Utilization of Bamboo Culm and Earth Materials in Construction for The Provision of Affordable Housing for Domestic Buildings at Mburumbu, Nkanu East L.G.A , Enugu State

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ABSTRACT

The study was carried out on the use of bamboo culm and earth materials in building construction in provision of affordable housing for domestic buildings at Mburumbu, Nkanu East Local Government Area, Enugu State. The purpose of the study was to determine the status of the use of bamboo culm and earth materials in construction at Mburumbu, Nkanu East; identifying the factors limiting the use of bamboo culm and earth materials in construction at Mburumbu, and examine the strategies that will improve the use of bamboo culm and earth materials in construction at Mburumbu, Enugu State. Three research questions and three hypotheses were formulated to guide the study. A population of 80 respondents, comprising of 20 engineers and 60 craftsmen was used for the study. A structured questionnaire was developed by the researcher and was used as an instrument for data collection. The data collected was analyzed using mean and standard deviation, while t-test statistic was used to test the three hypotheses at 0.05 level of significance. The findings of the study revealed that there are limitations in the use of bamboo culm for building construction at Mburumbu in Nkanu East L.G.A, Enugu State. Based on the findings of the study, it was recommended that the use of bamboo and earth materials in building construction should be introduced as part of the curriculum for construction education at both undergraduate and postgraduate levels in order to sensitize the students of their potential uses and benefits. The government should also formulate a policy for adapting bamboo and earth materials that require minimal amounts of capital, foreign exchange, make use of available raw materials and skills in small-scale operations. Viable suggestions were also made for further research works.

Keywords: Bamboo culm, Bamboo, Earth Materials, Building, Sustainable, Development, Mburumbu, Nkanu East.

INTRODUCTION

In building construction, local materials such as bamboo have served in building local houses for human habitation, livestock and to store crops. Skills in the use of this local material are transmitted from father to son and that enabled the construction of such buildings which possessed satisfaction, qualities of comfort and durability to some extent. The history of housing is inseparable from the social, economic and politics of mankind. As stated by United Nations Development Programme (UNDP), housing and sustainable human developments are closely linked together, since housing can either enhance or degrade human development. Abiola (2000) identified building material as one principal factor affecting the effective performance of Nigeria construction industry. The problem of providing affordable housing has long been a concern not only to individuals but also to government at all levels. A decent home is the basis of the possibility for obtained security, as well as other basic needs such as privacy, health and social integration. This explains the essential role that affordable housing can play in the achievement of sustainable human development.

A recent world bank report noted that two of the most critical urban development issues facing Nigeria are the financing of urban infrastructure and the institutional arrangement for housing delivery in urban centers. The provision of basic amenity particularly housing is partly the responsibility of the government which is

handicapped in recent times by declining financial resources, political instability and many other factors. Local building material (bamboo, mud, etc.) are available everywhere and exists in different compositions especially in Nigeria. It is most commonly used in developing countries for housing by higher percentage of the citizens. An earth lodge is a circular building made by some of the native of North America. They have bamboo post and beam construction and are done with shaped bamboo.

Bamboo and earth materials have a long and well-established tradition as a building material throughout the world's tropical and sub-tropical regions. It is widely used for many forms of construction, in particular for housing in rural areas. Bamboo is a renewable and versatile resources, characterized by high strength and low weight, and is easily worked using simple tools. It is widely recognized as one of the most important non-timber forest resources due to the high socioeconomic benefits from bamboo-based products. It is estimated to cover over 3 million hectares in area in Nigeria alone. Most of them grow in Asia, Africa and Latin America. Commercially, important species of bamboo usually mature in four- or five-years, after which multiple harvests are possible every second year, for up to 120 years in some species and indefinitely in others.

