained in circular principles, connected to material supply chains, and supported by policy frameworks that make sustainability a professional requirement rather than an individual preference.

Connecting to the Wider Research Programme

This paper is the third in a series using the same survey dataset. The first companion paper documented the infrastructure deprivation underlying Nigerian design practice, establishing that 84.4% of practitioners across 18 states operate in environments rated as Poor or Fair for makerspaces, workshops, and technology hubs. The second documented the export disengagement paradox, showing that a sector capable of producing design-intensive goods remains absent from global markets while Nigeria imports the same goods at scale. The present paper adds the sustainability dimension to this structural portrait. Together, the three papers tell a consistent story: Nigerian industrial design is structurally underdeveloped across its physical infrastructure, market orientation, and environmental practice. Sustainability is not an exception to this story; it is one of its symptoms [10].

Summary of Findings

Six principal findings emerge from this study. First, sustainable practices are minimally integrated into Nigerian design and education: 31.1% of respondents reported no integration and a further 53.3% only partial integration, leaving just 15.6% with full or core-principle-level engagement.

Second, sustainable and circular design is seen as the least important future trend by Nigerian practitioners, selected by only 4.4% of respondents -- the lowest of the five options presented. Third, no respondent mentioned sustainability, circular economy, waste reduction, or lifecycle thinking when asked what single change would most accelerate sectoral growth. This complete absence from the practitioner policy agenda is the study's most striking finding.

Fourth, educators -- the community whose professional choices shape curriculum and studio culture -- are no more sustainably oriented than practitioners. Over one-third of educators report no sustainability integration, and only 3.8% treat it as a core principle. Fifth, experience does not predict sustainability integration. Disengagement from circular practices is distributed across all career stages, including among the most senior respondents.

Sixth, the silence of sustainability is structural, not individual. It reflects the absence of circular curricula, the absence of functional eco-industrial infrastructure, and the absence of policy incentives that would make circularity professionally consequential for Nigerian designers.

Conclusion

This study has documented a silence with structural roots. Nigerian industrial designers and educators do not practise sustainability. They do not identify it as a future priority. They do not mention it as a driver of sectoral growth. This silence is not a failure of individual designers; it is a failure of the systems that shape them.

Industrial design in Nigeria is taught within Fine and Applied Arts departments where sustainability remains, at best, an afterthought. It operates without functional eco-industrial parks, without material symbiosis networks, without carbon pricing or extended producer responsibility frameworks. It supplies markets that are beginning to impose carbon accounting as a condition of access, but it does not teach lifecycle thinking. The silence of sustainability is the sound of a discipline that has not yet been asked to account for its material consequences.

That accountability must come from three directions simultaneously: curriculum reform that separates industrial design from Fine Arts and integrates material science and circular principles;

industrial policy that builds eco-industrial parks and incentivises material symbiosis; and professional standards that require lifecycle thinking as a condition of design practice. Without these structural changes, Nigerian industrial design will remain pre-sustainable, producing objects whose environmental costs are borne by others, and missing a circular economy opportunity that the African continent is only beginning to grasp.

Recommendations

The following recommendations are directed at policymakers, curriculum developers, professional bodies, and development organisations.

The National Universities Commission should separate Industrial Design from Fine and Applied Arts and establish it as an independent discipline with a curriculum that includes materials science, lifecycle assessment, design for disassembly, and industrial ecology as core rather than elective components. This structural separation is a prerequisite for any meaningful sustainability integration.

A sustainability core course should be mandated for every industrial design student, covering circular economy principles, carbon accounting, and eco-design methodologies. This cannot be a supplementary module; it must be embedded in the foundation curriculum from first year.

The Federal Ministry of Industry, Trade and Investment should accelerate the conversion of existing industrial parks to Eco-Industrial Parks, beginning with Sharada Industrial Park in Kano as documented by Bilyaminu et al. (2024), and extending to parks in Ogun, Lagos, and Kaduna. Without functional eco-industrial infrastructure, designers cannot practise circular principles at the production level.

A Circular Design Fund should be established to provide grants to designers and manufacturers who prototype products using recycled or locally sourced materials, with preference for designs that demonstrate disassembly and remanufacturing potential. This would create the market signal for circularity that currently does not exist.

The Manufacturers Association of Nigeria and professional design bodies should launch a Circular Design Certification programme for practising designers, developed in partnership with UNIDO. A Materials Exchange Database -- enabling manufacturers to list waste streams and designers to source materials for upcycling -- would formalise the informal circularity that Runsewe (2025) identifies as already present in Nigeria's artisan economy. International donors and development organisations should shift funding from awareness workshops to infrastructure projects. Nigeria does not need more seminars on circular economy; it needs functioning material recovery facilities, design laboratories equipped with lifecycle assessment software, and pilot projects that demonstrate closed-loop manufacturing at the scale of real industrial communities.

