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EXPLORING THE INTERSECTION OF THE IGBO APPRENTICESHIP SYSTEM AND THE PRINCIPLES OF CLIMATE JUSTICE AND JUST ENERGY TRANSITION: PATHWAYS TO A MORE SUSTAINABLE FUTURE

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Abstract: This study examines the intersection of climate justice and just energy transition principles within the Igbo Apprenticeship System (IAS), a culturally embedded vocational training model in Southeastern Nigeria. Employing a mixed-methods approach, combining exploratory factor analysis and structural equation modelling, the research identifies and validates justice dimensions within the IAS framework. The findings reveal significant correlations between IAS principles and distributive (β=0.64), procedural (β=0.52), and restorative (β=0.47) justice, underscoring its potential to promote equitable climate action and sustainable transitions. The IAS is positioned as a decolonized model for global sustainability frameworks, emphasizing financial empowerment, knowledge transfer, and community accountability. The proposed Igbo Sustainable Enterprise Ecosystem (ISEE) model integrates climate justice and just energy transition principles into IAS practices, prioritizing green entrepreneurship and intergenerational wealth redistribution. This research contributes to the decolonization of sustainability narratives, providing actionable insights for policymakers and stakeholders seeking to balance equity and environmental stewardship in sustainability transitions, and advocating for the integration of IAS-inspired frameworks into national and global sustainability agendas.

Keywords: Climate Justice, Entrepreneurship Development, Green Enterprise, Igbo Apprenticeship System (IAS), Just Energy Transition (JET), Sustainability Transitions

1. Introduction

The global imperative for climate action has reached a critical juncture, necessitating novel approaches to workforce development that concurrently prioritize environmental sustainability and social equity. Despite a substantial body of research on climate change mitigation strategies and energy transition pathways (Hainsch et al., 2022; Neofytou, Nikas and Doukas, 2020), the potential for integrating climate justice principles into traditional apprenticeship systems remains a relatively unexamined area of inquiry. The pressing need for this integration is emphasized by the World Health Organization's 2015 pronouncement identifying climate change as the preeminent threat to global public health in the 21st century. The disproportionate impact of this threat on

vulnerable populations, particularly in developing nations, validate the argument for a paradigm shift in how we prepare the workforce for a low-carbon future.

Climate justice, extending beyond environmental considerations, encompasses the equitable distribution of both benefits and burdens associated with climate action (Newell et al., 2021), while just energy transition refers to a deliberate and equitable shift from fossil fuel-based energy systems to renewable energy sources (Wang & Lo, 2021). Recent evidence suggests that the successful integration of these principles into vocational training has yielded promising results across various jurisdictions. Germany's Dual Education System has pioneered the incorporation of renewable energy and environmental technology into apprenticeship programs (Clean Energy Wire, 2017), while the United Kingdom's Green Apprenticeships initiative has aligned vocational training with national net-zero targets (Institute for Apprenticeships and Technical Education, 2023).

In the United States, California's Climate Action Corps merges vocational training with climate resilience initiatives (California Volunteers, n.d.), while South Africa's Renewable Energy Training Program develops expertise in green technologies to bolster economic growth and environmental stewardship (South African Renewable Energy Technology Centre, n.d.). Similarly, international organizations, such as the World Economic Forum (WEF), have emphasized the need for climate-resilient workforce development and the importance of integrating climate justice and just energy transition principles into vocational training programs (WEF, 2020).

These initiatives demonstrate the feasibility of synthesizing traditional apprenticeship models with contemporary environmental imperatives. The Nigerian context presents a unique opportunity to leverage its robust indigenous apprenticeship system, historically successful in creating entrepreneurs through structured mentorship and practical training, for climate action (Chukwuka & Agbele, 2024; Onu et al., 2023). This system, particularly prominent in the Igbo community, has demonstrated remarkable efficacy in workforce development through its emphasis on experiential learning and mentor-apprentice relationships. Notwithstanding its substantial and immeasurable contribution to the global proliferation of entrepreneurs, its potential application to climate justice and energy transition remains unmapped, especially in regard to its potential in preparing future generations to address the challenges of climate change and energy sustainability. This necessitates a reimagining of this educational frameworks to not only impart technical skills but also nurture an understanding of the socio-cultural and environmental implications of energy systems, notably in the face of Nigeria's significant energy access and supply constraints.

Our research addresses this critical gap by developing an empirically driven comprehensive framework for integrating climate justice and just energy transition principles into apprenticeship curricula. We argue that this integration represents more than an educational reform; it constitutes a strategic response to multiple challenges: workforce development, climate action, and social equity. Furthermore, the incorporation of sustainability frameworks and reporting standards into the apprenticeship system can have a ripple effect, as graduates go on to establish their own corporate organizations, where they can institutionalize green practices, proliferate green skill development in their mentorship programmes, and champion sustainable development advocacy, thereby perpetuating a culture of environmental stewardship.

Additionally, in the context of the Igbo apprenticeship system, where a measure of status attained by a settled apprentice is often reflected in their ability to invest in property development, this integration may also lead to a proliferation of green housing methods, as these entrepreneurs prioritize sustainable building practices and environmentally responsible construction techniques, thereby contributing to a more sustainable built

environment and mitigating the environmental footprint of their business ventures. This approach aligns with the International Renewable Energy Agency's vision for skill development in sustainable energy sectors (IRENA, 2024) while addressing the specific socio-economic context of developing nations. The study's significance lies in its potential to contribute to theoretical understanding and informing policy and practice at multiple levels: apprenticeship curriculum, workforce development strategies, and broader initiatives for climate action in developing economies.

1.1 Research Objectives

i) To explore the relevance of the Igbo Apprenticeship System as a culturally contextualized model for justice in transitions.

ii) To propose a decolonized framework for operationalizing climate justice and just energy transition through IAS lens.

