DOI:
https://doi.org/10.26593/josc.v4i1.8109

Journal of Sustainable Construction
Vol. 4, No. 1, October 2024, 10-36
https://journal.unpar.ac.id/index.php/josc
e-ISSN: 2808-2869 | p-ISSN: 2964-4437

Investigation of Community Engagement in Sustainable Construction Projects: Case Studies from Nigeria

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Sent: 19/06/2024 Revised: 09/10/2024 Accepted: 18/10/2024

ABSTRACT
This study investigates the role of community engagement in sustainable construction projects in Nigeria, focusing on three case studies: a green residential building in Lagos, an eco-friendly community center in Abuja, and a sustainable water infrastructure project in rural Kano. Using a mixed-methods approach, data were collected through interviews, surveys, and document analysis. The research identifies significant variations in engagement practices, with Lagos showing high engagement levels, leading to greater community acceptance and better environmental outcomes. Key success factors include strong leadership, adequate funding, and effective communication, while challenges such as socio-cultural barriers and political interference were noted. The findings emphasize the importance of sustained, tailored engagement strategies to enhance project sustainability and community support. This study contributes to the literature by providing empirical data on the long-term impacts of community engagement, offering insights for policy makers and project managers to improve community participation in sustainable construction.

Keywords: case study, community engagement, environmental sustainability, green building, social cohesion, sustainable construction, sustainability

1. INTRODUCTION

The construction industry is a cornerstone of global economic development, contributing significantly to national economies through infrastructure development, job creation, and the enhancement of living standards [1]. In Nigeria, the construction sector is one of the largest industries, playing a vital role in urban development and economic growth [2]. However, this sector is also a major contributor to environmental degradation, resource depletion, and greenhouse gas emissions, which poses significant challenges to achieving environmental sustainability [3][4]. The environmental issues associated with construction activities include deforestation, loss of biodiversity, and pollution of air, water, and soil, all of which adversely affect ecosystems and human health [5]. In response to these concerns, the concept of sustainable construction has gained prominence, aiming to balance economic growth, social equity, and environmental protection by integrating practices that promote resource efficiency, waste reduction, and improved living conditions [6].

Sustainable construction practices encompass the use of renewable and recyclable materials, energy-efficient building designs, water conservation techniques, and the implementation of green building standards [7]. These practices not only mitigate the negative environmental impacts of building activities but also contribute to the economic and social well-being of communities [8]. A critical component of sustainable construction is community engagement, which involves the active participation of local communities in the planning,

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execution, and monitoring of construction projects [9]. Effective community engagement ensures that projects align with the actual needs and priorities of the people they are intended to serve, leading to smoother implementation and reduced conflicts [10]. By fostering a sense of ownership and responsibility among local stakeholders, community engagement is crucial for the long-term sustainability and maintenance of projects [11].

In Nigeria, where diverse socio-economic and cultural landscapes exist, effective community engagement can bridge cultural gaps, ensure the inclusion of marginalized groups, and harness local knowledge and resources [12]. This approach not only enhances the relevance and effectiveness of construction projects but also empowers communities by giving them a voice in the development process [13]. Moreover, community engagement can result in innovative solutions that are culturally and environmentally appropriate, thereby contributing to the overall sustainability of construction projects [14].

Community engagement is essential in sustainable construction for several reasons. Firstly, it promotes transparency and accountability within the construction process, allowing projects to address local concerns and preferences, leading to more inclusive decision-making [15]. This approach helps to identify and address potential social and environmental issues early in the project lifecycle, preventing costly modifications and fostering trust between stakeholders and project developers [16]. Secondly, community engagement fosters a sense of ownership and responsibility among local stakeholders, which is vital for the long-term success and maintenance of construction projects [17]. When communities are actively involved in the planning and implementation phases, they are more likely to take pride in the outcomes and ensure that the infrastructure is maintained properly [18].

Additionally, involving the community helps harness local knowledge and resources, which can lead to more culturally and environmentally appropriate solutions [19]. Local communities possess invaluable insights into their environment, cultural practices, and needs, which can inform more sustainable and acceptable construction practices [20]. For instance, community members might suggest the use of locally available materials that are more sustainable and cost-effective or highlight cultural practices that could influence the design and use of the infrastructure [21]. In the context of Nigeria, where diverse socio-economic and cultural landscapes exist, effective community engagement can significantly contribute to the success and sustainability of construction projects [22]. Nigeria's diverse population includes numerous ethnic groups with distinct traditions and needs. Engaging these communities ensures that construction projects are tailored to fit the specific requirements and preferences of different groups, thereby enhancing their acceptance and utility [23].

Moreover, community engagement can help mitigate conflicts that often arise in construction projects. In many cases, construction projects can lead to displacement or disruption of local communities. By engaging these communities from the outset, project developers can negotiate and mitigate such impacts, ensuring that the benefits of the project are equitably distributed and that negative consequences are minimized [24]. This proactive approach can prevent delays and resistance, leading to smoother project implementation [25]. Furthermore, effective community engagement can enhance the social sustainability of construction projects by ensuring that they contribute to the well-being and quality of life of the local population [26]. Participatory approaches allow projects to be designed with features that enhance social cohesion, such as community centers, green spaces, and public amenities, which can have lasting positive impacts on the community [27].

The primary objective of this study is to explore the role of community engagement in sustainable construction projects in Nigeria. Specifically, the study aims to investigate the current practices of community engagement in sustainable construction projects, identify the success factors and challenges associated with community engagement, assess the impact of community engagement on the sustainability outcomes of construction projects, and provide recommendations for improving community engagement practices [28]. Through a

comprehensive analysis, this study seeks to contribute valuable insights into how community involvement can enhance the sustainability and success of construction projects, particularly within the diverse socio-economic and cultural context of Nigeria [29].

This study is guided by several critical research questions aimed at understanding the role and impact of community engagement in sustainable construction projects in Nigeria. The research seeks to investigate the current practices of community engagement, identify success factors for effective community involvement, and address the challenges faced during the process [30]. These challenges can range from socio-cultural barriers to logistical and communication issues, all of which can significantly affect the efficacy of community engagement [31]. Additionally, the study examines how community engagement impacts the sustainability outcomes of construction projects in Nigeria, including assessing long-term benefits and potential drawbacks [32].

The paper is structured to provide a comprehensive analysis of community engagement in sustainable construction projects. Following this introduction, the literature review will explore existing studies and theoretical frameworks related to sustainable construction and community engagement. The methodology section outlines the research design, data collection methods, and data analysis techniques used in this study. The results and discussion section will present and interpret the findings from the case studies, highlighting key insights and implications. Finally, the conclusion will summarize the main findings, discuss their implications for policy and practice, and offer recommendations for future research [33].

