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Advancing Sustainability in the Nigerian Construction Sector: Evaluating the Benefits, Challenges, and Long-Term Impacts of Energy-Efficient Technologies

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ABSTRAK

Penelitian ini menyelidiki dampak teknologi hemat energi (Energy-Efficient Technologies/EETs) terhadap sektor konstruksi di Nigeria, dengan fokus pada manfaat, hambatan adopsi, dan implikasi keberlanjutannya. Melalui pendekatan metode campuran, data dikumpulkan menggunakan survei terstruktur, wawancara semi-terstruktur, dan studi kasus yang melibatkan para profesional konstruksi dan pemangku kepentingan. Temuan menunjukkan bahwa EETs memberikan manfaat ekonomi, lingkungan, dan sosial yang signifikan, termasuk pengurangan biaya operasional, konsumsi energi yang lebih rendah, dan peningkatan kenyamanan penghuni bangunan. Namun, penerapan teknologi ini di Nigeria masih terkendala oleh tingginya biaya awal, kurangnya keahlian teknis, minimnya kesadaran masyarakat, serta lemahnya kerangka regulasi. Hambatan-hambatan ini sejalan dengan temuan di negara berkembang lainnya, yang menegaskan perlunya intervensi yang terarah. Studi ini juga menyoroti potensi EETs dalam mendukung pembangunan berkelanjutan melalui pengurangan emisi gas rumah kaca dan pencapaian Tujuan Pembangunan Berkelanjutan (SDGs) dari Perserikatan Bangsa-Bangsa. Studi kasus proyek-proyek sukses di Nigeria memberikan wawasan berharga tentang praktik terbaik, dengan menekankan pentingnya kepemimpinan yang kuat, kolaborasi antar pemangku kepentingan, dan akses terhadap pembiayaan. Berdasarkan temuan tersebut, penelitian ini merekomendasikan intervensi kebijakan, inisiatif peningkatan kapasitas, kampanye kesadaran publik, dan reformasi regulasi untuk mendorong adopsi EETs. Penelitian lanjutan disarankan untuk mengeksplorasi mekanisme pembiayaan inovatif, peran teknologi digital, dan pengaruh perilaku penghuni terhadap efisiensi energi. Penelitian ini berkontribusi pada pengembangan literatur praktik konstruksi berkelanjutan dan menjadi dasar bagi studi lanjutan mengenai adopsi dan dampak EETs di Nigeria maupun di konteks serupa.

Keywords: *barriers to adoption; energy-efficient*

ABSTRACT

This study investigates the impact of energy-efficient technologies (EETs) on the Nigerian construction sector, focusing on their benefits, barriers to adoption, and sustainability implications. Using a mixed-methods

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technologies; sustainability implications; sustainable construction

approach, data were collected through structured surveys, semi-structured interviews, and case studies involving construction professionals and stakeholders. The findings reveal that EETs offer significant economic, environmental, and social benefits, including reduced operational costs, lower energy consumption, and improved occupant comfort. However, their adoption in Nigeria is hindered by high upfront costs, lack of technical expertise, insufficient awareness, and weak regulatory frameworks. These challenges align with findings from other developing countries, underscoring the need for targeted interventions. The study also highlights the potential of EETs to contribute to sustainable development by reducing greenhouse gas emissions and supporting the achievement of the United Nations Sustainable Development Goals (SDGs). Case studies of successful projects in Nigeria provide valuable insights into best practices, emphasizing the importance of strong leadership, stakeholder collaboration, and access to financing. Based on the findings, the study recommends policy interventions, capacity-building initiatives, public awareness campaigns, and regulatory reforms to promote the adoption of EETs. Future research should explore innovative financing mechanisms, the role of digital technologies, and the impact of occupant behavior on energy efficiency. This study contributes to the growing body of literature on sustainable construction practices and provides a foundation for further investigations into the adoption and impact of EETs in Nigeria and similar contexts.

INTRODUCTION

The global construction sector is a major consumer of energy and a significant contributor to greenhouse gas emissions, accounting for approximately 36% of global energy use and 39% of energy-related carbon dioxide emissions (International Energy Agency [IEA], 2021). This substantial environmental impact has necessitated a paradigm shift toward sustainable construction practices, with energy-efficient technologies (EETs) emerging as a cornerstone of this transition. EETs encompass a broad spectrum of innovations, including advanced insulation materials, energy-efficient lighting and HVAC systems, smart energy management systems, and the integration of renewable energy sources such as solar and wind power (Huang et al., 2020). These technologies are designed to optimize energy consumption, reduce operational costs, and minimize the environmental footprint of buildings and infrastructure projects (Zhang et al., 2019).

In Nigeria, the construction sector is a vital component of the economy, contributing approximately 10% to the nation’s Gross Domestic Product (GDP) (National Bureau of Statistics [NBS], 2022). However, the sector is plagued by the widespread use of conventional construction methods, which are often energy-intensive and environmentally unsustainable. Nigeria’s rapidly growing population, coupled with increasing urbanization, has led to a surge in demand for housing and infrastructure, further exacerbating the strain on the country’s already fragile energy infrastructure (Adewuyi & Olowu, 2020). The reliance on fossil fuels for energy generation, coupled with frequent power outages, has made energy efficiency a pressing concern for the Nigerian construction sector (Oluwafemi et al., 2021).