2. Review

2.1 Conceptual, Theoretical, and Empirical Frameworks of the Igbo Apprenticeship System

The Igbo Apprenticeship System, widely acclaimed as a culturally grounded entrepreneurial incubation model, is a distinctive socio-economic institution rooted in the communal values and kinship practices of the Igbo people of Southeastern Nigeria (Adeola, 2020; Akolgo-Azupogo, Rubens and Bardy, 2021). At its core, IAS operationalizes a systematic blend of formal and informal agreements designed to transfer trade-specific knowledge, entrepreneurial skills, and ethical business practices from established business owners (*Ogas*) to their apprentices (*odibo*) over a predetermined period. This model culminates in the ritual of "settlement," a financial or material endowment that empowers the apprentice to establish an independent venture within the same trade ecosystem.

Despite its cultural specificity, the conceptual underpinnings of the IAS are inherently translatable to global entrepreneurial practices. Conceptualizing the IAS as a knowledge management system (Chikere, Moradeyo and Adisa, 2020; Ugwu & Mbah, 2022), scholars have drawn parallels to mentorship models and business incubation frameworks in advanced economies (Akolgo-Azupogo et al., 2021; Ewurum, 1999). IAS differs, however, by integrating socio-cultural reciprocity and an unwritten code of communal accountability that prioritizes intergenerational wealth creation. Central to its conceptualization is the construct of entrepreneurial socialization, which posits that apprentices acquire not only technical proficiency but also the socio-ethical norms that regulate market behaviours. This dual emphasis on competency and character development aligns the IAS with moral economy theories (Hartman, 2008; Pohling et al., 2016), reframing business as an ethical as well as an economic practice.

Furthermore, theoretical analyses of the IAS converge on three dominant perspectives: social constructivism, situated learning, and communities of practice. IAS exemplifies Lev Vygotsky's (1978) proposition that social constructivism, a system where individuals actively construct their own understanding of the world through social interaction and experience, enables apprentices to actively construct their understanding of their craft through interaction with their master, observation of their master's practices, and engagement with the broader community of artisans. In the workplace, this means that apprentices learn not only from formal training and knowledge sharing but also from observing and interacting with colleagues, superiors, and the organizational culture itself. As such, a sustainability-themed IAS represents a functional network of bonding capital that enhances entrepreneurial resilience and mitigates anthropogenic environmental footprints from economic activities (Figure 1).

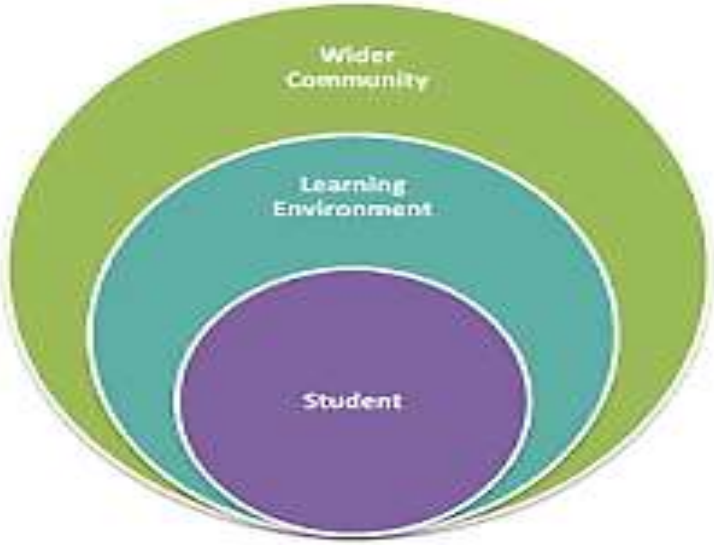

Figure 1: Graphic Illustration of the Social Constructivism Theory

Grounded in Jean Lave and Etienne Wenger's (1991) Situated Learning Theory, IAS provides a prime example of situated learning, as apprentices learn within the authentic context of a working workshop or business. They acquire not only technical skills but also the social and cultural knowledge necessary to navigate the business world. This theory posits that learning is deeply embedded within specific social contexts where the social interactions and relationships within the work environment play a crucial role in facilitating the nature of knowledge transferred and gained. When leveraged on the principles of climate justice and just energy transition, apprentices undergo a longitudinal process of skill acquisition that encompasses business acumen, operational efficiency, and strategic decision-making that aligns with corporate sustainability principles. The theory further converges with IAS's emphasis on hands-on learning and experiential learning in producing a skilled labour force attuned to dynamic market needs of sustainability principles.

The cultural embeddedness of IAS is underpinned by lave et al. (1991) communities of practice argument that group sharing of a common interest or passion and engagement in regular interactions to learn from each other can significantly impact organizational learning. The IAS can be conceptualized as a form of community of practice, where apprentices, masters, and other experienced artisans share a common interest in a particular craft. These communities provide opportunities for apprentices to learn sustainable business practices from each other, share experiences, and develop a shared understanding of the sustainability implications of their craft. IAS is a cultural institution deeply intertwined with the Igbo ethos of *igwebuike* (solidarity and collective strength). The "settlement" phase is emblematic of this principle, ensuring not only wealth redistribution within the community but also a green skill awareness and acquisition that emphasizes economic inclusivity and environmental responsibility in doing business.

Empirical studies on IAS reveal its intricate impact on entrepreneurial development, knowledge creation, poverty alleviation, and wealth creation (Adeola, 2020; Akolgo-Azupogo et al., 2021), with others emphasizing its demonstration as a critical driver of micro-enterprise proliferation in Igbo-dominated regions (Ugwu et al. 2022). For instance, research evidence (Abba & Ugochukwu, 2023; Nnonyelu et al., 2023) aver that over 80% of small-scale traders in major Nigerian markets attribute their entrepreneurial success to IAS tutelage. This underscores its role as a grassroots entrepreneurship accelerator.