Bamboo also excels in biomass production, giving 40 tons or more per hectare annually in managed stands. It accounts for around one quarter of biomass produced in tropical regions and one-fifth in subtropical regions. It has been used successfully to rehabilitate soil ravaged by brick making in India, and abandoned tin-mine sites in Malaysia. It shelters top soil from the slaughter of tropical downpours, preserves many exposed areas, providing micro-climate for forest regeneration and watershed protection. It is often introduced into the banks or streams or in other vulnerable areas, for rapid control of soil erosion; one bamboo plants closely matted roots can bind up to six cubic meters of soil. The advantages of local and indigenous building materials cannot be over emphasized. It includes, light, strong, versatile, environmental friendliness, easily accessible, self renewing resource, fast growing and highly productive, which can lead to improvement of productivity (Yekini et al 2018; Azeta et al 2017). The use of locally available and indigenous earth materials has several advantages in terms of sustainability (Nwoke et al 2017). They are: Reduction of energy costs related to transportation. Reduction of material costs due to reduced transportation costs, especially for well-established industries. Ecological balance within the region needs to be maintained while efficiently utilizing bamboo resources. For the purpose of this study, mud bricks are as walling unit produce from rammed sand and water. It is widely used in Nigeria for walling units. The quality of earth bricks is a function of the method employed in the production and the properties of the construction materials. Earth bricks are available for construction and structure of any types. Compress earth bricks (CEB) are one of the products that Nigeria building and road research institution (NBRRI) introduce into the construction industry due to the fact that laterite is readily available in Nigeria and that it required a very small quality of cement but still compress earth bricks (CEBs) are construction bricks made with rammed clay and other stabilizing ingredient. The earth mixture is poured into a hand operated or motorize hydraulic made, compress earth bricks are uniform in size and shape. Nowadays, improved technology induced people to use CEB as alternatives for earth bricks in building houses because they do not require much cement for bonding, the bricks during construction thereby further reducing the building cost and their mechanical cost, with a view to ascertaining which is more applicable in building affordable houses. It is on this basis that this research aim to ascertain the use of bamboo culm and earth materials in construction for the provision of affordable housing for domestic use at Mburumbu, Nkanu East L. G. A. Enugu State.

Statement of the Problem

Selection of good and sustainable building material is the major challenge affecting the construction industries in developing countries which has been influenced by cost, physical properties and compressive strength of the building materials. The continuous skyrocketing of the building cost in Nigeria is a matter of serious concern that calls for the appraisal of the conventional building processes in seeking for alternatives sustainable building materials. Currently, methods and the cost of materials and labor is continually on the increase beyond the reache of many Nigerians, Sustainable housing development especially to the low-income group of the society has become huge challenge particularly because of the huge capital outlay required to build and own a house, frequent increase in price of conventional building materials across Nigeria has reawakened serious awareness to related research to production, in the use of bamboo and earth materials as alternative for the construction of functional but affordable dwelling in rural area of Nigeria. Thus, acquisition of indigenous

building materials by way of compressed earth bricks (CEB) and bamboo has been suggested as a way out. Sustainability and durability are issues of great important for the building sector and society. Most developing countries are facing a real housing challenge (Harrison and Sinha, 1995). This therefore, underscores the aim of this research to determine the utilization of bamboo culm and earth materials in construction for the provision of affordable housing for domestic buildings at mburumbu, nkanu east l.g.a, enugu state

Aim and Objectives of the Study

The aim of this research work is to determine the utilization of bamboo culm and earth materials in construction for the provision of affordable housing for domestic buildings at Mburumbu, Enugu state. The objectives are to determine;

i. the status of the use of bamboo culm and earth materials in construction at Mburumbu, Enugu state

ii. the factors limiting the use of bamboo culm and earth materials in construction at Mburumbu, Enugu state.

iii. the strategies that will improve the use of bamboo culm and earth materials in construction at Mburumbu, Enugu state.

Research Questions

i. What is the status associated with the use bamboo culm and earth materials at Mburumbu, Enugu state?
ii. What are the factors limiting the use of bamboo culm and earth materials in construction at Mburumbu, Enugu state?

iii. What are the strategies that will improve the use of bamboo culm and earth materials in construction at Mburumbu, Enugu state?

Hypotheses

The following null hypothesis was formulated and tested at 0.05 level of significance.

1. There is no significant difference between the mean rating of engineer and craftsmen regarding the factors associated with the use of bamboo culm and earth materials in building construction at Mburumbu, Enugu State.

2. There is no significant difference between the mean responses of engineers and craftsmen regarding the factors limiting the use of bamboo culm and earth materials in building construction at Mburumbu, Enugu State.

3. There is no significant difference between the mean responses of engineers and craftsmen regarding the strategies that will improve the use of bamboo culm and earth materials in building construction at Mburumbu, Enugu State.

REVIEW OF LITERATURE

Practical Deployment Consideration of Bamboo in Construction Activities

Bamboo's high strength-to-weight ratio and rapid renewability make it a compelling alternative to steel and timber. However, its organic nature introduces unique engineering and logistical hurdles. Successfully deploying bamboo in construction requires a shift from traditional masonry mindsets toward specialized preservation and joinery techniques.