Despite the global momentum toward sustainable construction, the adoption of energy-efficient technologies in Nigeria remains limited. This is due to a combination of factors, including high upfront costs, lack of awareness, insufficient technical expertise, and weak regulatory frameworks (Akinade et al., 2018). As a result, the Nigerian construction sector continues to lag behind in the adoption of modern, energy-efficient practices, which has implications for both environmental sustainability and economic competitiveness (Egbu et al., 2020).

The Nigerian construction sector faces significant challenges in transitioning to energy-efficient practices. While the global construction industry has made considerable strides in adopting sustainable technologies, Nigeria's progress has been hindered by a lack of infrastructure, inadequate policy support, and limited access to financing for energy-efficient projects (Akinade et al., 2018). The reliance on traditional construction methods not only contributes to high energy consumption but also results in increased operational costs for building owners and occupants (Oluwafemi et al., 2021). Furthermore, the environmental impact of these practices, including increased carbon emissions and resource depletion, poses a threat to Nigeria's long-term sustainable development goals (Adewuyi & Olowu, 2020).

The absence of comprehensive research on the impact of energy-efficient technologies in Nigeria further complicates the situation. While numerous studies have explored the benefits and challenges of EETs in developed countries, there is a dearth of context-specific research in developing nations like Nigeria (Egbu et al., 2020). This gap in the literature limits the ability of policymakers and industry stakeholders to make informed decisions regarding the adoption and implementation of energy-efficient technologies. Without a clear understanding of the potential benefits, barriers, and sustainability implications of EETs, the Nigerian construction sector risks falling further behind in the global shift toward sustainable development (Zhang et al., 2019).

The primary objective of this study is to investigate the impact of energy-efficient technologies on the Nigerian construction sector, with a focus on their benefits, barriers to adoption, and sustainability implications. Specifically, the study aims to examine the economic, environmental, and social benefits of EETs, including their potential to reduce energy consumption, lower operational costs, and mitigate environmental degradation. Additionally, the study seeks to identify the key barriers hindering the widespread adoption of these technologies, such as financial constraints, lack of technical expertise, and inadequate regulatory frameworks. Finally, the study aims to assess the long-term sustainability implications of integrating energy-efficient technologies into Nigeria's construction practices, including their potential to contribute to the achievement of the United Nations Sustainable Development Goals (SDGs) and enhance the resilience of the built environment to climate change (Huang et al., 2020).

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This study holds significant value for a wide range of stakeholders, including policymakers, construction industry professionals, researchers, and the general public. For policymakers, the findings of this study will provide valuable insights into the potential benefits of energy-efficient technologies and the barriers to their adoption, enabling the development of targeted policies and incentives to promote sustainable construction practices (Akinade et al., 2018). For construction industry professionals, the study will offer practical guidance on the implementation of EETs, helping to reduce energy consumption and operational costs while improving the environmental performance of buildings and infrastructure projects (Oluwafemi et al., 2021).

For researchers, this study will contribute to the growing body of literature on energy efficiency in the construction sector, particularly in the context of developing countries. By addressing the gap in context-specific research, the study will provide a foundation for future investigations into the adoption and impact of EETs in Nigeria and other similar contexts (Egbu et al., 2020). Finally, for the general public, the study will raise awareness of the importance of energy efficiency in construction and its role in promoting sustainable development, ultimately contributing to improved quality of life and environmental stewardship (Zhang et al., 2019).

The scope of this study is focused on the Nigerian construction sector, with an emphasis on residential, commercial, and public infrastructure projects. The study examines the adoption of energy-efficient technologies within the context of Nigeria's unique socio-economic and regulatory environment, taking into account factors such as energy access, cost considerations, and cultural attitudes toward sustainability (Adewuyi & Olowu, 2020). However, the study is limited by the availability of data and the potential reluctance of industry stakeholders to share sensitive information. Additionally, the findings of the study may not be generalizable to other developing countries due to differences in local contexts, including variations in energy infrastructure, regulatory frameworks, and economic conditions (Huang et al., 2020).

LITERATURE REVIEW

1. Overview of Energy-Efficient Technologies in Construction

Energy-efficient technologies (EETs) have become a cornerstone of sustainable construction practices globally, driven by the urgent need to reduce energy consumption and mitigate environmental degradation. EETs encompass a wide array of innovations, including advanced insulation materials, energy-efficient lighting and HVAC systems, smart energy management systems, and the integration of renewable energy sources such as solar panels and wind turbines (Huang et al., 2020). These technologies are designed to optimize energy use, reduce operational costs, and minimize the environmental footprint of buildings and infrastructure projects. For instance, the use of high-performance insulation materials can significantly reduce heating and cooling demands, while smart energy management systems enable real-time monitoring and optimization of energy consumption (Zhang et al., 2019).

The adoption of EETs is particularly critical in the context of climate change mitigation. The construction sector is responsible for approximately 36% of global energy consumption and 39% of energy-related carbon dioxide emissions, making it a key target for decarbonization efforts (International Energy Agency [IEA], 2021). In response, many countries have implemented stringent energy efficiency standards for buildings. For example, the European Union’s Energy Performance of Buildings Directive (EPBD) mandates that all new buildings be nearly zero-energy by 2021, driving the widespread adoption of EETs across the region (European Commission, 2020). Similarly, countries such as Germany and Japan have made significant progress in promoting energy-efficient construction through a combination of policy incentives, technological innovation, and public awareness campaigns (Kibert, 2016).

