

# Appraising alternative building technologies adoption in low-cost housing provision to achieving Sustainable Development Goal 11

Appraising  
alternative  
building  
technologies

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## Abstract

**Purpose** – Though alternative building technologies (ABTs) have been encouraged to address accessible and affordable issues in low-cost housing (LCH) provision, their adoption is still overwhelmed with encumbrances. The encumbrances that hinder ABT adoption require an in-depth study, especially in developing countries like Nigeria. However, studies regarding ABT and its role in improving Nigeria's LCH to achieve Sustainable Development Goal (SDG) 11 are scarce. This research investigates encumbrances to ABT adoption in Nigeria's LCH provision and suggests feasible measures to prevent or reduce the encumbrances, thereby improving achieving SDG 11 (sustainable cities and communities).

**Design/methodology/approach** – This research utilised qualitative research and adopted a face-to-face interview as the primary data collection. The interviewees comprised ABT practitioners and end users in Nigeria who were chosen by a convenient sampling technique. The study's data were analysed manually through a thematic approach.

**Findings** – This study shows that stakeholders should embrace ABT in LCH provision to improve achieving SDG 11 in Nigeria. Also, it clustered the perceived 20 encumbrances to ABT adoption in LCH provision into government/policymaker, housing developers/building contractors, ABT users and ABT manufacturers-related issues in Nigeria's context. This study suggested mechanisms to mitigate encumbrances to ABT adoption in LCH provision, thereby improving achieving SDG 11.

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**Originality/value** – This research adds to the limited literature by analysing ABT adoption encumbrances in Nigeria's LCH provision, which could assist policy formulation for the uptake of ABT in LCH provision and improve achieving Goal 11.

**Keywords** Alternative building technologies, Goal 11, Low-cost housing, Low-income earners, Nigeria, Sustainable Development Goal

**Paper type** Research paper

## 1. Introduction

Housing provision is vital for contending extreme poverty and improving the physical well-being of households, especially in developing countries (Windapo *et al.*, 2021). A boost in housing provision, especially low-cost housing (LCH), would reduce unemployment. Adabre *et al.* (2020) affirmed that most economic sectors (finance, industry and commerce) benefit from the booming housing industry. Despite these benefits, accomplishing housing provisions for low-income earners (LIEs) is challenging (Moghayedi *et al.*, 2021). The LIEs and disadvantaged in the developed countries are not exempted from the housing crisis but are insignificant compared to the many developing countries. Adabre and Chan (2019) reported that Australia had 0.471% proportion of the population homeless, 0.435% belonged to Canada, 0.071% to Chile, 0.095% to Denmark and Ireland 0.083%. The inability to address LCH demand–supply gap would influence homelessness and urban slum growth in developing countries. The Sub-Saharan Africa (50.2%) is top on the list of major regions with urban population living in slums and followed by Central and Southern Asia (48.2%) (Alaazi and Aganah, 2020; Statista, 2023). VOA (2019) reported that about 53 million people in Sub-Saharan Africa live in slums and are generally underestimated by those in authority. In 2020, it is estimated that 49% of Nigeria's urban population live in slums without proper shelter (World Bank Group, 2023). Ekpo (2019) reported that the housing deficit is about 17.0 million and requires about 700,000 housing units annually to span through a 2-decade period to home the rising population. However, the Managing Director of Sow Real Estate (Mrs Uzo Onukwubiri) claimed that over 30% of Nigerians are facing housing challenges in a population of about 200 million people, translating to nearly 62 million Nigerians facing a housing crisis (Ajayi, 2022). The estate guru identified the high cost of building materials as partially responsible for the growing housing deficit in Nigeria. Thus, searching for alternative building materials driven by technology is inevitable.

Scholars acknowledged the relevance of ABT as a method to save construction costs, shorten the project completion period and make affordable, sustainable shelters with better quality (Dosumu and Aigbavboa, 2019; National Home Builder's Registration Council, 2020; Windapo *et al.*, 2021; Adetooto *et al.*, 2022a, b). The mechanism could enhance the cost-efficiency, deliverability and quality of public-built LCH. It provides many advantages that could enhance the quality of public-built LCH. Tshivhasa and Mbanga (2018) and Adetooto *et al.* (2022a, b) described ABT as any proficiency, talent, knowledge, tools, machinery or equipment other than the traditional ways to quicken housing delivery without bargaining the durability and quality of building projects. In South Africa, there is a perception that ABT-constructed houses are majorly for the disadvantaged (Adetooto *et al.*, 2022a, b). Grady *et al.* (2019) and Dosumu and Aigbavboa (2019) found that South Africans preferred to live in a shelter built of conventional materials. Bonisile *et al.* (2019) and the South African Housing and Infrastructure Fund (2020) opined that ABT are non-traditional building practices using economic and environmentally friendly materials to construct LCH. The approach enhances affordable, sustainable and quicker construction approaches. Despite ABT advantages to solving the housing demand–supply gap, especially in developing countries, there are challenges in applying them.

