Identifying the Key Behaviours to Promote Sustainable Constructions in Nigeria: A Principal Component Analysis

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Abstract

The burgeoning field of sustainable construction necessitates a profound re-evaluation of traditional building practices, with a transition towards eco-friendly, energy-efficient, and socially responsible methodologies in building construction. We studied a unique population of students in Building Technology Education (BTE) whose bi-directional training makes them relevant for environmental education both in classrooms and in actual building construction. We conveniently surveyed 171 students and 47 building construction experts using a 29-item questionnaire. "Restoring brownfields for low-cost habitable buildings" and "retraining manpower in sustainable methods" ranked highest in the Relative Importance Index. Validity checks confirmed participant sufficiency, and Principal Component Analysis revealed seven themed components: support for the local economy, manpower and social norms; value for humans and nature; reducing resource consumption and waste generation; use of integrated design approach and building site assessment; recycling and reusing of materials; attention to land use; and incremental green technology integration. These themes collectively offer a comprehensive framework for training future professionals to champion sustainability both in the classrooms and in the actual building construction operations. Thus, this study addressed diverse facets of construction sustainable behaviours, discovering the multifaceted and interconnected nature of sustainable construction and necessary behaviours.

Keywords: *building technology education, construction sustainable behaviours, principal component analysis, sustainable construction*

Introduction

Building construction continues to grow in leaps and bounds, to accommodate population growth, as well as rural-urban migration upshots. Likewise, the environmental footprint of the construction sector increases impact on all fronts: depleting natural resources, increasing environmental pollution, incessant waste generation, and unending deforestation (Karji et al., 2020). The global climate change impacts parallel the positive economic growth driven

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by the building construction sector, with detrimental effects on the triple bottom line of sustainability (i.e., people, planet, and profit). Since a society can only run an economy in an environment, the three pillars (society, economy, and environment) have become inseparable. Thus, in striving to meet housing demands, building construction practices that contribute to the sustainability agenda and also mitigate climate change impacts among young learners (Alsaati et al., 2020; Drejeris & Kavolynas, 2014), have become a critical focus today.

Sustainability is a pathway to create an all-round balance, now and in the future. Sustainability in the economy encourages policies for promoting innovations designed to enhance productivity and industrialisation without harm to the future. It opens up businesses, creating more jobs, and thereby tackling unemployment (Chan et al., 2017). Environmentally, sustainability enforces systems that integrate reduction in resource consumption, recycling, investment in alternatives, preventing over-exploitation of non-renewable resources, and integrating more renewable resources (Ahn et al., 2013; Kibert, 2013). Social sustainability fosters both individual and collective roles in ensuring working and business conditions of no detrimental consequences to health, comfort, and rights to life (Karji et al., 2020). In the building construction sector, sustainable construction practices and green building have been developed to ensure alignment of the built environment with a sustainability vision.

Sustainable construction is the practice of creating structures using environmentally responsible processes and resource-efficiency throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction (Environmental Protection Agency [EPA], n.d.). Sustainable construction is guided by principles (Kibert, 2013) which focus on reducing resource consumption, reusing and recycling resources, protecting nature, eliminating toxics, applying life-cycle costing, and focusing on quality. In practice, following sustainable construction principles ensures that building construction phases such as planning, development, design, construction, use and operation, maintenance, modification and deconstruction, pay attention to the use of land, materials, water, energy and the environment (Allcott & Mullainathan, 2010; Heeren et al., 2016; Kibert, 2013). Engaging the principles of sustainable construction produces green or high-performance buildings. Green buildings feature the use of renewable energy (for example, solar energy), efficient use of energy, water and other resources, good indoor environmental quality, pollution and waste reduction, use of recycled, recyclable and reusable materials in constructions, integrating green building technologies (GBTs) (Darko & Chan, 2018), to name a few.

The burgeoning field of sustainable construction necessitates a profound re-evaluation of traditional building practices, urging a transition towards eco-friendly, energy-efficient, and socially responsible methodologies, hence the need for construction sustainable behaviours (CSB). At the crux of this transformation are the students of building technology education programmes, who, as future professionals, wield the power to either perpetuate outdated

norms or champion innovative sustainable paradigms. This study aspires to unravel the key behaviours that hold the potential to drive sustainable construction practices among these budding professionals in Nigeria.