2. LITERATURE REVIEW

Definition and Scope of Sustainable Construction

Sustainable construction refers to the creation and responsible management of a healthy built environment through the application of resource-efficient and ecological principles [11]. This holistic approach encompasses every stage of a building's lifecycle, from initial planning and design to construction, operation, maintenance, renovation, and eventual deconstruction [12]. The goal of sustainable construction is to minimize the environmental impact of buildings by enhancing energy efficiency, reducing waste, conserving water, and utilizing sustainable materials [13]. The scope of sustainable construction is broad and multifaceted, integrating strategies and practices designed to achieve sustainability goals. During the planning and design stages, sustainable construction practices include site selection that minimizes environmental disruption, orientation that maximizes natural lighting and ventilation, and the incorporation of green roofs and walls that enhance biodiversity and reduce urban heat island effects [14]. Additionally, the use of Building Information Modeling (BIM) is emphasized to optimize resource use and reduce waste [15].

During the construction phase, sustainable practices include the use of recycled and locally sourced materials, implementation of waste management plans to recycle and reuse construction debris, and employment of energy-efficient machinery and construction techniques [16]. Moreover, managing the construction site to minimize dust, noise, and water pollution is crucial to reducing the project's environmental footprint [17]. In the operation and maintenance phase, sustainable construction focuses on energy-efficient building systems, such as advanced HVAC (heating, ventilation, and air conditioning) systems, high-performance glazing, and renewable energy sources like solar panels and wind turbines [18]. Water conservation measures, including rainwater harvesting and greywater recycling, are also integral components of sustainable construction [19]. Smart building technologies that monitor and optimize energy and water use contribute to ongoing sustainability [20].

Renovation and deconstruction represent the final stages of a building's lifecycle in sustainable construction. Renovation practices prioritize upgrading existing structures to improve energy efficiency and extend the building’s life, thereby reducing the need for new construction and conserving resources [21]. Deconstruction, as opposed to traditional demolition, focuses on systematically disassembling buildings to recover and reuse materials, minimizing waste sent to

landfills and reducing the need for virgin materials [22]. Sustainable construction integrates economic, social, and environmental objectives to create structures that not only benefit the environment but also enhance the quality of life and economic viability [23]. Economically, sustainable buildings often result in lower operating costs through reduced energy and water consumption, while also potentially increasing property values and marketability [24]. Socially, these buildings provide healthier indoor environments, improving occupant health and productivity, and can also foster community engagement and social equity through inclusive design processes and accessible spaces [25].

The Role of Community Engagement in Sustainable Development

Community engagement is fundamental to the success of sustainable development initiatives, ensuring that development projects are not only environmentally and economically viable but also socially inclusive and responsive to the needs and aspirations of the local populace [26]. This participatory approach involves the active involvement of community members in decision-making processes, which allows for the incorporation of local knowledge, cultural values, and preferences into the planning and execution of projects [27]. In the context of sustainable construction, community engagement plays several critical roles. Firstly, it enhances project acceptance by fostering a sense of ownership and responsibility among community members [28]. When people feel that their voices are heard and their contributions are valued, they are more likely to support and take pride in the project, leading to higher levels of community buy-in and long-term commitment [29]. This is particularly important in construction projects, where the involvement of the local community can significantly impact the maintenance and sustainability of the built environment [30].

Secondly, community engagement improves the relevance and appropriateness of design solutions [31]. Local residents possess unique insights into their environment and lifestyle that external developers might overlook [32]. By integrating these insights into the design phase, projects can better address the real needs and challenges faced by the community, resulting in more practical and sustainable solutions [33]. For instance, local knowledge about seasonal weather patterns, traditional building materials, and construction techniques can lead to the development of structures that are more resilient and environmentally friendly [34]. Furthermore, effective community engagement helps identify potential environmental and social impacts early in the project lifecycle [35]. By involving community members in environmental assessments and planning processes, developers can gain a comprehensive understanding of the potential consequences of their projects [36]. This proactive approach allows for the development of mitigation strategies that address the concerns and priorities of those most affected, thereby reducing negative impacts and enhancing the overall sustainability of the project [37].

Community engagement also fosters transparency and accountability in sustainable development projects [38]. Open communication and participatory decision-making processes help build trust between developers and community members, which is essential for the successful implementation of projects [39]. When stakeholders are involved in every stage of the project, from planning to execution and monitoring, they can hold developers accountable for their commitments and ensure that project goals align with community needs and values [40]. In Nigeria, the importance of community engagement in sustainable construction is particularly pronounced due to the diverse socio-economic and cultural landscapes [41]. Engaging local communities in the planning and execution of construction projects can help bridge cultural gaps, ensure equitable resource distribution, and promote social cohesion [42]. Effective engagement strategies in Nigeria often include community meetings, focus group discussions, participatory mapping, and collaborative planning sessions, all aimed at empowering communities and fostering a sense of collective responsibility [43].

Theoretical Frameworks on Community Engagement

Several theoretical frameworks underpin the concept of community engagement, each offering unique insights into the processes and outcomes of involving communities in decision-making and development projects. Arnstein's (1969) Ladder of Citizen Participation provides a foundational model for understanding the varying degrees of citizen involvement [44]. This model categorizes participation into eight levels, arranged in a ladder format, ranging from non-participation to full citizen control. The bottom rungs of the ladder, labeled as manipulation and therapy, represent non-participation, where the aim is to cure or educate the participants rather than genuinely engage them [45]. The next levels include informing, consulting, and placation, which involve some degree of participant feedback but still retain decision-making power primarily with the authorities [46]. Higher up the ladder are partnership, delegated power, and citizen control, where citizens have increasing degrees of influence and control over decision-making processes [47]. This model highlights the importance of moving beyond tokenism to genuine empowerment in community engagement [48].

The International Association for Public Participation (IAP2) Spectrum further refines the concept of community engagement by outlining a continuum of participation. This spectrum includes five levels: inform, consult, involve, collaborate, and empower [49]. At the inform level, the objective is to provide the public with balanced and objective information to assist them in understanding the problem, alternatives, and solutions [50]. Consulting involves obtaining public feedback on analysis, alternatives, and decisions [51]. Involving ensures that public concerns and aspirations are consistently understood and considered throughout the decision-making process [52]. Collaborating entails partnering with the public in each aspect of the decision, including the development of alternatives and the identification of the preferred solution [53]. Empowering places the final decision-making in the hands of the public [54]. This model emphasizes the need for a strategic approach to public participation that matches the level of engagement to the specific context and objectives of the project [55].