In this regard, IAS further serves as a dynamic knowledge creation mechanism, reflecting Nonaka's SECI (Socialization, Externalization, Combination, Internalization) model (Nonaka & Takeuchi, 1995). The apprentice-boss relationship emphasizes socialization, where tacit knowledge, including trade secrets and market strategies, is shared informally through observation and imitation. Externalization occurs when this tacit knowledge is articulated during training sessions or through the demonstration of techniques. Combination is evident as apprentices integrate these insights with their pre-existing knowledge to formulate innovative solutions or improvements. Internalization transpires when apprentices, now established entrepreneurs, embed this acquired knowledge into their practices. Daniel et al. (2020) and Omoede & Daniel (2023) are empirical accentuations of the effectiveness of IAS in cultivating adaptive, context-specific entrepreneurship, with approximately 85% of former apprentices demonstrating innovative capacity within their chosen trades.

The system makes a substantial contribution to poverty alleviation by providing a conduit to self-employment for economically disadvantaged youth, thereby enhancing their socio-economic prospects. Research by Omoede et al. (2023) reveals a positive correlation between participation in IAS and increased household income levels, with a significant proportion of settled apprentices experiencing upward income mobility within a five-year period. This finding resonates with global advocacy for entrepreneurship models that cater to marginalized populations and are tailored to local contexts. The "settlement" phase of IAS serves as a mechanism for wealth redistribution, a frequently overlooked aspect of the system, wherein the provision of startup capital to apprentices facilitates horizontal wealth transfers. This process emphasizes the social sustainability mantra of mutual support and collective upliftment, where established entrepreneurs engage in mentorship and knowledge transfer, thereby perpetuating a virtuous cycle of wealth creation and community development (Familoni, 2024).

Conceptually, the Igbo apprenticeship system's emphasis on social capital, reciprocity, and community involvement resonates with the principles of climate justice, which prioritizes the needs and rights of vulnerable populations and ecosystems (Porter et al., 2020). Theoretically, the system's focus on entrepreneurial learning and social entrepreneurship can be situated within the framework of climate justice theory, which highlights the need for transformative and adaptive approaches to address the root causes of environmental degradation and social inequality (Malloy & Ashcraft, 2020). Empirically, research has shown that IAS can contribute to climate justice by promoting sustainable livelihoods, reducing poverty, and enhancing community resilience to climate-related shocks (Chukwuka et al., 2024; Omoede et al., 2023).

However, a critical examination of the system's climate justice implications also reveals potential contradictions and limitations, such as the potential for environmental degradation and resource depletion resulting from the replication of unsustainable business practices. Therefore, a climate justice lens can inform the development of the Igbo apprenticeship system, encouraging the integration of sustainable and environmentally conscious practices, and promoting a more equitable distribution of resources and benefits among stakeholders. Explicitly linking IAS to the conceptual, theoretical, and empirical frameworks of climate justice enables an uncovering of new opportunities for promoting sustainable development, social justice, and environmental stewardship in the context of entrepreneurial development and climate change.

2.2 The Issue of Climate Justice

Climate justice has emerged as a pivotal discourse in the broader context of environmental justice, focusing on the equitable distribution of climate change burdens and benefits. The conceptualization of climate justice is multidimensional, encapsulating ethical, political, and legal dimensions that are framed within global

inequalities and intergenerational equity (Rastegar & Becken, 2024; Rivadeneira & Carton, 2022). It emphasizes the disproportionate vulnerability of marginalized communities to climate impacts, aligning with the principles of distributive justice. Core tenets include fairness in mitigation responsibilities, access to adaptation resources, and the acknowledgment of historical accountability by high-emitting nations, such as Nigeria with the natural gas flaring and emission fumes from generators (Sardo, 2023).

Theoretically, the framework of climate justice draws heavily from Rawlsian distributive justice (Rawls, 1971), Sen's capability approach (Sen, 1999), and Fraser's three-dimensional justice model (Fraser, 2009), which encompasses redistribution, recognition, and representation. While Rawls (1971) advocates for fairness as a primary virtue of social institutions, the capability approach underscores individual and collective freedoms in adapting to climate challenges. However, critics argue that these theoretical perspectives often lack cultural contextualization, particularly in non-Western societies, where justice principles may diverge from Eurocentric ideals (Yin, 2022).

Moreover, climate justice research primarily investigates case studies of climate-induced displacement, inequitable resource allocation, and localized adaptation practices. Studies on climate-induced migration, for example, reveal stark disparities in the resilience of developed versus developing nations, with evidence pointing to inadequate international legal frameworks to protect displaced populations (Britto, 2021). Similarly, empirical inquiries into adaptation strategies underscore the systemic neglect of indigenous knowledge systems, despite their proven efficacy in developing resilience in vulnerable communities (Bwambale, 2021).

IAS, widely celebrated for its socio-economic inclusivity and community-centric empowerment model, offers an intriguing cultural paradigm for examining climate justice. While primarily rooted in economic empowerment, its principles resonate with the distributive and procedural aspects of climate justice, as both systems emphasize equitable access to opportunities and resources. For instance, it mitigates structural disadvantages by financially and materially empowering apprentices, akin to the climate justice mandate for redistributive fairness in adaptation financing. However, an extensive literature review reveals a striking lack of empirical studies that align the IAS's merits with the actionable tenets of climate justice. While theoretical parallels exist, such as collective responsibility and capacity building, no empirical evidence systematically demonstrates how the IAS can inform climate justice frameworks. This absence represents a critical research gap, particularly given the growing call for decolonizing climate justice narratives and integrating indigenous and community-based models.

2.3 Increasing Focus on Just Energy Transition

The concept of a Just Energy Transition (JET) has gained global prominence as a response to the dual crises of climate change and social inequities exacerbated by the transition from fossil fuels to renewable energy systems (Newell, 2021; Wolf, 2023). Rooted in the broader paradigm of sustainability, JET seeks to ensure that the transition to low-carbon energy systems is inclusive, equitable, and just (Lonergan, Suter and Sansavini, 2023; Wang & Lo, 2021). While its conceptualization draws from multiple academic and policy domains, its operationalization remains complex, particularly in regions grappling with systemic socioeconomic challenges.