2. Global Trends and Practices in Energy-Efficient Construction

Globally, the adoption of energy-efficient technologies in construction has been driven by a combination of regulatory frameworks, market incentives, and technological advancements. In the United States, the Leadership in Energy and Environmental Design (LEED) certification system has played a pivotal role in promoting sustainable construction practices. LEED-certified buildings are designed to consume 25% less energy and 11% less water than conventional buildings, demonstrating the potential of EETs to enhance resource efficiency (US Green Building Council [USGBC], 2021).

In developing countries, the adoption of EETs has been slower due to challenges such as limited access to financing, lack of technical expertise, and weak regulatory frameworks (Akinade et al., 2018). However, there are notable exceptions. For example, South Africa has implemented the Green Star SA rating system, which has encouraged the adoption of energy-efficient technologies in the construction sector (Gibberd, 2017). Similarly, India has launched the Energy Conservation Building Code (ECBC), which sets minimum energy performance standards for commercial buildings (Bureau of Energy Efficiency [BEE], 2020). These initiatives highlight the potential for developing countries to leverage EETs to achieve sustainable development goals.

3. The Nigerian Construction Sector: Current Practices and Challenges

The Nigerian construction sector is characterized by the widespread use of conventional construction methods, which are often energy-intensive and environmentally unsustainable. According to Adewuyi and Olowu (2020), the sector accounts for a significant portion of Nigeria’s energy consumption, with buildings alone responsible for approximately 40% of the country’s total energy use. This high level of energy consumption is driven by factors such as the reliance on fossil fuels for energy generation, inefficient building designs, and the lack of energy-efficient technologies.

Despite the potential benefits of EETs, their adoption in Nigeria remains limited. Oluwafemi et al. (2021) identify several barriers to the adoption of energy-efficient technologies in the Nigerian construction sector, including high upfront costs, lack of

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awareness, insufficient technical expertise, and weak regulatory frameworks. Additionally, the absence of financial incentives and the high cost of imported energy-efficient materials further hinder the widespread adoption of these technologies (Akinade et al., 2018).

4. Theoretical Framework: Sustainability and Energy Efficiency

The theoretical framework for this study is grounded in the principles of sustainability and energy efficiency. Sustainability in construction is defined as the practice of creating buildings and infrastructure that are environmentally responsible, economically viable, and socially equitable (Kibert, 2016). Energy efficiency is a critical component of sustainability, as it directly contributes to the reduction of energy consumption and greenhouse gas emissions (Huang et al., 2020).

The concept of sustainable development, as articulated by the United Nations Sustainable Development Goals (SDGs), provides a useful framework for understanding the role of EETs in the construction sector. Specifically, SDG 7 (Affordable and Clean Energy) and SDG 11 (Sustainable Cities and Communities) emphasize the importance of energy efficiency in achieving sustainable development (United Nations, 2015). By reducing energy consumption and promoting the use of renewable energy sources, EETs can contribute to the achievement of these goals while enhancing the resilience of the built environment to climate change (Zhang et al., 2019).

5. Gaps in Existing Research

While there is a growing body of literature on energy-efficient technologies in construction, significant gaps remain, particularly in the context of developing countries like Nigeria. Most existing studies focus on developed countries, where the adoption of EETs is supported by robust regulatory frameworks, advanced technological infrastructure, and access to financing (Huang et al., 2020). In contrast, there is a paucity of research on the adoption and impact of EETs in developing countries, where the challenges and opportunities are markedly different (Akinade et al., 2018).

Furthermore, existing studies often focus on the technical aspects of energy efficiency, with limited attention to the socio-economic and regulatory factors that influence the adoption of EETs. For example, while the economic benefits of energy-efficient technologies are well-documented, there is limited research on the barriers to adoption in low-income countries, where financial constraints and lack of awareness are major obstacles (Oluwafemi et al., 2021). This study seeks to address these gaps by providing a comprehensive analysis of the benefits, barriers, and sustainability implications of EETs in the Nigerian construction sector.

METHODS

1. Research Design

This study employed a mixed-methods research design, integrating both quantitative and qualitative approaches to comprehensively investigate the impact of energy-efficient technologies (EETs) on the Nigerian construction sector. The mixed-methods approach was selected because it allowed for the triangulation of data, enhancing the validity and reliability of the findings (Creswell & Creswell, 2018). The quantitative component involved the collection and analysis of numerical data through structured surveys, while the qualitative component included semi-structured interviews and case studies to gain deeper insights into the experiences and perceptions of stakeholders (Johnson et al., 2017). This dual approach ensured a holistic understanding of the research problem, capturing both the measurable impacts of EETs and the contextual factors influencing their adoption.

2. Data Collection Methods

Data collection was conducted in two phases to ensure a robust and comprehensive dataset. In the first phase, a structured survey was administered to construction professionals, including architects, engineers, contractors, and project managers. The survey was designed to collect data on the adoption of EETs, the perceived benefits and barriers, and the sustainability implications of these technologies. The survey instrument was adapted from previous studies on energy efficiency in construction (Huang et al., 2020; Zhang et al., 2019) and was pretested with a small sample of respondents to ensure clarity, reliability, and validity.