Social capital theory, as articulated by [23], emphasizes the importance of social networks, norms, and trust in facilitating collective action [56]. Social capital is the collective value of social networks and the inclinations that arise from these networks to do things for each other [57]. High levels of social capital can enhance community engagement by fostering collaboration, mutual support, and trust among community members [58]. Putnam distinguishes between bonding social capital, which refers to the relationships within a homogenous group, and bridging social capital, which connects diverse groups [59]. Both forms of social capital are crucial for successful community engagement in sustainable projects, as they can help build strong, cohesive communities that are capable of working together towards common goals [60].

In addition to these models, participatory action research (PAR) offers another valuable framework for community engagement. PAR is a collaborative research approach that involves community members as active participants in the research process [61]. This approach is grounded in the principles of co-learning, mutual respect, and the co-creation of knowledge [62]. By involving community members in identifying research questions, collecting data, and analyzing results, PAR aims to produce actionable knowledge that directly benefits the community [63]. This approach is particularly relevant for sustainable construction projects, as it ensures that the research addresses the real needs and priorities of the community [64].

Previous Studies on Community Engagement in Construction Projects

A substantial body of research underscores the significance and impact of community engagement in construction projects. These studies collectively highlight that community participation is a critical factor in achieving project success and sustainability. One notable study by [65] examined community participation in public housing projects in Ogun State, Nigeria. The study found that involving community members in the planning and implementation phases significantly increased resident satisfaction. This involvement ensured that the housing projects were tailored to meet the specific needs and preferences of the community, leading to enhanced

acceptability and utility of the housing units. Ibem's research emphasized that community engagement is not merely a procedural formality but a strategic approach that can improve project outcomes and stakeholder satisfaction.

Another important study by [66] explored the role of participatory approaches in environmental management projects across several African countries. The study revealed that projects which actively involved local communities were more likely to achieve sustainable and widely accepted results. This was attributed to the inclusion of local knowledge and practices, which often provided more effective and culturally appropriate solutions to environmental challenges. The researchers found that community engagement facilitated better project planning and implementation, as it allowed for the early identification and mitigation of potential issues. This proactive approach not only reduced project risks but also built stronger community support and ownership. Further research by [67] delved into the specific mechanisms through which community engagement enhances project sustainability. Their study on urban development projects in Germany found that active community participation led to more innovative and adaptable project designs. By incorporating community feedback and ideas, project planners were able to develop solutions that were more resilient to changing social and environmental conditions. The study highlighted that community engagement can act as a catalyst for creativity and innovation, driving projects towards more sustainable outcomes.

In addition, a comprehensive review by [68] synthesized findings from various urban planning and construction projects globally. The review identified several key benefits of community engagement, including improved transparency, greater accountability, and enhanced social cohesion. The authors noted that when community members are involved in decision-making processes, there is a greater likelihood of trust and cooperation between stakeholders. This collaborative environment can lead to more efficient project execution and higher levels of community satisfaction and support. Moreover, a study by. [69] focused on post-disaster reconstruction projects in Sri Lanka, underscoring the importance of community engagement in ensuring the relevance and sustainability of such projects. The researchers found that involving the affected communities in reconstruction efforts led to more effective and contextually appropriate solutions. This engagement helped to address the specific needs of the disaster-affected populations, thereby enhancing the resilience and long-term success of the reconstruction projects.

Barriers to Effective Community Engagement in Nigeria

Despite its critical importance, several barriers hinder effective community engagement in sustainable construction projects in Nigeria. One significant barrier is the presence of socio-cultural factors, such as hierarchical social structures and entrenched gender roles, which can limit participation from certain segments of the population. In many Nigerian communities, decision-making power is often concentrated in the hands of traditional leaders or elder male figures, marginalizing women and younger community members [70]. This hierarchical structure can stifle diverse voices and inhibit comprehensive community involvement. Political and economic constraints also pose substantial challenges to effective community engagement. The lack of adequate funding for community engagement activities can severely limit the extent and quality of participation efforts. Many sustainable construction projects operate on tight budgets, and community engagement often becomes a secondary priority [71]. Additionally, inadequate policy frameworks that fail to mandate or incentivize community involvement can lead to insufficient or superficial engagement practices [72]. Political interference and corruption further exacerbate these issues, as project decisions can be influenced by political agendas rather than community needs.

Communication barriers significantly complicate the engagement process. Nigeria is a linguistically diverse country with over 500 languages spoken, leading to potential misunderstandings and miscommunications during engagement activities [73]. Language differences can create significant hurdles in ensuring that all community members fully

understand and participate in the discussions. Low literacy levels in some regions further exacerbate this problem, making it challenging to disseminate information and collect meaningful feedback from community members [74]. Moreover, there is often a general lack of awareness and understanding of the benefits of sustainable construction among community members. This lack of awareness can lead to resistance or indifference towards participation in such projects. Community members may prioritize immediate economic gains over long-term sustainability benefits, leading to conflicts and disengagement [75]. Additionally, previous negative experiences with construction projects, where promises were unfulfilled or the community was negatively impacted, can lead to skepticism and mistrust towards new projects [76].

Institutional barriers also play a significant role in hindering effective community engagement. Many local governments and construction companies lack the institutional capacity and expertise to effectively facilitate community engagement. There is often an absence of trained personnel who can manage and execute community engagement activities proficiently [77]. Furthermore, bureaucratic red tape can delay or complicate the engagement process, leading to frustration among community members and project stakeholders.

Benefits of Community Engagement in Sustainable Construction

Engaging communities in sustainable construction projects offers numerous benefits that extend beyond the immediate project outcomes, fostering long-term sustainability and community development. One of the primary advantages is the promotion of transparency and accountability. When project details and decision-making processes are openly shared with stakeholders, it ensures that the community is well-informed and involved at every stage [78]. This transparency is crucial in building trust between the project developers and the community, as it demonstrates a commitment to addressing local concerns and priorities. Trust, in turn, fosters a sense of ownership among community members, making them more likely to support and maintain the project over its lifecycle.

Furthermore, community engagement leverages local knowledge and resources, which can significantly enhance the contextual appropriateness and innovation of the project solutions. Local knowledge includes an understanding of the environmental, cultural, and social dynamics that external experts might overlook [79]. For example, community members can provide insights into traditional construction methods that are sustainable and cost-effective, or identify locally available materials that reduce the project's environmental footprint. This collaboration can lead to innovative approaches that are tailored to the specific needs and conditions of the community, enhancing the overall effectiveness and sustainability of the project.

