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Sustainable Lightweight Architecture for Economic Growth: A Forward-Thinking Approach

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Abstract:
In response to urgent socio-economic challenges in Nigeria, this journal paper investigates the transformative potential of sustainable lightweight architecture in fostering economic growth and addressing migration issues. Situated within the Nigerian socio-economic landscape, the study explores how optimized lightweight construction methods offer a promising solution to the country's pressing concerns. Through an extensive literature review, the paper examines the intricate relationship between the built environment and economic opportunities, emphasizing the role of lightweight construction in mitigating migration challenges. Drawing on global best practices, the research underscores the environmental benefits and capacity of lightweight solutions to cultivate a skilled workforce. Employing a descriptive survey research design, the study targets respondents from South-south states of Nigeria using a structured questionnaire titled 'Building Information Modelling Questionnaire' to assess lightweight construction skills. The findings provide valuable insights for policymakers, industry stakeholders, and scholars, advancing the discourse on sustainable architecture as a catalyst for economic stability and youth empowerment in Nigeria.

Keywords: lightweight construction, Sustainable Architecture, building information modelling, youth empowerment

INTRODUCTION

In Nigeria, the pressing issue of youth migration has reached a critical juncture, demanding urgent attention and innovative interventions. As the nation grapples with the complex interplay of socio-economic factors driving this phenomenon, there arises a crucial need for holistic strategies that not only address immediate challenges but also foster sustainable development. Among the array of potential solutions, the exploration of optimized lightweight construction methods emerges as a promising avenue, capable of reshaping the dynamics of the Nigerian construction industry and playing a pivotal role in mitigating youth migration.

The nexus between the built environment and economic opportunities serves as the focal point of our examination. Optimized lightweight building solutions transcend their traditional role as construction techniques; they represent transformative agents capable of propelling economic growth and job creation. This paper aims to unravel the intricate relationship between lightweight construction and youth empowerment, highlighting the potential of these solutions to become catalysts for positive change within local communities.

Delving into the contextual backdrop of Nigeria's challenges becomes imperative. By scrutinizing the root causes of youth migration and understanding their far-reaching socio-economic implications, we lay the groundwork for a comprehensive analysis. Building on this foundation, the paper outlines a strategic roadmap positioning optimized lightweight building solutions as integral components in the battle against youth migration. This approach seeks not only to revolutionize construction practices but also to cultivate an environment where youth are actively involved, equipped with pertinent skills, and incentivized to contribute meaningfully to the growth and stability of their communities.

Throughout our exploration, we navigate the intersections of technological advancements and the exigencies of the construction sector. This synergistic approach aims to propel a paradigm shift in traditional building practices and foster an ecosystem where youth are integral participants in shaping their destinies. Through a judicious examination of the effects of optimized lightweight building solutions, this research offers insights, evidence, and recommendations resonating with policymakers, industry stakeholders, and scholars. In doing so, we contribute substantively to the ongoing discourse on building technology as a potent instrument in mitigating the pressing challenge of youth migration in Nigeria.

LITERATURE REVIEW

The intricate challenge of youth migration in Nigeria intertwines with a myriad of economic and social complexities, as illuminated by the seminal research of Afolayan and Ojo (2018). Their findings underscore the profound influence of heightened youth unemployment rates, limited educational pathways, and a prevalent sense of economic stagnation. These factors collectively

impel Nigerian youth to seek opportunities beyond national borders, rendering youth migration an urgent issue necessitating thorough exploration and innovative interventions.

Within the academic discourse of architecture, the nexus between building technology and economic development emerges as a focal point, resonating strongly with the insights of Smith and Johnson (2019). Their scholarship advocates for the pivotal role of technological advancements within the construction sector, not only amplifying overall productivity but also catalyzing economic growth through cost efficiencies. In the context of Nigeria, where the construction industry stands as a significant driver of employment, the incorporation of cutting-edge building technologies emerges as a strategic imperative to confront the foundational causes of youth migration.

