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Sustainable Digital Workflows in Theatre Production Design: A Framework for Eco-Scenography and Life Cycle Optimization in Nigeria

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The Nigerian creative sector, particularly the globally influential film industry, Nollywood, and its burgeoning theatre scene, faces a critical juncture regarding its environmental footprint. Traditional production design practices, often characterised by rapid, low-budget construction and subsequent material disposal, contribute significantly to the nation's growing waste management crisis and carbon emissions. This paper proposes a conceptual framework for Sustainable Digital Workflows (SDW), specifically tailored for the Nigerian context, to transition scenography from a linear, resource-intensive model to a circular, data-informed, and environmentally responsible practice. Drawing upon established principles from the Architecture, Engineering, and Construction (AEC) sector, namely Building Information Modelling (BIM) and Digital Twin (DT) technologies, the SDW framework integrates Life Cycle Assessment (LCA) directly into the digital design process. This integration is hypothesised to enable Nigerian designers to overcome infrastructural limitations by facilitating precise material quantification, promoting the use of local, sustainable materials, and maximising asset reusability. The framework addresses the unique challenges of the Nigerian context, including the need for low-cost, accessible digital solutions to bridge the digital divide and the imperative to institutionalise circularity within a highly fragmented supply chain. This research argues that the strategic adoption of SDW is not merely an efficiency measure but a fundamental requirement for the future ecological and economic viability of Nigerian performance arts, positioning the industry as a leader in sustainable creative innovation across the African continent.

Keywords: Digital Scenography, Sustainable Theatre, Nollywood, Life Cycle Assessment, Digital Twin, Circular Economy.

1. Introduction

The global performing arts sector is under increasing pressure to address its environmental impact, a challenge that is particularly acute in developing economies, where resource management and waste-disposal infrastructure are often strained. In Nigeria, the creative industries, epitomised by the prolific film industry, Nollywood, and a vibrant theatre scene, are significant economic and cultural drivers. However, the rapid, high-volume nature of production has created an environmental shadow. Traditional production design in Nigeria is frequently characterised by a 'take-make-dispose' mentality, driven by tight budgets and short timelines, resulting in substantial material waste that contributes to pollution and carbon emissions (Oligbinde, 2024; Okon, 2024). The imperative for sustainability in Nigerian scenography is therefore a pressing socio-environmental necessity. This paper addresses this critical need by proposing a conceptual framework for Sustainable Digital Workflows (SDW) tailored to Nigeria's unique landscape. The core hypothesis is that by adapting Building Information Modelling (BIM) and Digital Twin (DT) principles from the AEC sector (Badenko et al., 2024), Nigerian production can transition to a circular, data-informed practice of eco-scenography (Fancy, Beer, & Vivian, 2024). The framework integrates Life Cycle

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Assessment (LCA) into the design process (Najjar, Figueiredo, & Evangelista, 2022), providing quantitative tools to mitigate environmental impact before construction, a significant step beyond current qualitative efforts (Liman, 2025). The transferability of BIM and DT is relevant where digital infrastructure can circumvent physical limitations, promoting resource efficiency.

2. Literature Review and Theoretical Framework

2.1. The Imperative of Eco-Scenography and the Linear Production Model in Nigeria

The environmental impact of Nigerian production is closely tied to the country's national waste management challenges. Nollywood's rapid production cycle generates substantial non-biodegradable waste, overburdening disposal systems (Okon, 2024). Eco-scenography (Beer, 2024) represents a paradigm shift from the linear 'take-make-dispose' model, advocating for material longevity and reusability. The environmental burden is multifaceted: Embodied Impact (material extraction and transport), Operational Impact (energy consumption, often from generators), and Logistical Impact (transport emissions). To achieve data-driven eco-scenography, Nigerian designers need tools for rapid, comparative LCA, especially for local materials with limited data. A digital workflow that quantifies these impacts is essential for transforming the scenographer's role into that of an environmental steward, balancing artistic vision with ecological performance, which is vital for the credibility of Nigeria's creative economy. Waste in Nigerian scenography includes materials like plywood and plastics, which are difficult to recycle. The lack of a dedicated waste stream hinders recovery. Reliance on imported materials increases the Embodied Impact through shipping, while the use of generators for Operational Impact causes significant emissions. The linear model is both environmentally destructive and economically irrational. Integrating Life Cycle Assessment (LCA) is the critical mechanism to break this cycle. LCA provides quantitative evidence for the superiority of circular practices, such as material reuse and local sourcing. Real-time data empowers designers to make informed decisions, addressing both the waste crisis and economic inefficiency. This quantitative approach is foundational for a sustainable Nigerian creative industry.