Material Selection and Grading

a. Structure: Not all bamboo is structural. Deployment begins with selecting the correct species, such as Guadua angustifolia in the Americas or Dendrocalamus asper in Asia.

b. Age Matters: Bamboo must be harvested at peak maturity typically between 3 and 5 years. If harvested too young, the fibers lack starch density; if too old, the culm (pole) becomes brittle (Nurdiah, 2016).

c. Grading Standards: Unlike steel, bamboo is non-homogeneous. Practitioners must account for variations in diameter, wall thickness, and taper. This requires rigorous sorting to ensure structural predictability (Kaminski et al., 2016).

Preservation and Durability

a. Vulnerability: The primary challenge in bamboo deployment is its vulnerability to biological decay. High starch and sugar content make untreated bamboo a target for powder-post beetles and termites.

b. Chemical Treatment: The "Boucherie" method or immersion in borax/boric acid solutions is the industry standard. These salts replace the sap, making the fibers unpalatable to insects (Liese & Tang, 2015).

c. Design for Durability: Bamboo should never touch the soil directly. Deployment strategies must include "elevated footings" and "generous roof overhangs" to protect the material from ground moisture and UV degradation (Archila et al., 2015).

Structural Joinery and Assembly

a. Joining: Traditional bolting often fails because bamboo is hollow and prone to longitudinal splitting.
b. Avoid Crushing: Conventional bolts can crush the culm. Effective joints often involve injecting cement mortar into the internodes (the hollow sections) where the bolt passes through to provide internal support (Nurdiah, 2016).

c. Lashing and Friction: Modern deployment often blends traditional lashing with steel connectors or specialized "fish-mouth" cuts to distribute loads evenly across the nodes, which are the strongest parts of the plant (Kaminski et al., 2016).

Regulatory and Skill Barriers

Despite its benefits, institutional barriers remain a significant hurdle for widespread use.

a. Building Codes: Many regions lack comprehensive building codes for bamboo, making it difficult to obtain insurance or permits. The ISO 22156 standard provides a framework, but local adoption is slow (Kaminski et al., 2016).

b. Labor Expertise: Bamboo construction is labor-intensive and requires craftsmen who understand the material's specific "behavior." There is currently a global shortage of engineers trained to calculate bamboo's organic load-bearing variables (Archila et al., 2015).

Figure 1: A bamboo stalk

Source: Gettyimages.com, 2026

METHODOLOGY

Research Design

The research design used was descriptive survey because Borg & Gall (1989) described descriptive studies as that which is aimed at finding out "what is", so observational and survey methods are frequently used to collect descriptive data. This method was successfully used by Kareem, Ma'aji, Ibrahim, Gazali and Shom (2014) and Kareem, Okwori, Hassan, Mohammed, Abubakar & Dada (2018) in similar research works.

Area of Study

This study was conducted at Mburumbu, Nkanu East Loval Government Area, Enugu State, Nigeria.

Population for the Study

The population of the study was eighty (80) respondents which made up of 20 engineers and (60)

craftsmen who are specialists in local material in the study area. This is in accordance with the opinion of Sekaran and Bougie (2020) that a sample size of between 30 and 500 is appropriate for any study. Since the population is manageable, there was no need for sampling.

Instrument for Data Collection

The instrument for data collection was a structured questionnaire developed by the researcher. It consisted of two parts (Part A and B); Part A indicated the Bio-data (age, gender and years of practice) of the respondents. Part B was divided into three sections A, B and C. All items are to be responded to by indicating the appropriate perception using four point rating scale. Strongly agree = 4 points (SA), Agree (A) = 3 points, Disagree (D) = 2 points, Strongly Disagree (SD) = 1 points. Eighty (80) questionnaires were distributed to twenty (20) engineers and sixty (60) craftsmen in building in the area of study. Eighty-Three percent (83%) of the distributed questionnaire were returned and used for data analysis. The data collected were analyzed using means and standard deviation. The items mean ( ) and criterion mean (2.50) were computed and utilized to measure the level of agreement and or disagreement. The decision adopted was that if item mean ( ) is equal or more than criterion mean (2.50), the adoption is positively rated (Agree); but if otherwise, the adoption is negatively rated (Disagree).

RESULTS

Research Question One: What is the status associated with the use bamboo culm and earth materials at Mburumbu, Enugu state?