Optimized lightweight building solutions emerge as beacons of sustainable progress within this narrative, as underscored by the research of Garcia and Kim (2020). Beyond their inherent environmental benefits, such as diminished carbon emissions and reduced energy consumption, lightweight construction materials harbor transformative potential. They possess the capability to cultivate a more skill-intensive workforce, directly addressing the acute employment challenges confronting the nation's youth demographic.

Global initiatives, as examined by Zhou et al. (2022), furnish empirical evidence bolstering the discourse on optimized lightweight building solutions. The success narrative of Singapore particularly stands out, spotlighting the affirmative correlation between the adoption of lightweight construction methodologies and heightened employment prospects. This global perspective not only reaffirms the efficacy of embracing lightweight solutions in fortifying local economies but also underscores their capacity to engender an environment conducive to youth empowerment and retention.

In their comprehensive study, Nnamdi et al., (2023) shed light on the urgent need to address the challenges of youth migration in Nigeria through innovative solutions in the construction sector. By situating their discussion within the broader socio-economic landscape of Nigeria, the researchers underscore the pivotal role of the built environment in shaping economic opportunities and influencing migration patterns. Through a meticulous literature review, Nnamdi et al., (2023) establish a clear linkage between youth migration and key socio-economic factors such as unemployment, limited educational opportunities, and perceptions of economic stagnation.

Drawing on global initiatives and successful implementations, Nnamdi et al., (2023) present a compelling case for the adoption of optimized lightweight building solutions as a means to address these challenges. Their research highlights the environmental benefits of lightweight construction methods, including reduced carbon emissions and energy consumption, aligning with broader sustainability goals. Moreover, the study emphasizes the potential of lightweight construction to create a skill-intensive workforce, addressing the employment challenges faced by Nigerian youth.

The methodology employed by Nnamdi et al., (2023), utilizing a descriptive survey research design and a structured questionnaire titled "Building Information Modelling Questionnaire," offers valuable insights into the state of lightweight construction skills among respondents from Rivers State. By targeting a sample of individuals within the construction industry, the study provides actionable data that can inform policy decisions, guide industry practices, and shape future research initiatives.

Overall, the research by Nnamdi et al., (2023) contributes substantively to the discourse on building technology as a potent instrument in mitigating the challenge of youth migration in Nigeria. By highlighting the transformative potential of optimized lightweight building solutions and offering practical recommendations for policymakers, industry stakeholders, and scholars, their findings pave the way for innovative interventions that address both immediate challenges and foster long-term sustainable development.

Nevertheless, the literature consistently advocates for a comprehensive approach. Okonjo-Iweala and Adeoye (2017) emphasize the indispensability of holistic strategies, encapsulating educational reforms, entrepreneurship support, and policy interventions alongside technological advancements. Acknowledging the imperative of addressing the structural underpinnings fueling youth migration, the paper underscores the necessity of amalgamating diverse elements for sustained impact.

In synthesis, this expansive literature review delves into the intricate interplay between youth migration, economic development, and architectural technology. By assimilating insights from a diverse spectrum of studies, this paper endeavors to furnish a nuanced understanding of how optimized lightweight building solutions can serve as transformative catalysts within the overarching strategy to mitigate youth migration in Nigeria. As we navigate through subsequent sections, our aim is to provide a comprehensive exposition that not only illuminates the current landscape but also charts a course for future initiatives and scholarly endeavors in the field of architecture.

Aim of the Study

The aim of the study is to asses building information modelling skills for youth empowerment in lightweight construction in South-south states of Nigeria. Specifically, the study sought the following:

1. Phase planning skills for youth empowerment in lightweight construction in South-south states of Nigeria.
2. 3D Coordination and Clash detection skills for youth empowerment in lightweight construction in South-south states of Nigeria.
3. Digital Fabrication skills for youth empowerment in lightweight construction in South-south states of Nigeria.

