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Research Article

ASSESSMENT OF PRACTITIONERS AWARENESS ON THE APPLICATION OF COMPRESSED EARTH BRICK AS A WALL MATERIAL IN NORTH-WESTERN NIGERIA

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Abstract

The study was designed to assess professional Architects' awareness of the use of compressed earth brick (CEB) as a sustainable wall material in North-Western Nigeria for decades, most parts of the world have used the earth as a building material for various structures. Earth material was well-known for its numerous long-term benefits. Therefore, this study aims to assess professional Architects awareness on the use of C.E.B as a wall materials for buildings. To collect data, a cross-sectional online survey design was used. The data was analysed using descriptive statistics and Analysis of Variance (ANOVA) on SPSS 25 software package. The ANOVA results were evaluated using a 5% significance level. results shows that Architects are aware of the use of C.E.B as a sustainable wall material because the mean scores of the level of awareness on the use of C.E.B. is greater than 3 (>3) out of the five (5) possible scores. Also, there is no significant difference in professional Architects' awareness based on their educational qualifications p-value (0.091) is greater than the alpha value of 0.05). Similarly, there is no significant difference based on their years of experience p-value (0.740) is greater than the alpha value of 0.05). These spark the need for government policies and professional bodies to enlighten the general public.

Keywords: compressed earth brick, north-western Nigeria, professional architects, sustainable building material, wall material.

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INTRODUCTION

Earth materials were the most commonly used materials for buildings before the foreign invasion on the west coast of African countries, and ~~it~~ they were widely and effectively used throughout Nigeria. Furthermore, each country region used an earth block walling technique that was appropriate for soil type (McBeth, Wilkie, Bedson, Chew-Graham, & Lacey, 2015). The earth block walling techniques employed in the Nigerian regions are shown in Table 1.

S/N	Wall Technique	Region of Nigeria	Remark
1	Torches (Wattle and dub)	Middle Belt, Southern & Eastern Nigeria	
2	Adobe (Earth brick)	Western Nigeria	
3	Adobe (Tubali)	Northern Nigeria	
4	Cob (Direct Layering)	Western Nigeria	
5	Compressed Earth Block (C.E.B)	All regions	

Table 1 The Earth Block Walling Techniques Employed in the Nigerian Regions

In the northern western region of Nigeria, where the climate is classified as a hot and dry region, the benefits of employing mud as a building material are fourfold: thermal physical benefit, environmental, economic, and social advantage. In contrast, since the climatic characteristics differ in other regions, the benefits of using the earth as a building material are primarily environmental, economic, and social.

Moreover, the thermophysical benefit earlier mentioned also has a link with economic aspect in twofold. Firstly, the excellent thermal property of the earth material of averting solar heat gain into the building interiors will drastically curtail the lifecycle cost for achieving indoor comfort. Second, sourcing, the material is inexpensive owing to its widespread availability, and it requires low skilful human resources; finally, it becomes another source of income to the local community.

A brick is an earthenware block used in the construction of masonry walls. They are laid in courses of a bonding pattern. The mortar was used as a binding agent to hold the bricks together in one place as monolithic units (Sassine, Younsi, Cherif, Chauchois, & Antczak, 2017). The oldest type of mud-brick was the hand-molded in conical shaped blocks locally as termed tubali. This makes the buildings thicker at the bottom and tapered as they rose to the top. The thickness was to avert heat permeation, which is the primary concern of the buildings in hot and arid areas. The tapering nature was to maintain the structural stability of the building (Eneh & Ati, 2010).