This study considers a vital population, whose impact on building construction spans across two sectors, education and the actual building construction operations. Building Technology Education (BTE) students with bi-directional study are vital in the quest for behavioural adjustment and in driving high-level sustainability consciousness among younger learners. Thus, the significance of this study extends beyond theoretical discourse, branching into practical implications for both academia and industry. BTE stands to gain insights into refining its curricula, ensuring that the identified key behaviours are seamlessly woven into the educational fabric. Consequently, graduates can embark on their professional journeys armed with not only technical prowess but also a staunch commitment to sustainable practices. Moreover, the research findings could resonate with policymakers and regulatory bodies, prompting a re-evaluation of existing norms and regulations surrounding building construction practices in Nigeria, especially those concerned with the principal components.

Central to this investigation is the application of Principal Component Analysis (PCA), a statistical method revered for its ability to distill intricate datasets into essential components (Matsunaga, 2010). By deploying PCA, this research aims to unravel underlying patterns and latent relationships within a multitude of behaviours that underpin sustainable construction. In doing so, it seeks to unearth pivotal behaviours that significantly correlate with sustainable construction practices, potentially unlocking a blueprint for educational interventions and policy frameworks. However, the landscape of sustainable construction is a complex terrain, fraught with challenges and multifaceted considerations. As such, this research also contemplates the potential barriers that impede the adoption of these key behaviours. Factors such as economic constraints, lack of awareness, and institutional barriers could thwart the translation of intent into action (Darko & Chan, 2018). By acknowledging these obstacles and solutions provided in the literature, this study strives for a comprehensive understanding of the intricate interplay between behaviour, education, and sustainable construction in the Nigerian context.

Methodology

The study consists of survey research, based on questionnaire responses from 218 participants. The participants comprised 171 300-level and 400-level building technology education students in 11 universities in Nigeria, and 47 building construction workers who were conveniently drawn for their perspectives and experience into the study. Building technology education undergraduate students receive dual-purpose training that prepares them to teach building construction and related technology subjects in secondary schools, colleges of education, polytechnics or universities, and also to practise the skills of

building construction in designing, erecting and supervising ongoing projects. As such, the students are in touch with both the theory and practical skills needed for effective building construction. Thus, different building construction sites were visited by the researchers, and two assistants, to ascertain the opinions of the supervisors, engineers and site-workers. The dual-purpose nature of the BTE programme, by implication, touches two sectors, education and industry, with education being an agreed means of transferring and sustaining ideas, concepts and behaviours. Deductively, BTE students have a significant role to play in the ESD movement, and sustainable construction advocacy and practice.

The instrument for data collection was a questionnaire titled *Construction Sustainable Behaviour Questionnaire (CSBQ)* comprising two sections, A and B. Section A elicited demographic information, and section B had 29 items on construction sustainable behaviours, developed from literature review and principles of sustainable constructions. The items were measured using a 5-point Likert scale ranging from *Not at all Important = 1* to *Extremely Important = 5*. Participants were asked to indicate the extent to which the behaviour is important in achieving sustainable construction in building sites. Before the instrument was taken to the field, five experts face-validated the instrument, among which were three building technology education lecturers with practical experience, and two contractors who had handled multi-million government projects, that would have accommodated conscious sustainability infusions. Corrections such as rewording, exclusions and inclusions led to the finalisation of 29 items. The instrument was administered directly and retrieved after completion. A total of 216 copies were returned, with 3 incompletely filled copies, thus 213 copies were used for the data analysis. The reliability test on the data with Cronbach's alpha showed a coefficient of .798, and the literature judged .70 to be acceptable.

Data analysis was done using descriptive statistics, relative importance index (RII), and principal component analysis (PCA), in both MS Excel and SPSS version 26. MS Excel was used to organise the data and calculate the RII, as well as rank using RANK.EQ syntax; SPSS was used for the rest of the analysis. Due to the diversity and high number of behavioural items (i.e. 29 behaviours), PCA was conducted to reduce the number of variables and deduce the most important construction behaviours that would yield practical results towards aligning with sustainable construction principles in building sites. The results of the data analysis are presented in the next section.