Adetooto *et al.* (2022a, b) conducted studies regarding ABT as a sustainable housing solution but not focussing on LCH provision to achieve SDG 11 and Nigeria's context. In Nigeria, citizens are not exempted regarding the perceived houses built through ABT. It was

found that building materials cost and components constitute about 60–70% of the building cost (Gbadebo, 2014). It implies that high building materials cost is a threat Sustainable Development Goal 11, one of the 17 SDGs. To curb this threat, the Nigerian Building and Road Research Institute (NBRRRI) has been working on local building materials with improved technologies for wider quality and acceptance (Gbadebo, 2014; Matawal *et al.*, 2018). Some of the outcomes from the research institute include filler slab roofs, containment reinforcement for earthquake-resistant masonry structures, compressed stabilised earth blocks, and lime–pozzolana cement, but they had some challenges. Tunji-Olayeni *et al.* (2020) addressed the issue of ABT from Nigeria’s sustainable construction. Gbadebo (2014) and Matawal *et al.* (2018) identified user prejudices, inappropriate technology use, legal problem, capital and adverse policy environment as perceived challenges facing ABT usage in the industry. The identified issues were general and not specified in LCH provision. Their studies did not cover how to mitigate them to improve achieving SDGs related to housing, especially Goal 11 (sustainable cities and communities). Goal 11 is making human settlements and urban locations inclusive, resilient, safe, and sustainable on or before 2030. This is one of the gaps this study will fill. Despite the benefits of ABT adoption in housing provision in many developing countries, such as South Africa and Malaysia, evidence of motivations for its wider adoption to cope with Nigeria’s LCH demand–supply gap and improve achieving Goal 11 is not available. Also, studies concerning critical encumbrances to ABT adoption in LCH provision in developing countries context are scarce. Therefore, this study aims to investigate the critical encumbrances to ABT adoption in Nigeria’s LCH provision and suggest feasible measures to prevent or mitigate the encumbrances, thereby improving achieving SDG 11. The study’s aim will be achieved through the following objectives:

To investigate critical encumbrances to ABT adoption in LCH provision.

To suggest feasible measures to prevent or mitigate encumbrances to ABT adoption in LCH provision, thereby improving achieving SDG 11 (sustainable cities and communities).

Given the above-stated objectives, besides the study’s findings and contribution to filling the research gap regarding ABT adoption encumbrances in Nigeria’s LCH, it would provide a valuable reference for assisting policymakers and experts in taking feasible measures to prevent or mitigate the ABT adoption encumbrances and therefore improve achieving Goal 11. Also, this research would be valuable, and recommendations might be helpful for global agencies and NGOs interested in promoting ABT adoption in LCH provision in Nigeria to improve achieving Goal 11 eventually. This study presentation is organised into seven sections: Section 2 offers a comprehensive description of the adopted research methodology. Section 3 presents the analysed interview findings and discussion. Section 4 presents the study’s implications. Section 5 discusses the study’s limitations and areas for future studies. Section 6 concludes the study with recommendations.

### *1.1 The role of LCH provision in achieving Goal 11 through ABT usage*

Construction practitioners are concerned about choosing building materials for construction work. The interest in ABT to construct LCH, especially in developing countries, is gaining more attention because of the increasing building materials costs associated with conventional approaches. Also, the approach consumes more energy (U.S. Energy Information Administration, 2014). Marut *et al.* (2020) opined that construction materials constitute about 60–70% of the building cost and compounded by double-digit inflation. The outcome motivates exploring other approaches, such as the ABT, to mitigate construction costs. The term ABT is a generic name with no universal definition, but different terms have been used to describe the context. This includes environmentally responsible building materials, eco-friendly building materials, alternative materials, sustainable building materials, green building materials, vernacular

building materials, unconventional building materials, indigenous building materials, local building materials and alternative residential construction materials (Marut *et al.*, 2020). Constructor's work, as cited in Marut *et al.* (2020), defined ABT as materials that can replace traditional building materials. These materials can minimise environmental pollution because they are made from end products. This includes polyester fiber aluminium, ferro-cement, bitumen materials, soil conditioning agents, glass fiber reinforced plastics, tempered glass, crumb rubber, fiber reinforced polymer, reinforced plastics and bamboo. Chanlers (2018) defined ABT as products that have been developed with environmental problems in mind, assisting in mitigating the large amount of carbon dioxide produced by the industry. However, Marut *et al.* (2020) defined ABT as the materials that constitute an alternative to the traditional building materials in total or partial replacement of the traditional materials or their constituents to mitigate construction costs, tackle environmental problems or deal with inadequate traditional materials.