Involving the community also plays a critical role in identifying and mitigating potential social and environmental impacts. Early and continuous engagement allows for the timely identification of issues that could affect the project's success, such as land use conflicts, cultural sensitivities, or environmental concerns [80]. Addressing these issues proactively, with input from those who are directly affected, ensures that the project can adapt and respond to potential challenges, making it more resilient and sustainable in the long term. This inclusive approach not only mitigates risks but also enhances the legitimacy and acceptance of the project, as community members feel that their voices are heard and their interests are considered. Additionally, community engagement contributes to capacity building within the community. By involving local people in the planning, implementation, and monitoring of the project, they acquire new skills and knowledge that can be applied to future initiatives [81]. This empowerment fosters a culture of continuous improvement and innovation, where communities are better equipped to manage and sustain their development projects. For instance, training programs on sustainable practices or participatory monitoring can leave a lasting impact, enabling communities to take greater control over their development trajectory.

Gaps in the Existing Literature

While there is substantial literature on the benefits and practices of community engagement, several gaps remain that warrant further investigation. Firstly, there is a notable lack of comprehensive studies focusing specifically on sustainable construction projects in Nigeria. Much of the existing research tends to address general construction projects or focus on other regions, particularly developed countries where the socio-economic and cultural contexts differ significantly from those in Nigeria [82]. This geographical and contextual gap limits the applicability of existing findings to the Nigerian setting, where unique challenges and opportunities exist.

Additionally, there is limited empirical data on the long-term impacts of community engagement on the sustainability of construction projects. Most studies provide a snapshot of community engagement practices and their immediate outcomes, but few track these impacts over extended periods to assess how they influence the durability and adaptability of sustainable construction efforts [83]. Understanding these long-term effects is crucial for developing strategies that not only initiate but also sustain community involvement throughout the lifecycle of a construction project. Another significant gap lies in the exploration of specific barriers and success factors related to community engagement in Nigeria. While general barriers such as socio-cultural factors, political and economic constraints, and communication issues are acknowledged [84], there is a lack of detailed, context-specific research that delves into how these barriers manifest in different regions and project types within Nigeria. Similarly, the success factors identified in the literature are often broad and generalized, lacking the nuanced understanding needed to tailor engagement strategies to local conditions effectively.

Moreover, there is a need for research that develops and tests innovative community engagement strategies tailored to the Nigerian context. Current literature predominantly discusses traditional engagement methods, which may not fully capture the potential of new technologies and participatory approaches that could enhance engagement effectiveness [85]. For example, the use of digital platforms for community consultations and feedback in remote or underserved areas remains underexplored. Research into these innovative methods could provide valuable insights into scalable and adaptable engagement strategies. Lastly, there is a paucity of interdisciplinary studies that integrate insights from social sciences, environmental sciences, and engineering to provide a holistic understanding of community engagement in sustainable construction. Such interdisciplinary approaches could offer more comprehensive solutions that address the multifaceted nature of sustainability challenges [86]. By bridging these disciplinary gaps, future research can develop more robust frameworks for community engagement that are both theoretically sound and practically applicable.

3. METHODOLOGY

Research Design

This study employed a mixed-methods research design, which integrated both qualitative and quantitative approaches to provide a more comprehensive understanding of community engagement in sustainable construction projects. The mixed-methods approach was specifically chosen for its ability to capture the complexity of social phenomena by combining the depth of qualitative insights with the generalizability of quantitative data. This approach was instrumental in triangulating data from various sources, thereby increasing the validity and reliability of the findings [87].

Within the mixed-methods framework, a multiple case study approach was utilized. This approach allowed the research to focus on multiple sustainable construction projects across different regions of Nigeria, thereby providing a comparative analysis of community engagement practices in varied contexts. By examining multiple cases, the study was able to identify patterns, variances, and contextual factors that influence community engagement in sustainable construction. Each case study offered unique insights into how community engagement was approached, executed, and perceived in different geographical and socio-cultural settings. The

multiple case study approach was crucial for developing a nuanced understanding of the research questions and capturing the diverse experiences of stakeholders involved in these projects.

The mixed-methods design further incorporated qualitative methods (e.g., semi-structured interviews and document analysis) and quantitative methods (e.g., surveys). The qualitative component provided rich, in-depth data on the subjective experiences and perspectives of stakeholders, while the quantitative component enabled the measurement of engagement levels and other variables of interest. The integration of these methods allowed for a more holistic exploration of community engagement practices and their outcomes, offering a robust foundation for the study's conclusions.

Case Study Selection Criteria

The selection of case studies was guided by purposive sampling to ensure that the chosen projects were representative of diverse contexts within Nigeria. This sampling strategy was employed to maximize the variability and depth of the data, allowing the research to cover a broad spectrum of community engagement practices across different project types and regions. The selection criteria were as follows:

1) Sustainability Focus: The project must be a sustainable construction initiative that emphasizes environmentally friendly practices, resource efficiency, and social responsibility. This criterion ensured that the selected projects were aligned with the study's objective of exploring community engagement in the context of sustainable development.
2) Community Engagement: The project should demonstrate a significant level of community engagement, indicating active involvement of local communities in various aspects of the project. This criterion ensured that the selected cases were suitable for examining the dynamics and effectiveness of community participation.
3) Project Lifecycle Stage: The selected projects should be at different stages of the construction lifecycle, including planning, implementation, and post-construction phases. This variation enabled the study to capture community engagement practices across all stages of project development, providing a comprehensive view of how engagement evolves over time.
4) Geographical and Socio-cultural Diversity: The selected projects should be geographically diverse, capturing both urban and rural settings across different regions of Nigeria. This criterion ensured that the findings reflected the diversity of socio-economic and cultural contexts in the country, thereby enhancing the generalizability of the results.

Based on these criteria, three projects were selected for the study: (1) a green residential building project in Lagos, representing an urban, implementation-phase project with high levels of community engagement; (2) an eco-friendly community center in Abuja, representing a planning-phase project in a semi-urban setting with moderate community involvement; and (3) a sustainable water infrastructure project in rural Kano, representing a post-construction project with lower levels of community engagement. These projects varied in scale, purpose, and community engagement strategies, providing a rich basis for comparative analysis and offering valuable insights into the factors influencing community engagement across different contexts [88].

Data Collection Methods

To ensure a comprehensive understanding of community engagement practices, a triangulated data collection approach was adopted, incorporating interviews, surveys, and document analysis. This multi-method approach allowed the research to collect data from multiple sources, enhancing the depth and breadth of the findings. Each data collection method contributed unique insights, making it possible to cross-validate the information obtained and ensure the robustness of the study's conclusions.