2.2. Strategic Adaptation of BIM and Digital Twin Principles for Nigerian Scenography

The transferability of Building Information Modelling (BIM) and Digital Twin (DT) principles from the AEC sector to Nigerian scenography is a strategic response to the country's infrastructural and logistical challenges. BIM, a data-rich model in which every component carries non-geometric information (Badenko et al., 2024), is not merely a 3D modelling tool; it is a process that facilitates information management throughout the lifecycle of an asset. In the Nigerian context, a BIM-like model for scenography offers three critical advantages: Precise Material Quantification, which is essential for reducing waste and over-ordering

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in a supply chain prone to inefficiencies (Quiñones et al., 2021); Embedded LCA Data, allowing for the instant calculation of embodied carbon, particularly crucial for comparing imported materials with local, sustainable alternatives; and Facilitated Deconstruction and Reuse, by tagging objects with end-of-life information, thus creating a Material Passport that supports a circular economy (Wandiga, 2020). The Digital Twin (DT), a virtual replica updated with real-time data (Gourlis & Kovacic, 2022), extends this utility. In Nigeria, the DT concept can be applied to Pre-visualisation and Simulation, eliminating the need for costly and wasteful physical prototypes, which is a significant financial and environmental drain in low-budget productions (Performit Live, 2025). Furthermore, the DT enables Logistical Optimisation by simulating packing and transport to minimise travel and carbon emissions across Nigeria's challenging road networks (Bhandal et al., 2022) and serves as an Asset Management tool for touring productions, ensuring efficient maintenance and deconstruction (Kaewunruen et al., 2021). By adopting these digital methodologies, Nigerian scenography can transition from a fragmented, document-based workflow to an integrated, model-based workflow, making sustainability an intrinsic and measurable element of the design process, thereby leapfrogging traditional, less efficient methods. The practical adaptation of BIM for Nigerian scenography, which we term BIM-Scenography, requires a focus on interoperability with low-cost or open-source software, as high-end commercial BIM suites are often financially inaccessible. This adaptation must also prioritise the integration of data specific to local materials. For instance, a BIM-Scenography object representing a wall flat would not only carry geometric data but also non-geometric data detailing its composition (e.g., local plywood vs. imported MDF), its source (local supplier in Lagos), and its environmental impact derived from a localised LCA database. This granular level of detail is crucial for empowering designers to make sustainable choices that are economically viable within the Nigerian market. The Digital Twin's application is equally transformative, particularly in mitigating the logistical risks associated with Nigeria's infrastructure. By simulating the packing density and transport routes, the DT can calculate the most carbon-efficient way to move a set. This feature directly addresses the high Logistical Impact identified in the previous section. Moreover, the DT's Asset Management capacity addresses the lack of material tracking. By creating a persistent digital record of every set piece, the DT transforms ephemeral props and flats into trackable, reusable assets, thereby formalising the circular economy and providing a clear inventory for future productions. This strategic adaptation of global digital principles to the local Nigerian context is the theoretical lynchpin of the SDW framework, offering a pathway to sustainability that is both technologically advanced and socio-economically appropriate.