Despite the benefits of ABT, such as eco-friendly, durable, less expensive and strong alternatives to conventional construction materials, and yielded compressed stabilised earth blocks, containment reinforcement for earthquake-resistant masonry structures, local bamboo, oil palm fiber and lime-pozzolana cement, many developing countries face implementation challenges. Previous studies (Zhang *et al.*, 2011; Chan *et al.*, 2018) reported that several encumbrances hindered ABT adoption in the building sector. This study summarised the reviewed potential encumbrances to ABT adoption, as presented in Table 1. The factors were documented and received attention in previous related studies, such as the higher cost of ABT, inadequate information and inadequate awareness. These are frequently identified as pertinent encumbrances to ABT adoption. In Ghana, the demand for ABT adoption materials for housing provision is low (Addy *et al.*, 2021). Despite the growing international interest in ABT, Umar *et al.* (2021) and Eze *et al.* (2021) found that ABT adoption in many developing countries, including Nigeria, are largely unsaturated.

Shelter provision is one basic need of humans after food. Housing significantly impacts economic growth (Arku, 2006; Kulshreshtha *et al.*, 2020). Access to affordable housing could mitigate poverty and social exclusion. Whether bought or rented, the cost of housing provision

Encumbrance factors	References
User prejudices	UNCHS (Habitat) (1992), Marut <i>et al.</i> (2020), Luthra <i>et al.</i> (2015)
Use of inappropriate technology	Marut <i>et al.</i> (2020)
Scarcity of ABT materials	Gou <i>et al.</i> (2013)
Legal issues	Marut <i>et al.</i> (2020)
Funding or higher costs of ABT	Marut <i>et al.</i> (2020), Darko <i>et al.</i> (2017), Chan <i>et al.</i> (2018), Eze <i>et al.</i> (2023)
Adverse policy environments or local research institutes	Hwang and Tan (2012), Marut <i>et al.</i> (2020), Amuda-Yusuf <i>et al.</i> (2020)
Lack of ABT databases	Akadiri (2015), Chan <i>et al.</i> (2018)
Lack of expertise in ABT	Chan <i>et al.</i> (2016, 2018), Amuda-Yusuf <i>et al.</i> (2020), Eze <i>et al.</i> (2023)
Lack of awareness of ABT	Chan <i>et al.</i> (2016), Darko <i>et al.</i> (2017c)
Lack of incentives and promotion by the government	Djokoto <i>et al.</i> (2014), Darko and Chan (2016), Shen <i>et al.</i> (2017), Amuda-Yusuf <i>et al.</i> (2020), Eze <i>et al.</i> (2023)
Lack of ABT codes and regulations	Chan <i>et al.</i> (2018), Amuda-Yusuf <i>et al.</i> (2020)
Lack of interest from clients and market demand	Darko and Chan (2016)
Resistance to change from the conventional technologies	Darko and Chan (2016), Shen <i>et al.</i> (2017), Amuda-Yusuf <i>et al.</i> (2020)
ABT adoption is time-consuming and causes project delay	Hwang and Tan (2012)
Risks and uncertainties involved in adopting new technologies	Chan <i>et al.</i> (2016, 2018)

**Table 1.**  
List of potential ABT adoption encumbrances identified from the literature

critically impacts households' living standards, especially for the LIEs and disadvantaged. This is a global issue. The urban LIEs are overburdened by housing costs, and other critical items such as education and health care suffer the consequences. Providing adequate shelter is becoming challenging for many developing countries, including Nigeria. [Onyegiri and Ugochukwu \(2016\)](#) found housing challenges in Nigeria. This is because of the lax implementation of some laudable housing policies. There is high demand for housing in developing countries, especially in cities for the low-income group and disadvantaged ([Kulshreshtha et al., 2020](#)). International organisations, such as the World Bank, estimated 300 million new housing units are required by 2030 to accommodate three billion people ([Grandolini and Ijjasz-vasquez, 2016](#)). It has increased the pressure on governments to provide housing, especially for the urban LIEs. Therefore, 80% of gross domestic product relies on 54% of the global population that lives in the cities ([World Bank, n.d](#)). Several attempts have been made to address the urban housing issue. Organisations and media have given the urban housing projects via slum upgrading significant attention. Still, the issue persists because critical issues such as the high cost of materials have not been tackled. [Kulshreshtha et al. \(2020\)](#) found that compressed earthen technique (CET) could promote earthen construction's image and acceptance for housing in developing countries. The CET is a modern earthen technology to improve the "poverty" image of earthen construction and make the LCH affordable for the LIEs.

In India, [Cherian et al. \(2020\)](#) found that glass fibre reinforced gypsum (GFRG) technology from waste gypsum consumes an abridged quantity of reinforced concrete compared to traditional construction. They discovered that besides construction cost savings (sand, granite, cement and steel rebar), the technology saves time, manpower required and reduction in structural weight. This is a good mechanism for the Government of India to explore housing provision through various schemes such as the Pradhan Manthri AwasYojana. The GFRG technology is a low-energy panel and sustainable housing material. This attracts attention in India and is used for over 1,600 units ([Cherian et al., 2020](#)). In China, to enhance ABT among construction stakeholders, the government floated a series of environmental policies and programmes to inspire green building cooperations in evolutionary game optimisation for LCH provision for her citizens ([Yang et al., 2021](#)). Besides using ABT to mitigate higher construction costs, its goal is to improve the welfare and health of building occupants. The essence is to use various materials, technologies or processes to maximise resource utilisation, achieve cleaner production and improve the urban environment ([Wang et al., 2019](#)).