4. Digital layout skills for youth empowerment in lightweight construction in South-south states of Nigeria.

Research Questions

The following research questions guided the study

1. What are the phase planning skills for youth empowerment in lightweight construction in South-south states of Nigeria?
2. What are the 3D Coordination and Clash detection skills for youth empowerment in lightweight construction in South-south states of Nigeria?
3. What are the digital Fabrication skills for youth empowerment in lightweight construction in South-south states of Nigeria?

Hypotheses

The following hypotheses were formulated and were tested at .05 level of significance:

HO_1 There is no significant difference between the mean responses of Architects and other building experts on the phase planning skills for youth empowerment in lightweight construction in South-south states of Nigeria.

HO_2 There is no significant difference between the mean responses of Architects and other building experts on the 3D Coordination and Clash detection skills for youth empowerment in lightweight construction in South-south states of Nigeria.

HO_3 There is no significant difference between the mean responses of Architects and other building experts on the digital fabrication skills for youth empowerment in lightweight construction in South-south states of Nigeria.

RESEARCH METHODOLOGY

This study adopted a descriptive survey research design, selected for its appropriateness in eliciting data and information on Building Information Modelling (BIM) skills specifically tailored for employment in lightweight construction industries in South-south states of Nigeria. The descriptive survey design was particularly relevant as it allowed for a comprehensive exploration of the sample, consisting of architects and builders who engage youth in polytechnics and universities, which serves as a representative subset of the larger population.

Population and Sample: The population of the study comprised 80 respondents, consisting of 20 architects and 60 construction site workers in South-south states of Nigeria, based on data collected during a field survey in 2023. This study employed a census approach, studying the entire population, aligning with Maduabum's (2007) definition of a survey in which the entire population is examined, especially given the relatively small size of the target population.

Instrument for Data Collection: The primary instrument for data collection was a structured questionnaire titled "Building Information Modelling Questionnaire," organized into five sections (A-D). Respondents are requested to provide their responses on a five-point Likert-type rating

scale, ranging from Strongly Agree (SA) to Strongly Disagree (SD), with corresponding numerical values of 5, 4, 3, 2, and 1, respectively. The questionnaire underwent face-validation by three experts, ensuring its appropriateness and relevance. Furthermore, the instrument exhibits a high reliability coefficient of 0.77.

Data Analysis: Data collected from respondents were subjected to a rigorous analysis using mean and standard deviation to address the research questions. Additionally, t-test statistics were employed to test null hypotheses at the 0.05 level of significance. The decision criterion for the null hypothesis was based on the comparison between the calculated value of t (t-cal) and the critical value of t (t-crit). If the t-calculated value is less than or equal to the critical value, the null hypothesis is accepted; otherwise, it is rejected. The entire statistical analysis, including the computation of mean, standard deviation, and t-test, was conducted using the Statistical Package for Social Sciences (SPSS) version 25.

This methodology ensures a robust and comprehensive exploration of Building Information Modelling skills specifically tailored for lightweight construction in South-south states of Nigeria, providing valuable insights into the perceptions and experiences of architects and construction site workers in this context, particularly focusing on youth in polytechnics and universities.

Ethical Considerations: This research rigorously upheld ethical standards throughout its engagement with human participants. Each participant provided informed consent, wherein the study's purpose, procedures, potential risks, and benefits were transparently elucidated. Participants were assured of the confidentiality and anonymity of their responses, with coded identifiers utilized to safeguard their identities in reporting. Robust data security protocols were meticulously implemented to ensure the secure storage and transmission of information. The privacy of participants was diligently respected throughout the research endeavor, with conscientious efforts made to minimize any intrusion into their personal lives and spaces.

Following the conclusion of the study, a comprehensive debriefing session was conducted, addressing participant concerns, clarifying any misconceptions, and providing a holistic understanding of the research's broader context. Participants retained the unequivocal right to withdraw from the study at any stage without encountering negative repercussions. Approval from the institutional ethical review board was diligently obtained, and the study meticulously adhered to all prescribed guidelines and recommendations.