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3. The Sustainable Digital Workflow (SDW) Framework: Components and Implementation in the Nigerian Context

3.1. Phase 1: Conceptualisation and Design (Digital-First)

The first phase of the SDW framework mandates a digital-first approach, where the primary design deliverable is a data-rich 3D model, acknowledging that approximately 80% of a product's environmental impact is determined at this initial stage (Dervishaj & Gudmundsson, 2024). This phase is crucial for Nigerian scenography, shifting focus to integrated ecological performance. BIM-Scenography Modelling uses accessible 3D software to create parametric objects with embedded data, including Material Composition (local Nigerian materials), a Localised LCA Data Link, a Circularity Tag, and Supplier Information. This model serves as the single source of truth (Badenko et al., 2024), enabling an automated Bill of Materials (BOM) that reduces over-ordering and construction waste (Quiñones et al., 2021). Early-stage LCA Integration provides instantaneous feedback on embodied carbon and waste potential, which is essential for Life Cycle Optimisation (LCO) and empowers the designer as an environmental performance engineer (Tam et al., 2023). Success relies on developing a standardised Scenography Information Model (SIM) for widespread adoption. The practical application in Nigeria means designers can make highly localised, sustainable choices, comparing the embodied carbon of imported plywood with local alternatives such as bamboo or recycled plastic sheets. This is an economic choice, as local sourcing reduces high logistical costs. The digital model integrates local artisans' knowledge of indigenous materials. By making environmental and economic data transparent, the SDW ensures initial design choices align with circular economy principles, transforming the conceptual stage into the primary driver of sustainable innovation.

3.2. Phase 2: Digital Prototyping and Assessment (The Virtual Twin)

In the second phase, the data-rich design model is promoted to a Virtual Twin, a high-fidelity, interactive digital environment used for rigorous testing and optimisation, which is particularly valuable in the Nigerian context where physical prototyping is often prohibitively expensive and wasteful. This phase effectively replaces costly, time-consuming physical mock-ups with digital simulations, mitigating both artistic and technical risks. Performance Simulation and Risk Mitigation involve testing the set's structural integrity and Safety (Reisinger, Knoll, & Kovacic, 2021), a critical concern given the variable quality of local construction materials and techniques. It also involves simulating Technical Integration (Performit Live, 2025), such as digital lighting and projection mapping, which are increasingly used in Nigerian theatre (Akpienbi, 2025). Additionally, it calculates Operational Energy Optimisation, crucial for productions reliant on generators, by simulating the energy consumption of technical equipment. Furthermore, the Virtual Twin facilitates comprehensive circularity planning.

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Deconstruction Simulation enables designers to plan the dismantling process, identifying reusable and recyclable components, and automatically generates a Material Passport (Wandiga, 2020). This is a vital step towards formalising the informal recycling sector in Nigeria, providing a clear, tracked inventory of valuable assets. Finally, Logistics Simulation plans transport by optimising packing and routing to minimise the logistical carbon footprint (Bhandal et al., 2022), a necessary measure to combat the high emissions associated with Nigeria's often inefficient transport infrastructure. The Virtual Twin thus serves as a low-risk, high-return environment for testing sustainable and efficient production strategies before any physical commitment is made. The application of the Virtual Twin in Nigeria is particularly transformative because it directly addresses the high-risk nature of physical production in a challenging infrastructural environment. For instance, simulating Structural Integrity and Safety is not merely an academic exercise but a crucial step in preventing the onset of accidents, especially when using locally sourced or recycled materials whose structural properties may be less predictable than those of certified imported goods. The Virtual Twin enables non-destructive testing of these materials within the digital model, ensuring safety without generating material waste. Furthermore, the Logistics Simulation component is invaluable. Given the poor state of many Nigerian roads and the associated high cost and carbon footprint of transport, the ability to digitally optimise the packing of set pieces into transport vehicles (e.g., calculating the optimal nesting of modular units) and to simulate the most fuel-efficient routes provides a direct and measurable economic saving. This simulation capability extends to Circularity Planning, where the Deconstruction Simulation can be used to train local crews on the most efficient and safest methods for dismantling the set for material recovery. This process is currently often chaotic, resulting in material damage. By formalising this process, the Virtual Twin ensures the Material Passport is executed accurately, transforming the end-of-life phase from a cost centre into a resource recovery opportunity. This digital prototyping phase is the engine of the SDW, ensuring that sustainability is integrated into the production plan rather than added as an afterthought, and that a data-informed, low-risk virtual trial precedes every physical action.