Studies such as [Omer and Noguchi \(2020\)](#) asserted a link between building materials categories, construction processes and SDGs. The United Nations' 17 SDGs and the 169 targets attracted scholarly attention from multidisciplinary approaches. [Omer and Noguchi \(2020\)](#) found interactions between the SDGs and building materials. They avowed that building materials can contribute meaningfully to accomplishing Goals 3, 7, 9, 11, 12, 13 and 15. It indicates that building materials are germane to achieving several SDGs apart from Goal 11 (sustainable cities and communities) and their relevant targets. The study's focus is on Goal 11. This is one of the 17 Goals of the United Nations SDGs to proffer measures to the world's housing crucial sustainability issues ([United Nations, 2015](#)). The operation of Goal 11 and its link with several other Goals and the New Urban Agenda cannot be over-stated. Goal 11 is one of the six SDG transformation scorecards ([Sustainable Development Report, 2022](#)). It implies that SDGs could be accomplished through the six transformations. This includes clean energy and industry, health and wellbeing, digital technologies, sustainable cities and communities, land use, education and skills. Also, [Sachs et al. \(2019\)](#) declared that the six scorecards are guided to stay on top of one and to a better agenda for policymakers. Goal 11 articulates a vision "... to make cities and human settlements inclusive, safe, resilient, and sustainable ... ." ([United Nations, 2015](#)). [Vaidya and Chatterji \(2020\)](#) affirmed that Goal 11 comprises ten main targets that deal with safe, affordable housing, basic services and sustainable urbanisation. They avowed that Goal 11 targets include accessible and affordable basic infrastructure and improving urban governance. Also, Goal 11 road map

includes “ . . . access to affordable housing and basic infrastructure for all, particularly slum dwellers, and access to safe, affordable, accessible, and sustainable transport systems for all . . . ” (p. 182). It is a template to guide urban policymakers.

**2. Research method**

This study adopted a qualitative method that utilised face-to-face interviews as the primary data collection. [Nadal et al. \(2018\)](#) asserted that a qualitative approach is a better method in tackling the social insight in housing-related study. Regarding the qualitative data collection method, the study adopted a face-to-face approach. [Ebekozien et al. \(2021\)](#) affirmed that a face-to-face approach could enhance participants’ perceptions towards gaining an in-depth thought of the issue. In this instance, the research explores the participants’ perception of the critical encumbrances of ABT adoption in LCH provision. It suggests suitable measures to mitigate them and thereby improve achieving SDG 11. This is in line with [Adetooto et al. \(2022a, b\)](#). They employed a qualitative method through focus group meetings to explore the use of ABT in improving affordable housing from South Africa’s perspective. Given this priority to ensure the participants have an in-depth ABT understanding, the study included ABT experts and end-users in Lagos, Nigeria, who were selected via a convenient sampling method, as presented in [Table 2](#). Also, some of the participants suggested contacts of their colleagues knowledgeable in ABT and willing to participate in the study. It is a non-probability sampling method where units/participants are chosen for inclusion in the study’s sample because they are the easiest for the investigators to access ([Creswell and Creswell, 2018](#)). One of the best approaches is engaging participants willing to participate in the study.

[Table 2](#) illustrates the summarised participants’ background information and evidence that most participants have a common interest in sustainable LCH provision. For privacy, the names of the organisations, interviewees and posts were hidden. The 22 interviews were conducted between July 2022 and November 2022. The interviews took place in their construction sites

Code	Position	Years of experience (years)	Involvement in ABT
P1	Engineer	25	ABT expert
P2		23	
P3		27	
P4		20	
P5		14	
P6	Architect	16	
P7		23	
P8		22	
P9		11	
P10		19	
P11	Consultant to ABT manufacturer and a leading researcher on alternative housing in developing countries	22	Consultant and a researcher on ABT in developing countries
P12		15	
P13		18	
P14	Housing developer	25	Housing developer that has used ABT to provide houses
P15		33	
P16		36	
P17	Above senior staff in the government’s housing ministry/department/agency	12	Involve in ABT programmes
P18		14	
P19		22	
P20	End-user	6	The occupant of ABT house in Nigeria
P21		7	
P22		9	

**Table 2.** Participants’ background information



and offices. Lagos State was selected as the ideal state for the face-to-face participants' interviews. Though not the Federal Capital Territory, a wider spectrum of experts' office and construction projects from Nigeria's building industry was present in person to participate. The study engaged 22 participants and achieved saturation at the 19th participant. The research saturation was accomplished when there was no evidence of a "new construct or further theoretical perceptions" from the in-depth interviews. The investigators employed their contextual perceptions in analysing and interpreting the data (Thorne, 2020; Ebekozi, 2021). The face-to-face interviews proffered answers to two main questions that sought the opinions of professionals and end users. The general questions were as follows:

- Q1. What are the critical encumbrances to ABT adoption in LCH provision in Nigeria?
- Q2. How can the encumbrances to ABT adoption in LCH provision be prevented or mitigated, thereby improving achieving SDG 11 in Nigeria?

