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Professional Architects Awareness on the Sustainable Benefits of Compressed Earth Brick as a Wall Material in North-Western Nigeria

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Abstract

The study intended to appraise the level of Awareness among the Professional Architects on the sustainable benefits of using compressed earth brick as a wall material for school in North-Western Nigeria. In the past, schools were built with earth, and their indoor thermal environments are friendly and more energy-efficient compared with the nowadays walling material. In order to accomplish the purpose of the study, a cross-sectional online survey design was adopted to collect the relevant data for evaluating the awareness level of the sustainable benefits of compressed earth bricks amongst the professional Architects in North-western Nigeria. Statistical analysis software ANOVA and SPSS 25 were utilized to determine the respondent's awareness level, on the sustainable benefits of C.E.B., and concerning their educational qualifications and year of experiences. The research data are analyzed based on a 5% level of significance for all statistical tests in this study. The analysis results reveal that the professionals are aware of the benefits, including availability, renewability, recyclability, and affordability. There is no significant difference in the professional Architects level of Awareness concerning their educational qualification because the p-value (0.376) is greater than the alpha value of 0.05, and also based on their years of experiences, there is no significant difference (p-value (0.850) is greater than the alpha value of 0.05). These trigger the need for government policies and the general public enlightenment by the building industry's professional bodies.

Key-words: Compressed Earth Brick, Professional Architects, Sustainable Benefits Awareness.

1. Introduction

Mud material is the oldest buildings construction material which has a manifold benefit that encapsulates the following; excellent thermal property, Non-toxic, energy-efficient building materials, environmentally friendly, embodied Energy, economical, low, act as a buffer to stabilize the relative humidity fluctuations, sound insulation, fire resistance, and aesthetic value [1, 2,3,4,5]

The building construction philosophy in Nigeria during the pre-independence era was entirely reliant on earth's use to construct various forms of building typology, the material extraction processes, and the product manufacturing methods. It assembles to erecting the enclosed space of the building's techniques were sustainable. All the processes involved do not cause any negative impact on the environment, resulting in the emission of G.H.S. [6, 7].

In the past, the earth is the preferred material for construction usage in hot-dry climate, due to its excellent characteristic ranging from its ability to avert the penetration of solar heat gain into the interior spaces of the building enclosure, flexible, readily available, less expensive, it is available and can be sourced locally. And there are several wall construction techniques, namely; tubali, adobe, wattle, and doubt, cob, [8,9,10,11]

Earth as a material for the construction of buildings, regardless of their typology, has been used for thousands of years. Approximately 30% of the world population still live-in structures built using earth materials [12]. The author further stated that earth as a building material is extensively used in part of the world that their weather condition is characterized by extreme temperature, particularly hot and arid climate regions. The earth material for the construction of the building is known with the better thermal property which does not allow the heat transfer from outdoor to the indoor environment which as a result will lead to an enhanced comfortable indoor space which in turn curb the utility bills.

Sustainable building materials are materials that are sourced locally and considered to be beneficial to the building occupants enormously ranging from low maintenance, energy efficiency, environmentally friendly, enhanced comfort and safety, and improved job efficiency; [13, 14, 15].

Earth buildings were found in the early human settlement decades ago, and the Egyptian dynasty promoted the use of earth bricks, with the aids of using hand implements to produce these bricks. The bricks are sun-dried before the construction development. Lately, the two technologies were combined both the traditional and modern technology for an improvement to the traditional techniques whereby they mixed earth is poured into the mold of the desired dimension and shape, and compressed it manually by aids using a hand to pressed the manual molding machine to attain the

desired quality or mechanically by using of automated machine to pressed the earth material to achieve a desired configuration or form of the brick product.

The manual process of compressed earth brick is more sustainable when compared with the mechanically processing type, as it does not require the use of fossil fuel or electricity to energize the machine for production, which would lead to emission of harmful gasses to the outdoor environment, which in turn contribute to the depletion of the ozone layer. Moreover, employing the use of earth for the building has numerous advantages, an example of few, namely environmentally (Nontoxic and No embodied Energy) and Economically (Less expensive, job Creation opportunity and Readily available); Social (Enhanced occupant comfort and Enhanced esthetic quality), among others.