1) Interviews

Semi-structured interviews were conducted with key stakeholders, including project managers, community leaders, local government officials, and residents. A total of 30 interviews were planned, with 10 interviews conducted for each case study. The semi-structured format provided flexibility, allowing the interviewer to probe deeper into specific issues while maintaining consistency across interviews. This approach facilitated the exploration of stakeholders' experiences, perceptions, and opinions regarding community engagement practices, challenges faced, and perceived impacts on project sustainability [89]. The interview questions were designed to elicit detailed and nuanced information, covering themes such as the effectiveness of engagement strategies, barriers to participation, and the role of community members in decision-making processes.

The qualitative data obtained from these interviews were analyzed using thematic analysis, which involved coding and categorizing the responses to identify recurring themes and patterns. This analysis enabled the research to capture the diversity of experiences and perspectives across the different case studies, providing a rich and contextualized understanding of community engagement.

2) Surveys

A survey was administered to a broader sample of community members involved in or affected by the selected projects. A sample size of 150 respondents was targeted, with 50 respondents for each case study. The survey was designed using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) to quantitatively assess community engagement practices, levels of satisfaction, and perceived project impacts.

The survey instrument included questions related to current community engagement practices, success factors, challenges, and impacts on sustainability outcomes. The instrument was pre-tested to ensure the clarity and relevance of the questions, and adjustments were made based on the feedback received. The quantitative data collected through the survey were analyzed using descriptive and inferential statistics, allowing the study to measure and compare engagement levels across different projects. This method provided a numerical representation of engagement practices and their outcomes, which could be correlated with qualitative findings to offer a more complete picture of community engagement.

3) Document Analysis

Document analysis was conducted to supplement the data obtained from interviews and surveys. Relevant project documents, including project plans, meeting minutes, progress reports, and community feedback forms, were analyzed to provide historical and contextual information about each project. This method helped trace the evolution of community engagement practices over time, verify the accuracy of information provided by interviewees and survey respondents, and identify any discrepancies or inconsistencies.

The use of multiple data collection methods—interviews, surveys, and document analysis—facilitated the triangulation of data, enhancing the credibility and validity of the study’s findings. This comprehensive approach allowed the research to capture both the qualitative depth and quantitative breadth of community engagement practices in sustainable construction projects across different contexts in Nigeria.

Table 1. Questionnaire Survey

S/N	Question	Source
	Current Practices of Community Engagement	
1	The project team regularly holds community meetings to discuss project updates.	[90]
2	Community members are involved in decision-making processes for the project.	[91]
3	Feedback from the community is actively sought and valued.	[92]
4	There are clear channels for community members to voice their concerns.	[93]
5	The project incorporates local cultural practices and values.	[94]
6	Community engagement activities are well-publicized.	[95]
7	The project team respects community opinions and suggestions.	[96]
8	Community engagement strategies are regularly reviewed and improved.	[97]
9	Local leaders are actively involved in the project.	[98]
10	The project team ensures transparency in all community engagements.	[99]
	Success Factors of Community Engagement	
11	Adequate resources are allocated for community engagement activities.	[100]
12	There is strong leadership from within the community.	[101]
13	The project team has good communication skills.	[102]
14	Trust exists between the community and the project team.	[103]
15	Community engagement is started early in the project.	[104]
16	There is ongoing training for community engagement personnel.	[105]
17	Clear objectives for community engagement are set and communicated.	[106]
18	The project team is culturally sensitive and aware.	[107]
19	Community members feel their participation is meaningful.	[108]
20	There is a formal process for addressing community grievances.	[109]
	Challenges in Community Engagement	
21	Socio-cultural differences hinder effective engagement.	[110]
22	Political interference affects community engagement efforts.	[111]
23	Lack of funding limits community engagement activities.	[112]
24	Low literacy levels in the community are a barrier.	[113]
25	Language differences pose significant challenges.	[114]
26	There is resistance to change within the community.	[115]
27	Community members lack trust in the project team.	[116]
28	There is insufficient training for community engagement personnel.	[117]
29	Conflicts arise between community members and the project team.	[118]
30	Inadequate communication channels hinder effective engagement.	[119]
	Impact of Community Engagement on Sustainability Outcomes	
31	Community engagement improves project acceptance.	[120]
32	Projects with strong community engagement have better environmental outcomes.	[121]
33	Community engagement enhances social cohesion.	[122]
34	Engaged communities contribute to better project maintenance.	[123]
35	There is a noticeable improvement in local quality of life.	[124]
36	Community engagement leads to more innovative project solutions.	[125]
37	Projects are more likely to be completed on time with community involvement.	[126]
38	Community engagement helps in mitigating project risks.	[127]
39	Community-engaged projects experience fewer conflicts.	[128]
40	Community engagement enhances the overall sustainability of the project.	[129]

Data Analysis Techniques

Data analysis was conducted using a combination of qualitative and quantitative methods to provide a comprehensive understanding of the findings. Qualitative data from interviews and open-ended survey responses were analyzed using thematic analysis. This involved coding the data to identify key themes and patterns related to community engagement practices, success factors, challenges, and impacts [131]. NVivo software was used to assist with data management and analysis, ensuring a systematic and rigorous approach. Quantitative data from survey responses were analyzed using descriptive and inferential statistics. Descriptive statistics

provided an overview of engagement practices and community perceptions, while inferential statistics (such as chi-square tests and regression analysis) were used to explore relationships between variables and identify significant factors influencing community engagement outcomes [132]. In addition, comparative analyses were conducted using Multivariate Analysis of Variance (MANOVA) and Hierarchical Linear Modeling (HLM) to further explore the differences in community engagement practices and their impacts across the selected projects [133].

Ethical Considerations

Ethical considerations were paramount in this study to ensure the integrity of the research and the protection of participants' rights. Informed consent was obtained from all participants, ensuring they were fully aware of the study's purpose, procedures, potential risks, and benefits. Participants were assured of their right to withdraw from the study at any time without penalty. Confidentiality and anonymity were maintained throughout the research process. Personal identifiers were removed from data sets, and all information was stored securely to prevent unauthorized access. Ethical approval for the study was obtained from the relevant institutional review board, ensuring compliance with ethical standards and guidelines [134].

4. RESULTS AND DISCUSSIONS

Overview of Selected Case Studies

The selected case studies for this research include three sustainable construction projects in Nigeria (Table 2): a green residential building project in Lagos, an eco-friendly community center in Abuja, and a sustainable water infrastructure project in rural Kano. These projects were chosen to reflect a diverse range of contexts, scales, and community engagement strategies.

In order to determine the level of community engagement for each project, a scoring system was developed using responses to the questionnaire items related to community engagement practices. Each question was rated on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The scores for community engagement-related questions were aggregated for each project to obtain an overall community engagement score. This score was then divided by the total number of questions to generate an average engagement score for each project, which served as the basis for classification. Based on the calculated average engagement scores, community engagement levels were categorized as **High**, **Medium**, or **Low**. Specifically, projects with an average score of 4.0 and above were classified as having **High** community engagement, those with scores between 3.0 and 3.9 were categorized as **Medium**, and those with scores below 3.0 were classified as **Low**.