Table 1: The current status in the use of bamboo culm and earth materials for building construction at at Mburumbu, Enugu.

S/N	Items on the status	Mean	SD	Decision
1	Bamboo culm and earth materials are used because it easily absorbs water in water logged areas	1.71	0.92	Disagreed
2	Bamboo culm and earth materials are not used because of low level of commercialization.	2.77	1.09	Agreed
3	Bamboo culm and earth materials are not used because of Poor engineering design	2.75	0.32	Agreed
4	Bamboo culm and earth materials are used because they are largely available in our locality.	3.29	0.95	Agreed

5	Bamboo culm and earth materials are not used due to poor inspection of building by building inspection agency	3.02	0.37	Agreed
6	Bamboo culm and earth materials are not used because of low patronage of bamboo and earth materials.	3.86	0.38	Agreed
7	Bamboo culm and earth materials are not used due to Government lukewarm attitude towards the use of local building materials	3.38	1.12	Agreed
8	Bamboo culm and earth materials are used because they are easily work upon and available in abundance using simple tools.	2.82	1.12	Agreed
9	Bamboo and earth materials are not used because of discrimination in using them	2.41	1.29	Disagreed

Source: Field Work, 2026

The data presented in Table 1 on the status of the use of bamboo culm and earth materials at Mburumbu, Enugu State, revealed that the respondent agreed with all the items with mean score ranging from 2.75 - 3.82 except items 1 and 9 which has mean score of 1.71, 2.41 respectively. This signifies that most of the respondents Agreed with the status in the use of bamboo and earth materials in building construction at Mburumbu, Nkanu East L.G.A, Enugu State as it is readily available.

Research Question Two: What are the factors limiting the use of bamboo culm and earth materials for building at Mburumbu, Nkanu East L.G.A, Enugu State?

Table 2: Identify the factors limiting the use of bamboo culm and earth materials for building at Mburumbu, Nkanu East L.G.A, Enugu State.

S/N	**Items on the factors limiting the use of bamboo culm**	**Mean**	**SD**	**Decision**
1	Bamboo culm and earth materials give Poor wall finishes	2.57	1.12	Agreed
2	Local building materials like clay suffer shrinkage and cracking.	2.51	0.97	Agreed
3	Too many quack craftsmen.	2.84	0.99	Agreed
4	Doubtful durability and longevity lifespan of Bamboo culm and earth materials	2.91	0.89	Agreed
5	Early deterioration decay of bamboo	3.16	1.05	Agreed
6	Deterioration of earth buildings as a result of Absorption of moisture content	2.69	1.20	Agreed
7	Local materials such as bamboo and clay absorb Water in water logged areas	2.59	1.08	Agreed
8	Bamboo culm and earth materials are cheap to acquire	2.85	1.15	Agreed

9	Small scale production of bamboo and earth materials	2.77	1.08	Agreed
10	Poor road networks to transport materials to the site	2.66	1.18	Agreed
11	Bamboo culm and earth materials are easy to find	2.21	1.18	Disagreed
12	Lack of precise design specification	2.34	1.12	Disagreed
13	Bamboo culm and earth materials are easily worked on	2.45	0.41	Disagreed

Source: Field Work, 2026

The data presented in Table 2 on the factors limiting the use of bamboo and earth materials for building construction at Mburumbu, Nkanu East L.G.A, Enugu State, revealed that the respondent agreed with all the items with mean score ranging from 2.51 - 2.91 except items 11, 12 and 13 which has mean score of 2.21, 2.34 and 2.45 respectively. This signifies that most of the respondents agreed with the factors limiting the use of bamboo and earth materials for building construction at Mburumbu, Nkanu East L.G.A, Enugu State.

Research Question Three: What are the strategies that will improve the use of bamboo culm and earth materials for building construction at Mburumbu, Nkanu East L.G.A, Enugu State?

Table 3: To determine the strategies that will improve the use of bamboo culm and earth materials for building construction Mburumbu, Nkanu East L.G.A, Enugu State.