The interview lasted 40 min on average per session and was taped with the participants' permission. But Participants P17, P18 and P19 refused us to record via tape, and we took notes during the interview sessions. The notes, recorded tape and other output forms generated were collected, transcribed and analysed manually via open coding. Draucker *et al.* (2007) asserted that open coding involves a verbatim evaluation of data in which the qualitative method was selected as the unit of meaning. The study employed thematic analysis to develop the study's codes (Ibrahim *et al.*, 2022). The researchers read the 22 transcripts multiple times to capture the interviewees' thoughts concerning the phenomenon. This aligns with Ebekozi and Aigbavboa (2021). They employed the same approach to generate the initial coding scheme for their studies. The study's different codes derived were utilised to highlight the key point (Jaafar *et al.*, 2021). These were clustered into 15 sub-themes and further into two main themes. To mitigate the lack of rigour and prejudice perceived associated with qualitative research, the study validity and reliability were confirmed by utilising a consistent interviewer (lead researcher) and a recognised method (semi-structured open interview questions), therefore validating the themes of this research (Fleming and Vanclay, 2009). Also, verbatim quotes from the participants were reported to give assurance of the data's validity and reliability (Rosenthal, 2016). Also, the researchers utilised member checking, researcher reflexivity and triangulation as the validity methods for the collected data (Creswell and Creswell, 2018).

### 3. Findings and discussion

The section presents the study's main findings and discussion.

#### 3.1 Theme 1: encumbrances to ABT adoption in LCH provision

Theme 1 offers a concise x-ray of Nigeria's ABT adoption encumbrances and affirms that if not curbed, achieving affordable and accessible LCH provision might become a mirage. This may become a threat to achieving Goal 11. This is because affordable and accessible Nigeria's LCH provision is germane to achieving Goal 11. Besides cost reduction in the use of ABT materials, it minimises the influence of construction tasks on the environment, global warming and climate change, and the inequity in the ecosystem (P2, P11, P17, P18 and P20). Findings show that the perceived aftermath of Nigeria's Government's attitude to ABT adoption in LCH provision threatens to achieve Goal 11. One pertinent point which emerges is the categorisation of encumbrances to ABT adoption in LCH provision into four main groups, as summarised in Table 3 and the first column of Table 4, respectively. They are government/policymaker, housing developers/building contractors, ABT users and ABT manufacturers-related issues in Nigeria. Results reveal that the perceived major encumbrances emerged from the government/policymaker and housing developers/building contractors. This indicates that the housing developers/building contractors and the government role in ABT adoption

Categorisation	Housing developers/ Building contractors- related issue	ABT users-related issue	ABT manufacturers- related issue
Government/ Policymaker-related issue			
Lax local research institutes	Lack of experience with ABT methodologies or Use of inappropriate technology	User preconceptions	Scarcity of ABT materials/suppliers' availability
Adverse policy	Scarcity of ABT materials/ suppliers' availability	Lack of experience with ABT methodologies or Use of inappropriate technology	Adverse policy
Lack of ABT databases	High costs of ABT materials	High costs of ABT materials	Inadequate training on local ABT materials
Lack of ABT awareness/information hindrance	Lack of expertise and skilled labour in ABT	Lack of ABT awareness/ information hindrance	Poor education on ABT methodologies in LCH provision
Lack of incentives and promotion by the government	Lack of ABT awareness/ information hindrance	Lack of interest from clients and other stakeholders	
Lack of ABT codes and regulations	Lack of interest from clients and other stakeholders	Resistance to change from the conventional technologies	
Poor education on ABT methodologies in LCH provision	Resistance to change from the conventional technologies	Risks and uncertainties involved in adopting new technologies	
Lack of interest from clients and other stakeholders	ABT adoption is time- consuming and causes project delay	Poor education on ABT methodologies in LCH provision	
Risks and uncertainties involved in adopting new technologies	Risks and uncertainties involved in adopting new technologies		
Inadequate research and development funding	Inadequate examples of ABT-adopted housing projects		
Lack of example demonstration housing projects	Inadequate training on local ABT materials		
Inadequate training on local ABT materials	Poor education on ABT methodologies in LCH provision		

**Table 3.**  
Emerging major  
encumbrances to ABT  
adoption in LCH  
provision

for LCH provision are critical. The findings slightly differ between [Amuda-Yusuf et al. \(2020\)](#) and [Eze et al. \(2023\)](#). Besides not addressing their research from the perspective of LCH provision to improve achieving Goal 11, the identified barriers were not clustered into groups. [Amuda-Yusuf et al. \(2020\)](#) identified the absence of institutions to formulate policies and programmes and set guidelines, inadequate information about ABT products and high-performance building systems, and low awareness regarding sustainability problems as the top barriers to ABT adoption. [Eze et al. \(2023\)](#) found sustainable materials and labour, government incentive and suppliers' availability, cost and market hindrances, regulation and funding of R&D, and resistance and information barriers as the key variables of barriers to sustainable materials adoption in projects.