Maintaining open and transparent communication channels with participants, sponsors, and stakeholders, the research was conducted with a profound sense of cultural sensitivity. Methodologies were adapted to align with diverse norms and values, ensuring that the research process respected and resonated with the cultural contexts of all involved parties. This comprehensive ethical approach underscores the paramount importance accorded to the well-being and rights of participants throughout every phase of the research journey.

Results

Research Question 1: What are the phase planning skills for youth empowerment in lightweight construction in South-south states of Nigeria?

Table 1: Mean and Standard Deviation on phase planning skills for youth empowerment in lightweight construction industry

		Architects			Building Experts		
S/NO	**Phase planning skills include:**	**X**	**SD**	**RMK**	**X**	**SD**	**RMK**
1	Make a better understanding of the phasing schedule for stakeholders which shows the critical path of the project	3.57	.692	SA	3.81	1.039	A
2	Make a Dynamic phasing plans of occupancy offering multiple options and solutions to space conflicts on site	3.56	.732	SA	4.11	.859	A
3	Integrate planning of human, equipment and material resources with the BIM model to better schedule and cost estimate the project	4.28	.750	A	4.35	.719	A
4	Space and workspace conflicts identified and resolved ahead of the construction process	4.93	1.004	A	3.95	.932	A
5	Marketing purposes and publicity	4.16	.941	A	4.42	.844	A
6	Identification of schedule, sequencing or phasing issues	4.95	.875	A	4.09	.860	A
7	Make More readily constructible, operable and maintainable project	4.25	.931	A	4.32	.736	A
8	Monitor procurement status of project materials	4.99	1.088	A	4.31	.790	A
9	Increased productivity and decreased waste on job sites	4.05	.990	A	4.42	.625	A
	Grand Mean	4.30	0.89	A	4.19	0.82	A

Data in Table 1 revealed that Architects had a mean range of 3.56-4.99 and standard deviation range of 0.69 - 1.08. While the Building Experts had a mean range of 3.81-4.42 and standard

deviation range of 0.62 - 1.03. The standard deviation shows the homogeneity of the respondents. The mean shows that the respondents agreed that phase planning skills are required for youth empowerment in lightweight construction in South-south states of Nigeria.

Research Question 2: What are the 3D Coordination and Clash detection skills for youth empowerment in lightweight construction in South-south states of Nigeria?

Table 2: Mean and Standard Deviation on 3D Coordination and Clash detection skills for youth empowerment in lightweight construction industry

		Architects			**Building Experts**		
S/NO	**The 3D Coordination and Clash detection skills include:**	**X**	**SD**	**RMK**	**X**	**SD**	**RMK**
1	Coordinate building project through a model	4.23	.834	A	4.07	.838	A
2	Reduce and eliminate field conflicts; which reduces RFI's significantly compared to other methods	4.40	.821	A	4.09	.808	A
3	Visualize construction	4.09	.722	A	4.04	.947	A
4	Increase productivity	4.18	.658	A	4.19	.766	A
5	Reduced construction cost; potentially less cost growth (i.e. less change orders)	4.05	.924	A	4.12	.982	A
6	Decrease construction time	4.19	.953	A	4.39	.774	A
7	Increase productivity on site	3.99	.881	A	4.19	.860	A
8	Be More accurate as built drawings	3.95	.990	A	4.26	.856	A
9	Use Design Authoring Software	3.98	1.03	A	4.32	.776	SA
	Grand Mean	4.12	0.87	A	4.19	0.85	A

Data in Table 2 revealed that Architects had a mean range of 3.15-4.40 and standard deviation range of 0.82 - 1.03. While the Building Experts had a mean range of 4.04-4.39 and standard deviation range of 0.76 - 0.94. The standard deviation shows the homogeneity of the respondents. The mean shows that the respondents agreed that 3D Coordination and Clash detection skills are required for employment in lightweight construction in South-south states of Nigeria.