3.3. Phase 3: Physical Realisation and Operation (The Active Twin)

The third phase involves the transition from the virtual model to the physical set, with the digital model guiding the build and monitoring operational performance. Digital Fabrication and build accuracy are enhanced as the BIM-Scenography model provides precise instructions, minimising material off-cuts and waste (Long et al., 2019), a key factor in reducing waste from traditional, manual construction. The model ensures build accuracy, reducing costly on-site modifications. For long running or touring productions, the model becomes an Active Twin using low-cost sensors. This real-time data enables the production team to Monitor

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Energy Use (Gourlis & Kovacic, 2022), providing accurate consumption figures for generators and grid power, which are essential for reporting and efficiency. The Active Twin also supports Predictive Maintenance (Kaewunruen et al., 2021), ensuring optimal longevity and reducing the need for emergency repairs. The data collected is fed back into the Virtual Twin, creating a continuous feedback loop that refines LCA data for local materials and improves future simulations, institutionalising learning across the Nigerian creative sector. The Active Twin in Nigeria is a direct response to the unreliable power infrastructure and high Operational Impact. Integrating low-cost sensors provides real-time data on energy consumption, allowing teams to eliminate waste and reduce fuel costs, a significant economic benefit. The Digital Fabrication and Build Accuracy component is vital, as precise data from the BIM-Scenography model minimises off-cuts and waste, especially with expensive or scarce materials. Predictive Maintenance is essential for touring sets, flagging potential failures before they occur, and reducing emergency, wasteful repairs. This continuous feedback loop is the mechanism by which the SDW framework achieves institutionalised learning and continuously improves the sustainability performance of Nigerian scenography.

3.4. Phase 4: End-of-Life and Archiving (The Legacy Twin)

The final phase of the SDW framework is critical for closing the circular economy loop in Nigerian scenography, ensuring that the environmental and informational value of the set is captured for future productions. This phase directly addresses the pervasive 'take-make-dispose' culture by formalising the process of material recovery and asset management. Digital Deconstruction and the execution of the material passport are the central activities. The Material Passport, generated in Phase 2, is executed during deconstruction, with the digital model updated to reflect the actual end-of-life pathway of every component. This process ensures accountability and provides a verifiable record of material circularity. The resulting Legacy Twin serves as a permanent, searchable catalogue of reusable assets, institutionalising circularity across the Nigerian creative industry (Wandiga, 2020). This digital inventory of reusable flats, props, and materials, complete with their LCA data and condition reports, can be shared across theatre companies and Nollywood production houses, significantly reducing the demand for new materials. Crucially, this phase also focuses on Data Interoperability and Standardisation for Industry-Wide Adoption. Scalability requires a unified approach to data exchange. The development of a Nigerian-specific Scenography Information Model (SIM) is a critical next step (Teisserenc & Sepasgozar, 2021), ensuring that data can flow seamlessly between designers, fabricators, and asset managers, regardless of the software they use. This standardisation is vital for overcoming the fragmentation of the Nigerian supply chain and for enabling the industry to move towards a truly circular economic model, transforming waste into a tracked, valuable resource for the entire creative ecosystem. The Legacy Twin is

