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Critical Analysis of Compressed Earth Block Technology Adoption in Bauchi State of Nigeria

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Abstract:

The construction sector worldwide must implement sustainable material solutions because its current operations create substantial environmental damage. The use of Compressed Earth Blocks (CEB) provides construction professionals with an environmentally friendly option that replaces traditional concrete blocks through its benefits of decreased energy needs, lower expenses, and the use of regional resources. Nigeria experiences a critical need for housing, yet its current adoption rate of CEB technology remains low. The research analyses the various factors which affect CEB technology implementation in Bauchi State, Nigeria, through its assessment of critical elements. The researchers adopted a quantitative approach using a survey distributed to 416 households in Bauchi Metropolis. The data were analysed using descriptive (Mean, percentage and RII) and inferential (multiple regression analysis) statistics. The results showed that people know about CEB benefits, which include creating job opportunities (Mean = 4.55) and reducing importation (Mean = 4.49). Furthermore, the findings showed low adoption of CEB technology, as evidence suggests that most respondents don't live in houses made of CEB (Mean = 1.64). The main obstacle to CEB technology adoption is untrained workers, leading to substandard products (RII = 0.90). The regression analysis shows that awareness positively influences acceptability ($\beta = 0.372$, $p < 0.001$), while challenges create a strong negative impact ($\beta = -0.588$, $p < 0.001$). The study concludes that residents are aware of CEB socio-economic benefits but are lacking in technical and performance-related benefits. Also, technical obstacles, together with socio-cultural issues and institutional challenges, create major obstacles which impede the transition from awareness to adoption. The solution requires developing a robust framework to establish CEB as an attractive, modern sustainable building material.

Keywords: *Adoption; Awareness; Construction Industry; Compressed Earth Blocks; Sustainable Construction.*

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1. Introduction:

1.1. Background:

The construction industry requires massive amounts of energy and natural resources, which result in major pollution problems and greenhouse gas emissions [1], [2]. The sector needs to change its material selection process because it has to choose materials which produce less environmental damage while maintaining their cost-effective nature [3]. Earth-based building materials have experienced a worldwide revival as global construction industry professionals turn to these materials for their building projects. Unfired earth stands as the oldest building material used by humanity, which now enables sustainable construction of buildings that use less energy and reflect cultural heritage [1], [4].

The traditional earth-based building method evolved into its current version, known as Compressed Earth Blocks (CEB). The construction process creates masonry units by using a mechanical press to apply pressure on damp soil, which meets the same building requirements as native earth material but requires a small amount of cement or lime stabilisation. CEBs bring various benefits when compared to traditional fired bricks and concrete blocks because they need less energy to produce while offering better thermal and acoustic insulation and using locally sourced materials and bringing cost reductions which can reach 20-30% [5], [6], [7].

Nigeria faces a severe housing shortage, which affects its population of over 200 million people because the country needs more than 22 million additional housing units [8]. The crisis worsens because regular construction materials are expensive, making it impossible for most low and middle-income people to buy their own homes. The Centre for Earth Construction Technology (CECTech) in Nigeria has worked since the 1990s to develop and promote CEB technologies. The project established earth construction as a reliable building option while demonstrating that local lateritic soils could be used to produce CEBs [9]. States including Bauchi established these bodies, yet their adoption rate remains low, as over 90% of new buildings continue to use concrete blocks [10], [11], [12]. The socio-cultural preferences, misconceptions about material durability, lack of technical knowledge, scarcity of demonstration projects, and weak state-level policy incentives collectively establish this pattern of behavior [13].

Bauchi State presents a clear example of this phenomenon. The study found that more than 90% of new buildings in Bauchi Metropolis use concrete blocks even though CEBs provide both economic and environmental benefits. The research gap emerges because the study needs to investigate which factors prevent sustainable technologies from achieving their full technical potential in society. The previous research documents CEB material properties and structural performance [14], [15], [16], but research has not investigated the specific socio-technical and perceptual barriers to CEB usage in particular Nigerian regions [11], [17].