The Green Residential Building Project in Lagos achieved an average score of 4.2, thereby classifying its community engagement level as **High**. This classification was verified by consistently high scores on questions related to regular community meetings, workshops, and active feedback mechanisms. On the other hand, the Eco-friendly Community Center in Abuja had an average score of 3.5, resulting in a **Medium** level of engagement. This score reflected moderate community involvement, primarily through the inclusion of community leaders during the planning phase. Conversely, the Sustainable Water Infrastructure Project in Kano received an average score of 2.8, indicating a **Low** level of community engagement. The lower score was due to limited community participation and infrequent consultations with local stakeholders. The revised Table 2 now includes the average engagement scores alongside the engagement levels for each project, ensuring transparency in the classification process.

Table 2. Overview of Selected Case Studies

SN	Project Location	Project Type	Project Stage	Average Engagement Score	Community Engagement Level
1	Lagos	Green residential building	Implementation	4.2	High
2	Abuja	Eco-friendly community center	Planning	3.5	Medium
3	Kano	Sustainable water infrastructure	Post-construction	2.8	Low

Analysis of Community Engagement Practices

Community engagement practices varied significantly across the three projects (Table 3). The values in Table 3 represent the average score (on a scale of 1 to 5) for each engagement practice based on responses from community members and project stakeholders. In Lagos, the project team held regular community meetings (average score: 4.5), workshops (average score: 4.3), and feedback sessions (average score: 4.4), ensuring high levels of participation. In Abuja, the community center project involved community leaders in the planning process (average score: 3.8), but broader community involvement was limited (average score: 2.9). In Kano, engagement was primarily through sporadic consultations with village elders, resulting in lower overall participation scores (average score: 2.3).

Table 3. Community Engagement Practices

SN	Practice	Lagos (Avg. Score)	Abuja (Avg. Score)	Kano (Avg. Score)
1	Regular community meetings	4.5	2.5	2
2	Workshops and training sessions	4.3	3.8	2.2
3	Feedback and consultation sessions	4.4	3.2	2.3
4	Use of digital engagement platforms	2.1	2	1.8
5	Engagement through local leaders	4	3.5	2.5

Success Factors in Community Engagement

Success factors identified in the Lagos project included strong leadership (average score: 4.8), adequate funding for engagement activities (average score: 4.5), and effective communication strategies (average score: 4.6) (Table 4). In Abuja, the involvement of respected community leaders (average score: 3.7) and clear communication of project benefits (average score: 3.9) were key success factors. In Kano, the primary success factor was the historical trust between the community and project initiators (average score: 3.6).

Table 4. Success Factors in Community Engagement

SN	Success Factor	Lagos (Avg. Score)	Abuja (Avg. Score)	Kano (Avg. Score)
1	Strong leadership	4.8	3.5	3.7
2	Adequate funding for engagement	4.5	3.9	2.5
3	Effective communication strategies	4.6	4	2.8
4	Involvement of community leaders	4	3.7	3.5
5	Historical trust	3.8	3	3.6

Challenges Faced During Implementation

Challenges included socio-cultural barriers (average score: 3.5), political interference (average score: 2.8), and limited funding (average score: 3.1) (Table 5). In Lagos, managing diverse community interests was a major challenge (average score: 4.1). In Abuja, political interference and bureaucratic delays hindered engagement efforts (average score: 3.8). In Kano, low literacy levels (average score: 3.4) and language differences (average score: 3.2) posed significant barriers.

Table 5. Challenges Faced During Implementation

SN	Challenge	Lagos (Avg. Score)	Abuja (Avg. Score)	Kano (Avg. Score)
1	Socio-cultural barriers	3.8	2.9	3.5
2	Political interference	2	3.8	2.5
3	Limited funding	3.2	3.5	3.1
4	Diverse community interests	4.1	3	2.5
5	Low literacy levels	2.3	2.5	3.4
6	Language differences	2.5	2.7	3.2

Impact of Community Engagement on Project Outcomes

Community engagement, as shown in Table 6, positively impacted project outcomes in Lagos and Abuja. In Lagos, high engagement led to increased community acceptance (average score: 4.6) and better environmental outcomes (average score: 4.4). In Abuja, engagement improved social cohesion (average score: 4.0) and project design relevance (average score: 3.8). In Kano, limited engagement resulted in fewer conflicts (average score: 3.5) but also lower community involvement in project maintenance (average score: 2.8).

Table 6. Impact of Community Engagement on Project Outcomes

SN	Impact	Lagos (Avg. Score)	Abuja (Avg. Score)	Kano (Avg. Score)
1	Increased community acceptance	4.6	3.9	2.5
2	Improved environmental outcomes	4.4	3.5	2.2
3	Enhanced social cohesion	4	4	2.3
4	Better project design relevance	4.2	3.8	2.5
5	Reduced conflicts	3	3.2	3.5
6	Community involvement in maintenance	4	3.1	2.8

Comparative Analysis of Case Studies Using MANOVA and HLM

In order to further explore the differences in community engagement practices and their impacts across the selected projects, Multivariate Analysis of Variance (MANOVA) and Hierarchical Linear Modeling (HLM) were conducted.

MANOVA Analysis

MANOVA was used to assess the effect of location (Lagos, Abuja, Kano) on multiple dependent variables related to community engagement practices and outcomes (e.g., community acceptance, environmental outcomes, social cohesion). The results indicated significant differences across the projects.

Table 7. MANOVA Results

SN	Variable	Wilks' Lambda	F	p-value
1	Community acceptance	0.63	5.24	<0.01
2	Environmental outcomes	0.58	6.34	<0.01
3	Social cohesion	0.69	4.12	<0.05
4	Project design relevance	0.72	3.76	<0.05

The MANOVA results (Table 7) suggest that the location significantly affects community engagement outcomes, with Lagos showing the most positive results. Specifically, the results indicate that community acceptance, environmental outcomes, social cohesion, and project design relevance all vary significantly based on the project's location. In Lagos, the green residential building project achieved the highest scores across all these dimensions. This indicates that the strategies employed in Lagos, such as regular community meetings, workshops, and effective communication, were particularly successful in fostering community engagement. The high levels of community acceptance in Lagos suggest that residents felt more included and

heard, which likely contributed to their support for the project. Similarly, the positive environmental outcomes indicate that the community's involvement helped to implement and maintain sustainable practices effectively.