In [Table 3](#), the majority, with the exemption of P18 and P19, agree that successive governments have not shown enough commitment to promoting ABT in LCH provision in



Theme one: Encumbrance factors	Theme two: Measures to mitigate ABT adoption encumbrances
User preconceptions	Revamp NBRRI and sensitisation to stakeholders, including end-users and professional bodies in the built environment (majority)
Lack of experience with ABT methodologies or Use of inappropriate technology	Revamp NBRRI and upskilling and reskilling (P4, P13, and P17)
Scarcity of ABT materials/suppliers' availability	Encourage investors to invest in ABT housing materials (majority)
Lax local research institution	Revamp NBRRI, and government should create an enabling environment for manufacturers to excel (P1, P3, P8, and P12)
High costs of ABT materials	Create the enabling environment for manufacturing firms to access "soft loans" for ABT projects (majority)
Adverse policy	Revamp NBRRI, and the agency should work with other relevant government agencies/ministries/departments to enhance ABT adoption in LCH provision (P5, P7, and P11)
Lack of ABT databases	Harmonise relevant agencies for a common goal to improve ABT adoption for LCH provision and digitalise for record purposes
Lack of expertise and skilled labour in ABT	Revamp NBRRI and upskilling and reskilling of housing developers' staffers
Lack of ABT awareness/information hindrance	Revamp NBRRI and sensitisation to various professional bodies in the built environment (majority)
Inadequate incentives and promotion by the government	Governments should lead through policies and ABT adoption for LCH provision (P1, P3, and P14)
Lack of ABT codes and regulations	Revamp NBRRI to work with relevant authorities (majority)
Absence of interest from clients and other stakeholders	Reduction in the reluctance to new building materials approaches (P3, P9, and P11)
Resistance to change from the conventional technologies	Increased awareness of ABT benefits (majority)
ABT adoption is time-consuming and causes project delay	Increased awareness of ABT benefits (majority)
Risks and uncertainties involved in adopting new technologies	Increased awareness of ABT benefits (majority)
Market hindrance	Revamp awareness through government dissemination agencies and commercialisation of ABT adopted housing materials (P5, P12, P17, P19, and P22)
Inadequate research and development funding	Revamp NBRRI and increase funding for commercialisation (P17)
Inadequate examples of ABT-adopted housing projects	Revamp NBRRI (majority)
Inadequate training on local ABT materials	Revamp NBRRI (majority)
Poor education on ABT methodologies in LCH provision	Revamp NBRRI, and governments should show more commitment to LCH provision through ABT adoption (P2, P6 and P10)

**Table 4.**  
Emerged measures to mitigate encumbrances to ABT adoption in LCH provision

Nigeria. P20 says, "... I doubt our leaders are concerned about ABT adoption in LCH provision since they can afford conventional building materials, irrespective of the cost. It would have been a thing of attention if refusal to act put their lives in danger like the COVID-19 era ...". This claim was rebuffed by Participant P17, who affirmed a few pilot ABT projects are ongoing in Lagos, Nigeria but agreed that more work is needed to achieve the desired goal. Findings validate Ekpo (2020), who reported that the Lagos State Governor (Mr Babajide Sanwo-Olu) plans to invest more funds in LCH to mitigate the housing deficit in the state through collaboration with stakeholders and professionals in the building industry to arrive at a lower cost of building materials (ABT).

Findings identified “government/policymaker-related issues as encumbrances associated with ABT adoption.” It includes lax local research institutes, adverse policy, lack of ABT databases, lack of ABT awareness/information hindrance, inadequate incentives and promotion by government, lack of ABT codes and regulations, poor education on ABT methodologies in LCH provision, and absence of interest from clients and other stakeholders. Others are risks and uncertainties involved in adopting new technologies, inadequate research and development funding, lack of example demonstration housing projects, and inadequate training on local ABT materials. This study agrees that the successive Nigerian Governments (federal, state and local governments) have not done enough to promote ABT adoption in the housing sector. Participant P6 says, “. . . I doubt our building research institute is serious about novel output to reduce construction costs and engage stakeholders. When last did you hear that the Nigerian Building and Road Research Institute (NBRRI) came up with a novel material(s) that can bring down building project cost, be sustainable, and be acceptable by the end-users? . . .” Participant P18 rebuffed the claim by Participant P6 and emphasised that the research institute made some novel attempts in the past. However, inadequate incentives and promotion by the government, absence of interest from clients and other stakeholders, and funding of research institutions hindered the full manifestation. A quick check on the net reveals that in 2011, NBRRI launched cement stabilised bricks technology as an ABT (NBRRI, 2021). This is to reduce building costs but was never developed and promoted by the government to attract investors, housing developers and end-users.