Bauchi State serves as an ideal research site, allowing investigators to study the factors influencing CEB technology adoption, as the region needs sustainable building solutions and has abundant local soil resources. Current scientific research demonstrates that standard construction materials have a significant environmental impact. Almost 8% of global carbon pollution is caused by cement production [18]. The sharp rise in cement prices has created housing affordability problems in Nigeria. Bauchi State residents still do not adopt CEB technology, which delivers affordable and sustainable results through its natural lateritic soil and minimal cement stabilization requirements.

1.2. Statement of the Problem:

Despite the multiple advantages which CEB presents, the people of Bauchi Metropolis still choose to build with concrete block [19]. Research shows that earth materials face three main challenges, which include being perceived as "poor people’s materials," people lacking knowledge about their benefits, and there being no current CEB demonstration facilities [20]. The state of Bauchi will continue to use expensive construction materials, which generate high carbon emissions, until specific solutions are implemented.

The study will evaluate how CEB technology is used in Bauchi State through its critical assessment. The assessment goes further than technical evaluation because it examines how three factors, namely awareness, perception, and institutional frameworks, interact to either help or hinder sustainable technology implementation. The research will identify essential barriers while recognizing crucial leverage points, which will lead to evidence-based recommendations for Nigerian policymakers and industry stakeholders who work in sustainable housing projects throughout developing countries.

1.3. Aim and Objectives:

The research investigates how various factors determine CEB technology acceptance in Bauchi State, Nigeria, while creating research-based solutions to enhance sustainable earth construction practices across the area.

The study has the following objectives which are:

1. To determine the awareness of CEB technology in Bauchi State.
2. To evaluate the acceptance and adoption of CEB technology in Bauchi State.
3. To determine the prospective challenges faced in CEB technology adoption.

The study is limited to the opinions of the heads of households in Bauchi metropolis, who are predominantly males due to the cultural norms of household leadership in the region. No attempt was made to separately analyse the opinions of exceptional cases where household leaders are females, even though there is a possibility of having varying perceptions about CEB technology.

2. Literature Review:

2.1. The Global Imperative for Sustainable Building Materials:

The building sector accounts for nearly 40% of global energy-related CO_2 emissions [21]. The production of conventional materials like Ordinary Portland Cement (OPC) is exceptionally energy-intensive because every ton of produced cement results in the emission of approximately one ton of CO_2 [22]. The environmental impact of non-renewable resource depletion through sand and aggregate extraction has led to increased demand for low-carbon solutions [23]. Earth-based materials require minimal processing and no firing, which makes them more efficient because their embodied energy is 5 to 15 times lower than that of fired bricks and concrete blocks [4], [24].

2.2. Compressed Earth Block Technology: An Overview:

The definition of CEBs states that these masonry elements exist as small-sized building materials which can be identified through their standard physical properties that result from the process of earth compression at humid conditions, followed by immediate demoulding [25]. Compressed Stabilised Earth Blocks (CSEBs) are produced when binders such as cement are applied to earth materials at 3-7%, resulting in materials that exhibit higher strength and durability and improved resistance to water [26], [27]. The literature provides comprehensive evidence for CEB benefits, which exist in multiple studies [1], [4], [5], [28]; through three main advantage categories, which include:

1. Environmental: Their low embodied energy, minimal pollution and biodegradable nature allow for efficient resource management.
2. Economic: The use of local materials results in cost savings, which also creates job opportunities while decreasing the need for imported materials.
3. Socio-Technical: The building provides heating, comfort, fire protection and soundproofing and meets cultural needs.

Despite these numerous advantages, the system still faces three main difficulties; erosion will occur without proper stabilisation, soil identification and production, which requires skilled workers, and many countries lack standard codes [1], [5], [29].

2.3. The Nigerian Housing Context and Earth Construction:

The housing crisis in Nigeria shows both quantitative and qualitative problems through its overcrowding issues, slum growth and housing costs, which exceed people's ability to pay [8][30]. The crisis exists because people face high costs when they try to buy standard construction materials. Nigerian builders used earth as their primary material until colonial powers and post-colonial systems shifted their preference toward "modern" materials, which included concrete and steel that became status symbols [31], [32]. The social and cultural environment which exists today creates a situation where people view earth construction as an inferior building method because they associate it with temporary, low-quality solutions which low-income people can afford despite proof of its long-lasting nature [33], [34].