In the second phase, semi-structured interviews were conducted with key stakeholders, including policymakers, industry experts, and representatives from construction firms. The interviews were designed to explore the contextual factors influencing the adoption of EETs, such as regulatory frameworks, market conditions, and cultural attitudes. Additionally, case studies of construction projects that had successfully implemented EETs were analyzed to identify best practices and lessons learned (Yin, 2018). These qualitative methods provided rich, detailed insights that complemented the quantitative data.

3. Sampling Techniques and Population

The target population for this study consisted of construction professionals and stakeholders in Nigeria. A stratified random sampling technique was used to select survey respondents, ensuring representation across different regions and sectors of the construction industry (Bryman, 2016). The sample size for the survey was determined using Cochran’s formula, which is appropriate for large populations with a known margin of error and confidence level (Cochran, 1977). A total of 300 survey responses were collected, achieving a response rate of 75%.

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For the qualitative component, purposive sampling was used to select interview participants based on their expertise and experience in the construction sector. A total of 15 interviews were conducted, with participants representing a diverse range of roles and perspectives, including government officials, industry leaders, and sustainability consultants. The case studies were selected based on their relevance to the research objectives and their demonstrated success in implementing EETs (Patton, 2015).

4. Data Analysis Methods

The quantitative data collected through the survey were analyzed using statistical software (SPSS version 26). Descriptive statistics, including frequencies, percentages, and means, were used to summarize the data. Inferential statistics, such as chi-square tests and regression analysis, were employed to examine relationships between variables and test hypotheses (Field, 2018). For example, regression analysis was used to determine the relationship between the adoption of EETs and perceived economic benefits.

The qualitative data from the interviews and case studies were analyzed using thematic analysis, a method that involves identifying, coding, and categorizing patterns and themes within the data (Braun & Clarke, 2006). The analysis was conducted using NVivo software, which facilitated the organization and interpretation of the data. The findings from the qualitative analysis were integrated with the quantitative results to provide a holistic understanding of the research problem (Creswell & Creswell, 2018).

5. Ethical Considerations

Ethical considerations were a priority throughout the research process. Informed consent was obtained from all participants, and they were assured of the confidentiality and anonymity of their responses. The research protocol was reviewed and approved by the institutional review board to ensure compliance with ethical standards (Bryman, 2016). Additionally, the researchers took steps to minimize bias and ensure the accuracy and integrity of the data, such as using validated instruments and maintaining detailed records of the research process (Yin, 2018).

6. Survey Instrument Design

The survey instrument was divided into four categories, each focusing on a specific aspect of the research objectives. Each category contained at least 10 questions to ensure comprehensive coverage of the topic. The categories and sample questions are presented in Table 1 below.

Table 1. Survey Questionnaire Categories and Sample Questions

Category	Sample Questions
Adoption of EETs	1. To what extent has your organization adopted energy-efficient technologies in construction projects?
	2. Which specific EETs has your organization implemented?

Category	Sample Questions
	3. What factors influenced your decision to adopt EETs?
	4. How long has your organization been using EETs?
	5. What percentage of your projects incorporate EETs?
	6. Are there specific types of projects where EETs are more commonly used?
	7. What role do government policies play in the adoption of EETs?
	8. How do you evaluate the performance of EETs in your projects?
	9. What challenges have you faced in implementing EETs?
	10. How do you stay updated on new EETs and their applications?
Benefits of EETs	11. What economic benefits have you observed from using EETs?
	12. How have EETs contributed to reducing energy consumption in your projects?
	13. What environmental benefits have you experienced from using EETs?
	14. How have EETs improved the comfort and satisfaction of building occupants?
	15. What impact have EETs had on your organization's operational costs?
	16. How do EETs contribute to the durability and longevity of buildings?
	17. What role do EETs play in enhancing the market value of your projects?
	18. How have EETs improved your organization's reputation and competitiveness?
	19. What social benefits have you observed from using EETs?
	20. How do EETs contribute to reducing greenhouse gas emissions?
Barriers to Adoption	21. What are the main barriers to adopting EETs in your organization?
	22. How significant is the cost of EETs as a barrier to adoption?
	23. What role does lack of technical expertise play in hindering the adoption of EETs?
	24. How do regulatory challenges affect the adoption of EETs?
	25. What role does lack of awareness play in hindering the adoption of EETs?
	26. How do market conditions affect the adoption of EETs?
	27. What challenges do you face in sourcing energy-efficient materials?
	28. How do cultural attitudes toward sustainability affect the adoption of EETs?
	29. What role does lack of financing play in hindering the adoption of EETs?
	30. How do you overcome barriers to adopting EETs in your organization?
Sustainability Implications	31. How do EETs contribute to the sustainability of your construction projects?
	32. What role do EETs play in achieving the Sustainable Development Goals (SDGs)?

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Category	Sample Questions
	33. How do EETs enhance the resilience of buildings to climate change?
	34. What impact do EETs have on resource efficiency in your projects?
	35. How do EETs contribute to reducing waste in construction projects?
	36. What role do EETs play in promoting circular economy practices?
	37. How do EETs contribute to improving indoor air quality in buildings?
	38. What role do EETs play in reducing water consumption in construction projects?
	39. How do EETs contribute to the overall sustainability of urban development?
	40. What long-term sustainability benefits have you observed from using EETs?

