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THE DEVELOPMENT OF MASSIVE AFFORDABLE HOUSING UNITS UTILIZING INDIGENOUS MATERIALS IN ENUGU STATE, NIGERIA.

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Abstract

A wide range of construction materials are accessible locally. Lower building expenses can also be achieved through decreased material prices, which make up a significant portion of construction expenditures. The building business and those wishing to purchase a home are both seriously endangered by the growing cost of building supplies. Using local resources is a crucial strategy for reducing the cost of construction supplies for affordable housing. This study looks into how local materials' dynamic costs are taken into account when building mass housing in Nigeria. The goals are to determine which indigenous building materials are used in Nigerian home construction as well as the variables that influence those selections. Only eight of the studies identified 11 indigenous resources in Nigeria are "often used". A review of the literature reveals that local dirt or earth is frequently utilized as flooring in residential buildings. Durability and manufacturing costs account for the majority (57%) of the 14 criteria's use of local resources, whereas air quality qualities had the least impact. The results also revealed that two of the eight benefits of utilizing local materials are lower building costs and the availability of inexpensive homes, as reported by 65% of respondents. The government should create a strategy to optimize and balance the usage of regional resources, according to the report's recommendations.

Keywords: Indigenous Materials, Housing Construction, Cost, and local resources.

1.0 Introduction

The building of homes is one of the main industries fostering the economic growth of any country. Housing is one of man's basic needs as well because of his desire for security, solitude, and protection from the elements (Ugochukwu & Chioma, 2015). Every Nigerian knows that having a home improves one's social standing (Nubi, 2018). Nonetheless, one of the problems with the lack of housing is the types and prices of the materials used in its construction (Chenari, Carrilho, & da Silva, 2016).

According to Oshike (2015), building materials are all the material objects that are combined to make the outside and inside of a structure. Since the industry's participants largely employed conventional materials and gave little to no consideration to natural or local resources when carrying out their activities, the cost of building construction has lately grown (Adedeji, 2020).

Ezemeribe, et. al (2022) asserts that native materials are accessible throughout the nation. In the past, buildings were constructed using local resources that had low energy requirements and negative environmental effects. However, modern structures employ materials like concrete, PVC, glass, cement, aluminum, and other things that have higher energy requirements and negative environmental effects (Bribián, Usón, & Scarpellini, 2019). In many cities in developing nations, particularly in Nigeria, building materials are frequently the single largest input used in the construction of houses (Ugochukwu & Chioma, 2015). In a typical low-income housing unit, the cost of building materials alone can account for up to 70% of the construction cost component, according to Windapo and Iyagba (2017). As a result, it continues to be a key factor in the high price of building construction (Taiwo and Adeboye, 2013). Local building materials (LBMs) are those that are manufactured using locally sourced raw materials or those that are sourced locally and exist naturally (Omole & Bako, 2013). These resources are accessible and cost less and are more readily available as compared to imported ones (Oloruntoba & Ayodele, 2013). Nigeria in particular and Africa as a whole are endowed with an abundance of natural resources that can support their manufacture of building materials.

To meet their construction demands, they continue to rely heavily on imported building materials (Ugochukwu & Chioma, 2015). For instance, the study by Iwuagwu, Onyegiri, and Iwuagwu (2016) demonstrated that fibrous trees are primarily found in the Savannah region (Middle Belt) of Nigeria and are utilized to generate good structural components for the construction of roofs, walls, lintels, ceilings, and bridges.

Additionally, Nigerian traditional architecture uses grasses, which are plentiful in the Middle Belt and Northern region of the country, for construction (Oruwari, Margret, & Opuene, 2021). According to Taiwo and Adeboye (2013), Nigeria has been massively importing building materials while gradually using less domestically produced building materials, considerably expanding the gap between imports and exports. The majority of the regional construction material businesses import their equipment, replacement parts, and occasionally even the technical employees needed to maintain the machinery. Due to costs incurred, the finished items are now prohibitively expensive, making this challenging and unprofitable (Windapo & Iyagba, 2017). The majority of enterprises, particularly cement plants, are running much below their installed capacities. In addition to other issues including the scarcity of cement bags, gypsum, and recurrent power outages, this is due to the difficulty in obtaining replacement components to fix malfunctioning kilns and manufacturing engines (Diogu, 2022).