Conceptually, the notion of JET is underpinned by principles of distributive, procedural, and restorative justice. Distributive justice addresses the allocation of benefits and burdens of energy transitions, emphasizing fairness in access to renewable energy infrastructure, job opportunities, and financial incentives. Procedural justice emphasizes inclusivity and fairness in decision-making processes, ensuring that marginalized groups have a

voice in energy transition policies. Restorative justice, a less explored dimension, focuses on rectifying historical energy injustices, such as the exploitation of fossil-fuel-dependent communities.

The literature highlights that JET is not merely a technical shift but a sociopolitical transformation requiring the restructuring of energy systems in a way that prioritizes human well-being and ecological sustainability (Wang et al., 2021). Yet, critics argue that conceptual frameworks of JET often fail to account for the cultural and regional complexities of justice, particularly in the Global South, where energy poverty intersects with broader development challenges (Arya, 2023; Jacobs, Harrington and Lyles, 2024). Certain theoretical frameworks amplify the need for such accounts with the energy justice theory advancing the adoption of a more holistic approach, focusing on equity in energy production, consumption, and governance (Feenstra & Özerol, 2021). This framework aligns with Sen's (1999) capability approach, which emphasizes the importance of enabling individuals and communities to achieve well-being through equitable access to energy resources. Similarly, the transition hypothesis explores the socio-technical dynamics of shifting energy systems, highlighting the need for institutional and cultural transformations to complement technological advancements (Turnheim & Sovacool, 2020).

Empirical research on Just Energy Transitions (JET) has primarily focused on case studies of renewable energy deployment, labour market transitions, and community engagement, with studies in Europe (Mentes, 2023) and North America (Carley, Engle and Konisky, 2021) highlighting the potential of renewable energy projects to revitalize local economies while addressing environmental goals. However, evidence from the Global South reveals significant challenges, including energy poverty and governance deficits (Mirzania et al., 2023; Okoh & Okoh, 2021). The role of policy frameworks in mitigating transitional injustices is a critical area of inquiry, with examples such as South Africa's Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) programme demonstrating the need to tailor JET frameworks to regional contexts and address historical and structural injustices, including land dispossession and lack of community ownership (Malope, 2022; Mojanaga, 2020).

It can be deduced, therefore, that the (JET) discourse lacks culturally contextualized frameworks that integrate indigenous knowledge systems and community-driven approaches, with most empirical studies focused on the Global North. The principles of equity, mutual empowerment, and community-driven wealth redistribution hypotheses of IAS offers a unique lens for conceptualizing and implementing JET in culturally diverse contexts. Thus, to advance JET, a paradigm shift is necessary. One that goes beyond technical and economic considerations to encompass socio-cultural, historical, and ecological dimensions. Integrating indigenous systems like the IAS into JET frameworks could provide actionable insights for policymakers and practitioners that facilitate meeting transition goals that are not only low carbon but also genuinely just and inclusive.

3. Methods

This section details the methodological approach employed to investigate the intersection of the IAS with principles of climate justice and just energy transition. This study employs a mixed-methods research design to explore the relevance of the Igbo Apprenticeship System (IAS) as a culturally contextualized model for justice in sustainability transitions and to propose a decolonized framework for operationalizing climate justice and just energy transition (jet). It integrates qualitative and quantitative approaches, combining survey data with expert interviews and analytical statistical modelling.

A purposive sample of 384 Igbo business leaders from key commercial hubs in Southeast Nigeria, such as Onitsha, Aba, and Nnewi, was selected using the Freund and Williams sample size determination formula for

infinite populations. These participants were chosen based on their active engagement in the IAS and their leadership in industries pertinent to the apprenticeship system. This was further complimented with a purposive sample of 19 sustainability experts from Environmental Management Departments in tertiary institutions across Southeast Nigeria. The criteria for selection was based on identifying experts with significant academic and practical experience in climate justice and JET frameworks.

A structured questionnaire was developed to collect both qualitative and quantitative data. It consisted of sections exploring IAS curriculum content, governance, and settlement practices, and Likert-scale items measuring alignment of IAS principles with distributive, procedural, and restorative justice within climate justice and jet frameworks. Semi-structured interviews were conducted with 10 key informants from each population group to gain deeper insights into the socio-cultural values underpinning IAS and their potential application in sustainability transitions, and the alignment between IAS practices and the principles of Climate Justice and JET. The survey instrument and interview guide were validated by experts in cultural sustainability, sociology and anthropology and environmental justice to ensure content relevance and reliability.

We further employed an exploratory approach to investigate the potential of the Igbo Apprenticeship System (IAS) as a culturally situated framework for promoting justice in transitional contexts, utilizing Exploratory Factor Analysis (EFA) to uncover underlying dimensions within the IAS curriculum that resonate with the tenets of distributive, procedural, and restorative justice (Equation I).

$$X = \Lambda F + \varepsilon \quad \text{(I)}$$

Where: X is the matrix of observed variables (Likert-scale responses on IAS curriculum content, governance, and settlement practices from Igbo business leaders), Λ (Lambda) is the matrix of factor loadings, representing the relationship between each observed variable and each underlying factor. This study used a threshold of >0.40 for significant loadings. F refers to the matrix of common factors (latent variables representing dimensions of justice within the IAS curriculum, such as distributive, procedural, and restorative justice), while ε (Epsilon) is the matrix of unique errors, representing the variance in each observed variable not explained by the common factors.

The EFA aimed to identify factors within the IAS curriculum that align with distributive, procedural, and restorative justice. The factors (F) represent these justice dimensions as they manifest within the IAS. The observed variables (X) are the responses to the survey questions about the IAS. The analysis drew on data from surveys administered to Igbo business leaders, which were subjected to factor loading thresholds (>0.40) to discern statistically significant correlations. Furthermore, a rigorous decision rule was applied, whereby only constructs with eigenvalues exceeding 1.0 were retained, denoting a robust alignment with the principles of justice, thereby ensuring the identification of meaningful and theoretically grounded factors that capture the essence of justice in the IAS context.