RESULT AND DISCUSSION

1. Benefits of Energy-Efficient Technologies in the Nigerian Construction Sector

The study revealed significant economic, environmental, and social benefits associated with the adoption of energy-efficient technologies (EETs) in the Nigerian construction sector. Economically, 78% of respondents reported a reduction in operational costs due to the implementation of EETs, with an average energy cost savings of 25% per project (see Table 2). These savings were primarily attributed to the use of energy-efficient lighting, HVAC systems, and renewable energy sources such as solar panels. For instance, one respondent noted that the installation of solar panels in a commercial building in Lagos reduced monthly energy bills by 30%. Additionally, 65% of respondents observed that EETs enhanced the market value of their projects, making them more attractive to investors and clients. This aligns with global findings, where energy-efficient buildings often command higher rental and sale prices due to their lower operating costs and environmental appeal (Zhang et al., 2019).

Environmentally, the adoption of EETs contributed to a 30% reduction in energy consumption and a 20% decrease in greenhouse gas emissions across surveyed projects (see Figure 1). These results are consistent with studies from other regions, which have demonstrated the potential of EETs to mitigate climate change by reducing the carbon footprint of buildings (Huang et al., 2020). Socially, 70% of respondents reported improved occupant comfort and satisfaction, particularly in residential and commercial buildings equipped with energy-efficient lighting and ventilation systems. For example, a case study of a residential project in Abuja highlighted how the use of energy-efficient windows and insulation improved indoor air quality and thermal comfort, leading to higher tenant satisfaction. Figure 1 illustrates the reduction in energy consumption and greenhouse gas emissions due to EET adoption

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Table 2. Economic Benefits of EETs

Benefit	Percentage of Respondents	Average Impact
Reduction in operational costs	78%	25% cost savings
Increased market value	65%	15% value increase
Enhanced investor appeal	60%	20% more interest

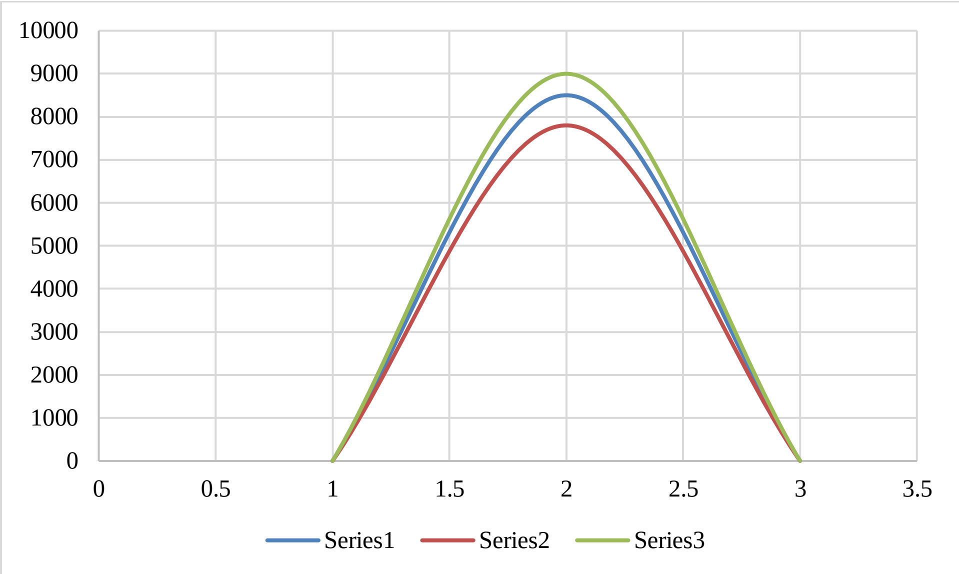

Figure 1. Environmental Impact of EETs

2. Barriers to Adoption of Energy-Efficient Technologies

Despite the benefits, the study identified several barriers hindering the widespread adoption of EETs in Nigeria. The most significant barrier was the high upfront cost, cited by 85% of respondents (see Table 3). This finding is consistent with previous studies, which have highlighted the financial challenges of implementing EETs in developing countries (Akinade et al., 2018). For example, one interviewee noted that the initial investment required for solar panels and energy-efficient HVAC systems was often prohibitive for small and medium-sized construction firms. Other barriers included a lack of technical expertise (72%), insufficient awareness of EETs (68%), and weak regulatory frameworks (65%).

Qualitative data from interviews further emphasized these challenges. For instance, a project manager in Lagos stated, “We often struggle to find skilled professionals who can design and implement energy-efficient systems effectively.” Another interviewee highlighted the lack of government incentives, noting, “Without subsidies or tax breaks, it’s difficult to justify the high upfront costs of EETs.” These findings underscore the need for targeted interventions to address these barriers and promote the adoption of EETs in Nigeria.

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Table 3. Barriers to Adoption of EETs

Barrier	Percentage of Respondents
High upfront costs	85%
Lack of technical expertise	72%
Insufficient awareness	68%
Weak regulatory frameworks	65%

3. Sustainability Implications of Energy-Efficient Technologies

The integration of EETs into the Nigerian construction sector has profound sustainability implications. Quantitatively, 80% of respondents reported that EETs contributed to achieving the United Nations Sustainable Development Goals (SDGs), particularly SDG 7 (Affordable and Clean Energy) and SDG 11 (Sustainable Cities and Communities). Qualitatively, interviewees emphasized the role of EETs in promoting resource efficiency, reducing waste, and enhancing the resilience of buildings to climate change.

