ADOPTING NON-CONVENTIONAL MATERIALS IN AFFORDABLE HOUSING DELIVERY

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The second greatest human need is shelter and this indicates the necessity for everyone to be housed. Adequate housing provision reduces a host of other risk that the sustainable development goals are expected to reduce or even eliminate. However, due to policies, rapid population growth, rural-urban migration, housing provision for the homeless populace fall short. This paper highlights the prospects and problems of using non-conventional materials for low cost or affordable housing provision. The non-conventional materials investigated included earthworm cast as partial replacement of cement, stabilized earth bricks, bamboo, ash from waste incineration. A survey research was designed, and 200 questionnaires were distributed to both professionals and end users of housing. The findings showed that funding was a major obstacle to affordable housing provision, but this could be improved by employing non-conventional sustainable materials. The findings also showed that thought there was inadequate funding, lack of awareness of some of these materials were critical to the utilization of these materials. It was recommended that the potential users be sensitized to promote sustainable construction practices.

Keywords: Sustainable construction, Recycled waste, Low-cost housing, Shelter, Locally sourced materials, Perception.

1 INTRODUCTION

Aluko (2004) asserts that housing in the ranking of man's needs comes second only after food. Despite this importance of housing, 50.2 % of Nigerians still live in slums (United Nations 2015). Kabir and Bustani (2008) defined housing as dwellings, buildings or other shelters in which people live. Shelter is undeniably important for human survival, and with its great significance to man comes increasing demand for houses that are habitable. The basic shelter to be provided must be safe, healthy, and most importantly affordable for the occupants. According to the United Nations Habitat (UN Habitat), the population of families living in slums has increased by 18.62% between the year 2000 and 2020 (UN Habitat 2015). The number of families living in slums will continue to rise due to rural-urban migration, poverty, poor house planning and lack of infrastructure, and a host of other factors. It therefore is no surprise that housing is one of the sustainable development goals of the United Nations. To achieve this goal, stake holders in the construction industry and policy makers must work closely together to reduce the housing deficit being experienced worldwide. According to Olotuah and Bobadoye (2009), over 60% of the population of Nigeria are without shelter and over 75% dwell in slums.

In Nigeria, the housing deficit is upwards of 17 million houses (Rahimian *et al.* 2017). Aduwo *et al.* (2016) highlighted the efforts made by the Federal Government of Nigeria in trying to bridge the gap that is the deficit in housing provision. They showed that even though the Federal government proposed to build 653,271 housing units in forty-eight years (1962– 2010), they only succeeded in building only 95,594 units. This is a gross underachievement because even if the initial plan of 653,271 was achieved, there would still be a needed balance of 16,346,729 units that remain to be constructed because of the current housing deficit that sits at 17,000,000 (Ezeigwe 2015). This means that the government would have solved only 3.86% of the problem. Moreover, the Government's plan to provide "low-income" houses the low-income earners has not always been successful. Nigerian government in its quest to proving shelter for its populace admits that building materials take up about 60% of the total housing cost and the rising cost has been a major challenge.

Several researchers have investigated several aspects of affordable housing (Bajunid and Ghazali 2012, Puri *et al.* 2017, Gan *et al.* 2017, Ben-Shahar *et al.* 2018, Gohnert *et al.* 2018, Srivastava and Kumar 2018). Iwuagwu and Iwuagwu (2015) proposed the use of locally sourced materials in construction to reduce the cost of Building materials.

2 METHODOLOGY

This research was designed to investigate the utilization of indigenous materials for low-income housing delivery in Nigeria in the bid to bridge the house deficiency gap in the country. Hence, all the source of primary data found for this research is from structured questionnaires. The research was quantitative in nature and therefore a survey research design was adopted for the study. The survey research design was implemented the cross-sectional survey research design, which relied on data obtained from respondents. The sampling technique adopted was the random sampling technique. A reasonable amount of data was gotten from randomly selecting the subject matter considered.

The target population to be reached was that of the construction professionals and residents in the Federal Capital Territory, of Abuja, Nigeria. The population comprised of construction professionals such as architects, builders, quantity surveyors and structural/civil engineers, as well as residents who are government workers, entrepreneurs and private developers. These construction professionals were selected due to their experience in dealing with materials and residents were selected due to the importance of the client's preference.