Results

Relative importance index and descriptives

The first recommended test in identifying the most important factors such as the CSB, is the relative importance index (RII). RII of each CSB in Table 1 was calculated using the following equation (1), as seen in the literature relating to construction studies (Karji et al., 2020).

$$RII_i = \frac{\Sigma W_i}{(AN)'} \quad (1)$$

where:
RII = the relative importance index for CSB i
ΣW_i = the sum of all ratings from students & building construction workers for CSB i
A = the higher possible rating permissible in the questionnaire (i.e., 5 for this study)
N = the total number of respondents (i.e., 213 for this study)

Table 1 shows easily interpretable values. The minimum and maximum responses (between 1 and 5) show how the participants rated the items. The behavioural items have mean scores above 3.50 with the least being 3.70 for items 28 and 29. Likewise, standard deviations were all below 1.0. Table 1 also shows the RII, which ranges between 0 and 1, indicating participants' ratings of the lowest and highest relative importance, respectively. The RII was used to rank-order the CSB, and many ties were observed. According to Table 1, "restoring brownfields, and contaminated fields for low-cost habitable buildings" (RII = .837) was rated to have the highest relative importance, while "purchasing buy-back or second-hand building materials for construction" and "observing company's attention towards employees and sustainability before buying goods" (RII = .740) were jointly-rated to have the lowest impacts as behaviours expected to stir sustainable building constructions.

Table 1: *Descriptive statistics and relative important index of the received data*

Construction Sustainable Behaviours	N	Minimum	Maximum	Mean	Std. Deviation	RII	Rank
CSB1	213	1.00	5.00	3.75	0.98	0.749	26
CSB2	213	1.00	5.00	3.75	0.92	0.750	*24
CSB3	213	1.00	5.00	3.80	0.96	0.761	22
CSB4	213	1.00	5.00	3.85	0.90	0.769	19
CSB5	213	2.00	5.00	3.81	0.90	0.762	21
CSB6	213	1.00	5.00	3.78	0.86	0.756	23
CSB7	213	2.00	5.00	3.88	0.80	0.777	17
CSB8	213	1.00	5.00	4.09	0.81	0.819	3

Construction Sustainable Behaviours	N	Minimum	Maximum	Mean	Std. Deviation	RII	Rank
CSB9	213	2.00	5.00	4.02	0.72	0.805	5
CSB10	213	2.00	5.00	4.00	0.76	0.799	8
CSB11	213	2.00	5.00	4.10	0.72	0.821	2
CSB12	213	2.00	5.00	4.02	0.76	0.804	6
CSB13	213	2.00	5.00	3.95	0.72	0.791	12
CSB14	213	2.00	5.00	3.96	0.74	0.792	*10
CSB15	213	2.00	5.00	4.01	0.77	0.802	7
CSB16	213	2.00	5.00	4.04	0.71	0.808	4
CSB17	213	2.00	5.00	3.96	0.72	0.792	*10
CSB18	213	2.00	5.00	3.92	0.72	0.785	16
CSB19	213	2.00	5.00	4.18	0.73	0.837	1
CSB20	213	2.00	5.00	3.93	0.72	0.786	*13
CSB21	213	1.00	5.00	3.98	0.73	0.796	9
CSB22	213	2.00	5.00	3.93	0.76	0.786	*13
CSB23	213	1.00	5.00	3.93	0.79	0.786	*13
CSB24	213	2.00	5.00	3.86	0.78	0.772	18
CSB25	213	1.00	5.00	3.82	0.85	0.763	20
CSB26	213	1.00	5.00	3.75	0.82	0.750	*24
CSB27	213	1.00	5.00	3.72	0.78	0.744	27
CSB28	213	1.00	5.00	3.70	0.75	0.740	*28
CSB29	213	1.00	5.00	3.70	0.79	0.740	*28

* Indicates a tie

Table 2: *KMO and Bartlett's Test*

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.788
Bartlett's Test of Sphericity	Approx. Chi-Square	2511.425
	Df	406
	Sig.	.000

To ascertain the adequacy of the participants sampled, Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (MSA) was used. Table 2 shows the KMO test results; we obtained MSA value = .788, which was above the acceptable threshold of 0.5 recommended by Kaiser (1974). It also satisfied the higher recommendation by Beaumont (2012) that MSA value

≥ .70 should be accepted, while below should be discarded. Similarly, Bartlett's Test of Sphericity for the items showed associated *p*-value of 0.000, making the data suitable for factor analysis.

Principal Component Analysis (PCA)

This study ascertained the participants' rating of how important each behaviour is in aligning the building construction sector towards sustainable constructions. Thus, PCA is used to summarise information, thereby reducing large sets of variables into fewer numbers of components (Matsunaga, 2010). This is a common approach in research, used to reduce a large number of variables to a smaller amount called the principal components. PCA achieves this by first identifying variables that are similar, which can be grouped to form a new variable, capable of explaining the components. To arrive at a conclusion, we observed the communalities to know if all the items would be retained for the analysis, and then observed the eigenvalue test, the scree plot, and the proportion of variance explained, in order to choose the principal components.