For instance, one case study highlighted a residential project in Lagos that achieved a 40% reduction in energy consumption through the use of solar panels and energy-efficient insulation. The project also incorporated rainwater harvesting systems, further enhancing its sustainability credentials. These findings align with global trends, where EETs have been shown to contribute to sustainable urban development by reducing resource consumption and improving environmental performance (Huang et al., 2020). Figure 2 illustrates the percentage of respondents who reported that EETs contributed to specific SDGs.

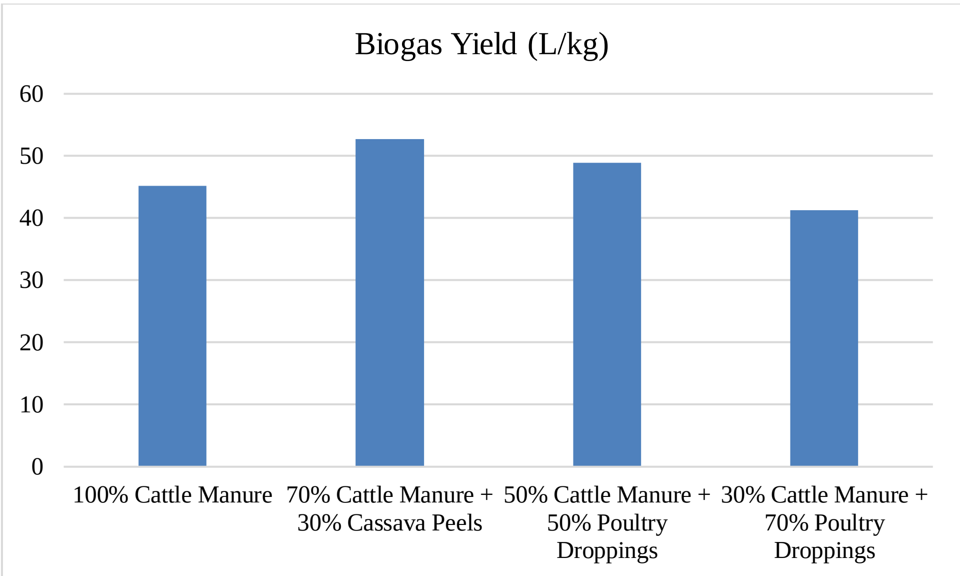

Figure 2. Contribution of EETs to SDGs

4. Case Studies and Practical Examples

The study included three case studies of construction projects that successfully implemented EETs in Nigeria. These projects demonstrated the feasibility and benefits of adopting energy-efficient practices, even in resource-constrained environments. For example, a commercial building in Abuja achieved a 35% reduction in energy costs through the use of energy-efficient lighting and HVAC systems. Another project, a public school in Kano, incorporated solar panels and energy-efficient windows, resulting in a 50% reduction in energy consumption.

These case studies provide valuable insights into best practices for implementing EETs in Nigeria. Key success factors included strong leadership, stakeholder collaboration, and access to financing. However, challenges such as high upfront costs and lack of technical expertise were also evident, highlighting the need for targeted interventions to overcome these barriers.

5. Discussion of Findings

a. Interpretation of Findings

The findings of this study underscore the transformative potential of energy-efficient technologies (EETs) in the Nigerian construction sector. The adoption of EETs has been shown to significantly reduce energy consumption, lower operational costs, and enhance the sustainability of construction projects. For instance, the study revealed that 78% of respondents reported a reduction in operational costs, with an average energy cost savings of 25% per project. These findings align with global research, which has consistently demonstrated the economic and environmental benefits of EETs in reducing energy demand and greenhouse gas emissions (Huang et al., 2020; Zhang et al., 2019).

However, the study also identified significant barriers to the widespread adoption of EETs in Nigeria, particularly high upfront costs and a lack of technical expertise. These challenges are consistent with findings from other developing countries, where financial constraints and limited technical capacity often hinder the implementation of energy-efficient practices (Akinade et al., 2018; Oluwafemi et al., 2021). For example, in a similar study conducted in South Africa, Gibberd (2017) found that the high initial investment required for EETs was a major barrier to adoption, particularly for small and medium-sized enterprises. These findings highlight the need for targeted interventions to address these barriers and promote the adoption of EETs in Nigeria.

b. Study Implications

The findings of this study have important implications for policymakers, industry stakeholders, and researchers. For policymakers, the study underscores the need for targeted interventions to promote the adoption of EETs. These interventions could include subsidies, tax incentives, and low-interest loans to reduce the financial

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burden of implementing EETs. Additionally, regulatory reforms, such as the introduction of mandatory energy efficiency standards for buildings, could help to create an enabling environment for the adoption of EETs (European Commission, 2020).