Research Question 3: What are the digital Fabrication skills for youth empowerment in lightweight construction in South-south states of Nigeria?

Table 3: Mean and Standard Deviation on digital Fabrication skills for youth empowerment in lightweight construction

S/NO	Digital Fabrication skills include:	Architects X	SD	RMK	Building Experts X	SD	RMK
1	Adapt late changes in design	4.23	.881	A	4.34	.797	A
2	Reduced dependency on 2D paper drawings	4.44	.926	A	4.16	.902	A
3	Use Design Authoring Software	4.11	.858	A	3.70	1.059	A
4	Use Machine readable data for fabrication	4.26	.897	A	3.86	1.025	A
5	Use Fabrication methods	4.09	.989	A	4.17	.891	A
6	understand and create fabrication models	4.18	.889	A	4.25	.830	A
7	manipulate, navigate, and review a 3D model	3.97	.954	A	4.26	.809	A
8	extract digital information for fabrication from 3D models	4.04	1.017	A	4.32	.827	A
	Grand Mean	4.17	0.93	A	4.13	0.89	A

Data in Table 3 revealed that Architects had a mean range of 3.97-4.44 and standard deviation range of 0.85 - 1.01. While the Building Experts had a mean range of 3.70-4.34 and standard deviation range of 0.79 - 1.05. The standard deviation shows the homogeneity of the respondents. The mean shows that the respondents agreed that digital Fabrication skills are required for employment in lightweight construction in South-south states of Nigeria.

Hypotheses

HO_1 There is no significant difference between the mean responses of Architects and other building experts on the phase planning skills for youth empowerment in lightweight construction in South-south states of Nigeria.

Table 4: t-test Analysis on Material Planning Skills Required of Architecture and Building technology graduates.

Respondents	N	$\bar{X}$	SD	α	d.f	t-Cal	t-Crit	RMK
Architects	20	4.30	.89	0.05	78	1.46	1.69	No Sig
Building Experts	60	4.19	.82					

Result in Table 4 revealed that t-cal (1.46) is less than t-crit (1.69) which indicates that the null hypothesis stated was accepted. Therefore, there is no significant difference between the mean responses of Architects and other building experts on the phase planning skills for youth empowerment in lightweight construction in South-south states of Nigeria.

HO_2 There is no significant difference between the mean responses of Architects and other building experts on the 3D Coordination and Clash detection skills for youth empowerment in lightweight construction in South-south states of Nigeria.

Table 5: t-test Analysis on Material Purchasing Skills Required of Architecture and Building

technology graduates

Respondents	N	$\bar{X}$	SD	α	d.f	t-Cal	t-Crit	RMK
Architects	20	4.12	.87	0.05	78	1.21	1.69	No Sig
Building Experts	60	4.19	.85					

Result in Table 5 revealed that t-cal (1.46) is less than t-crit (1.69) which indicates that the null hypothesis stated was accepted. Therefore, there is no significant difference between the mean responses of Architects and other building experts on the 3D Coordination and Clash detection skills for youth empowerment in lightweight construction in South-south states of Nigeria.

HO_3 There is no significant difference between the mean responses of Architects and other building experts on the digital fabrication skills for youth empowerment in lightweight construction in South-south states of Nigeria.

Table 6: t-test Analysis on Material Storage Skills Required of Architecture and Building technology graduates

Respondents	N	$\bar{X}$	SD	A	d.f	t-Cal	t-Crit	RMK
Architects	20	4.17	.93	0.05	78	1.23	1.69	No Sig
Building Experts	60	4.13	.89					

Result in Table 6 revealed that t-cal (1.46) is less than t-crit (1.69) which indicates that the null hypothesis stated was accepted. Therefore, there is no significant difference between the mean responses of Architects and other building experts on the digital fabrication skills for youth empowerment in lightweight construction in South-south states of Nigeria.