2.4. Theoretical Frameworks for Technology Adoption:

The process of adopting CEB technology goes beyond its technical aspects because it involves multiple social dynamics. [35] establishes five key factors which determine whether people will adopt new technologies. The sustainable cost advantages of CEB technology in Nigeria become less important when people believe that its sustainable qualities do not match their standards for sustainable construction. The inability to observe successful CEB buildings and the requirement for users to conduct actual trials creates major obstacles [11], [17].

Research conducted in various African countries has uncovered identical obstacles. [7] emphasise the critical role of government policy and standards in Ghana, while [12] point to a lack of technical knowledge and skilled artisans as a primary barrier in Southwestern Nigeria. This research study contributes to the existing literature by presenting an empirical examination which focuses on Northern Nigeria.

2.4.1 Theoretical Justification for Variable Selection

The selection of Awareness and Challenges as explanatory variables for Acceptability is grounded in two complementary theoretical frameworks:

Diffusion of Innovations Theory [35]: Rogers identifies five attributes that predict adoption speed: relative advantage, compatibility, complexity, trialability, and observability. Awareness directly operationalizes knowledge of relative advantage (economic benefits) and compatibility (local material availability). Challenges operationalize perceived complexity (technological know-how, skilled labor requirements) and observability (poor quality of existing CEB buildings serving as negative observations).

Technology Acceptance Model (TAM) [36]: TAM posits that perceived usefulness and perceived ease of use determine technology adoption. Awareness captures perceived usefulness (employment creation, cost reduction, environmental benefits). Challenges capture perceived ease of use barriers (untrained workers, time requirements, lack of codes).

3. Methodology:

3.1. Research Design and Area:

This study employed a quantitative, cross-sectional research design, utilising a field survey to collect primary data. The study area was Bauchi Metropolis, the capital of Bauchi State, located in North-Eastern Nigeria. The metropolis was stratified into eight (8) administrative zones (clusters) as defined by the Power Holding Company of Nigeria (PHCN), following the zoning framework established [37].

3.2. Population and Sampling:

The target population for this study was all households in Bauchi Metropolis, totalling 33,339 households [37]. Using the Krejcie and Morgan (1970) sample size determination table, a representative sample of 379 households was selected. A cluster sampling technique was employed, where the eight zones constituted the clusters. Households within each zone were then selected using simple random sampling, with the sample size per zone proportional to its population (Table 1).

Table 1: Sample Size Distribution Across Zones

Zone	Household Distribution	% Distribution	Effective Sample Size	Sample Interval	Sample Size after 10% Addition for Non-response
ZONE 1	4,544	13.63	52	87	57
ZONE 2	4,123	12.37	47	88	52
ZONE 3	4,439	13.31	50	89	55
ZONE 4	5,782	17.34	66	88	73
ZONE 5	2,566	7.70	30	86	33
ZONE 6	3,289	9.87	38	87	42
ZONE 7	2,765	8.29	31	89	33
ZONE 8	5,731	17.19	65	88	71
TOTAL	33,339	100	379		416

3.3. Data Collection and Instrument:

Data was collected using a structured questionnaire, divided into four main sections:

1. Section A: Demographic information of respondents (gender, education, duration of residence).
2. Section B: Assessed respondents' knowledge of CEB benefits using a 5-point Likert scale (1=Never True to 5=Always True).
3. Section C: Measured the level of CEB acceptability using a 5-point Likert scale (1=Strongly Oppose to 5=Strongly Favor).

4. Section D: Identified challenges to CEB acceptability using a 5-point Likert scale (1=Strongly Disagree to 5=Strongly Agree).

3.4.Data Analysis:

Data was analysed using the Statistical Package for the Social Sciences (SPSS version 21). Descriptive statistics (frequencies, percentages, means, and RII) were used to summarise the data. The Relative Importance Index (RII) was calculated for each variable in the knowledge and challenges sections to rank them. The RII is computed as: $RII = \Sigma W / (A * N)$, where W is the weight given to each factor by respondents, A is the highest weight (5), and N is the total number of respondents. The RII ranges from 0 to 1, with higher values indicating greater importance or agreement [38]. To determine the effect of awareness and challenges on the level of acceptability, an inferential statistic (multiple regression analysis) was performed. The model was specified as:

Acceptability = $\beta_0 + \beta_1$(Awareness) + β_2(Challenges) + ε

Where β_0 is the constant, β_1 and β_2 are regression coefficients, and ε is the error term.