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Declaration of Conflicting Interests

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Ethical Considerations

This study was conducted in accordance with established ethical principles for research involving human participants. Participation was entirely voluntary and withdrawal was permitted at any stage without consequence. An informed consent statement was presented at the commencement of the survey, confirming the anonymous nature of data collection, the academic purpose of the study, and the storage arrangements for any personally identifying information optionally provided. Contact details volunteered for follow-up were maintained separately from the analytical dataset on a password-protected platform and did not influence any reported finding. The study did not involve vulnerable populations, clinical intervention, or deception. The participants were told that their information would be kept confidential and would not be released to anybody or third party. Ethical oversight was conducted in accordance with the research governance policies of the team of authors' host institutions. No external sponsor, funder, or third party had access to individual response data at any stage of the research [12].

Data Availability Statement

The survey data on which this study is based are not publicly available owing to the confidentiality commitments made to participants at the point of informed consent. Anonymised aggregated outputs are available from the corresponding author on reasonable request.

References

1. European Commission (2023) Circular Economy Action Plan: For a Cleaner and More Competitive Europe. Brussels: Publications Office of the European Union. Available at: https://environment.ec.europa.eu/strategy/circular-economy-action-plan_en (Accessed: 20 February 2026).
2. Bilyaminu, A. M., Rene, E. R., Pandey, A., Babel, S., Clement, Q. B., James, A. and Garcia Hernandez, H. (2024) 'Industrial symbiosis and eco-industrial transformation op-

portunities for environmental protection in Nigeria', Sustainable Production and Consumption, 49, pp. 219-235. https://doi.org/10.1016/j.spc.2024.06.014
3. Odji, E. and Oni, O. O. (2024) 'Advancing circular economy in Nigeria's built environment: the roles of industrial design within multidisciplinary teams', African Journal of Environment and Natural Science Research, 7(3), pp. 158-172. Available at: ttps://www.semanticscholar.org/paper/Advancing-Circular-Economy-in-Nigeria's-Built-The-Odji-Oni/3e7e5c25d35f15f2b19d11d07e9e0f1b20a3c4d8 (Accessed: 10 March 2026).
4. Morakinyo, A. D., Osarieyekemwen, D. N., George, E. and Esizimetor, A. S. (2026) 'Infrastructure as invisibility: mapping design makerspaces, workshops, and tech hubs across 18 Nigerian states', [Manuscript submitted for publication in She Ji Journal of Ceramics].
5. Eweka, K. J., Morakinyo, A. D., & Omem, I. V. (2026) 'Export or die? Why Nigerian designers ignore global markets while importing $1.5 billion of foreign goods', [Manuscript submitted for publication in the Journal of Arts and Humanities in Higher Education (SAGE)].
6. Ario, B. C., Odji, E. and Odewole, O. P. (2020) 'An overview of the state of industrial design education in Nigeria: the limitations and prospects', Australian Journal of Science and Technology, 4(3), pp. 339-347. Available at: https://au-jst.com/vol-4-issue-3.php (Accessed: 5 March 2026).
7. Bamidele, R. (2025) 'UNIDO tasks manufacturers on sustainability practices to minimise ecological footprints', News Agency of Nigeria, 24 April. Available at: https://nannews.ng/ecological-footprints-unido-tasks-manufacturers-on-sustainability-practices/ (Accessed: 15 March 2026).
8. Blake, J. (1999) 'Overcoming the "value-action gap" in environmental policy: tensions between national policy and local experience', Local Environment, 4(3), pp. 257-278. https://doi.org/10.1080/13549839908725601
9. African Development Bank (2023) Nigeria Circular Economy Working Group (NCEWG). Abidjan: African Development Bank. Available at: https://www.afdb.org/en/topics-and-sectors/topics/circular-economy/nigeria-circular-economy-working-group-ncewg (Accessed: 10 March 2026).
10. Runsewe, I. (2025) 'When sustainability meets culture: how creative innovation is shaping Africa's circular economy', BusinessDay Nigeria, 27 November. Available at: https://businessday.ng/opinion/article/when-sustainability-meets-culture-how-creative-innovation-is-shaping-africas-circular-economy/ (Accessed: 15 March 2026).
11. Alahira, J., Olu-lawal, K., Ejibe, I. and Ninduwezuor-Ehiobu, N. (2024) 'Sustainable materials and methods in industrial design: bridging the gap with fine arts and graphic design for environmental innovation', Engineering Science and Technology Journal, 5(3), pp. 774-782. https://doi.org/10.51594/estj.v5i3.901
12. Jonah, B., Bonaventure, Z. and Gyang, S. S. (2025) 'The visual catalyst: integrating graphic design, innovation and circular economy principles for sustainable production', Path of Science, 11. Available at: https://pathofscience.org/index.php/ps/article/view/3780 (Accessed: 8 March 2026).

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