The sample size selected from the population was two hundred (200): one hundred (100) construction professionals and one hundred (100) residents. The survey questions were designed as a 5-point Likert scale that ranged from strongly agree to strongly disagree. The data collected from the survey were analyzed and presented in descriptive format, with the aid of tables and charts. The different factors used in the ranking were obtained from other studies carried out by other researchers (Dayaratne 2010, Iwuagwu and Iwuagwu 2015, Gan *et al.* 2017, Nanyam *et al.* 2017). The ranking of the different factors considered was achieved using the relative importance index RII.

3 FINDINGS AND DISCUSSION

A total of 200 respondents answered the survey questions. Among the professionals in the construction industry, 12% of the respondents were females while 88% were male professionals in the construction industry. Among the residents, 40% were females, while 60% were male residents. This shows that the respondents were predominantly male. Both

professionals and residents were asked about their age. From the result of respondents who were professionals in the construction industry, none were below the age of 21, 30% were between the ages of 20 – 40, 54% were between the ages of 40 – 60 and 16% were 60 and above. Among the residents, none were below the age of 21 or above the age of 60, 44% were between the ages of 20 – 40 and 56% were between the ages of 40 – 60.

From the result of residents, 22% were Government Workers, 4% were entrepreneurs, 34% were private developers and 40% responded as "others." From the result of professionals, those who were architects were 30%; those that were builders were 30%; those that were civil engineers were 30% and estate managers 10%. Also, from the result of residents, 10% had a higher national diploma, 48% had a BSc, 28% had an MSc and 4% had a PhD. The result showed that, 10% lived in self-owned houses, 60% lived in rented houses and 30% lived with family or engage in squatting.

Figure 1. Evaluation of the housing deficit by Clients and Construction Professionals.

The chart in Figure 1 ranked the perceptions of both the clients and the construction professionals on the factors that lead to the housing deficit. According to the construction professionals, "Inadequate Funding" was the most important factor as it ranked 1st with an index score of 0.716 and the high cost of material ranked 2nd with an index score of 0.696. The clients on the other hand, perceived that high cost of materials was the most critical factor as it ranked 1st with an index score of 0.876 and inadequate funding ranked 2nd with an index score of 0.868. The least ranked factors highlighted include "Unavailability of Labour" and "Unavailability of Materials," which had index scores of 0.428 and 0.404 respectively. Both professional and clients both ranked inadequate funding and high cost of materials as their first two choices, showing that both categories of respondents shared the same perceptions towards housing deficit. While professionals ranked unavailability of land and labour as their least favourable factors, residents chose unavailability of labour and materials; these results are quite similar as well.

Table 1 shows the ranking of factors that influence the use of indigenous materials by Residents. The results obtained show that "Client Preference" was the most favoured benefit as it ranked 1st with an index score of 0.852 and the "Quality Superiority of Foreign Products" ranked 2nd with an index score of 0.808.

Both professionals and clients ranked client preference and quality superiority of goods as the most important factors that influence indigenous materials, but they ranked different factors as the least important.

Table 2 shows the construction professionals' ranking of the factors that influence the use of non-conventional building materials in construction. The table shows that "Client Preference" was the most favoured benefit as it ranked 1st with an index score of 0.736 and "Quality Superiority of Foreign Products" ranked 2nd with an index score of 0.68. The least ranked factors highlighted were the "Lack of Awareness" and "Unavailability of Materials," which had index scores of 0.64 and 0.608 respectively.

Table 1. Evaluation of factors that influence the use of indigenous materials by professionals.

Factors	Index	Rank
Client Preference	0.852	1st
Quality Superiority of Foreign Products	0.808	2nd
Unavailability of Technology to develop indigenous materials	0.76	3rd
Lack of Awareness	0.748	4th
Unavailability of Materials	0.712	5th
Inadequate Sustainability Culture	0.566	6th
Limitations from Building Codes and Regulations	0.444	7th

Table 2. Evaluation of factors that influence the use of indigenous materials by residents.