3.5. Data Cleaning and Validation Procedure:

After the data collection stage, the full set of returned questionnaires was basically run through a cleaning and validation routine, quite systematically, but also not only one time.

Exclusion screening rules for removal of returned questionnaires (n=7) that did not make it into the final analysis are:

Incomplete answers (n=4): questionnaires were left out when more than 15% of responses were absent across the four sections. The 15% cut-off was used because it matches common survey recommendations [39].

Straight lining behavior (n=2): respondents who repeatedly picked the same Likert option, like all “5”, for 20 or more successive items. This is usually interpreted as response fatigue or inattentiveness [40].

Illegible or conflicting answers (n=1): there was one form where the respondent gave internal contradictions; for instance, they said they had “no knowledge of CEB” but still moved on to rate CEB characteristics with high agreement. Hence, it was removed.

3.6. Composite Variable Construction for Regression Analysis:

Three composite variables were constructed as predictors and outcome for the multiple regression analysis:

Awareness (Independent variable I): This composite variable represented how respondents knew about CEB benefits, across 15 items (Table 4). The items, in a way, tapped three theorized parts of awareness: socio-economic payoffs (items 1-5), technical or performance advantages (items 6-11), and environmental benefits (items 12-15). For every respondent, the Awareness score was computed like this:

$Awareness_i = (\Sigma x_j) / k$

Where x_j stands for the Likert score (1-5) for each awareness item j, and k = 15 (total number of awareness items). Mean aggregation was selected over summed scores to preserve the original 1-5 metric, facilitating interpretation of regression coefficients (i.e., a one-unit increase in mean awareness corresponds to a β-unit change in acceptability). Standardised scores (z-scores) were also computed for sensitivity analysis and produced materially identical results (available from corresponding author).

Acceptability (Dependent Variable): This measured adoption intention and behavior across five items (Table 5). The construct addressed two behavioural stages, current adoption (items 4&5: "your house is made of CEB," "most houses are made of CEB") and future intention (items 1-3: willingness to learn, encourage others, consider living in CEB). $Acceptability_i$ was computed as the mean score across all five items. A separate sensitivity analysis treated current adoption and future intention as separate composites, which confirms that the aggregated measure didn't hide any divergent patterns.

Challenges (Independent Variable 2): This composite variable represented perceived barriers for CEB adoption across 16 items (Table 6). The items captured technical challenges (items 1-3, 5, 8, 11, 12, 14), institutional challenges (items 4, 13, 15) and socio-cultural challenges (items 6, 7, 9, 10, 16). $Challenges_i$ was calculated as the mean score across all those 16 items. Reverse-coding was applied only to the items that were worded as absence of barriers, like when the statement was "CEB is more expensive than concrete blocks", and it was kept exactly as written; no reverse-coding was needed because every item was positively framed as an obstacle.

3.7. Reliability and Validity Assessment:

3.7.1 Reliability

The reliability of each composite scale was assessed using Cronbach's alpha coefficient (Table 2) to check for internal consistency. All three scales exceeded the conventional threshold of $\alpha \geq 0.70$ [41], indicating acceptable to excellent internal consistency.

Table 2: Reliability Statistics for Composite Variables

Composite variable	Number of items	Cronbach's α	95% CI for α	Interpretation
Awareness	15	0.87	(0.84, 0.90)	Good
Acceptability	5	0.81	(0.77, 0.85)	Good
Challenges	16	0.91	(0.89, 0.93)	Excellent

3.7.2 Validity

Face validity was established through expert review. The questionnaire was reviewed by five experts in sustainable construction with an average of 30 years' experience in both academic and industry practice, who confirmed item appropriateness. Content validity was assessed using the Content Validity Ratio (CVR) following Lawshe (1975). Eleven experts rated each item as "essential," "useful but not essential," or "not necessary." Items with CVR < 0.59 (critical value for 11 experts at p=0.05) were revised or removed. All final items exceeded this threshold (CVR range: 0.64-1.00).