(1) Communalities

Communality is the total amount of variance each variable shares with all other variables included in a PCA analysis. It is also called common variance (Santos et al., 2019). Table 3 shows communalities of the items; all items had communalities above .50, suggesting that the items met the requirement for factor analysis (Field, 2013). Having communality values equal to or above .50, principal component extraction with promax rotation was therefore used to determine the underlying group potentials of the 29 items. Promax rotation is essential when correlation of components or factors is necessary. Unlike varimax rotation, which analyses components on orthogonal basis, without correlations among the components, promax does the orthogonal and goes further to raise the factor loadings, thereby giving maximally distinguishable correlated components (Matsunaga, 2010).

Table 3 shows highest and lowest communality values of .775 (CSB19) and .508 (CSB5) respectively, against the initial communalities set at 1.00. The communalities show the proportion of variance in each variable that is explained by the extracted factors. These values range from .508 to .775, indicating that a larger proportion of the variance is accounted for by the common factors. The communalities thus provide insight into how much of each variable's variance is captured by the factors, and guide decisions on retaining or removing variables to improve the model's overall explanatory power.

Table 3: *Communalities*

Construction Sustainable Behaviours	Initial	Extraction
CSB1	1.000	.632
CSB2	1.000	.659
CSB3	1.000	.658
CSB4	1.000	.688
CSB5	1.000	.508
CSB6	1.000	.657
CSB7	1.000	.763
CSB8	1.000	.515
CSB9	1.000	.696
CSB10	1.000	.587
CSB11	1.000	.530
CSB12	1.000	.578
CSB13	1.000	.588
CSB14	1.000	.709
CSB15	1.000	.661
CSB16	1.000	.559
CSB17	1.000	.593
CSB18	1.000	.542
CSB19	1.000	.775
CSB20	1.000	.620
CSB21	1.000	.512
CSB22	1.000	.703
CSB23	1.000	.615
CSB24	1.000	.622
CSB25	1.000	.694
CSB26	1.000	.650
CSB27	1.000	.587
CSB28	1.000	.553
CSB29	1.000	.668

Extraction Method: Principal Component Analysis

(2) Total variance explained

Table 4 shows seven underlying group potentials with eigenvalues greater than 1 extracted in this study. In observing the eigenvalue of the components, as shown in Table 4, seven components (1-7) have values greater than 1, and those seven underlying groupings explain 62.489% of the variance, which is higher than the recommended 60% (Malhotra, 2006). Thus, only seven items make up the components, while items 8 – 29 will be overlooked or classified to explain the principal components.

(3) Scree plot

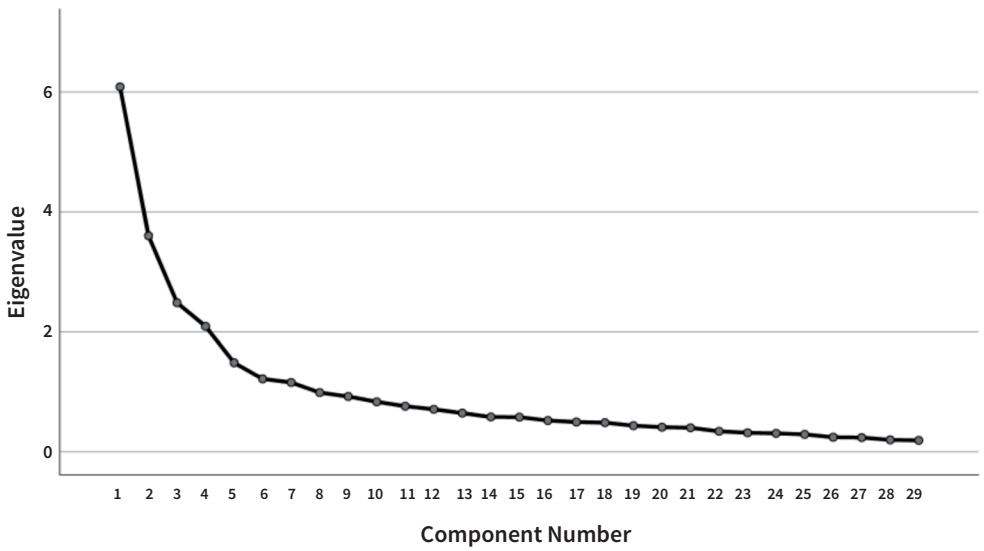

Figure 1: *Scree plot of the principal components*

The scree plot in Figure 1 shows a common line diagram plotted with eigenvalues from the highest to the least values of the components. Figure 1 shows the principal components, and the points of division necessitating the seven groupings. A scree plot has a common rule, whereby components before the elbow shape are accepted as the required number necessary to explain each of the groupings at every point. Similarly, as in Table 4, components 1-7 are above the elbow, while components 8-29 are after, and thus can be disregarded.