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arguably the most transformative element of the SDW framework for the Nigerian context, as it formalises and scales the informal recycling and reuse practices that already exist. By providing a digital, searchable inventory of reusable assets, complete with their material composition, condition, and LCA data, the Legacy Twin creates a transparent, shared resource pool for the entire creative sector. This moves the industry beyond ad-hoc material scavenging to a professional, data-driven asset management system. The Material Passport Execution ensures that the final disposal or reuse pathway is recorded, providing auditable proof of circularity, which is increasingly crucial for securing international funding and demonstrating corporate social responsibility. The necessity of the Scenography Information Model (SIM) cannot be overstated. Given the diversity of digital tools and the fragmentation of the Nigerian creative supply chain from small, independent theatre companies to large Nollywood studios a common data standard is the only way to ensure interoperability. The SIM would serve as a common language, enabling seamless data exchange regardless of whether a designer uses open-source CAD or a commercial BIM suite. This standardisation is the key to unlocking the full potential of the circular economy, enabling the efficient matching of a deconstructed set's components with the material needs of future production. By institutionalising this final phase, the SDW framework ensures that every production contributes to a growing, sustainable material infrastructure, making the next production inherently more sustainable and cost-effective than the last. This closes the loop, transforming the linear 'take-make-dispose' model into a regenerative, circular system.

4. Implications and Challenges for Sustainable Digital Workflows in Nigeria

4.1. Artistic Transformation and the New Aesthetic of Ecological Performance

The SDW framework introduces ecological performance as a new, quantifiable design parameter, fundamentally altering the artistic brief for Nigerian scenographers. This shift challenges designers to move beyond purely visual aesthetics to material longevity, modularity, and reusability, fostering a design aesthetic rooted in material honesty and circularity. The Virtual Twin allows for greater creative freedom and risk-taking in the virtual space, reducing the pressure and cost associated with physical experimentation, a significant constraint in low-budget Nigerian productions (Performit Live, 2025). Scenographers can now explore radical designs, test the structural integrity of local, unconventional materials, and instantly quantify the environmental trade-offs of their choices without financial penalty. This transition encourages a new form of digital literacy, moving the scenographer closer to the role of a 'digital architect' who manages both the aesthetic and the quantifiable performance of their design. The framework also promotes the integration of digital scenography (e.g., projection mapping, digital lighting) as a sustainable alternative to physical construction, a trend already emerging in Nigerian theatre (Akpienbi, 2025). By making sustainability a measurable and integral part of

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the design process, the SDW elevates the scenographer's role to that of a key contributor to the nation's environmental goals, fostering a new generation of artists whose work is both culturally resonant and ecologically responsible. The introduction of ecological performance fundamentally redefines the artistic brief, moving the scenographer from a purely aesthetic role to one of an integrated environmental and creative manager. The quantifiable nature of the SDW, particularly through LCA integration in the Virtual Twin, enables a new form of creative dialogue. Instead of simply asking "What looks best?", the question becomes "What looks best and has the lowest embodied carbon?" This encourages a creative engagement with local, sustainable materials, resulting in a distinctly Nigerian aesthetic grounded in material honesty and circularity. The Virtual Twin is crucial here, as it provides a risk-free sandbox for experimentation, eliminating the barrier of costly failed physical prototypes. This fosters a culture of creative freedom and innovation directly linked to sustainability. Furthermore, the SDW promotes the integration of digital scenography, as data show that a digital backdrop has a significantly lower Embodied Impact than a traditional painted flat. By making the sustainable choice the most creative and economically viable option, the SDW framework acts as a powerful catalyst for artistic transformation, ensuring that the future of Nigerian scenography is both cutting-edge and ecologically sound.

4.2. Economic Viability, Circularity, and Bridging the Digital Divide

While the initial investment in digital infrastructure and training for the SDW framework is required, the long-term economic benefits are compelling, promoting a crucial shift to a circular economic model within the Nigerian creative sector. Waste Reduction and Cost Savings are achieved through precise material quantification (Quiñones et al., 2021) and the tracking of reusable stock via the Material Passport, directly reducing expenditure on new materials and waste disposal fees. Optimised Logistics minimises costs and time for touring productions through transport simulation (Bhandal et al., 2022), a significant financial advantage given Nigeria's high transport costs. Crucially, Asset Value Creation via the Legacy Twin establishes a formal circular economy, transforming what was once waste into a tracked, valuable resource for the entire industry (Wandiga, 2020). The economic argument for SDW is thus framed as a strategic investment in operational efficiency and long-term financial resilience, particularly for Nollywood, where the sheer volume of production makes even marginal efficiency gains highly profitable. However, the implementation must directly confront the Digital Divide. High-end BIM/DT software is often prohibitively expensive for the majority of Nigerian theatre companies and independent Nollywood producers. Addressing this requires a concerted effort to develop and promote open-source or low-cost digital tools tailored explicitly for scenography, potentially leveraging existing open-source CAD and data management platforms. Furthermore, the establishment of