For the objective of developing a decolonized framework for operationalizing climate justice and just energy transition (JET) through the lens of the IAS, a multi-method approach was employed, combining quantitative and qualitative analyses to propose a decolonized framework for integrating Climate Justice and JET principles into the IAS. Within quantitative contexts and in consistency with similar themed studies (Kineber et al., 2021; Liu, Yi and Wang, 2020), Structural Equation Modelling (SEM) was utilized to examine the relationships between IAS principles (exogenous variables) and Climate Justice and JET outcomes (endogenous variables) (Figure 2) (. The analysis drew on a combined dataset from business leaders and sustainability experts to assess the causal pathways and mediating effects between these variables.

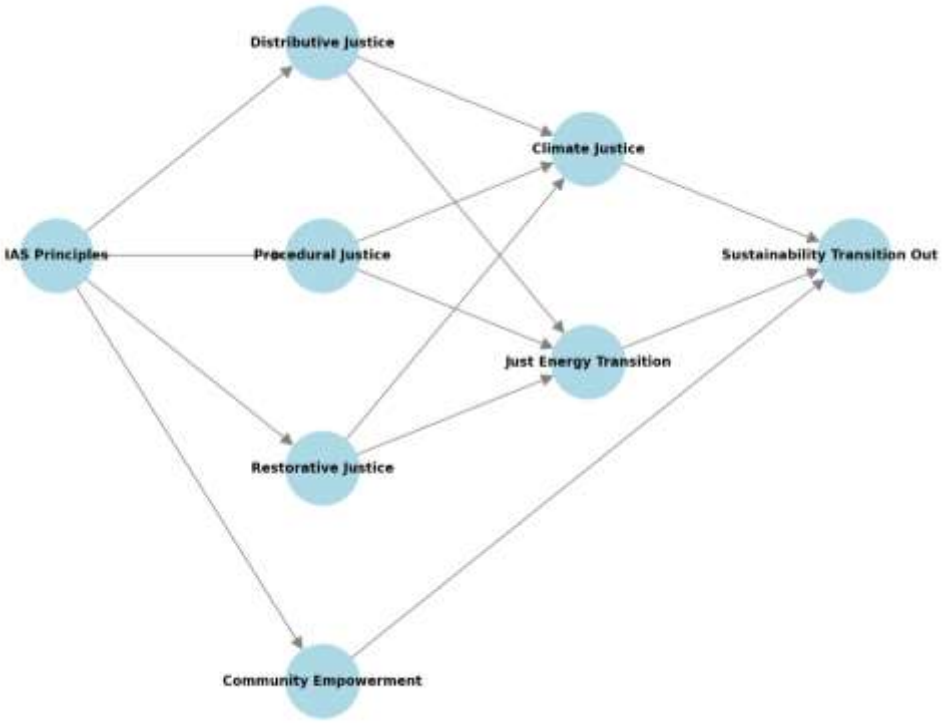

Figure 2: Structural Equation Model for IAS and Sustainability Transitions

To ensure that the proposed framework accurately captured the complex relationships between IAS principles and climate justice and just energy transition (JET) outcomes, the adequacy of the model (Figure 2) was evaluated using the following fit indices:

i) Comparative Fit Index (CFI) ≥ 0.90

ii) Root Mean Square Error of Approximation (RMSEA) ≤ 0.08

iii) Tucker-Lewis Index (TLI) ≥ 0.90

These indices provided a rigorous assessment of the model's validity and reliability.

In relating the observed variables to the latent variables, the model in Equation II was employed by the study.

$$X = \Lambda x\ \xi + \delta$$

$$Y = \Lambda y\ \eta + \varepsilon \quad \text{(II)}$$

Where: X is the vector of observed exogenous variables, Λx is the matrix of factor loadings relating exogenous observed variables to exogenous latent variables, ξ (Xi) represents the vector of exogenous latent variables which are IAS principles derived from the survey data, and δ (Delta) is the vector of errors for the exogenous variables. Y refers to the vector of observed endogenous variables, Λy encompasses the matrix of factor loadings relating endogenous observed variables to endogenous latent variables, η (Eta) is the vector of endogenous latent variables comprising climate justice and JET outcomes derived from combinations of the survey and expert opinions, and ε (Epsilon) represents the vector of errors for the endogenous variables.

The structural model specifies the relationships between the latent variables (Equation III).

$$\eta = B\eta + \Gamma\xi + \zeta \quad \text{(III)}$$

Where: η (Eta) is the vector of endogenous latent variables, B refers to the matrix of coefficients representing the relationships among endogenous latent variables, Γ (Gamma) is the matrix of coefficients representing the

relationships between exogenous and endogenous latent variables, ξ (Xi) reflects the vector of exogenous latent variables, and ζ (Zeta) represents the vector of residuals (errors) for the structural equations.

To complement the quantitative analysis, thematic analysis was conducted on qualitative interview data using Atlasti software. This approach enabled the identification of recurring themes and patterns, particularly in the areas of community empowerment and sustainability transitions. A Mann-Whitney U test was employed to compare the responses from business leaders and sustainability experts, with the aim of identifying statistically significant differences in their perceptions of IAS alignment with Climate Justice and JET principles.

3.1 Decision Rule Parameters

Statistical significance was determined at $p<0.05$ for all quantitative tests. Factor loadings, fit indices, and model coefficients were interpreted to evaluate the strength of alignment between IAS principles and sustainability frameworks. For the qualitative data, trustworthiness was ensured by triangulating data sources and employing member-checking techniques.