Concerning “housing developers/building contractors-related issues,” findings identify a lack of experience with ABT methodologies or use of inappropriate technology, scarcity of ABT materials/suppliers’ availability, high costs of ABT materials, lack of expertise and skilled labour in ABT, lack of ABT awareness/information hindrance, absence of interest from clients and other stakeholders, and resistance to change from the conventional technologies. Others are ABT adoption is time-consuming and causes project delays, risks and uncertainties involved in adopting new technologies, inadequate examples of ABT-adopted housing projects, inadequate training on local ABT materials and poor education on ABT methodologies in LCH provision. This study’s findings agree that the housing developers and building contractors have yet to help regarding ABT adoption in Nigeria’s LCH provision. Participant P7 says, “. . . until stakeholders, especially housing developers, start to view housing provision for the urban poor as a welfare and social responsibility as against government responsibility, ABT adoption might not get the expected outcome . . .” Findings support Marsh *et al.* (2020), Umar *et al.* (2021), and Eze *et al.* (2023). They found that stakeholders in the building industry, especially housing developers/contractors, resist innovative mechanisms involving new materials and techniques. Poor information management in building materials innovation and low awareness of benefits are major drawbacks to ABT adoption (Eze *et al.*, 2023). Also, the high capital cost is inevitable at the initial stage of ABT development. This is a challenge to many developing countries, and more needs to be done to change the narrative. Participant P13 says, “. . . besides the high cost required for the initial investment, there is poor demand from clients or end-users. This is a setback for investors . . .” Findings support Abraham and Gundimeda (2018). They found the high cost of capital as top of the barrier to ABT. For the details of the other two clustered (ABT users-related and ABT manufacturers-related issues), refer to Table 3.

### 3.2 Theme 2: measures to mitigate and improve achieving SDG 11

This theme offers the participants a platform to suggest measures to mitigate encumbrances to ABT adoption in LCH provision, thereby improving achieving SDG 11 (sustainable cities and communities), as summarised in Table 4. The study findings agree that ABT adoption is the way to go in the digitalisation era. Participants P1, P3, P8, P14, P16 and P18 affirm that Nigeria’s housing construction projects should look beyond the conventional block model or

brick-and-mortar and embrace alternative building systems. Participant P14 says, “. . . . . apart from the evidence that ABT assists in mitigating high housing construction cost, it is self-sustaining and environmental-friendly. This will enhance good value to home buyers and end-users . . . .” Findings agree that proffering practical measures to mitigate barriers to ABT adoption in LCH provision implies enhancing achieving SDG 11 (sustainable cities and communities) (majority). Besides this study’s qualitative approach to unravelling the encumbrances and proffer measures emerging from key stakeholders in the field, this is one gap that preceding studies, including [Amuda-Yusuf et al. \(2020\)](#) and [Eze et al. \(2023\)](#), which attempted to address the barriers to ABT adoption left unfilled.

Successive governments’ absence to finding lasting economical, viable and sustainable solutions in LCH provision for the low-income group via ABT adoption has not helped matter (majority). This has threatened to achieve Goal 11 in less than a decade. Participant P11 says, “. . . the government agency (Nigerian Building and Road Research Institute [NBRRI]) mandated with the responsibility to conduct integrated applied research and development into various building and engineering materials to determine the most sustainable and economic mechanisms of their utilisation should be revamped, and experts engaged for better productive outputs . . . .” Participants P1, P4, P10, P13 and P22 acknowledge that NBRRI should be involved in conducting applied research on local building materials, but the results do not prove it. NBRRI was conceived in April 1978. The birth under the Federal Government of Nigeria was conceived under the National Science and Technology Development Agency Bill 1977, now an Act, and Research Institute Establishment Order 1977 (P18).

The agency (NBRRI) is one of the 17 parastatals under the Federal Ministry of Science, Technology and Innovation. A quick check on NBRRI’s website shows that the agency has produced several materials to mitigate building materials cost. This includes NERRI compressed stabilised earth blocks, roof tiles, NBRRI blended cement, NBRRI laminated bamboo for floor and ceiling, and NBRRI brick blocks ([NBRRI, 2021](#)). Participant P9 says, “. . . there is a gap between the industry and the government research institute. I’m aware of some building materials’ innovations from NBRRI that can reduce cost and be environmental-friendly, but there is lax public awareness and commercialisation to attract investors. For example, do you know that housing developers can make savings from the NBRRI brick block than from the conventional method but no awareness and commercialisation . . . . .” Findings support [NBRRI \(2021\)](#). They affirmed that about 40% savings could be made using NBRRI brick block than the conventional approach. Thus, findings suggest revamping policies and programmes to promote products commercialisation (majority), adequate and feasible building regulations to promote ABT materials in LCH provision (majority), access to “soft loans”, encouraging investors to invest in ABT housing materials, public awareness regarding the benefits of new products (majority), integrated training of field workers regarding the application (human resources and capacity building) and engaging stakeholders (majority), including investors and housing developers to mitigate ABT adoption barriers in LCH provision, and by extension, promoting achieving Goal 11. Refer to [Table 4](#) for details. Results align with [Eze et al. \(2023\)](#) and recommended that stakeholders, including housing developers and end-users should accept innovative changes, new mechanisms and building materials in the delivery of building projects. Therefore, reducing the reluctance to new mechanisms and increasing awareness and information concerning the advantages of ABT will assist in overcoming the resistance.