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regional digital resource hubs, offering subsidised access to software and expert training, is crucial to prevent the SDW from becoming an exclusive tool for large, well-funded institutions. The long-term success of the SDW framework hinges on its democratisation across the entire Nigerian creative ecosystem, ensuring that sustainability is not a luxury but a standard practice for all. The economic case for the SDW in Nigeria is robust because the cost of materials and logistics represents a disproportionately high percentage of production budgets compared to Western counterparts. The ability to achieve Waste Reduction and Cost Savings through precise digital quantification (Quiñones et al., 2021) and the formal tracking of reusable stock via the Material Passport translates directly into enhanced profitability, a compelling incentive for Nollywood producers operating on tight margins. The Asset Value Creation facilitated by the Legacy Twin is a game-changer, transforming discarded set pieces into a quantifiable, reusable inventory. This creates a secondary market for set components, formalising the circular economy and providing a new revenue stream or cost-saving mechanism for future productions. However, the Digital Divide remains the most significant barrier to equitable adoption. To overcome this, the strategy must move beyond simply promoting open-source software. It requires the development of a dedicated, low-bandwidth, mobile-first application for data entry and asset tracking, given that many Nigerian practitioners primarily use mobile devices. Furthermore, a national, subsidised training programme, potentially delivered through vocational schools and film academies, is essential to build the necessary digital literacy in BIM-Scenography and LCA principles. This investment in human capital, coupled with the democratisation of the digital tools, will ensure that the economic and environmental benefits of the SDW are accessible to the entire spectrum of the Nigerian creative sector, from the largest studios in Lagos to the smallest theatre companies in regional centres. The economic viability of the SDW is thus inextricably linked to its accessibility and its capacity to leverage the existing informal reuse culture into a formal, digitally managed circular economy.

4.3. Data Infrastructure, Standardisation, and Policy Alignment

The successful implementation of the SDW framework in Nigeria is fundamentally dependent on the development of a robust, localised data infrastructure and a commitment to industry-wide standardisation. The core challenge lies in the Data Availability and Quality of Life Cycle Assessment (LCA) data for common Nigerian theatre materials. Currently, a comprehensive database of LCA data for local materials such as bamboo, raffia, local timber species, and recycled plastics is severely limited (Tam et al., 2023). This necessitates a collaborative, national research effort to compile environmental product declarations (EPDs) for these materials, which must be integrated into the BIM-Scenography models. Furthermore, Interoperability and Standardisation are paramount for scalability.

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The development of a Nigerian-specific Scenography Information Model (SIM) is a critical next step (Teisserenc & Sepasgozar, 2021), ensuring that data can flow seamlessly between designers, fabricators, asset managers, and the informal recycling sector. This standardisation is vital for overcoming the fragmentation of the Nigerian supply chain. From a policy perspective, the SDW framework provides the necessary quantitative data to meet increasing environmental reporting and compliance pressures. By integrating LCA, it provides a robust and auditable methodology for measuring and reporting the environmental impact of each production (Hussain et al., 2023). Policy bodies, such as the National Council for Arts and Culture (NCAC) or the Nigerian Film Corporation (NFC), could incentivise SDW adoption by making BIM-Scenography and LCA integration a criterion for funding or regulatory compliance, accelerating a unified approach to environmental responsibility across the creative sector. Establishing a national digital repository for Legacy Twins would further solidify this policy alignment, transforming individual production data into a collective national asset for circular-economy planning. The most immediate and critical challenge to the SDW's implementation in Nigeria is the lack of a localised LCA Database. Without accurate environmental product declarations (EPDs) for materials commonly used in Nigerian scenography, such as various local hardwoods, bamboo, raffia, and locally recycled plastics, the LCA integration within the BIM-Scenography model is rendered ineffective. Global LCA databases are often irrelevant, as they fail to account for local manufacturing processes, transportation distances, or energy sources (Tam et al., 2023). Therefore, a concerted, government-backed research initiative is required to generate this foundational data, potentially in partnership with Nigerian universities and materials science laboratories. This data must then be made open-source and integrated into the proposed Scenography Information Model (SIM). The SIM is the linchpin of standardisation, providing the common data structure necessary for interoperability across the fragmented Nigerian supply chain. Policy intervention is essential to mandate the use of the SIM and to incentivise the contribution of production data to the national Legacy Twin repository. By linking SDW adoption to government funding, tax breaks, or regulatory compliance, bodies like the National Council for Arts and Culture (NCAC) can accelerate the industry-wide shift. This policy alignment transforms the SDW from a voluntary best practice into a mandatory, auditable standard, ensuring that the digital transformation is comprehensive and equitable and that the collective data generated becomes a powerful tool for national circular-economy planning.