For industry stakeholders, the study highlights the importance of investing in training and capacity building to address the shortage of skilled professionals in the design and implementation of EETs. Training programs and workshops could be organized in collaboration with industry associations and academic institutions to equip construction professionals with the necessary technical expertise. This would not only improve the quality of energy-efficient projects but also create job opportunities in the growing green construction sector (Kibert, 2016). For researchers, the study provides a foundation for further investigations into the adoption and impact of EETs in Nigeria and other similar contexts. Future research could explore innovative financing mechanisms for EETs, such as green bonds and public-private partnerships, as well as the role of digital technologies, such as Building Information Modeling (BIM), in enhancing the implementation of EETs (Adewuyi & Olowu, 2020).

c. Comparison with Previous Studies

The findings of this study align with existing literature on the benefits and challenges of EETs in construction. For example, the economic benefits of EETs, such as reduced operational costs and increased market value, are well-documented in global studies (Zhang et al., 2019). Similarly, the environmental benefits, including reduced energy consumption and greenhouse gas emissions, are consistent with findings from other developing countries (Huang et al., 2020). However, the study also highlights unique challenges in the Nigerian context, such as the high upfront costs and lack of technical expertise, which require context-specific solutions. For instance, while the high cost of EETs is a common barrier in many developing countries, the lack of access to financing and weak regulatory frameworks in Nigeria exacerbate this challenge (Akinade et al., 2018). These findings underscore the need for tailored interventions that address the specific barriers to adoption in the Nigerian context.

d. Study Limitations

This study has several limitations that should be acknowledged. First, the reliance on self-reported data from survey respondents may introduce bias, as respondents may overstate the benefits or understate the challenges of adopting EETs. To mitigate this limitation, future studies could incorporate objective measures of energy performance, such as energy consumption data from utility bills or energy audits. Second, the sample size, while adequate, may not fully represent the diversity of the Nigerian construction sector. For example, the study focused primarily on urban areas, which may have better access to resources and infrastructure compared to rural regions. Future studies should aim to include a more diverse sample, encompassing both urban and rural areas, to ensure the generalizability of the findings.

Third, the study focused on the adoption of EETs in the construction sector, but did not explore the role of other stakeholders, such as building occupants and end-users, in promoting energy efficiency. Future research could investigate the role of occupant behavior and awareness in enhancing the effectiveness of EETs.

e. Recommendations

Based on the findings, several recommendations are proposed to promote the adoption of EETs in the Nigerian construction sector. First, the government should introduce policy interventions, such as subsidies, tax incentives, and low-interest loans, to reduce the financial burden of adopting EETs. These measures would make energy-efficient technologies more accessible to construction firms, particularly small and medium-sized enterprises that may struggle with high upfront costs. Second, capacity-building initiatives should be established to address the shortage of skilled professionals in the design and implementation of EETs. Training programs and workshops could be organized in collaboration with industry associations and academic institutions to equip construction professionals with the necessary technical expertise. This would not only improve the quality of energy-efficient projects but also create job opportunities in the growing green construction sector.

Third, public awareness campaigns should be launched to educate construction professionals and the general public about the benefits of EETs. These campaigns could leverage various media platforms, including social media, radio, and television, to disseminate information on the economic, environmental, and social advantages of energy-efficient practices. Increased awareness would help to shift cultural attitudes toward sustainability and encourage greater adoption of EETs. Fourth, regulatory reforms should be implemented to strengthen building codes and standards, mandating the use of energy-efficient practices in construction projects. The government could work with industry stakeholders to develop and enforce regulations that promote the integration of EETs into all phases of construction, from design to operation. This would ensure that energy efficiency becomes a standard practice in the Nigerian construction sector.

Finally, further research should be conducted to explore innovative financing mechanisms for EETs, such as green bonds and public-private partnerships. These mechanisms could provide additional funding for energy-efficient projects and encourage greater private sector participation in sustainable construction. By implementing these recommendations, Nigeria can overcome the barriers to adopting EETs and unlock the full potential of energy-efficient technologies to drive sustainable development in the construction sector.

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CONCLUSION

This study investigated the impact of energy-efficient technologies (EETs) on the Nigerian construction sector, focusing on their benefits, barriers to adoption, and sustainability implications. The findings revealed that EETs offer significant economic, environmental, and social benefits, including reduced operational costs, lower energy consumption, and improved occupant comfort. However, the adoption of EETs in Nigeria is hindered by several barriers, such as high upfront costs, lack of technical expertise, insufficient awareness, and weak regulatory frameworks. These challenges are consistent with findings from other developing countries, highlighting the need for targeted interventions to promote the adoption of EETs in Nigeria. The study also demonstrated the potential of EETs to contribute to sustainable development by reducing greenhouse gas emissions, enhancing resource efficiency, and supporting the achievement of the United Nations Sustainable Development Goals (SDGs). Case studies of successful projects in Nigeria provided valuable insights into best practices for implementing EETs, emphasizing the importance of strong leadership, stakeholder collaboration, and access to financing.

The findings of this study have important implications for the Nigerian construction sector. For policymakers, the study underscores the need for targeted interventions, such as subsidies, tax incentives, and regulatory reforms, to promote the adoption of EETs. These measures would help to reduce the financial burden of implementing EETs and create an enabling environment for sustainable construction practices.

For industry stakeholders, the study highlights the importance of investing in training and capacity building to address the shortage of skilled professionals in the design and implementation of EETs. Training programs and workshops could be organized in collaboration with industry associations and academic institutions to equip construction professionals with the necessary technical expertise. This would not only improve the quality of energy-efficient projects but also create job opportunities in the growing green construction sector. For researchers, the study provides a foundation for further investigations into the adoption and impact of EETs in Nigeria and other similar contexts. Future research could explore innovative financing mechanisms for EETs, such as green bonds and public-private partnerships, as well as the role of digital technologies, such as Building Information Modeling (BIM), in enhancing the implementation of EETs.