The import content of building raw materials is a barrier to the growth of the local building materials sector. This is true despite the fact that the deposits of current indigenous raw resources are mostly untapped and are not being utilised to their full potential (Taiwo & Adeboye, 2013). The term "local materials" refers to any building materials that are manufactured locally using primarily local raw

resources and equipment (Hamid, 2021). Cement, for example, is a local material if the raw materials required to make it—limestone, clay, and gypsum—and the production method can both be found nearby (Oruwari, 2015). Extensive applied research and development, most notably by the Nigerian Building and Road Research Institute (NBRRRI), has resulted in improved substitutes for indigenous or local materials. These consist of reinforced roofing sheets, coir fiber cement, clay roofing tiles, stabilized earth blocks, and tiles made of clay.

Nigeria, one of the world's poorest countries, often has a significant portion of its population living in slums and poor-condition houses due to a lack of available land for construction and rising living costs. Building materials are essential in all phases of construction, from excavation to completion. Access to clean housing remains a dream for many Nigerians, with over 70% earning less than \$1 per day. Governments face challenges in providing effective service delivery due to stagnating economic development and high population expansion. Reducing material waste is crucial for low-efficiency home construction, and using locally available building supplies has a lower environmental impact than materials like bricks, concrete, and iron. These locally available building supplies are inexpensive, have a high level of durability, and have a minimal environmental impact.

The use of natural materials, renewable materials, and eco-friendly building materials are all made possible by using locally available materials, making them one of the greatest ways to finance housing (Windapo & Iyagba, 2017). To cut costs and achieve inexpensive, sustainable, and green building, locally accessible materials can be used, resource allocation should be minimized, and new solutions can be used (UN-Habitat 2011). As a result, it is widely believed that one major factor contributing to Nigeria's high construction costs is the high cost of the materials used in construction, many of which are imported. This is true because a variety of factors, including foreign exchange, freight, inflation, import levies, and more, have an impact on the prices of imported materials (Taiwo & Adeboye, 2013). Similarly, Oruwari, Jev, and Owei (2022) also agree that it is now hard for individuals to purchase affordable homes in Nigeria due to the rising cost of construction due to materials. Therefore, it may be concluded that Nigeria does not make good use of local building materials. This is a result of the high caliber and quantity of the materials, as well as their social standing, acceptance, and lack of government regulations, among other things. Given the consequences of this carelessness, Ademiluyi (2020)

The use of local building materials, intermediate technology, and the provision of other essential infrastructures like safe drinking water, roads, electricity supply, and other social amenities were also suggested by Ajanlekoko (2021) in the same vein, specifically to improve the quality, livability, aesthetics, and affordability of housing in Nigeria. Numerous studies have been conducted in relation to the plentiful availability of local building materials (LBMs) and their underutilization in Nigeria, but none of them has specifically targeted towns or cities in Nigeria to examine the availability, level of usage, and issues related to the adoption in particular towns. By examining the dynamic cost consideration of local materials for mass home building in Enugu State, Nigeria, this study attempts to close the gap.

1.1 Statement of Problem

The rising costs of building materials in Nigeria have significantly impacted the housing market and construction sector, leading to delayed completions and a lack of access to affordable housing. The country's inadequate building materials sector and high reliance on imports have contributed to this issue. The government has proposed limiting the import of building materials to promote domestic production. However, the building construction industry still faces challenges such as low working capital, high inflation rates, and rising costs. These issues have led to abandoned projects, damaged ones, and fewer opportunities for affordable housing. The utilization of local building materials (LBMs) for construction in Nigeria is hindered by issues such as mass production, lack of standards, legal acceptability, social acceptability, doubtful durability, technology, cost uncertainty, government double standards, and uncertainty about material demand and strength. Housing growth in Nigeria has been hampered by the high cost of construction materials, with a decline in builders and landlords setting high rents due to the high cost of construction.

1.2 Aim and Objectives of the Research Study

The purpose of this study is to investigate how local materials' dynamic costs are taken into account when building mass housing in Enugu State, Nigeria. The project's particular goals are to:

- i. Identifies the local materials that are readily available for use in house construction there.
- ii. Identify the variables influencing the selection of regional building materials for the construction of houses in Nigeria's Enugu State.
- iii. Investigate the advantages of using local resources to build homes in Enugu State, Nigeria.