Earth bricks, also called tubali from a long time ago, were primarily used for walls in the north-western part of Nigeria. Moreover, the material source is usually earth dug from the specified borrow pits in the community. The dug earth differs considerably from area to area or even from pit to pit (Dmochowski, 1990). After gathering a heap of earth from the pits for the production of tubali, a bare hand was used as an implement, and the earth will be watered and allowed to soak for some time before molding the tubali. The grass/straw will then be added before the mixing to increase compressive strength and prevent cracks. The mixing process began with the use of barefooted legs trampled. Furthermore, when the mud is thoroughly mixed with sufficient water content, then the moulding of Tubali using a bear hand to attain a conical shaped pattern starts. After producing the adequate number of the tubali then it will be allowed to dry for a fortnight, after which the dried tubali is stack in one place

Earth has a low resistance to rain and has a structural limitation, which requires routine maintenance. For this reason, professionals do not promote earth buildings because they make little gains (Eneh & Ati, 2010; Pallant & Manual, 2013; Sassine et al., 2017). Also, the use of earth as a building material has a structural limitation on the height of complex structures. However, introducing a reinforced concrete frame structural technique would amicably resolve all the weaknesses mentioned earlier. Then, the earth materials will be used as an infill to cover up and demarcate spaces. Moreover, the wall surfaces of the earth structure can receive an additional coating to improve the quality of the surface, to serve as a treatment that will act as a water repellent surface to make the earth surface less vulnerable to water permeation through the external wall surfaces, as proposed by (Vyncke, Kupers, & Denies). Therefore, the additional

protective layer on the earth wall's surfaces, as well as surface treatment will extend the lifespan. Similarly, the extraction processes, product manufacturing methods, and strategies for constructing the building's enclosed space were all environmentally friendly. Thus, the entire processes produces no green house gasses GHGs and has no negative impact on the environment (Alagbe, 2010).

Objective/Hypotheses

This study aims to assess the professional architect's level of awareness regarding the use of compressed earth bricks as a wall material. The study's specific goals are as follows:

a) **To determine professional Architect's awareness of the use of compressed earth brick as a wall material.**
b) **To investigate whether there are differences in professional Architect's awareness of the use of compressed earth brick as a wall material based on their educational qualifications.**
c) **To determine whether professional Architect's awareness of the use of compressed earth brick as a wall material varies by their years of experience.**

Hypotheses

The following hypotheses were established and tested in this study based on the research objectives. Therefore;

H_{O1}: Based on their educational qualifications, there is no significant difference in the level of professional Architect's Awareness regarding the use of compressed earth brick as a wall material.

H_{O2}: There is no significant difference in the level of professional Architect's awareness regarding the use of compressed earth brick as a wall material based on their years of experience.

METHODOLOGY

Design

This is a quantitative study, and the data was collected using a cross-sectional online survey design to assess Professional Architects' knowledge of compressed earth bricks as a wall material in North-western Nigeria. In a cross-section survey design, the researcher measures both the outcome and the survey participants' exposures at the same time(Levin, 2006; Setia, 2016).

The Research Instrument/Scale

The instrument used in this study is a questionnaire that has been structured and verified questionnaire was divided into two (2) sections. Section A consists of questions about respondents' gender, years of experience, educational qualifications, and so on. Section B consists of items regarding the awareness of the use of compressed earth brick as a wall material. All of the items were prepared using known processes from the literature as well as the viewpoint of experts in the field of this study.

1) Measure of Application of Compressed Earth Brick

This section questions designed to assess respondents' knowledge of the use of compressed earth brick. The questionnaire was designed to be closed-ended and used a Likert scale to suit this study. This includes 12 carefully chosen items that are on a five-point (5) **Likert scale: Strongly Agree (S.A.), Agree (A), Disagree (D), and Strongly Disagree (S.D.)** The questionnaire was subjected to content validity, construct validity, and reliability tests.

2) Content Validity of the Research Instrument

The ability of an instrument to measure what it claims to be measuring is referred to as its validity. Accordingly, Some selected researchers in architecture and environmental sciences, as well as one other expert in related behavioral research participated in validating the instrument. The expert validation of instrument was based on the clarity of the language, the ambiguity of the statement, the relevance to the topic, and the appropriateness of the items, and only minor changes were made. The instrument was then updated before the final draft was produced.

3) Reliability/Internal Consistency of the Scale

The overall Cronbach's Alpha reliability coefficients of the items is 0.769. Even though it is close to the acceptable limit, the instrument's reliability must be improved by removing the last item (Q20) which is below 0.70 benchmark set out as acceptable for the internal consistency reliability of the items (Dewey et al., 2010; Hair, 2009). After removing the item, the new reliability coefficient revealed a Cronbach's Alpha reliability coefficient of 0.842.