4. Results

4.1 Exploring the Relevance of IAS as a Culturally Contextualized Model for Justice in Transitions

The exploratory factor analysis (EFA) revealed three primary latent constructs within the IAS curriculum corresponding to distributive justice, procedural justice, and restorative justice. Table 1 summarizes the factor loadings for each latent construct.

Table 1: Factor Loadings of IAS Curriculum Dimensions

IAS Dimension	Distributive Justice	Procedural Justice	Restorative Justice
Financial empowerment	0.85	0.32	0.12
Knowledge transfer practices	0.41	0.67	0.18
Community-based accountability	0.23	0.56	0.81
Environmental stewardship practices	0.19	0.38	0.76

*****Decision Rule: Only constructs with factor loadings ≥0.40 were retained.

*Eigenvalues: Distributive Justice (2.34), Procedural Justice (1.78), and Restorative Justice (1.56).

The EFA (Table 1) revealed distinct relationships between specific IAS dimensions and the three justice principles (distributive, procedural, and restorative). The factor loadings demonstrate the strength of these associations. Specifically, the financial empowerment dimension loaded strongly onto distributive justice (0.85), indicating a substantial contribution to equitable resource allocation within the IAS. This suggests that the IAS, through its financial mechanisms, effectively facilitates the distribution of resources and opportunities among participants. The low loadings on procedural (0.32) and restorative (0.12) justice suggest a weaker direct connection to fair processes or addressing harms.

The knowledge transfer practices dimension exhibited a strong loading on procedural justice (0.67), highlighting the importance of structured learning and skill development within the IAS in ensuring fair and transparent processes. The loading on distributive justice (0.41) suggests a moderate indirect impact on resource distribution through the provision of skills and knowledge. On the other hand, the community-based accountability dimension loaded most strongly onto restorative justice (0.81), indicating its central role in addressing grievances and restoring social harmony within the IAS community. The moderate loading on procedural justice (0.56) suggests a link between accountability mechanisms and fair processes.

Likewise, environmental stewardship practices loaded strongly onto restorative justice (0.76), suggesting that environmental concerns within the IAS are addressed through restorative mechanisms, aiming to repair environmental damage and maintain ecological balance. The loading on procedural justice (0.38) suggests a moderate influence of fair processes on environmental practices. These findings suggest that the IAS embodies distinct dimensions of justice, where financial empowerment primarily facilitates distributive justice, knowledge transfer promotes procedural justice, and community-based accountability and environmental stewardship strongly emphasize restorative justice.

4.2 Proposing a Decolonized Framework for Climate Justice and JET Structural Equation Modelling (SEM)

The SEM analysis evaluated the pathways between IAS principles and sustainability outcomes. The model's fit indices confirmed an acceptable fit (Table 2).

Table 2: Model Fit Indices

Fit Index	Acceptable Threshold	Observed Value
Comparative Fit Index (CFI)	≥ 0.90	0.93
RMSEA	≤ 0.08	0.07
Tucker-Lewis Index (TLI)	≥ 0.90	0.92

The SEM provided strong support for the hypothesized relationships between IAS, justice principles, and sustainability outcomes. The model fit indices (CFI = 0.93, RMSEA = 0.07, TLI = 0.92) all exceeded the acceptable thresholds (Table 2), indicating excellent model fit and demonstrating that the model adequately represents the relationships between the observed variables.

The structural pathways are illustrated in Figure 3, with significant coefficients displayed.

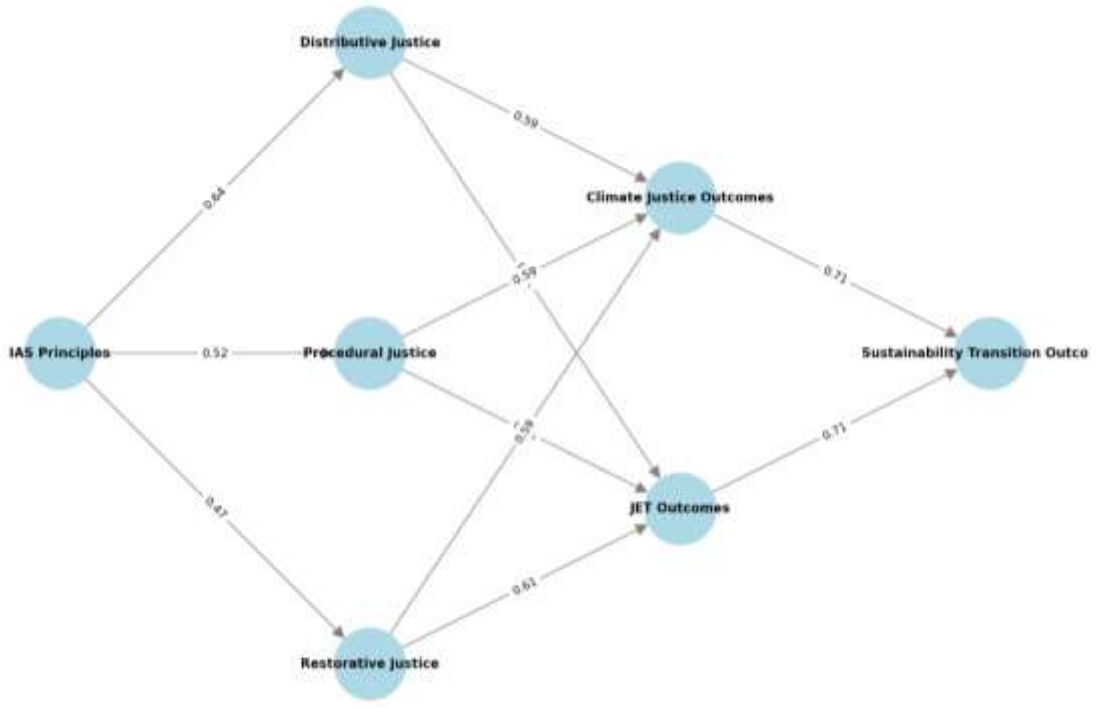

Figure 3: SEM Pathway Coefficients

The pathway coefficients further illuminate these relationships:

i) IAS → Distributive Justice ($\beta = 0.64$, $p < 0.001$), IAS → Procedural Justice ($\beta = 0.52$, $p < 0.001$), IAS → Restorative Justice ($\beta = 0.47$, $p < 0.001$): These highly significant coefficients demonstrate that the IAS significantly influences all three dimensions of justice. The strongest effect is on distributive justice, followed by procedural and then restorative justice, corroborating the EFA findings.