3.8. Theoretical Justification for Relative Importance Index (RII):

The Relative Importance Index was selected due to its compatibility with ordinal Likert data. While Likert scales are often treated as interval data in parametric analyses [42], RII makes no interval assumption; rather, it uses the principle of weighted proportions. This non-parametric approach is more conservative and appropriate for ranking perceptual data where equal spacing between response categories cannot be assumed [43]. RII has also been extensively validated and widely adopted in construction management and sustainable building research across developing economies [42]. Hence, facilitating cross-study comparison, becoming an advantage given the limited body of CEB adoption research in Northern Nigeria.

The use of RII will also facilitate intuitive interpretation for practitioners. The RII's 0-1 scaling provides an accessible metric for policymakers and industry stakeholders who may not be statistically trained. An RII of 0.90 indicates that 90% of the maximum possible agreement was achieved, directly communicating item importance.

4. Results and Discussion:

4.1. Response Rate and Demographics of Respondents:

A total of 416 questionnaires were distributed, 352 were duly completed, and 345 were used for analysis, yielding a response rate of 83%, which is considered very adequate [44]. The demographic data (Table 2) indicate that a significant proportion had lived in Bauchi Metropolis for over 20 years (75.1%) and in their current homes for 16-20 years (50.1%), suggesting deep-rooted familiarity with local building practices. Education levels varied, with 35.1% having a First School Leaving Certificate and 24% holding an SSCE, indicating that the sample was literate and capable of providing informed responses.

Table 3: Demographic Characteristics of Respondents

S/No.	Variables	Options	Frequency	Percentage
1.	Education Background	FSL CERT	121	35.1
		SSCE	83	24.0
		HND/DEGREE	51	14.8
		MSc/Phd	10	2.9
		Others	80	23.2
		Total	345	100
2.	Staying Period in Bauchi Metropolis	1-5 years	22	6.4
		6-10 years	19	5.5
		11-15 years	16	4.6
		16-20 years	29	8.4
		Above 20 years	259	75.1
		Total	345	100
3.	Staying Period in the present house	1-5 years	33	9.6
		6-10 years	29	8.4
		11-15 years	30	8.7
		16-20 years	173	50.1
		Above 20 years	80	23.2
		Total	345	100

4.2. Awareness and Knowledge of CEB Technology:

The analysis of respondents' knowledge (Table 4) reveals a surprisingly high level of awareness regarding the socio-economic benefits of CEBs. The top-ranked characteristics were; creation of employment for unemployed people (RII=0.91), reduction of importation (RII=0.90), readily available materials (RII=0.82) and affordability when compared to concrete blocks (RII=0.82). This suggests that information campaigns and the logical appeal of CEB's economic benefits have been effective. However, awareness of its technical and performance-related benefits was markedly lower. Characteristics such as durability (RII=0.47), energy efficiency (RII=0.52), and resistance to insects (RII=0.61) were ranked at the bottom. This indicates a critical knowledge gap; while people understand CEB's economic and local value proposition, they are sceptical of its long-term performance and structural integrity compared to concrete. This aligns with findings by [32], who noted that perceived poor durability is a major mental block against earth-based construction in Nigeria.

Table 4: Respondents' Level of Awareness of CEB Technology

S/No.	Level of awareness of CEB?	Mean	RII	Rank
1	It creates employment for unemployed people	4.55	0.91	1st
2	It reduces importation	4.49	0.90	2nd
3	Its materials are readily available	4.11	0.82	3rd
4	It is cheaper and more affordable compared to concrete blocks.	4.09	0.82	4th
5	CEB buildings are beautiful in appearance compared to concrete blocks.	4.05	0.81	5th
6	It is a simple technology, easy to learn.	4.02	0.80	6th
7	Materials for CEB are completely natural and non-toxic.	3.95	0.79	7th
8	It has excellent fire resistance properties.	3.94	0.79	8th
9	It is consistently made of uniform size.	3.66	0.73	9th
10	It is a thermal insulator.	3.41	0.68	10th
11	It resists insects because it is a solid block.	3.06	0.61	11th
12	It serves as sound resistance.	2.97	0.59	12th
13	CEB house can withstand minimal maintenance.	2.63	0.53	13th
14	It is energy efficient and eco-friendly.	2.61	0.52	14th
15	It makes durable building material for a home.	2.37	0.47	15th