Participants

This study involved 179 professional Architects from ~~the~~ seven states in Nigeria's northwestern zone. The sample size includes men and women of varied ages, educational backgrounds, and years of experience the demographic information collected from Section A of the questionnaire was described in this study using descriptive analysis (frequency and percentage).
The result of ~~the~~ gender distribution of the respondents revealed that 148 (82.7 percent) of the respondents are male, while 31 (17.3%) are female. According to the distribution of respondents' working experience, those with 1-5 years of experience make up 34 (19 percent), while those with 6-10 years of experience make up 83 percent (46.4 percent). Similarly, there were 62 participants with 11 or more years of work experience (34.6 percent).
Similarly, on the respondents' educational qualifications, it was revealed that 12 (6.7 percent) of them are National Diploma/N.C.E. holders, 68 (38 percent) are HND/B.Sc/B.Tech. certificate holders, and 77 (43 percent) are M.Sc/M.Tech. certificate holders. According to the distribution, 22 (12.3 percent) of the participants a Ph.D. Finally, the sample distribution of the study indicated that all segment of the study's population were fairly represented.

Administration of the Scale Questionnaire

The researcher administered the validated questionnaire directly by hand to the respondents with the help of some research assistants. The questionnaires were directly retrieved, scored, entered into SPSS package, and the data was used for analyses.

Data Analysis

The analyses employed in this study include descriptive statistic and Analysis of Variance (ANOVA). Descriptive statistical analyses were performed on respondent's background information and professional Architect's awareness on the use of compressed earth brick as a wall material. Similarly, ANOVA was employed to test whether the respondents' awareness on the use of compressed earth brick as a wall material differed based on their educational qualifications and years of experience.

RESULTS/FINDINGS AND DISCUSSIONS

Test of Normality

The basic requirement for conducting a parametric inferential statistical analysis is to test the data for normality (Pallant, 2013).
The normality test according to (Pallant, 2013)can be determined by assessing the skewness and kurtosis values. Subsequently, to demonstrate that the data is normally distributed, the skewness value should therefore be in the range of -2.0 to 2.0, while the kurtosis value should be in the range of 3.0 to 3.0. (Pallant, 2013). The results of normality test are presented in Table 2.

Variable		Skewness		Kurtosis	
	N	Statistic	Std. Error	Statistic	Std. Error
Application of CEB	179	-0.744	0.182	0.769	0.361

Table 2 Normality Test Results

As shown in Table 2, the application of compressed earth brick (CEB) has a skewness of -0.744 and kurtosis of 0.769, which falls within the acceptable ranges. Thus, the data was assumed to be normally distributed.

Descriptive Analysis

~~A~~ The descriptive statistical analysis was performed to achieve the objective of this study, and the results are presented in Table 3.

Research Question

What is the level of professional Architect's awareness regarding the use of compressed earth brick (C.E.B) as a wall material?
The variables in this section were the level of awareness of C.E.B. application among professional

Architects in North-western Nigeria. The goal is to determine the level of awareness among professional Architects regarding the use of C.E.B. as a wall material in North-western Nigeria. Table 3 displayed the mean and standard deviation values resulting from the descriptive analysis of C.E.B. application awareness among professional Architects in North-western Nigeria.

Variable	N	Min	Max	Sum	Mean	Std. Dev
Application of CEB	179	1.73	4.55	596.00	3.33	0.533

Table 3 Descriptive statistics

The results shows that the mean is greater than three (>3) out of a possible five, indicating that professional Architects have a moderate or favourable awareness level of C.E.B application. This implies that the professional Architects are fully aware of C.E.B application as a wall material.

Hypotheses Testing

The professional Architects responses on the questionnaire items were analysed using Analysis of Variance (ANOVA) to test whether the respondent's awareness on the use of C.E.B differed based on their educational qualifications and years of experience. The findings of the analysis are presented as follows:

H_{01}: *There is no significant difference in professional Architect's awareness of the use of compressed earth brick as a wall material based on their educational qualifications.*

To evaluate the above hypothesis, mean scores in Table 4 and ANOVA results in Table 5 were used.