2.0 Literature Review

2.1 Local Material

Building materials that are locally sourced, either naturally occurring or produced using locally acquired basic materials, are referred to as "local material." As it has been done profitably in Tanzania and Sweden, Olayiwola et. a. (2015) propose using local building materials to lower construction costs in Nigeria. Similar to this, Daramola (2016) highlights the importance of embracing the use of local building materials to create a practical and inexpensive housing scheme in Nigeria. The high cost of building materials is one of the reasons government interventions in Nigeria's housing project have failed, according to Ademiluyi (2020) Akeju (2017) suggests reviewing the government's ban on importation of building materials and encouraging local production to reduce costs associated with building homes in Nigeria. Rising manufacturing costs are attributed to the lack of long-lasting local building supplies, leading to the use of imported materials. Windapo and Iyagba's research shows a positive correlation between building material costs, real estate prices, foreign currency rates, labor costs, per capita disposable income, and money supply. Therefore, switching to locally produced materials may lower construction costs in Nigeria and promote affordability. This suggests that a shift

to locally produced materials could help reduce construction costs and promote affordability in the country.

Local building materials are plentiful and can help with housing issues, but they are still developing and therefore socially unacceptable. To cut construction costs, Adedeji (2020) recommends using mortarless masonry materials rather than traditional blocks. African cities should be built with local building materials, advice Dimoniaku and Obiozo (2019). Other nations that have effectively adopted hydra form blocks include Uganda, Kenya, Ghana, Nigeria, Guinea, Ethiopia, Sudan, Tanzania, and Zambia. Earth materials, according to Nnadi et.al (2022), have thermal comfort, durability, and cost effectiveness.

2.2 Local Building Materials (LBMs) in Nigeria

The Nigeria Building Road Research Institute (NIBRRI) and the Raw Materials Research Institute (RMRI) are the two research institutions now responsible for obtaining all functional materials in Nigeria (Madedor, 2022). These Institutes' primary function involves disseminating knowledge about local materials through seminars, conferences, and workshops. It is a special requirement of NIBRRI to do research on all types of construction materials. At various stages of building construction, Oloruntoba and Ayodele (2013) provided insight into the potential of LBM as a substitute for imported building materials. They claim that it is possible to combine stone and laterite-containing rocks to create an enduring strip foundation. Similar to bamboo reinforced terracrete, laterite can be used to create concrete-quality slabs when reinforced with bamboo or coconut palm. wood can be utilized to create high-quality wood board flooring if it is properly treated and impregnated with liquid preservation (Akinmoladun & Oluwoye, 2017).

Similar to that, when polished and treated to create Bamboo floor and foist, they make excellent building floors. When appropriately combined with clay screening, cow dung created a sturdy and attractive floor. In order to further strengthen the flooring's ability to withstand moisture, fermented leaves and bitumen can be added. Additionally, bricks joined with laterite provide a good building wall with better conductivity than hollow concrete blocks. Additionally, a desirable building wall made of coconut palm, bamboo, and timber treated as stakes buried in the ground generates a high compressive strength wall when stone is joined with laterite mortar or lime stabilized mortar. Because of its cohesive qualities, Earth conserves cement when it is necessary to mix cement. To attain the desired strength and stop wall breaking, earth walls can also be reinforced with some additives (vegetable, stems, reeds, and straws).

Laterite reinforced with bitumen for walls can deter ants and rats, while clay and bricks are essential materials for construction due to their longevity, aesthetics, economic viability, and fire resistance. Bamboo, with its varying tensile strength, is a popular local choice for construction. Sun-dried earth block bricks are used for vaults and domes, bonding masonry units on a wooden framework. Clay and bricks are the best for creating walls, while earth stabilized with cement is a good plastering medium. Timber is a good cladding material, and stones can be used as stone faces on walls. These materials

offer various benefits, including longevity, aesthetics, economic viability, and fire resistance. Further exploration is needed in the construction industry to maximize the benefits of these materials.

2.3 Challenges in the use of Local Building Materials in Nigeria

Similar to this, Sun-dried earth block bricks have also been employed in the construction of vaults and domes; the process entails laying and bonding the masonry units on a wooden framework that will be removed once the vaults or domes have dried (Popoola et al, 2015). In comparison to other building materials, clay and bricks are the best for creating walls (Oloruntoba & Ayodele, 2013). Earth stabilized with cement makes a good plastering medium for finishes and fittings. Timber is a good cladding material, whereas stones can be utilized as stone face on walls. Ikechukwu and Iwuagwu (2016) noted additional problems influencing the adoption of LBMs in Nigeria, including the issue of public acceptance, durability and low strength, deforestation, civilization, regular maintenance, and difficulties with the use for tall buildings.