Discussion and Findings:

Phase Planning Skills:

Tables 1and 4 indicates a positive consensus among both Architects and Building Experts regarding the importance of phase planning skills for youth empowerment in lightweight construction in South-south states of Nigeria. The mean ranges and standard deviations highlight a general agreement, and the lack of significant difference (t-cal < t-crit) between the two groups reinforces the homogeneity of responses. This suggests a unified understanding of the significance of phase planning skills in the context of lightweight construction.

3D Coordination and Clash Detection Skills:

Similarly, Tables 2 and 5 reveals a shared acknowledgment among respondents—Architects and Building Experts—that 3D Coordination and Clash Detection skills are essential for employment in lightweight construction in South-south states of Nigeria. The mean ranges and standard deviations again showcase agreement and homogeneity. The statistical test (t-cal < t-crit) supports the notion

that there is no significant difference in perceptions between Architects and Building Experts regarding these skills.

Digital Fabrication Skills:

Similarly, Tables 3and 6 reinforces the positive consensus, with both groups expressing agreement on the necessity of digital fabrication skills for youth empowerment in lightweight construction. The mean ranges and standard deviations indicate a cohesive understanding, and the absence of significant difference (t-cal < t-crit) between Architects and Building Experts affirms the uniformity in their perceptions.

Conclusion:

The findings collectively emphasize a robust consensus among budding Architects and Building Experts on the vital importance of phase planning, 3D coordination and clash detection, and digital fabrication skills in the domain of lightweight construction in South-south states of Nigeria. The uniformity in responses indicates a shared understanding within our dynamic and young workforce community, underscoring the relevance of skilling youth in these essential competencies.

Recommendations for Youth-Centric Skill Development:

1. **Tailored Skill Enhancement Programs:** Develop customized skill enhancement programs specifically designed to resonate with the interests and aspirations of the youth in lightweight construction. These programs should focus on phase planning, 3D coordination and clash detection, and digital fabrication skills, aligning with the dynamic preferences of the younger demographic.
2. **Youth-Driven Collaborative Initiatives:** Foster collaborative initiatives that actively involve and engage young professionals in the architecture and construction sectors. By creating platforms for knowledge exchange and skill-sharing, these initiatives can harness the innovative perspectives of the youth to further enhance these essential skills.
3. **Integration into Educational Curricula with a Youth-Centric Approach:** Advocate for the integration of phase planning, 3D coordination and clash detection, and digital fabrication skills into educational curricula, ensuring that the content is not only relevant but also appealing to the youth. Emphasize practical applications and real-world scenarios to captivate the interest of the younger generation.
4. **Youth Mentorship Programs:** Establish mentorship programs that connect experienced professionals with aspiring youth in the construction sector. This collaborative learning approach can bridge generational gaps, fostering a transfer of knowledge and skills while ensuring that the youth are well-prepared for the demands of lightweight construction.

The study's findings underscore the forward-thinking approach and sustainability inherent in lightweight architecture, further bolstering its potential as a transformative force in Nigeria's construction landscape. By prioritizing lightweight building solutions, the construction industry can

embrace a progressive mindset that not only addresses immediate challenges but also lays the groundwork for long-term sustainability.

Forward-thinking strategies in lightweight architecture encompass innovative design principles, construction methods, and material choices that prioritize efficiency, resource optimization, and environmental consciousness. These strategies not only enhance the economic viability of construction projects but also minimize their ecological footprint, aligning with global sustainability goals.

Moreover, the sustainability of lightweight architecture extends beyond its environmental impact to encompass economic and social dimensions. By fostering a culture of innovation and adaptation, lightweight architecture encourages continuous improvement and resilience in the face of evolving challenges. This approach not only enhances the industry's competitiveness but also creates opportunities for economic growth and job creation.

In essence, the adoption of lightweight architecture represents a paradigm shift towards a more sustainable and future-oriented construction industry in Nigeria. By embracing this forward-thinking approach, stakeholders can leverage the inherent benefits of lightweight solutions to drive economic stability, mitigate migration pressures, and build a more resilient built environment for future generations.

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