The enhanced social cohesion observed in Lagos can be attributed to the inclusive engagement practices that brought community members together, fostering a sense of collective responsibility and collaboration. The project's design relevance, which scored highest in Lagos, suggests that community input was effectively integrated into the project's planning and execution, making it more attuned to the local needs and preferences. In contrast, the projects in Abuja and Kano showed lower scores across these dimensions. In Abuja, while community engagement did occur, it was more limited and primarily involved community leaders rather than broader community participation. This resulted in moderate levels of community acceptance and social cohesion but did not translate as strongly into environmental outcomes or design relevance.

Kano, with the lowest engagement scores, highlighted the challenges of sporadic and less structured community involvement. The limited engagement in Kano, primarily through consultations with village elders, resulted in lower community acceptance and minimal impact on environmental outcomes and project design relevance. This underscores the importance of continuous and inclusive engagement practices to achieve better sustainability and community support. The significant p-values ($p < 0.05$) across all variables confirm that location plays a crucial role in determining the effectiveness of community engagement practices. The higher F-values for community acceptance and environmental outcomes highlight that these dimensions are particularly sensitive to the context and methods of engagement employed in different locations.

These findings emphasize the need for tailored community engagement strategies that consider the unique socio-political and cultural contexts of each location. The success observed in Lagos provides a model for effective community engagement, illustrating the benefits of comprehensive and inclusive practices. For other regions, adopting similar strategies while adapting to local conditions could enhance community support and project sustainability. The results underscore the importance of early, continuous, and inclusive community involvement in achieving positive outcomes in sustainable construction projects.

HLM Analysis

HLM was employed to account for the nested structure of the data (individual responses within projects). This model evaluated the influence of individual-level (e.g., education level, age) and project-level (e.g., engagement practices, funding) predictors on community acceptance and environmental outcomes.

Table 8. HLM Results

SN	Predictor	Coefficient (β)	SE	t	p-value
1	Education level (individual-level)	0.34	0.12	2.83	<0.01
2	Age (individual-level)	0.22	0.1	2.2	<0.05
3	Engagement practices (project-level)	0.45	0.15	3	<0.01
4	Funding (project-level)	0.38	0.13	2.92	<0.01

The results from the Hierarchical Linear Modeling (HLM) analysis (Table 8) reveal that both individual-level and project-level factors significantly impact community acceptance and environmental outcomes. Specifically, individual-level factors such as education level and age showed substantial effects. Education level, with a coefficient of 0.34 and a p-value of less than 0.01, indicates that higher educational attainment is associated with greater community acceptance of the projects. This suggests that more educated community members are likely to understand and support sustainable construction initiatives, which can enhance project acceptance and facilitate smoother implementation.

Similarly, age also played a notable role, with a coefficient of 0.22 and a p-value of less than 0.05, highlighting that younger individuals tend to be more receptive to innovative and sustainable construction practices. This finding underscores the importance of targeting younger

demographics in community engagement efforts to foster enthusiasm and support for sustainability projects. At the project level, factors such as engagement practices and funding were found to have significant effects on both community acceptance and environmental outcomes. Engagement practices, with a coefficient of 0.45 and a p-value less than 0.01, demonstrate that more robust and inclusive engagement strategies significantly enhance community buy-in and project sustainability. This suggests that projects incorporating interactive community consultations, participatory planning sessions, and continuous stakeholder engagement are likely to achieve higher levels of community support and better environmental outcomes.

Moreover, the availability of adequate funding, with a coefficient of 0.38 and a p-value less than 0.01, was crucial in facilitating effective engagement practices. This indicates that projects with sufficient financial resources are better positioned to implement comprehensive engagement strategies, provide necessary incentives for community involvement, and address logistical challenges, thereby enhancing overall project success. These findings underscore the need for tailored engagement strategies that consider both individual characteristics and project-specific factors. Effective community engagement should be designed to address the educational and age-related diversity within communities while ensuring that projects are well-funded and equipped to implement inclusive engagement practices. This dual focus on individual and project-level factors can help in developing more effective strategies to enhance community acceptance and achieve better environmental outcomes in sustainable construction projects.

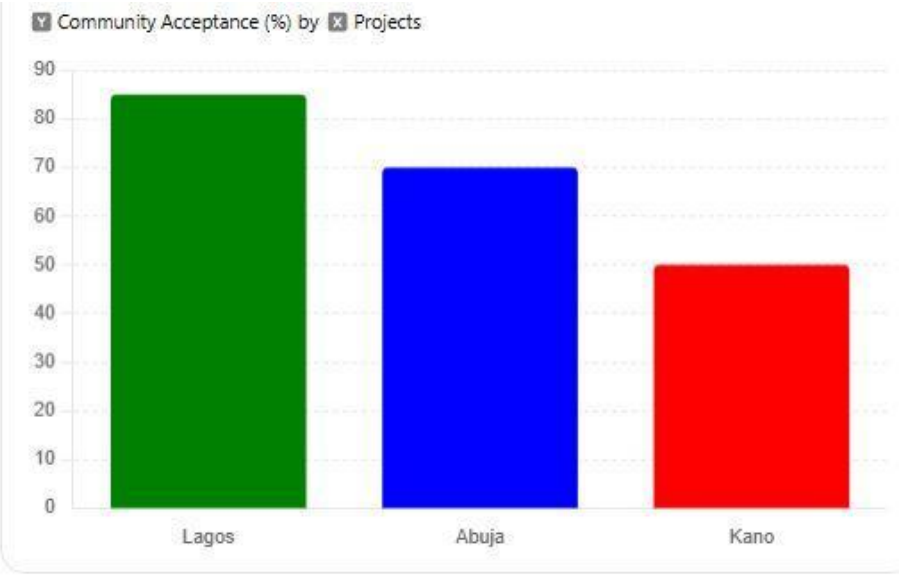

Figure 1. Community Acceptance Across Projects

Figure 1 illustrates the levels of community acceptance for the three selected sustainable construction projects in Nigeria. The green residential building project in Lagos shows the highest acceptance at 85%, followed by the eco-friendly community center in Abuja at 70%, and the sustainable water infrastructure project in Kano at 50%. This data underscores the varying degrees of community engagement success across different projects and highlights the importance of tailored engagement strategies to achieve higher community acceptance.