Factors	Index	Rank
Client Preference	0.736	1st
Quality Superiority of Foreign Products	0.68	2nd
Inadequate Sustainability Culture	0.668	3rd
Unavailability of Technology to develop indigenous materials	0.652	4th
Limitations from Building Codes and Regulations	0.648	5th
Lack of Awareness	0.64	6th
Unavailability of Materials	0.608	7th

Since the construction brief is expected to be based on the client's request and preference, it is only logical that both categories of respondents would agree on the Client's preference as being the most important factor influencing the use of non-conventional materials.
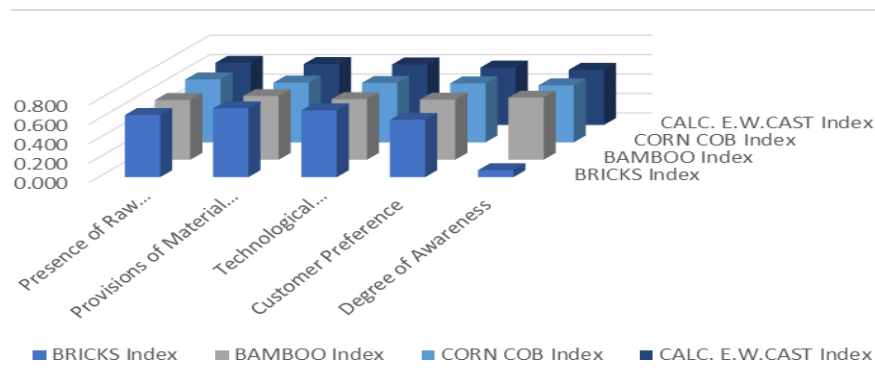

Figure 2. Evaluation of the utilization of different non-conventional materials.

Figure 2 displays the professional perceptions of the factors that influence the utilization of different non-conventional materials. The results obtained shows that "Degree of awareness" was the most favourable factor, in influencing the development of "Bricks", as it ranked 1st with an index score of 0.72 and the least favourable factors highlighted was "Customer Preference" which had an index score of 0.596. The results also showed that "Provision for Material Development" was the most favourable factor, in influencing the development of "Bamboo", as it ranked 1st with an index score of 0.656 and the least favourable factors highlighted was "Presence of Raw Materials" which had an index score of 0.596. One of the most common uses of bamboo in Nigeria has been for scaffolding. Few people have seen how its proper development and processing can enhance its aesthetic qualities. This could be why the respondents picked provision for material development as the major factor for the use of bamboo. Figure 2 also showed that the "Presence of Raw Materials" was the most favourable factor, in influencing the development of "Corn Cob", as it ranked 1st with an index score of 0.64. The least favourable factor highlighted was the "Degree of Awareness" which had an index score of 0.568. The parts of the country where these raw materials are abundant are not readily accessible to those who would need them for construction. As for "Calcined Earthworm Cast," the results showed that the "Presence of Raw Materials" was the most critical factor in influencing the development of "Calcined Earthworm Cast" as it ranked 1st with an index score of 0.648 and the least favourable factors highlighted was the Degree of Awareness which had an index score of 0.588.

4   CONCLUSIONS

From the findings, the high cost of materials and inadequate funding were the two most critical factors ranked by both professionals and residents in identifying the cause of Low-Income Housing Deficit in the Nigerian Construction Industry. "Inadequate funding" ranking high shows low-income housing projects are not funded properly.

The findings also showed that client preference and quality superiority of conventional materials were the two most critical factors ranked by both professionals and residents in analyzing factors that mitigate against the "Utilization of Non-Conventional Materials." "Client preference" ranking high means that clients are identified as very important stakeholders in the material selection. Clients' choice of materials needs to be influenced to ensure the use of non-conventional materials. "Quality Superiority of Conventional Materials" ranking high means that the quality of the conventional materials is perceived to be of higher standards than the quality of the non-conventional ones. Perceptions of quality superiority of foreign products greatly influence the choice of material by the client.

From the findings in examining the prospects and problems of developing non-conventional materials, "Provision of Material Development" ranked as the highest for "Bamboo" and second highest for "Ash Bricks." This means professionals believe "Bamboo" and "Ash Bricks" have provision for material development. Also, in examining the prospects and problems of developing non-conventional materials, customer preference and degree of awareness ranked as the lowest factors for "Calcined Earthworm Cast" and "Corn Cob." This implies that the professionals believe that the awareness on glulam and cob is very low and therefore, clients prefer conventional materials.