ii) Justice Dimensions → Climate Justice Outcomes ($\beta = 0.59$, $p < 0.001$), Justice Dimensions → JET Outcomes ($\beta = 0.61$, $p < 0.001$): These significant pathways indicate that the combined dimensions of justice (as embodied in the IAS) have a substantial positive impact on both climate justice and just energy transition outcomes.

iii) Climate Justice and JET → Sustainability Transition Outcomes ($\beta = 0.71$, $p < 0.001$): This strong and significant coefficient confirms that achieving climate justice and just energy transition significantly contributes to broader sustainability transition outcomes.

A Mann-Whitney U test comparing responses from business leaders and sustainability experts revealed no significant differences in their perceptions of IAS alignment with Climate Justice and JET principles ($U = 189$, $p = 0.32$), demonstrating consensus across stakeholder groups. The non-significant result of the Mann-Whitney U test indicates a strong consensus between business leaders and sustainability experts regarding the alignment of IAS principles with climate justice and JET. This convergence of perspectives across key stakeholder groups strengthens the validity and generalizability of the study's findings.

Thematic analysis of interview data identified four recurring themes:

i) Community Empowerment: IAS enhances resilience through collective financial endowments and mentorship cycles. This result highlights the role of IAS in building community capacity and promoting social cohesion.

ii) Entrepreneurial Sustainability: Participants emphasized the necessity of embedding sustainability principles in IAS practices. The emphasis on integrating sustainability principles into IAS practices buttresses a growing awareness of the need for environmentally and socially responsible business practices within the apprenticeship system.

iii) Cultural Contextualization: Respondents highlighted the value of IAS in representing African knowledge systems in global justice frameworks. Recognizing the IAS as a representation of African knowledge systems within global justice frameworks emphasizes the importance of culturally relevant approaches to sustainability.

iv) Policy Integration: Stakeholders called for governmental support in integrating IAS principles into national sustainability policies. This call highlights the potential for leveraging traditional systems to achieve national sustainability goals.

5. Discussion of Results

The findings of this study firmly position the Igbo Apprenticeship System (IAS) as a culturally contextualized model that integrates justice dimensions, such as distributive, procedural, and restorative, into sustainability transitions. The statistical evidence provided by the EFA and SEM analyses validates IAS's alignment with justice principles, with significant loadings on distributive ($\beta = 0.64$), procedural ($\beta = 0.52$), and restorative ($\beta = 0.47$) justice. This outcome supports prior research emphasizing the socio-economic inclusivity of IAS, such as Omoede et al. (2023), who identified its role in reducing poverty and enhancing resilience in marginalized communities. Its embodiment of justice principles within a culturally situated framework ensures that IAS does

not only facilitate equitable access to resources but also addresses historical inequities, echoing broader calls for localized justice models in sustainability, as highlighted by Rastegar et al. (2024).

This study also advances the discourse on IAS beyond entrepreneurial outcomes by employing a mixed-methods approach that bridges quantitative rigour and qualitative insights. Unlike descriptive methodologies common in IAS literature (Adeola, 2020; Akolgo-Azupogo et al., 2021), the structural pathways illuminated through SEM provide empirical evidence linking IAS principles to climate justice and Just Energy Transition (JET) outcomes. This methodological depth challenges Eurocentric models critiqued for overlooking indigenous systems (Yin, 2022), offering IAS as a viable alternative rooted in community-centric practices.

The results emphasize IAS's alignment with international justice paradigms, notably its resonance with the distributive and procedural dimensions of climate justice and JET, as outlined in Rawlsian and Fraserian justice theories (Rawls, 1971; Fraser, 2009). The strong relationship between IAS's financial empowerment dimension and distributive justice (loading = 0.85) highlights its potential to address systemic inequities, a principle central to JET (Wang & Lo, 2021). Furthermore, the emphasis on knowledge transfer practices (loading = 0.67) reinforces procedural justice, aligning IAS with global best practices such as Germany's Dual Education System and South Africa's Renewable Energy Training Program (Clean Energy Wire, 2017; South African Renewable Energy Technology Centre, n.d.).

One of the study's key contributions lies in advancing restorative justice through IAS's community-based accountability (loading = 0.81) and environmental stewardship (loading = 0.76). These dimensions resonate with critiques of JET frameworks that often exclude restorative justice (Arya, 2023). The findings demonstrate the system's capacity to redress historical and systemic inequities, offering a model for integrating indigenous knowledge systems into global sustainability narratives. This aligns with Malloy and Ashcraft's (2020) call for transformative approaches that prioritize cultural contextualization over Eurocentric solutions.

Furthermore, the study highlights IAS's adaptability to climate justice and JET by demonstrating its role as a community learning hub, fostering green entrepreneurship and intergenerational wealth redistribution. These findings corroborate theories such as Communities of Practice (Lave & Wenger, 1991) and SECI knowledge-creation models (Nonaka & Takeuchi, 1995), positioning IAS as a replicable framework for equitable transitions. However, the results also reveal challenges, such as the risk of replicating unsustainable practices, underscoring the need for policy interventions that integrate sustainability principles into IAS curricula. Future research should explore cross-regional adaptations, specifically examining how IAS principles can be tailored to diverse socio-cultural contexts to advance global sustainability goals.