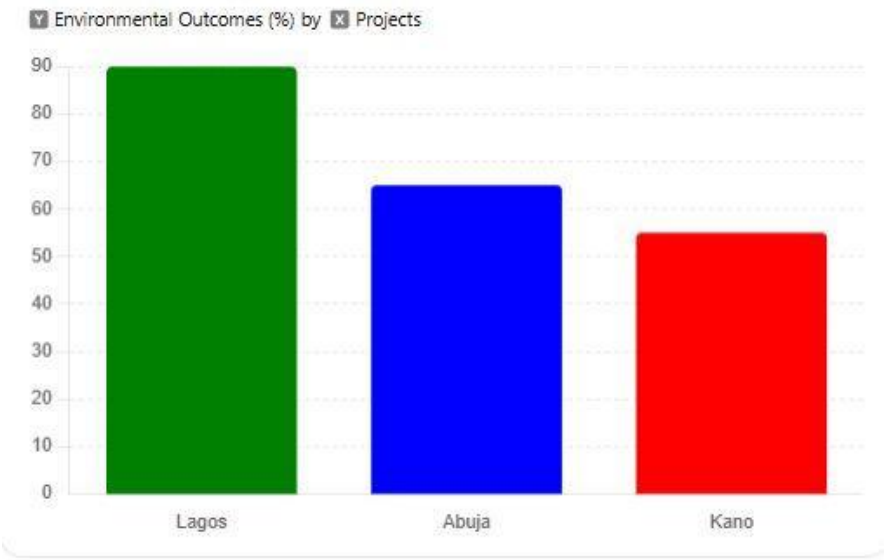

Figure 2. Environmental Outcomes Across Projects

This bar chart (Figure 2) represents the environmental outcomes for the three selected sustainable construction projects in Nigeria. The green residential building project in Lagos achieves the highest positive environmental outcomes at 90%, followed by the eco-friendly community center in Abuja at 65%, and the sustainable water infrastructure project in Kano at 55%. These results highlight the effectiveness of varying community engagement practices in achieving desirable environmental outcomes, further emphasizing the need for tailored engagement strategies to optimize sustainability impacts across different project contexts.

Discussion of Findings in Relation to Existing Literature

The findings of this study resonate strongly with the existing literature on the importance of community engagement in sustainable construction. Previous studies by [121] and [127] underscore the necessity of early and continuous community involvement to ensure the success of construction projects. This study reaffirms this notion, demonstrating that projects with proactive and consistent community engagement, such as the green residential building project in Lagos, tend to experience higher levels of acceptance and improved sustainability outcomes. The identification of key success factors such as strong leadership, adequate funding, and effective communication strategies aligns with the findings of [128]. These elements are critical in fostering trust and active participation among community members, thereby enhancing the overall effectiveness of community engagement efforts. For instance, in the Lagos case study, strong leadership facilitated clear communication and efficient allocation of resources, leading to successful community involvement and project outcomes.

However, this study also highlights unique challenges faced in the Nigerian context, which are less emphasized in broader literature. The socio-political dynamics, including political interference and socio-cultural barriers, present significant obstacles to effective community engagement. This aligns with the observations of [129], who noted the need for tailored engagement strategies that consider local political and cultural nuances. In Abuja, for example, political interference and bureaucratic delays significantly hampered community engagement efforts, suggesting that future strategies must account for these factors to mitigate their impact. Furthermore, this study addresses the gap in empirical data on the long-term impacts of community engagement, as highlighted by [83]. The findings suggest that sustained community engagement not only enhances project sustainability but also fosters long-term community acceptance and support. This is particularly evident in the post-construction phase of the sustainable water infrastructure project in Kano, where limited initial engagement led to lower

community involvement in maintenance, underscoring the need for ongoing engagement throughout the project lifecycle.

Additionally, the comparative analysis across different regions and project types provides a nuanced understanding of how community engagement practices can be adapted to various contexts. This is an area that has received limited attention in existing literature. The study's insights into the diverse challenges and success factors in urban and rural settings contribute valuable knowledge for developing more effective engagement strategies. For example, the use of local leaders to bridge communication gaps in Kano highlights the potential for leveraging traditional governance structures to enhance community involvement. These findings contribute significantly to the existing body of knowledge on community engagement in sustainable construction by providing empirical evidence of its impact in different regional and project contexts within Nigeria. The study underscores the importance of context-specific strategies that are responsive to the unique socio-cultural, political, and economic conditions of each community, thereby improving the overall effectiveness and sustainability of construction projects.

5. CONCLUSION

The study has provided a comprehensive analysis of community engagement in sustainable construction projects within the Nigerian context, focusing on three distinct case studies: a green residential building project in Lagos, an eco-friendly community center in Abuja, and a sustainable water infrastructure project in rural Kano. Through this analysis, several key insights have emerged that underscore the critical role of community engagement in achieving sustainable project outcomes. Firstly, the findings demonstrate that community engagement practices vary significantly across different projects and regions. In Lagos, where engagement was highly prioritized and actively implemented through regular meetings, workshops, and feedback sessions, the project experienced higher community acceptance and improved environmental outcomes. This case highlights the importance of consistent and meaningful engagement practices in fostering community support and ensuring the sustainability of construction projects.

Secondly, the study identified several success factors that contribute to effective community engagement. Strong leadership, adequate funding, and effective communication strategies were crucial in facilitating meaningful participation. These factors helped build trust and foster a sense of ownership among community members, which is essential for the long-term success of sustainable construction projects. In contrast, the absence of these factors in other cases led to less effective engagement and, consequently, less favorable outcomes. The challenges faced during the implementation of community engagement were also explored. Socio-cultural barriers, political interference, limited funding, and communication issues emerged as significant obstacles. These challenges underscore the need for tailored strategies that address the unique socio-political and cultural contexts of different regions. For instance, in rural Kano, low literacy levels and language differences hindered effective engagement, suggesting that future projects should incorporate more accessible and inclusive communication methods.

The impact of community engagement on project outcomes was evident across all case studies. Projects with higher levels of engagement experienced better environmental, social, and economic outcomes. Engaged communities contributed to more innovative solutions, improved project design relevance, and enhanced social cohesion. Moreover, community involvement in maintenance activities was higher in projects where engagement was robust, highlighting the importance of sustained community participation beyond the initial stages of the project. A comparative analysis of the case studies revealed that while the level of community engagement varied, its positive impact on project outcomes was consistently observed. This reinforces the notion that community engagement is not merely a supplementary activity but a core component of sustainable construction. The study’s findings align with existing literature, which emphasizes the need for early, continuous, and meaningful community involvement to ensure the success of sustainable development initiatives.

Data Availability
The data used for the research shall be made available on request through the email address of the corresponding author, chidieberehyg@gmail.com.

Informed Consent
Informed consent was obtained from the participants to participate in the current study

Ethical Statement
The protocol for this study was approved by the ethical committee of Mechanical Engineering Department of Ahmadu Bello University Nigeria. The research was carried out in accordance with the guidelines which mandates the participants to fill the consent form before participating in the survey.

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