Building Materials and Housing Construction in Nigeria

There is a correlation between an architect's attitude toward space and the materials he uses to define and articulate it. Because it is a synthetic product, housing is dependent on the materials' qualities and technical capabilities. Building materials' variety and quality improve their aesthetic qualities and structural capabilities (Olanitori & Olotuah, 2015). Nigeria depends on the importation of building materials for its construction activities because the country's building materials sector is in a poor state of development (Aremu, & Adeyemi, 2016). Building materials are brought into the country at extravagant rates as a result of the country's economic slump, which has caused the Naira (Nigeria's currency) to fall against foreign currencies.

The shortage of building materials in the country is causing a significant impact on the quality of housing. The quality of architectural objects is determined by their technical properties, historical precedence, and future prospects. The effectiveness and quality of building materials, such as strength, stiffness, heat resistance, fire resistance, and durability, are crucial factors in evaluating quality. Factors such as face patterns, color, surface quality, and texture also play a role.

The design process is influenced by social, structural, climatic, cultural, economic, technological, and resource constraints. Traditional architecture, created by and for the people within their community, is an example of this. Vernacular architecture, on the other hand, is the adoption and growth of a people's inherent domestic architectural ideals, considering climate, culture, and materials. This type of design is hospitable to people and considerate of their surroundings. Native building materials like stone, clay and its derivatives, wood, and bamboo may be included, along with improved alternatives like cement stabilized blocks made from lateritic soil, bricks and blocks made from mineral and industrial waste, cement bonded wood, and wood boards, as well as brand-new synthetic materials like coated fabric and synthetic membranes. Modern architects would be encouraged to employ regional building materials of indigenous origin as a result of the adoption of vernacular architecture and, as a result, the social structures and cultural values that have an impact on house designs (Olanitori, & Olotuah, 2015).

In Nigeria, these materials have been in use for many generations, and technological advancements are being made. They are particularly applicable to housing with the main goal of making it affordable for Nigeria's poor majority, who live in difficult conditions.

Ways of Improving the Quality of Local Building Materials

Research is being done to technically advance these materials, which have been utilized in Nigeria for generations. Since the majority of Nigerians are poor and live in difficult conditions, they are particularly appropriate to housing with the main goal of making it affordable.

Similarly, Windapo and Iyagba (2017) acknowledged that the lack of durability of local building materials has forced home builders to import supplies. The transformation of dirt into mortarless blocks, manufactured by a technology of a South African-based company named Hydraform, is considered as a revolutionary illustration of what proper and modern technology can do (Dimoniaku and Obiozo, 2020). Numerous stunning and long-lasting homes have been made with the blocks, and awareness of them is expanding. It has been shipped to various African nations due to its high quality and longevity and is devoid of any biases or forms of discrimination. In this regard, Jamil and Ahmad (2016) also identified inadequate technology as the cause of Bangladesh's low-quality products.

Local building materials are of higher quality if workers possess the necessary skills and imaginative thinking. Innovative thought and skilled employees are key to producing high-quality products, as seen in the automotive industry. To ensure high-quality, local material producers must focus on innovation and talent development. Strategies such as Lean construction (LC) and total quality management (TQM) can be used to improve the efficiency and quality of locally produced building materials. Government intervention can address challenges with local materials, such as exclusion from National Building Codes and lack of support. Insufficient funding can also impact quality, which can be addressed by facilitating access to cash, lowering taxes, and offering incentives. Training is essential for producing high-quality goods, and the use of local materials should be taught to building professionals and staff. Research should be actively conducted to produce new goods and enhance the properties of existing materials. Stakeholders should fund research, and the industry should effectively receive and apply the findings.

3.0 Research Methodology

The study investigated the dynamic cost consideration of local materials for the construction of mass housing in Enugu State utilizing a literature review and survey research design. Survey research, according to Left Wich (2013), is a sort of study in which a sample is chosen at random from the study population and examined; the findings are then utilized to draw generalizations about the subject under investigation. The study's target audience was Enugu State, Nigeria's building industry. Professionals who are directly or indirectly involved in construction operations, including as builders, engineers, quantity surveyors, architects, project and facility managers in construction organizations with a branch or headquarters in Enugu State, are among the respondents for the study. To collect information from the respondents, a questionnaire was developed.