6. Conclusion and Implications of the Study

This study provides compelling empirical and theoretical evidence that the IAS represents a robust, culturally contextualized model for operationalizing climate justice and just energy transition. The alignment between IAS principles with climate justice and just energy proxies bridges significant gaps in sustainability transitions literature, especially as regards the nexus between entrepreneurial development systems with equitable and inclusive climate action. The study contributes to the decolonization of sustainability narratives, emphasizing the IAS as an exemplar of community-centred justice frameworks capable of addressing systemic inequities and advancing resilience in the face of global environmental challenges. Key findings demonstrate that IAS principles, such as financial empowerment, knowledge transfer, and community-based accountability, not only support socio-economic equity but also provide actionable pathways for embedding justice in sustainability

transitions. These insights affirm the IAS's scalability and relevance as a justice-oriented framework for sustainable development, particularly in regions with similar socio-cultural dynamics.

6.1 Conceptual Model: Igbo Sustainable Enterprise Ecosystem (ISEE)

The ISEE model (Figure 4) is rooted in the Igbo concept of "Isee", a term that signifies affirmation and approval of positive outcomes. This model is guided by the sustainability principle of *oganihu di mma, di mkpa*, which translates to "progress that is good, is important", underscoring the importance of prioritizing just and sustainable entrepreneurial development in achieving climate resilience societies.

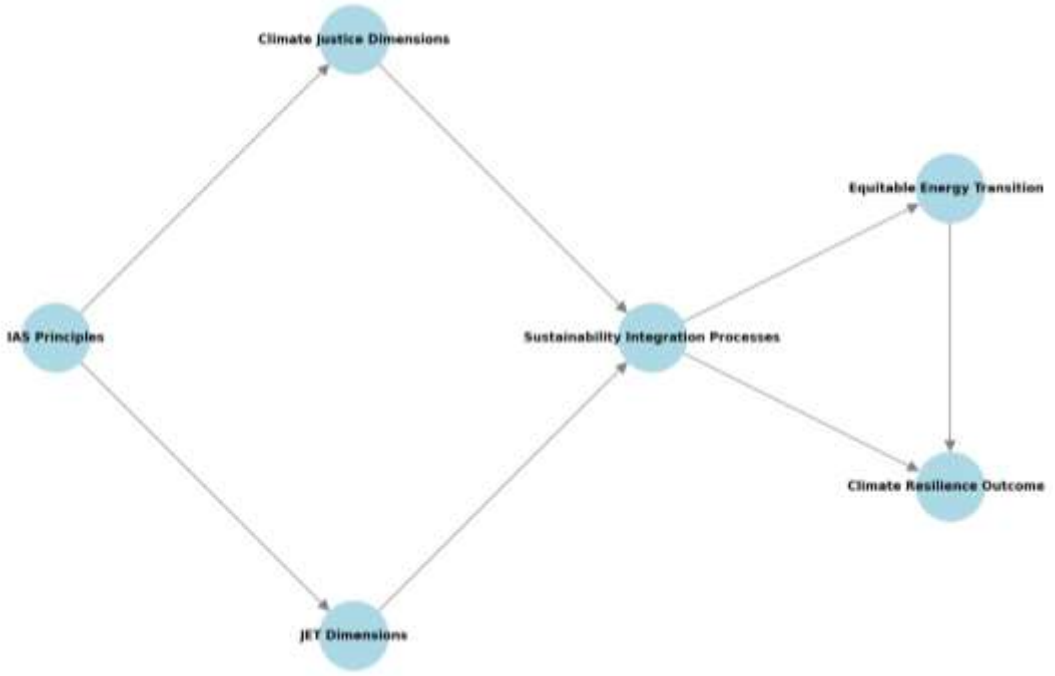

Figure 4: The ISEE Model - Incorporating Climate Justice and JET into IAS

ISEE model presents a dynamic framework for integrating Climate Justice and Just Energy Transition (JET) into the Igbo Apprenticeship System (IAS), highlighting key pathways including the foundational input of IAS principles, the intersection of justice dimensions, sustainability integration processes, and outcome-oriented transitions. The model underscores the potential of IAS to address socio-economic inequities, environmental stewardship, and equitable resource allocation, while promoting equitable energy transitions and climate resilience outcomes through the strategic fusion of IAS practices with Climate Justice and JET principles.

6.2 Theoretical Implications

The study enriches justice theories by extending their applicability to indigenous systems, particularly IAS, thereby addressing critical gaps in non-Western justice paradigms. It underscores the multidimensional nature of justice (distributive, procedural, and restorative) in sustainability transitions and contributes to the conceptual integration of community-driven models into global justice frameworks. Situating IAS within the context of Climate Justice and JET challenges Eurocentric narratives, thereby accentuating advocacies for including culturally specific, community-centred frameworks in global sustainability debates. The findings emphasize the need for theoretical models that account for the socio-cultural diversity of justice systems.

6.3 Practical Implications

The IAS's focus on mentorship and financial empowerment can be adapted to vocational training programs globally and across organizations to enhance green skills and prepare the workforce for low-carbon economies. This approach ensures that entrepreneurship development is aligned with sustainability goals. Yet again, practical integration of IAS principles into entrepreneurial ecosystems facilitates local businesses' capacities to adopt sustainable practices, creating ripple effects in community-driven environmental stewardship and resilience-building. Likewise, embedding IAS-inspired sustainability curricula in apprenticeship systems can institutionalize environmentally responsible business practices, addressing challenges such as resource depletion and environmental degradation.

6.4 Policy Implications

Within policy spheres, policymakers should leverage IAS principles to design and implement vocational training and entrepreneurship policies that prioritize justice and sustainability. These policies can address systemic issues such as energy poverty and youth unemployment while promoting green transitions. Accordingly, national governments and international organizations should adopt IAS-inspired models to develop culturally sensitive frameworks for Climate Justice and JET, ensuring inclusivity and equity in sustainability transitions. Policy interventions should also empower IAS practitioners through funding, capacity building, and integration into broader sustainability agendas. This approach ensures that local knowledge systems are preserved and scaled to address global challenges.

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