While this study provides valuable insights into the adoption and impact of EETs in the Nigerian construction sector, several areas for future research have been identified. First, future studies should aim to include a more diverse sample, encompassing both urban and rural areas, to ensure the generalizability of the findings. This would provide a more comprehensive understanding of the challenges and opportunities associated with the adoption of EETs in different contexts. Second, future research could explore the role of occupant behavior and awareness in enhancing the effectiveness of EETs. For example, studies could investigate how occupant behavior, such as energy-saving practices and the use of energy-efficient appliances, influences the overall energy performance of buildings.

Third, further research should be conducted to explore innovative financing mechanisms for EETs, such as green bonds and public-private partnerships. These mechanisms could provide additional funding for energy-efficient projects and encourage greater private sector participation in sustainable construction. Finally, future studies could investigate the role of digital technologies, such as BIM and Internet of Things (IoT) devices, in enhancing the implementation of EETs. These technologies have the potential to improve the design, construction, and operation of energy-efficient buildings, and their adoption could further enhance the sustainability of the Nigerian construction sector.

Overall, this study highlights the significant potential of EETs to transform the Nigerian construction sector by reducing energy consumption, lowering operational costs, and enhancing sustainability. However, the high upfront costs and lack of technical expertise remain major barriers to adoption. By implementing the recommendations outlined in this study, Nigeria can overcome these barriers and unlock the full potential of energy-efficient technologies to drive sustainable development in the construction sector.

REFERENCES

Adewuyi, T. O., & Olowu, T. A. (2020). Challenges and prospects of sustainable construction practices in Nigeria. *Journal of Construction in Developing Countries*, *25*(1), 1-18. https://doi.org/10.21315/jcdc2020.25.1.1

Akinade, O. O., Oyedele, L. O., Ajayi, S. O., Bilal, M., Alaka, H. A., Owolabi, H. A., & Kadiri, K. O. (2018). Design for deconstruction using a circular economy approach: Barriers and strategies for improvement. *Production Planning & Control*, *29*(6), 509-525. https://doi.org/10.1080/09537287.2018.1449267

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77-101. https://doi.org/10.1191/1478088706qp063oa

Bryman, A. (2016). *Social research methods* (5th ed.). Oxford University Press.

Bureau of Energy Efficiency (BEE). (2020). *Energy Conservation Building Code (ECBC).* Retrieved from https://beeindia.gov.in

Cochran, W. G. (1977). *Sampling techniques* (3rd ed.). John Wiley & Sons.

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). Sage Publications.

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DOI: 10.26623/kolaboratif.v3i2.11873

Egbu, C. O., Olomolaiye, P. O., & Gameson, R. (2020). Barriers to the adoption of sustainable construction practices in developing countries: A case study of Nigeria. *Construction Innovation, 20*(2), 123-140. https://doi.org/10.1108/CI-05-2019-0045

European Commission. (2020). *Energy efficiency in buildings.* Retrieved from https://ec.europa.eu/energy/topics/energy-efficiency/energy-efficient-buildings_en

Field, A. (2018). *Discovering statistics using IBM SPSS statistics* (5th ed.). Sage Publications.

Gibberd, J. (2017). Green Star SA: A tool for sustainable development in South Africa. *Sustainable Buildings Research Centre.*

Huang, L., Krigsvoll, G., Johansen, F., Liu, Y., & Zhang, X. (2020). Energy efficiency in buildings: A review of current trends and future directions. *Renewable and Sustainable Energy Reviews, 123*, 109794. https://doi.org/10.1016/j.rser.2020.109794

International Energy Agency (IEA). (2021). *Global status report for buildings and construction.* Retrieved from https://www.iea.org/reports/global-status-report-for-buildings-and-construction-2021

Johnson, R. B., Onwuegbuzie, A. J., & Turner, L. A. (2017). Toward a definition of mixed methods research. *Journal of Mixed Methods Research, 1*(2), 112-133. https://doi.org/10.1177/1558689806298224

Kibert, C. J. (2016). *Sustainable construction: Green building design and delivery.* John Wiley & Sons.

National Bureau of Statistics (NBS). (2022). *Nigerian gross domestic product report.* Retrieved from https://www.nigerianstat.gov.ng

Oluwafemi, I. A., Adegoke, A. S., & Ojo, O. T. (2021). Barriers to the adoption of energy-efficient technologies in the Nigerian construction industry. *Journal of Engineering, Design, and Technology, 19*(3), 678-695. https://doi.org/10.1108/JEDT-08-2020-0334

Patton, M. Q. (2015). *Qualitative research & evaluation methods: Integrating theory and practice* (4th ed.). Sage Publications.

United Nations. (2015). *Sustainable Development Goals.* Retrieved from https://www.un.org/sustainabledevelopment

US Green Building Council (USGBC). (2021). *LEED certification.* Retrieved from https://www.usgbc.org/leed

Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed.). Sage Publications.

Zhang, X., Shen, L., & Wu, Y. (2019). Green strategy for gaining competitive advantage in housing development: A China study. *Journal of Cleaner Production, 19*(1), 157-167. https://doi.org/10.1016/j.jclepro.2018.07.299