4.3. Level of CEB Acceptance:

Residents of Bauchi Metropolis showed extremely low adoption rates for CEB technology despite their high understanding of its advantages (Table 5). The statements "Most houses in Bauchi metropolis are made of CEB" and "Your house is made of CEB" received the lowest RII scores of 0.30 and 0.33, respectively, which confirmed the visual observation that over 90% of constructions use concrete blocks. The most telling finding, however, lies in the contrast between current reality and future intention. Respondents showed strong interest in learning about CEB technology despite the fact that its current usage rate remains extremely low (RII=0.79). The participants showed mild support for promoting the material to others (RII=0.72) and for living in CEB homes themselves (RII=0.72). Organisations face a "willingness-adoption gap." The population shows interest in the concept yet fails to take any concrete steps forward in adopting CEB technology. The analysis focuses on this gap, which acts as the analysis's primary issue.

Table 5: Level of CEB Acceptance in Bauchi Metropolis

S/No.	Statement on Acceptability	Mean	RII
1	Willing to learn more about CEB	3.97	0.79
2	Will encourage others to use CEB	3.62	0.72
3	Will consider living in a CEB house	3.60	0.72
4	Your house is made of CEB	1.64	0.33
5	Most houses in Bauchi are made of CEB	1.51	0.30

Source: Field survey, 2025

4.4. Critical Barriers to Adoption:

The research uncovered multiple significant obstacles which led to the discovery of non-technical challenges as the primary obstacles (Table 6). The most significant barriers were:

1. Untrained teams produce bad quality products RII=0.90. This is arguably the most critical barrier. Building structures which endure poor construction standards will develop cracks, erosion and complete structural failures, which create visible evidence that supports negative public views and destroys community trust in the construction process [29].

2. The process of production and construction requires additional time RII=0.89. Fast-growing urban areas consider construction speed to be an essential performance measurement. CEB construction appears to progress too slowly, which reduces its overall advantages.

3. Existing CEB buildings exhibit poor quality RII=0.83, which results directly from the first barrier. These poorly executed buildings serve as negative advertisements which create a vicious cycle of distrust.

4. The absence of building codes and performance standards RII=0.81. This implies that the national standard for earth construction is nonexistent, which constitutes a critical institutional shortcoming. The absence of an official quality benchmark forces clients, builders and regulators to operate under uncertainty, which prevents financial institutions from granting loans for CEB projects [7], [27].
5. The two barriers of technological expertise deficiencies (RII 0.78) and connections with impoverished groups (RII 0.72) function together as a single obstacle. The expertise gap results in poor building quality, which leads to occupancy by people who cannot afford modern materials, thus perpetuating the stigma. The socio-cultural perspective acts as a strong barrier which prevents the aspiring middle class from achieving their housing goals, as a house represents their main status symbol [17], [31].

The ranking of "unavailability of laterite" RII=0.57 and "CEB is more expensive" RII=0.35 as less critical obstacles proves that material shortages and expenses do not constitute the main difficulties. The fundamental challenges stem from human capacity deficits, which affect institutional frameworks and lead to prevailing societal beliefs.

Table 6: Challenges to CEB Acceptability

S/N	Challenges	Mean	RII	Rank
1	Untrained teams produce bad quality products	4.50	0.90	1st
2	It takes more time to produce and erect compared to concrete blocks.	4.44	0.89	2nd
3	Poor quality of existing CEB buildings.	4.17	0.83	3rd
4	Lack of building codes and performance standards.	4.03	0.81	4th
5	Lack of technological knowhow.	3.91	0.78	5th
6	It requires regular maintenance	3.82	0.76	6th
7	It is not as durable as concrete blocks	3.77	0.75	7th
8	Poor soil identification	3.62	0.72	8th
9	High and long buildings are difficult to build with CEB.	3.60	0.72	9th
10	It is associated with the poor.	3.57	0.72	10th
11	It has poor resistance to abrasion and impact.	3.22	0.64	11th
12	Unavailability of production equipment.	3.10	0.62	12th
13	Unavailability of laterite in some areas.	2.84	0.57	13th
14	Bad quality production equipment.	2.59	0.52	14th
15	Lack of commercial production of CEB.	1.75	0.35	15th
16	It is more expensive than concrete blocks.	1.74	0.35	16th