A sample size of 46 professionals was chosen from the frame using a purposive sampling technique. The survey includes questions that inquire about the study's goals. A structured questionnaire was employed as the data collection tool. The scale, which has four points and goes from strongly agreeing at 4 to strongly disagreeing at 1, is called a 4-point likert scale. The researcher's ability to cut up distributed questionnaire copies and return them on his own is the study's method of data collecting. In order to avoid being disfigured, the researcher did not utilize any help when distributing and returning his copies of the questionnaire.

The data produced from the questionnaire instrument was analyzed by the researcher using a straightforward percentage data presentation and analysis. Using frequency counts and percentages as descriptive statistics, survey responses were examined. Demographic factors and research goals were analyzed using descriptive statistics such as frequency counts and percentages.

4.0 Data Presentation, Analysis and Interpretation of Results

4.1 The Socio-demographic Characteristics of the Respondents

This section describes the traits of each of the 46 respondents that were chosen at random from the study area and participated in the survey. The respondents' age, sex, and marital status are among their characteristics.

Table 1: Age, Sex and Educational Status Composition of the Respondents

Variable Name	Categories	Frequencies	Percentages	Total	
Age	21-30 Years	6	13%	46	100
	31-40Years	31	67%		
	41-50Years	9	20%		
Sex	Male	36	78%	46	100
	Female	10	22%		
Educational Status	HND, BSc	30	65%	46	100
	M.Sc., PhD	16	35%		

The distributions of respondents' ages, sexes, and educational levels are shown in table 1 above. According to the results, 6 (13%) of the respondents fall into the 21–30 age range, followed by 31 (67%) respondents in the 31–40 age range, and 9 (20%) respondents in the 41–50 age range. Additionally, the table shows that 36 (78%) of the responders were men and 10 (22%) were women. According to the results, 15 (33%) of the respondents had a first degree, while 30 (65%) had a higher degree. This means that the majority of respondents were men, had at least a first degree, and were between the ages of 31 and 40.

Table 2: The local materials used for housing construction in Enugu State, Nigeria

S/n	Construction materials	Number of housings Constructed	Percentage (%)
1	Flooring		
	Earthen	32	70
	Stone	14	30
2	Walling		
	Limestone	41	89
	Wood	5	11
3	Roofing		
	Corrugated iron sheet	30	65
	Wood	16	35

Source: Field survey, 2023

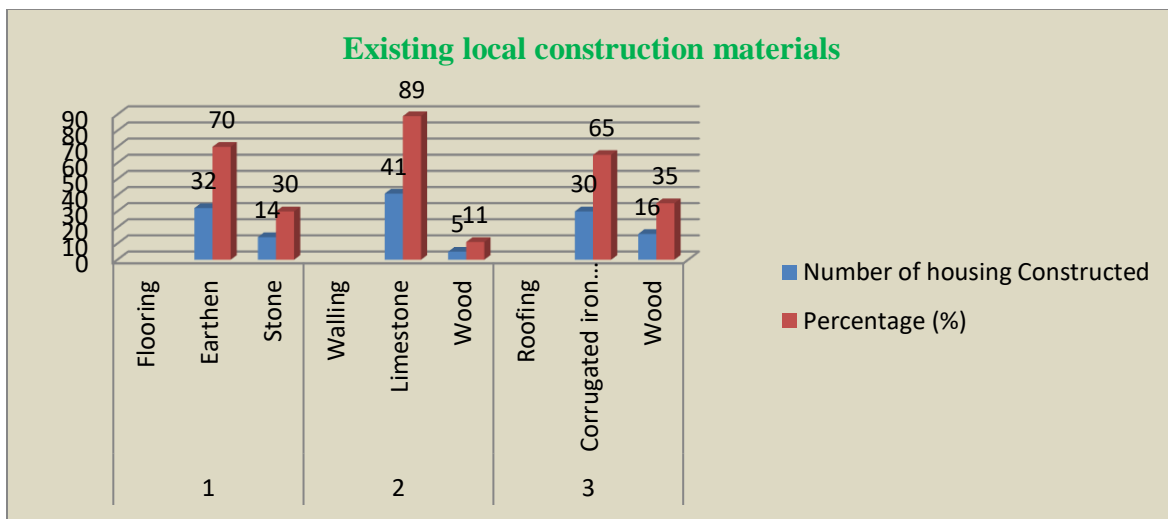


Figure 1: Existing local construction materials

The Nigerian project utilized all local building materials, with 70% of floor finishes made of earth or soil and 30% made of stone or concrete. The walls were built using limestone and clay soil, with 11% made of wood. Corrugated iron sheet made up 65% of the roof construction, while wood made up 35%. Most dwellings were constructed using flimsy materials, which could deteriorate quickly. To prevent health issues, dirty floors should be avoided and stone-concrete floors should be used. This supports Adedeji's (2020) assertion that there are several locally available building materials in Nigeria, but they differ in quality.