Mud materials for building the building have a low embodied energy during its material extraction, production, and assembly. During the building operation, the energy consumption for cooling varies depending on the area's climate intensity [16]. Mud is an energy-efficient building material. Any building built with mud would benefit from less spending on utility bills to achieve a comfortable indoor thermal environment and less operational cost for cooling than the conventional concrete masonry unit.

A decade ago, buildings irrespective of their typology, were built with earth, and their remains still retained the acknowledged thermal characteristics which result in accomplishing comfortable interiors, [17, 18, 19]

[20] further elucidates that the contemporary modern materials were discovered as a result of the industrial revolution. Such materials are concrete and concrete masonry unit /sandcrete hollow block. The modern materials replaced the earth material without taking into cognizant to their thermal behavior is not as Energy efficient as earth material.

In view of the change in the use of the earth material that is known with excellent thermophysical property, and Energy-efficient material, to an advanced material that is predominantly used for building construction which requires a lot of energy demand for cooling to achieve indoor comfort, which will amount for huge operational cost and others relating to environmental and social advantage. Moreover, the study quest to assess the professional's Awareness of the benefits of the earth as material for building a building with their qualification and experience.

According to [21] Opines that a considerable number of the building industry professionals are aware and knowledgeable that the inappropriate selection of building materials led to the significant negative impacts on the environment during their extraction and production processes. However, the author further explained that, the professionals do not follow the sustainable design approaches in terms of materials specification and construction techniques.

Professional architects whose part of their responsibility, apart from designing buildings, are also to ensure an appropriate selection of building materials, that are environmentally friendly, energy-efficient, economically viable to enhance the building's comfort and life cycle cost of the building.

1.1. Objective/Hypotheses

The present study aims to assess the Professional Architects awareness level on the benefits of compressed earth bricks. Specifically, the study intends to:

a) Determine the levels of professional Architects Awareness of the Benefits of Compressed Earth Brick.
b) Examine whether differences exist in the level of professional Architects Awareness of the Benefits of Compressed Earth Brick concerning their educational qualifications.

Examine whether difference exist in the level of professional Architects Awareness of the Benefits of Compressed Earth Brick concerning their year of experience.

1.2. Hypotheses

Based on the research objectives, the following hypotheses were generated and tested in this study. Thus;

Ho1: There is no significant difference in the level of professional Architect Awareness on the Benefits of Compressed Earth Brick concerning their Educational Qualifications

Ho2: There is no significant difference in the level of professional Architect Awareness on the Benefits of Compressed Earth Brick concerning their year of experience.

2. Methodology

2.1. Design

This is quantitative research; A cross-sectional online survey design was adopted to collect the relevant data to evaluate the Professional Architects awareness level on the benefits of

compressed earth bricks in North-western Nigeria. In a cross-section survey design, the researcher measures the outcome and the exposures in a survey participant at the same time [22, 23]

2.2. The Research Instrument/Scale

The instrument for this study is a constructed and validated questionnaire. The instruments titled 'Awareness of Sustainable Benefit Earth Brick Assessment Scale (ASUSBAS)' were divided into two (2) sections; A and B. Section A contains items to assess respondents' demographic information that includes gender, years of experience, educational Qualifications, e.tc. Section B. contained items to measure: Benefits of Compressed Earth Brick. All the items generated were developed using established procedures in the literature and the stakeholders' perspectives, who are specialists in this study.

2.2.1. Measure of Benefits of Compressed Earth Brick

The instruments contain items to measure respondents' Awareness of the Benefits of the Compressed Earth Brick. The developed instrument was structured to suit the current research on closed-ended responses with a Likert-Type scale in different categories. The section contained eight (8) items carefully selected items rated on a 5-point Likert scale (Strongly Agree (S.A.), Agree (A), Disagree (D) and Strongly Disagree (S.D.). With a few modifications, the instrument was subjected to the content validity, construct validity, and reliability.