Source: Field survey, 2025

4.5. Effect of Awareness and Challenges on Acceptability:

The multiple regression analysis (Table 7) provides a robust statistical model to understand the dynamics of adoption. The model established statistical significance through its F-value of 164.063 and achieved a p-value below the 0.001 threshold, which enabled it to account for 60.6% of CEB acceptability variance ($R^2 = 0.606$).

The results confirm the dual nature of the problem: Awareness ($\beta = 0.372$, $p < 0.001$): Has a significant positive effect on acceptability. The results demonstrate that awareness campaigns together with knowledge dissemination represent the essential first step which needs to happen before any future work can proceed.

Challenges ($\beta = -0.588$, $p < 0.001$): Have a stronger, significant negative effect on acceptability. The discovered obstacles function as active blockers towards adoption because their harmful effects exceed the beneficial impacts which awareness creates.

The quantitative result demonstrates that increasing awareness does not lead to sufficient outcomes. To achieve effective adoption, people must work together to solve all the main obstacles which stop them from adopting new practices.

Table 7: Multiple Regression Analysis Results

	Coefficients	**Standard Error**	**T-Value**	**P-value**
Constant	3.920	.432	9.065	<.0001
Awareness	.372	.078	4.746	<.0001
Challenges	-.588	.074	-7.954	<.0001
R = 0.779, **R^2** = 0.606 **F(2, 342) = 164.063** (p<0.0001)		**Adjusted R^2 = 0.603**		

The model explains 60.6% of variance in CEB acceptability ($R^2 = 0.606$). The negative coefficient for Challenges ($\beta = -0.588$) is substantially bigger in magnitude than the positive coefficient for Awareness ($\beta = 0.372$), so it looks as if the barriers to adoption exert around 1.58 times the influence of the awareness benefits. The strong negative coefficient for Challenges ($\beta = -0.588$) suggests that perceived ease of use barriers outweigh perceived usefulness benefits in the current

Nigerian context a finding consistent with TAM's prediction that usability barriers can nullify utility advantages.

4.5.1 Regression Assumption Diagnostics

Prior to model estimation, all assumptions for ordinary least squares (OLS) regression were tested:

Assumption 1 (Linearity): Scatterplots of residuals versus predicted values revealed no discernible curvilinear patterns. The Ramsey RESET test ($F = 1.42$, $p = 0.24$) confirmed linearity, failing to reject the null of correct functional specification.

Assumption 2 (Normality of Residuals): The Shapiro wilk test for standardized residuals ($W = 0.99$, $p = 0.11$) and visual inspection of Q-Q plots indicated approximate normality. Skewness (0.12) and kurtosis (-0.08) values were within acceptable ranges ($|skewness| < 2$, $|kurtosis| < 7$).

Assumption 3 (Homoscedasticity): The Breusch pagan test for heteroscedasticity ($\chi^2 = 2.34$, $df = 2$, $p = 0.31$) indicated constant error variance. The White test ($\chi^2 = 6.78$, $df = 5$, $p = 0.24$) confirmed this finding.

Assumption 4 (Independence of Errors): The Durbin watson statistic ($d = 1.89$) was within the acceptable range (1.5-2.5), indicating no autocorrelation.

Assumption 5 (Multicollinearity): Variance Inflation Factor (VIF) values were 1.38 for Awareness and 1.42 for Challenges (tolerance = 0.72 and 0.70, respectively), substantially below the threshold of 5 [46], confirming no multicollinearity concern.

Assumption 6 (Influential Observations): Cook's distance values ranged from 0.00 to 0.08 (threshold: >1 indicates influence), and DFBETAS values for all predictors were < 0.2, indicating no cases exerted undue influence on model estimates.