Based on the conclusions, it is therefore recommended that in order, to increase funding, the government should collaborate with the private sector towards implementing low-income housing schemes; this will aid in an incremental generation of financial resources for low-income housing projects. It is also recommended therefore that the government should endorse non-conventional materials, to create better price competition in the construction industry by implementing codes

and regulations for the use of non-conventional materials. Seminars and workshops should be conducted to create awareness of the types of non-conventional materials and various benefits that use of non-conventional materials. Mass marketing of non-conventional materials can aid the perception of clients towards acquisition of non-conventional materials. The government should facilitate the development of industries that ensure the development of non-conventional materials to significantly increase the quality of non-conventional materials. Further research should be carried out on the psychological implications of the building materials in affordable housing and how this affects the stakeholders in the design and implementation of these non-conventional materials. Research into the effects of non-conventional materials on climate change and environment is also recommended.

References

Aduwo, B. E., Edewor, P., and Ibem, E. O., Urbanization and Housing for Low-Income Earners in Nigeria: A Review of Features, Challenges and Prospects, *Mediterranean Journal of Social Sciences*, *7*(3S1), 347-357, 2016.

Aluko, O., *Housing and Urban Development in Nigeria*, KINS, 2004.

Bajunid, A. F. I., and Ghazali, M., Affordable Mosaic Housing: Rethinking Low-Cost Housing, *Procedia-Social and Behavioral Sciences*, *49*, 245-256, 2012.

Ben-Shahar, D., Gabriel, S., and Golan, R., Housing Affordability and Inequality: A Consumption-Adjusted Approach, *Journal of Housing Economics*, 2018.

Dayaratne, R., Reinventing Traditional Technologies for Sustainability: Contemporary Earth Architecture of Sri Lanka, *Journal of Green Building,* 5(4), 23-33, 2010.

Ezeigwe, P. C., Evaluation of The Causes of Housing Problems in Nigeria: A Case Study of Awka The Capital City of Anambra State, *Journal of Economics and Sustainable Development*, *6*(20), 87-93, 2015.

Gan, X., Zuo, J., Wu, P., Wang, J., Chang, R., and Wen, T., How Affordable Housing Becomes More Sustainable? A Stakeholder Study, *Journal of Cleaner Production*, 162, 427-437, 2017.

Gohnert, M., Bulovic, I., and Bradley, R., A Low-Cost Housing Solution: Earth Block Catenary Vaults, *Structures*, July 2018.

Iwuagwu, U., B., and Iwuagwu, C. M. I. B., Local Building Materials: Affordable Strategy for Housing the Urban Poor in Nigeria, *Procedia Engineering*, *118*, 42-49, 2015.

Kabir, B., and Bustani, S. A., *A Review of Housing Delivery Efforts in Nigeria*, International Housing Conference, University of Glasgow, Scotland, September 2009.

Nanyam, V. N., Sawhney, A., and Gupta, P. A., Evaluating Offsite Technologies for Affordable Housing, *Procedia Engineering,* 196, 135-143, 2017.

Olotuah, A. O., and Bobadoye, S. A., Sustainable Housing Provision for The Urban Poor: A Review of Public Sector Intervention in Nigeria, *The Built and Human Environment Review*, *2*, 51-63, 2009.

Puri, V., Chakrabortty, P., Anand, S., and Majumdar, S., Bamboo Reinforced Prefabricated Wall Panels for Low Cost Housing, *Journal of Building Engineering*, *9*, 52-59, 2017.

Rahimian, F. P., Goulding, J., Akintoye, A., and Kolo, S., Review of Motivations, Success Factors, and Barriers to The Adoption of Offsite Manufacturing in Nigeria, *Procedia Engineering*, *196*, 512-519, 2017.

Srivastava, M., and Kumar, V., The Methods of Using Low Cost Housing Techniques in India, *Journal of Building Engineering*, *15*, 102-108, 2018.

UN Habitat, United Nations Habitat Almanac, U. H. S. 2015-2016, *Tracking Improvement in the Lives of Slum Dwellers,* Technical Report, 2015.