#### 4. Implication and benefit of this study

The study’s implications to the built environment practitioners and policymakers’ sector would be to further the discussions on promoting ABT adoption for LCH provision in Nigeria, especially as it concerns achieving SDG 11, and proffering feasible measures and

mechanisms to mitigating ABT adoption encumbrances. Understanding the ABT adoption encumbrances would lead to better decisions from the stakeholders, especially the industry partners. Besides the outcome of promoting ABT adoption uptake, it would increase the chances of investors in the sector and promote the market (local eco-friendly materials) beyond Nigeria. Because of the eco-friendly nature of ABT materials, end-users benefit from the toxic-free and enhanced productivity and performance for the field workers. Stakeholders, especially the housing developers and end-users, would find this research germane in improving their overall labour performance, productivity and healthy well-being. The emerged encumbrances and possible mitigation measures would enhance future ABT adoption.

The study's findings are imperative for developing LCH policies to uptake ABT in Nigeria's LCH provision. Therefore, this research is envisioned to stir pertinent stakeholders regarding enhancing LCH provision for urban low-income groups via ABT adoption in Nigeria, and by extension, in other developing countries. This study's emerged measures are informative to a better understanding to the stakeholders, especially governments/policymakers and housing developers, to promote ABT adoption in LCH provision to mitigate construction cost and make the houses affordable to the right targets. If well embraced via all-inclusive and integrated approaches, the outcome will improve sustainable cities and communities and reduce dangerous gaseous emissions from building sites. This approach is indirectly curbing the impact of the building sector's contribution to climate change acceleration.

### **5. The study's limitation and area for future studies**

Despite the study's implications, the study area, sample size, sampling technique and analysis adopted limited the findings' generalisation. The study's in-depth reviewed literature and achieved data collection saturation has enhanced the robustness of the findings. Therefore, this study suggests a larger sample size and coverage unravel more encumbrances and feasible measures via a mixed methods approach. The future study outcome will validate this study.

### **6. Conclusion and recommendations**

This study investigated the major encumbrances to ABT adoption in LCH provision and suggested measures to mitigate them, thereby improving achieving SDG 11 in Nigeria. The study adopted semi-structured questions through face-to-face interviews to accomplish the study's aim. Data were collated from ABT experts and end-users using the convenient sampling technique. The collected data were analysed manually through a thematic approach. Based on the study's findings, 20 issues emerged as the encumbrances to ABT adoption in LCH provision and clustered into four groups. This includes 20 encumbrances to ABT adoption in LCH provision into government/policymaker, housing developers/building contractors, ABT users and ABT manufacturers-related issues in Nigeria. Also, the study suggested mechanisms to mitigate encumbrances to ABT adoption in LCH provision, thereby improving achieving SDG 11. This is part of the study's contribution to knowledge. Apart from affordable and accessible LCH provision through ABT adoption to achieve Goal 11, it would enhance sustainable urban housing for low-income groups and households. This mechanism will promote shared prosperity in urban locations and enhance urban sustainability. The study's outcome will enhance sustainable and affordable urban LCH provision and urbanisation tailored toward achieving SDGs associated with housing provision before 2030, especially Goal 11. As emphasised in the two main themes, ABT adoption should be all-inclusive. The government's political will to lead must be demonstrated through policies and construction activities using ABT materials.

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In line with this study's results and conclusion, the following are recommended:

- (1) If the proportion of ABT adoption for sustainable LCH provision is to increase in Nigeria's cities, key stakeholders, especially government and housing developers/contractors, should be in the vanguard of supporting the sustainability mission in regulations, sensitisation, commercialisation and enabling environment for investors and manufacturers via incentives such as "soft loans" to manufacturers seeking for financial support to invest in ABT housing materials. Also, housing developers should embrace cost-effective, eco-friendly, and sustainable change that mitigates dangerous gaseous emissions from building sites.
- (2) ABT adoption requires understanding the sustainability concepts regarding local building materials, competence, and skills for implementation. Thus, upskilling and reskilling of practitioners are germane for improving sustainable ABT adoption for LCH provision. Government agencies such as NBRRI and other relevant authorities should ensure regular training programme for housing developers/building contractors and other stakeholders involved in applying ABT adoption in LCH provision. This should be done at no charge to the participants as part of government incentives to encourage stakeholders to adopt ABT.
- (3) ABT adoption demands adequate funding for research and development to enhance innovative materials and technology. This is key to improving ABT adoption and integration in LCH projects. For sustainable funding, there should be an institutional framework and a workable regulation to drive the system. Thus, policymakers should develop an institutional framework to guide research and development concerning ABT adoption for LCH provision.
- (4) Information management and knowledge about ABT building materials adoption among the stakeholders, especially housing developers and the end-users, will assist in increased participation and sustainable LCH provision for low-income groups. Educational sensitisation about adopting ABT building materials should be encouraged because it will mitigate users' preconceptions and increase the embracing of ABT adoption.

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