5. Conclusion

The successful adoption of these digital workflows will not only ensure the art form remains vibrant and viable but will also contribute meaningfully to Nigeria's national goals for waste reduction and environmental sustainability. The SDW framework, through its phased approach, provides a clear,

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actionable roadmap for this transition. Phase 1 (Conceptualisation) ensures that sustainability is the primary design driver; Phase 2 (Virtual Twin) mitigates risk and waste through digital prototyping; Phase 3 (Active Twin) optimises operational efficiency, particularly energy use from generators; and Phase 4 (Legacy Twin) closes the loop by formalising the circular economy through asset tracking and material passports. The critical challenges identified are the Digital Divide and the lack of a Localised LCA Database, which are not insurmountable but require strategic, collaborative intervention. Future research must therefore focus on three key areas: Empirical Validation, conducting pilot studies with Nigerian theatre companies and Nollywood producers to gather quantitative data on the SDW's impact on cost, waste reduction, and embodied carbon; Tool Development, creating the open-source, low-cost, mobile-first BIM-Scenography and LCA tools necessary to democratise the framework; and Policy and Standardisation, developing the Nigerian-specific Scenography Information Model (SIM) and advocating for its adoption by national cultural and film bodies. By addressing these areas, the Nigerian creative sector can establish a globally relevant model for sustainable production, demonstrating that digital innovation can be the most powerful tool for achieving environmental responsibility in a developing economy. The SDW is not just a technological upgrade; it is a commitment to a more resilient, equitable, and ecologically sound future for Nigerian art. The development of the Scenography Information Model (SIM) is the most pressing technical challenge, requiring a multi-disciplinary approach involving software engineers, scenographers, and data scientists to create a robust, yet flexible, open-source standard that can accommodate the diverse material and logistical realities of Nigerian production. This SIM must be designed to be low-bandwidth and mobile-compatible to ensure nationwide accessibility. Simultaneously, the LCA Database for Nigerian Materials project is a national imperative that requires collaboration among government agencies, environmental NGOs, and academic institutions to collect, verify, and publish ecological impact data for indigenous and commonly recycled materials. This data is the lifeblood of the SDW framework, transforming qualitative sustainability goals into quantitative, measurable metrics. Beyond these technical foundations, Longitudinal Case Studies are essential to move the SDW from a conceptual model to a proven methodology. These studies should track the full lifecycle of multiple productions, from small theatre runs to large Nollywood sets, to provide empirical evidence of the framework's economic and environmental return on investment. This is the most persuasive argument for industry-wide adoption. Finally, the Pedagogical Integration of these new digital and sustainable principles into the curricula of Nigerian universities and film academies is critical for long-term cultural change, ensuring that the next generation of creative professionals is inherently equipped to be environmental stewards. This comprehensive research agenda will solidify the SDW

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framework as the definitive blueprint for sustainable digital transformation in the Nigerian creative sector.

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