Table 3: The factors affecting the use of local building materials for housing construction in Enugu State, Nigeria

S/ N	Factors	Strongly Agree (%)	Agree (%)	Disagree (%)	Strongly Disagree (%)
1	Durability and lifespan of materials	26(57%)	16(35%)	4(9%)	0(0%)
2	Cost of production	22(48%)	12(26%)	7(15%)	5(11%)
3	Reusability of materials	19(41%)	15(33%)	8(17%)	4(11%)
4	Public awareness about the local materials	20(43%)	17(37%)	3(7%)	6(9%)
5	Government intervention	18(39%)	20(43%)	2(4%)	6(13%)
6	Renewability of materials	21(47%)	14(30%)	9(20%)	2(4%)
7	Availability of the local materials	16(35%)	19(41%)	5(11%)	6(9%)
8	Availability of manpower	13(28%)	23(50%)	7(15%)	3(7%)
9	Aesthetic purposes	23(50%)	19(41%)	3(7%)	1(2%)
10	Social acceptability of materials	17(37%)	21(47%)	6(9%)	2(4%)
11	Sound insulation properties	24(52%)	10(22%)	8(17%)	4(9%)

Source: Field survey, 2023

The study reveals that 57% of respondents use local building materials due to their durability and lifespan. Other factors influencing their usage include cost of production, reuse, public awareness, government intervention, renewability, availability, personnel, aesthetics, social acceptability, and sound insulation. The results support Dominiaku & Obiozo's (2019) claim that using local materials can lower construction costs and increase housing affordability. However, indigenous materials are rarely used due to their lack of longevity.

Table 4: The benefits of using local materials for housing construction in Enugu State, Nigeria

S/ N	Benefits	Strongly Agree (%)	Agree (%)	Disagree (%)	Strongly Disagree (%)
1	Affordable housing	30(65%)	10(22%)	5(11%)	1(2%)
2	Reduced construction cost	25(54%)	14(30%)	4(9%)	3(7%)
3	Improvement of local economy	23(50%)	15(33%)	2(4%)	6(13%)
4	Economic empowerment	19(41%)	13(28%)	12(26%)	2(4%)
5	Employment opportunities	20(43%)	10(22%)	11(24%)	5(11%)

6	Development and patronage of indigenous technology and skills	18(39%)	21(46%)	3(7%)	4(9%)
7	Usage of environmentally friendly resources	22(48%)	16(35%)	6(13%)	2(4%)
8	Provision of energy conservative products	27(57%)	12(26%)	4(9%)	3(7%)

The report discusses the advantages of using indigenous building materials for housing development in Enugu State, Nigeria. The main advantage is affordability, with 65% of respondents agreeing. This aligns with Ademiluyi (2020)'s findings that local materials lead to lower construction costs and stabilized local economies, promoting economic empowerment for the populace.

5.0 Conclusion

The study focuses on local building materials for construction in Enugu State, Nigeria, highlighting the importance of local materials in reducing housing costs. The literature review and field survey reveal that local materials are readily available, but high prices of imported materials make it difficult to afford homes in the region. The study also highlights the availability of natural stone in the region, which can be used for affordable and long-lasting buildings. The study suggests that local building material manufacturers should be aware of these issues and consider them during production. The study highlights the nine advantages of using local building materials, including affordable housing and reduced construction costs. The government and home builders should benefit from these advantages. The study also highlights the main obstacles to utilizing local materials in the construction industry, such as technological limitations and poor product quality due to non-compliance with standards.

5.1 Recommendations

- i. The government should also take drastic measures to reduce the cost of production and transportation of goods by ensuring an adequate supply from the power sector and production of petroleum products through local refineries as opposed to dependence on importation, the study recommends after having conducted this research and analyzed the field data.
- ii. By promoting research into the manufacture of domestic building materials, the government can temper opposition to the use of imported building materials.
- iii. Last but not least, relevant organizations like the Nigerian Building and Road Research Institute (NBRRI), among others, should work with experts to conduct additional studies on the use of materials that are in line with peoples' socioeconomic situations and locals' preferences.

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