2.2.2. Content Validity of the Scale

An instrument is said to be valid if it essentially measures what it is intended to measure. The content validity of the scale (Awareness of Sustainable Benefit Earth Brick Assessment Scale (ASUSBAS) was content validated by (3) three professional researchers in building technology and environmental sciences as well as one other expert in related behavioral research (measurement and evaluation) for proper scrutiny. The experts validated the instruments in terms of clarity of language, the statement's ambiguity, relevance to the topic, and appropriateness of the items. After scrutinizing the instruments, some constructive suggestions and corrections made by the experts were affected before producing the instruments' final draft.

2.2.3. Reliability/Internal Consistency of the Scale

The result of the reliability analysis revealed the items' Cronbach's Alpha reliability coefficients of 0.800. This parameter is considered satisfactory reliability because according to [24, 25] a Cronbach's alpha scale of at least 0.70 is acceptable for the internal consistency reliability of the items and can therefore be accepted for study's purpose. These criteria served as the guidelines in interpreting the internal consistency-reliability coefficients in this research. As established by the result of analysis based on reliability statistics, the Awareness of Sustainable Benefit Earth Brick Assessment Scale (ASUSBAS) showed that, all the 08 items were retained.

2.3. Participants

The participants in this study were the 179 professional Architects selected from the 7 states in the North-western zone of Nigeria. The sample size comprises males and females of different ages, educational qualifications, and years of experience. In this study, descriptive analysis (Frequency and percentages) was conducted to describe the respondents' demographic information collected from Section A of the survey questionnaire. The information is presented in Table1 and was followed up with a comprehensive description.

Table 1- Demographic Information of the Respondents

	Variable	Level	N	%
1	Gender	Male	148	82.7
		Female	31	17.3
2	Experience	1-5 Years	34	19.0
		6-10 Years	83	46.4
		11 - Above	62	34.6
3	Education	ND/NCE	12	6.7
		HND/B.Sc/B.Tech	68	38.0
		M.Sc/M.Tech	77	43.0
		PhD	22	12.3

The summary distribution of the respondents presented in Table 1, above illustrates that, the distribution of the respondents based on gender shows that, 148 (82.7%) of the respondents are male while 31 (17.3%) of the respondents are female. The distribution for the respondent's working experience indicated that respondents with 1-5years of working experience are 34 (19%), those with

6-10years of working experiences are 83 (46.4%). Sımılarly, participants with 11 and above working experience were 62 (34.6%).

Similarly, the distribution based on respondents' highest educational qualifications, the data revealed that 12 (6.7%) are National Diploma/N.C.E. holders, 68 (38%) are holders of the HND/B.Sc/B.Tech certificate, 77 (43%) of the respondents' holds M.Sc/M.Tech The distribution also revealed that, 22 (12.3%) of the participants had obtained a PhD. Finally, looking at the study's sample distribution, it clearly depicted that all the sections of the study's population were fairly represented in this study.

2.4. Administration of the Scale

The developed and validated 'Awareness of Sustainable Benefit Earth Brick Assessment Scale (ASUSBAS)' was administered to the sample by the researcher after given specific instructions for the survey with the help of some research assistants. The questionnaire was retrieved directly, scored, entered, and used as data for the analyses.

2.5. Data Analysis

The data obtained from the respondents were coded, scores, and entered into MS-Excel 2016 file. After cleaning, the data were prepared into two different formats appropriate for the softwares used to analyzed data in this study. Descriptive statistical analysis (frequency, percentages, mean and standard deviation) was carried out to summarized data and addressed the first research objective. Similarly, inferential statistical analysis (ANOVA) was used to test the two study's hypotheses to detect a difference in the respondents' Awareness concerning their educational qualifications and year of experience. The SPSS 25 was utilized in analyzing the research data. 5% level of significance was set for all statistical tests in this study.