Variable	Level	N	Mean	Std. Dev
Application of CEB	ND/NCE	12	3.14	0.321
	HND/B.Sc/B.Tech.	68	3.25	0.569
	M.Sc/M.Tech.	77	3.44	0.493
	PhD	22	3.31	0.590

Table 4 Descriptive Statistics

Test Variables		Sum of Squares	df	Mean Square	F	Sig.
Application of C.E.B.	Between Groups	1.826	3	.609	2.189	0.091
	Within Groups	48.669	175	.278		
	Total	50.495	178			

Table 5 ANOVA results of Architect's awareness of C.E.B. application based on educational qualifications

The results of One-way ANOVA shows that the F statistics (175) = 2.189 and *p*-value = 0.091, which is greater than 0.05 level of significance The results implies that the mean scores of professional Architect's awareness on the application of compressed earth brick are not significantly different based on their educational qualification (p>0.05). Thus, the null hypothesis was accepted.

H_{02}: *There is no significant difference in professional Architect's awareness on the use of Compressed Earth Brick as a wall material based on their year of experience.*

To evaluate the awareness of professional Architects in Northwestern Nigeria on the use of compressed earth brick based on their years of experience, mean scores and ANOVA were performed on the above hypothesis. The findings of the analyses are presented in Table 6 and Table 7.

Variable	Level	N	Mean	Std. Dev
Application of CEB	1-5 Years	34	3.37	0.489
	6-10 Years	83	3.34	0.521
	11 - Above	62	3.29	0.575

Table 6 Descriptive Statistics

Test Variables		Sum of Squares	df	Mean Square	F	Sig.
Application of C.E.B.	Between Groups	0.173	2	0.086	0.302	0.740
	Within Groups	50.323	176	0.286		
	Total	50.495	178			

Table 7 ANOVA results of Architect's awareness of C.E.B. application based on years of experience

The ~~test~~ ANOVA results as shown in Table ~~6~~ 7, revealed that the F statistics (175) = 0.302 and *p*-

value= 0.740 greater than 0.05 set out for the level of significance. The results implies that the mean scores of awareness of professional Architects in Northwestern Nigeria on the application of compressed earth brick are not significantly different, $p>0.05$. Therefore, the null hypothesis was accepted.

Overall, the study's findings shows no significant difference in professional Architects' level of awareness of the sustainable benefits of compressed earth brick based on their educational qualifications and years of experience.

CONCLUSIONS

According to the findings, Architects in North-western Nigeria are aware of compressed earth brick as a wall material. This is as a result that there is no significant difference in their level of awareness based on their educational qualifications and years of experience.

Furthermore, the application of earth as building material has structural limitation to height and construction of complex structures. However, introducing a reinforced concrete frame structural technique would amicably resolve all the weaknesses mentioned earlier. Thus, the earth materials can be used as an infill to cover up and demarcate spaces. Moreover, the wall surfaces of the earth structure can receive an additional coating to improve the quality of the surface, which serve as a treatment that can act as a water repellent to make the earth surface less vulnerable to water permeation through the external wall surfaces as proposed by (Vyncke et al.). The additional protective layer on the surfaces of the earth wall and surface treatment will prolong the lifespan.

RECOMMENDATIONS

Architects in North-western Nigeria are aware of the long-term advantages of C.E.B. as a wall material for constructing buildings. Then there is the need for the following strategies should be taken to improve sustainability of C.E.B in North-western Nigeria. These include:

1. As part of their community development service, Architects in North-western Nigeria should organize a symposium to educate the public on the trend of C.E.B. production and assembly as a sustainable wall material for building construction.
2. The government should implement a policy that encourages the public to use C.E.B. as a building material because of its numerous advantages, such as environmental, economic, and social advantages. Subsequently, the government should set a good example by using compressed earth brick (C.E.B.) to construct schools and government offices.

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