S/N	Items on the strategies	Mean	SD	Decision
1	Reduction in development of foreign building materials in construction sectors	3.79	0.89	Agreed
2	Effective mobilization of human resources	3.42	0.87	Agreed
3	Co-operative effort by government in the developing of bamboo and earth material to meet the housing need	3.10	1.11	Agreed
4	Encouragement of women in housing construction	2.26	0.93	Disagreed
5	Government should increase import duties on importation of building materials that can be sourced locally	2.88	1.14	Agreed
6	Government should grant fiscal incentives to manufacturing of bamboo and earth materials	3.01	0.97	Agreed
A	Government should provide technical support and advice to entrepreneurs on production of bamboo and earth materials	3.91	0.28	Agreed
8	Development and propagation of indigenous technology in production of bamboo culm and earth materials	3.94	0.28	Agreed

9	Reduction cost of bamboo culm and earth materials since they are sourced locally	3.19	1.11	Agreed
10	Government should encourage large scale production of bamboo and earth materials.	3.77	0.39	Agreed

Source: Field Work, 2026

The data presented in Table 3 on strategies that will improve the use of bamboo culm and earth materials for building construction at Mburumbu, Nkanu East L.G.A, Enugu State, revealed that the respondents agreed with all the items with mean score ranging from 2.88 - 3.94 except item 4 which has mean score of 2.26. This signifies that most of the respondents Agreed with the strategies that will improve the use of bamboo culm and earth materials for building construction at Mburumbu, Nkanu East L.G.A, Enugu State.

DISCUSSION OF THE FINDINGS

The results obtained from Table 1 revealed that all the items identified except item 1 and 9, are the status of the use of bamboo culm and earth materials at Mburumbu, Nkanu East L.G.A, Enugu State. This is in line with the view of De-Boer and Baries (2000) which postulated that bamboo is widely used as a construction material around the world with an estimated 800,000 people currently living in bamboo structure. Similarly, the finding is in unison with that of Yekini et al (2018) and Azeta et al (2017) who posited that bamboo is mostly used in constructing local houses because of their availability in most rural areas. The availability is in line with the study items.

The result obtained from table 2 revealed that all the items identified except item 11,12 and 13 are the factors limiting the use of bamboo culm and earth materials for building at Mburumbu, Nkanu East L.G.A, Enugu State. This is in line with the view of Anand and Ramamurthy (2003) who stated that foreign materials require high technology and energy in their production, transportation and usage. Also, the finding corroborates that of Yekini et al (2018), Azeta et al 2017) and Nwoke et al (2017) who averred that the utilization of bamboo as construction material is necessitated due to factors like lightweight nature, strong, versatile, environmental friendliness, easily accessible, self-renewing and ability to improve sustainability of construction works.

The result obtained from table 3 revealed that all the items identified except item 4 are the strategies that will improve the use of bamboo culm and earth materials for building construction at Mburumbu, Nkanu East L.G.A, Enugu State. Harrison and Sinha (1995) corroborated this finding that sustainability and durability is an issue of great important for the building sector and society. Most developing nations are facing a real housing deficiency. Therefore, it is mandatory to construct and build houses that are more sustainable and durable at affordable rate (Adams and Agib, 2001).

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

Summary of Findings

From the study, the following findings were revealed.

1. It was revealed from the study that the use of bamboo and earth materials in building construction at Mburumbu, Nkanu East L.G.A, Enugu State were significant.

2. The study revealed that the factors limiting the use of bamboo culm and earth materials for building at Mburumbu, Nkanu East L.G.A, Enugu State included shrinkage and cracking, too many quack craftsmen, inexpensive nature of bamboo and earth, lack of precise design specification amongst others.

3. The study revealed that notable strategies to improve the use of bamboo culm and earth materials for building construction at Mburumbu, Nkanu East L.G.A, Enugu State include reduction in development of foreign building materials in construction sectors, encouragement of women in housing construction among others.

Conclusion

Going by the findings of this research, it was concluded that there are limitations in the use of bamboo and earth materials for building construction in the study area. This is because the water rising through clay and bamboo tends to reduce the service span of the building due to bamboo water absorption, this is problem of poor road networks to transport materials to the site, unavailability of skilled men and women, local building materials like clay suffer shrinkage and cracking.

Recommendations

It was therefore recommended that the study of indigenous building materials should be introduced as apart of the curriculum for building construction education in our tertiary institutions, a sustainability knowledge in construction should be harmonized and embedded in various document, and should be developed in an integrated way across geographical boundaries and the architects and other players in the building industry should be encouraged to prepare designs that reflects an awareness of all the relationship that exists between the natural resources utilized in construction.

However, despite all the inherent and potentials of bamboo culm with its usage with earth material, there are no known research addressing methods of splicing or the behaviour in earth material matrix. The issue of bonding strength and prevention of water penetration in bamboo are still very unclear.

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