3. Results/Findings and Discussions

3.1. Test of Normality

In order to conduct the parametric inferential statistical analyses to determine the relationship or difference in study variables, it is recommended that, one of the most important requirements is to test the initial data for normality or usually distribution status of the data [26].

The normality test is essential for inferential analysis such as t-test, correlation, ANOVA, e.tc. Thus, according to [26], the normality could be asses by analyzing the values of skewness and kurtosis. Subsequently, to make the data evident of normally distributed is by implying the skewness value, which should be in the range of -2.0 to 2.0, whereas kurtosis's value has to be in the range of – 3.0 to 3.0 [26]. The results of the normality test in this study are presented in Table 2 below.

Table 2- Normality Test Result

Variable		Skewness		Kurtosis	
	N	Statistic	Std. Error	Statistic	Std. Error
Benefits of CEB	179	0.367	0.182	0.173	0.361

The measurement value of skewness and kurtosis for the total score of all the dimensions of the questionnaire represented by the data obtained revealed that all are is within the acceptable ranges for both skewness and kurtosis value. An inspection of the displayed results shows that, Benefits of C.E.B. have a skewness of 0.367 and kurtosis of 0.173. The measurement value of skewness and kurtosis are within the acceptable range. This explains that, the data is usually distributed.

3.2. Descriptive Analysis

Addressing the study's objective and answer the following research question, a descriptive statistical analysis was conducted, and the result of the analysis was summarized and presented in Table 3 below

3.3. Research Question 1: the levels of professional Architects awareness of the Benefits of Compressed Earth Brick

The variables of this study were the awareness level of Benefits of C.E.B. among professional Architects in North-western, Nigeria. The objective is to determine the level of professional Architects Awareness of the Benefits of C.E.B. in North-western, Nigeria. Table 3 presented the global mean and standard deviation values obtained from the descriptive analysis on the awareness level of Benefits of C.E.B. among professional Architects in North-western Nigeria. The mean scores for the awareness level of Benefits of C.E.B. are above 3 (>3) out of the (5) five obtainable scores, which symbolized a relatively moderate or favorable awareness level among professional Architects. Finally, the overall awareness level of the professional Architects in North-western Nigeria on the

Benefits of C.E.B. is considered to be favorable, meaning there is a significantly high level of Awareness among professional Architects in North-western Nigeria.

Table 3- Descriptive Statistics

Variable	N	Min	Max	Sum	Mean	Std. Dev
Benefits of CEB	179	2.63	4.88	644.63	3.60	0.414

3.4. Hypotheses Testing

In the test, the study's hypotheses, the Analysis of Variance (ANOVA), was conducted using the professional Architects responses on the questionnaire items. The results of the analysis are presented in the following headings and described accordingly. Thus;

Hypothesis 1: There is no significant difference in the level of professional Architects Awareness on the Benefits of Compressed Earth Brick concerning their Educational Qualifications.

in testing the above hypothesis, the Awareness on the Benefits of Compressed Earth Brick mean scores of professional Architects in the North-western Nigeria based on their educational qualification were used to conduct the test of ANOVA. The results of the analyses are presented in Table 4 and 5 below:

Table 4- Descriptive Statistics

Variable	Level	N	Mean	Std. Dev
Benefits of C.E.B.	ND/NCE	12	3.44	0.195
	HND/B.Sc/B.Tech	68	3.62	0.422
	M.Sc/M.Tech	77	3.63	0.439
	PhD	22	3.53	0.374

Table 5- Architects Awareness of C.E.B. Benefits (Qualifications)

Test Variables		Sum of Squares	df	Mean Square	F	Sig.
	Between Groups	0.535	3	0.178	1.041	0.376
Benefits of C.E.B.	Within Groups	29.989	175	0.171		
	Total	30.524	178			