5. Conclusion and recommendations:

5.1.Conclusion:

The research investigated how CEB technology was adopted in Bauchi State by studying its technical capacity and socio-technical system, which determines market performance. The research results show that the residents of Bauchi Metropolis have a latent interest in CEB technology; while they understand its socio-economic advantages, they are, however, lacking in the understanding of its technical and performance-related benefits. The existing potential development for the area suffers from critical barriers, which include skilled labour shortages, missing quality assurance systems and negative social attitudes toward the industry.

The research discovered that the "willingness-adoption gap" functions as the main obstacle to progress. The residents of the area display a willingness to learn about CEB technology because they do not actively oppose it. The community currently values risk management more than the proven advantages, which include cost savings and sustainable development. The regression analysis shows that awareness helps adoption, but organisations will achieve widespread adoption through their efforts to tackle existing obstacles.

5.2. Recommendations:

The CEB technology requires a comprehensive strategic method to achieve its transition from being a niche, underused solution to widespread application for solving Nigeria's housing problem. The following recommendations are proposed:

1. Develop the needed capability for CEB adoption through effective and efficient training of skilled (site managers, project managers and other relevant construction professionals) and unskilled (masons, carpenters, iron benders, tilers, painters, etc.) workers. This training will in turn improve technical know-how, productivity time and the quality of workmanship, which are major challenges limiting its full adoption.
2. Establishing relevant building codes and performance standards with respect to CEB technology would also improve its adoption. The standard should define procedures for selecting soil materials, methods for implementing stabilisation, building manufacturing processes, and conducting quality tests.
3. A wide-scale awareness campaign programme within and outside Bauchi metropolis on the technical and performance-related benefits of CEB technology, such as its durability, thermal resistance, sound resistance, ability to withstand minimal maintenance, energy-efficient and eco-friendly nature, would help improve its adoption, as it has been established from this research that a strong relationship exists between awareness and adoption.

5.3.Limitations and Future Research:

The study acknowledges the predominance of male respondents, which is basically anchored in the cultural reality of household headship in Bauchi State; the possible effect of this gender imbalance on the study's outcomes is worth noting.

Potential gender-based differences in CEB Perception: Newer insights on sustainable construction uptake keep hinting that women and men might judge building materials differently, depending on varying domestic needs [45]. Women, as day-to-day managers of indoor spaces, are often more attached to thermal comfort, indoor air quality, and the things that keep a home running well. In our case, these are the exact items where awareness was low (like "energy efficient and eco-friendly", which came 14th, RII=0.52; and "durable building material", which came 15th, RII=0.47). Men, on the other hand, may lean more toward economic angles such as job opportunities, cost reduction, and general structural strength, which were more noticeable in the responses. So, those relatively high awareness scores for socio-economic gains could end up sounding louder than what the wider public truly knows if women's views, often more tuned to performance and comfort, are not sufficiently represented.

Therefore, the findings can be generalized mainly to male-headed households in Bauchi Metropolis, which is a big part of the picture but not the entire landscape of housing decisions. In many Nigerian homes, housing choices are negotiated through joint spousal consultation, even when the formal headship is male. For that reason, future work using mixed methods and with purposive sampling of women is quite essential, so that gender differentiated adoption routes can be understood properly. The authors also suggest that subsequent studies in this area should intentionally oversample women (for instance, 40-50% female representation), by focusing enumeration on female-headed households, and by including married women as respondents on their own, not as stand-in proxies for the household head.

Authorship Contributions Statement:

C.I. Egwuda: Conceptualisation, Methodology, Formal analysis, Writing – original draft, Writing – review & editing, Supervision; **A.A. Isah**: Data curation, project administration, Investigation, Validation, Writing – original draft, Resources, Software (SPSS). **A.A. Salihu**: Validation, Writing – review & editing,Supervision; **M. Sadiq**: Data curation, Writing – original draft, Visualisation; **U.S. Odaudu**: Research title restructuring and proofreading.

All authors have read and approved the final version of this manuscript and agree to be accountable for all aspects of the work.

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Declaration of competing interest:

The authors declare that they have no financial interests or personal relationships which would have affected their research work in this paper. The authors of this study have no connection to organisations which develop compressed earth block technology or to organisations which develop alternative building materials such as cement or concrete block production. The research was conducted as an independent academic study.

Data availability:

The article contains all the data which supports the study findings. The corresponding author will provide access to raw survey data for anyone who makes a reasonable request.

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