The test results for the differences using the One-Way ANOVA, as shown in Table 5, show the F statistics (175) = 1.041 and p value= 0.376, $\alpha = 0.05$ for Awareness on the Benefits of Compressed Earth Brick. The analysis results reveal that the mean Awareness on the Benefits of Compressed Earth Brick scores of professional Architects based on their educational qualification in the North-western Nigeria are not significantly different (because the p-value (0.376) is greater than

the alpha value of 0.05). The null hypothesis, which says There is no significant difference in professional Architects Awareness on the Benefits of Compressed Earth Brick concerning their Educational Qualifications in the North-western Nigeria, is accepted since 0.376 > 0.05 according to [27].

Hypothesis 2: There is no significant difference in the level of professional Architects Awareness of the Benefits of Compressed Earth Brick concerning their year of experience

In testing the above hypothesis, the Awareness on the Benefits of Compressed Earth Brick means scores of professional Architects in the North-western Nigeria based on their educational qualification were used to conduct the test of ANOVA. The results of the analyses are presented in Table 6 and 7 below:

Table 6- Descriptive Statistics

Variable	Level	N	Mean	Std. Dev
Benefits of CEB	1-5 Years	34	3.57	0.429
	6-10 Years	83	3.61	0.416
	11 - Above	62	3.60	0.408

Table 7- Architects Awareness of C.E.B. Benefits (Experience)

Test Variables		Sum of Squares	df	Mean Square	F	Sig.
	Between Groups	.056	2	.028	0.163	0.850
Benefits of C.E.B.	Within Groups	30.468	176	.173		
	Total	30.524	178			

The test results for the differences using the One-Way ANOVA, as shown in Table 7, show the F statistics (175) = 0.163 and p value= 0.850, $\alpha = 0.05$ for Awareness on the Benefits of Compressed Earth Brick. The analysis results reveal that the mean Awareness on the Benefits of Compressed Earth Brick scores of professional Architects based on their years of experience in the North-western Nigeria is not significantly different (the p-value 0.850 is greater than the alpha value of 0.05). The null hypothesis says there is no significant difference in the level of professional Architects Awareness on the Benefits of Compressed Earth Brick with respect to their years of experience in the North-western Nigeria, which is accepted since 0.850 > 0.05 according to [28].

4. Conclusion

The study findings indicated that the professional Architects in northwestern Nigeria are aware of the benefits of using C.E.B. as walling material. The study also indicated that, there is no

significant difference in their level of Awareness concerning their level of educational qualification and the years of experience.

However, previous studies, reveal that the buildings built with earth materials have a tremendous advantage over what is used as building materials for wall construction nowadays.

Earth materials have demonstrated environmental quality in their extraction, product production, and finished product assembly. C.E.B as a product of earth material also exhibited excellent thermal performance as it does allow heat permeation from outdoor to indoor heat gain into the interior space of the building enclosure, it is affordable, resistant to fire, sound insulation, reusable, recyclable, flexible, and from an Architectural viewpoint, it requires little maintenance over a long period and has aesthetic value.

School buildings constructed with earth material for decades are acknowledged to have a more comfortable indoor thermal environment and energy efficiency than walling material. The use of earth as wall material improves the indoor living condition and boosts the academic environment for teaching and learning activities in northwestern Nigeria's hot dry climate regions.

5. Recommendation

The Architects in northwestern Nigeria are aware of the benefits of C.E.B. as a sustainable material for the construction of the building. Then there is the need for the following strategies, which includes:

1. Through their professional bodies, the professional Architects should organize a colloquium to enlighten the general public on the importance of embracing earth material as a sustainable wall material for building construction in northwestern Nigeria.
2. The Architects should enlighten and draw the attention of the governmental unit that is established to manage the infrastructural development, on the manifolds benefits of using C.E.B. as a product of earth material for construction buildings in northwestern Nigeria,
3. The government to make policies that will encourage the general public to embrace C.E.B. as a material for the construction of buildings due to several benefits that encapsulate the following Environmental, Economic, and Social benefits.

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