Table 4: *Total variance explained*

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	6.086	20.986	20.986	6.086	20.986	20.986
2	3.602	12.421	33.408	3.602	12.421	33.408
3	2.486	8.572	41.979	2.486	8.572	41.979
4	2.092	7.214	49.194	2.092	7.214	49.194
5	1.484	5.118	54.312	1.484	5.118	54.312
6	1.215	4.190	58.502	1.215	4.190	58.502
7	1.156	3.986	62.489	1.156	3.986	62.489
8	.986	3.401	65.890			
9	.922	3.179	69.069			
10	.833	2.872	71.940			
11	.759	2.618	74.558			
12	.709	2.444	77.002			
13	.644	2.221	79.223			
14	.580	2.001	81.224			
15	.577	1.990	83.214			
16	.521	1.796	85.010			
17	.497	1.713	86.722			
18	.485	1.673	88.395			
19	.435	1.500	89.895			
20	.410	1.414	91.309			
21	.400	1.380	92.689			
22	.341	1.174	93.863			
23	.316	1.090	94.954			
24	.307	1.058	96.012			
25	.289	.998	97.010			
26	.242	.835	97.844			
27	.237	.817	98.661			
28	.198	.684	99.345			
29	.190	.655	100.000			

(4) Pattern matrix

To better understand the seven components and how they relate to the 29 construction sustainable behaviours, we observed the component matrix and the pattern matrix (Table 5). The component matrix simply shows the correlation of each item with its components. But the squared loadings of each item across components already accounted for their communalities. Hence, we interpreted the grouping of components based on the pattern matrix. Table 5 shows the pattern matrix, revealing the correlation and factor loading of each of the variables and the principal components. The loading values in a pattern matrix are crucial in determining which items to retain or eliminate during a factor analysis. High loading values indicate a strong correlation between an item and a specific factor, suggesting that the item is a good representative of that factor. Conversely, low loading values suggest a weak association, implying that the item may not effectively contribute to the factor's overall structure. Items with low loading values are typically eliminated to enhance the clarity and reliability of the factors, ensuring that only the most relevant and significant items are retained for further analysis. This process helps in refining the measurement model by focusing on items that meaningfully contribute to the underlying constructs. Hence, the pattern matrix reveals the alignment of each component to the factor(s) that best represents the components.

In order to resolve cross-loading items and eliminate a number of items (reduction of a data set) under the components, we used the highest loading with the cutoff approach. Factor loading cut-off has been seen in several research studies, but there has been no concession on the threshold (Matsunaga, 2010). Thus, acceptance of items has been based on cutoff factor loadings of .40, .50, .60, and .70, but Karji et al. (2020) suggest a cutoff ≥ .55. Likewise, we judged Table 5 using the ≥ .55 cut-off criterion for CSB under each of the seven components, while for cross-loaded factors, the highest loading value ≥ .55 is taken.

Table 5 shows that only three items (CSB 8, 17 and 18) have factor loadings below the stipulated threshold ≥ .55, and were completely disregarded. Even when CSB 17 and CSB 18 were cross-loaded, both ends had low factor loadings. On the other hand, component 1 has strong correlations with CSB 9-13, component 2 correlates with CSB 24-28, component 3 also correlates with CSB 1-5 etc. The correlating factors and components after elimination are shown in Table 6, with the suggested names of the components.

Table 5: *Pattern Matrix*[a]

	Component						
CSB Index	**1**	**2**	**3**	**4**	**5**	**6**	**7**
CSB1	--	--	.716	--	--	--	--
CSB2	--	--	.778	--	--	--	--
CSB3	--	--	.757	--	--	--	--
CSB4	--	--	.858	--	--	--	--

	Component						
CSB Index	**1**	**2**	**3**	**4**	**5**	**6**	**7**
CSB5	--	--	.598	--	--	--	--
CSB6	--	--	--	--	--	--	.767
CSB7	--	--	--	--	--	--	.859
CSB8	.496	--	--	--	--	--	--
CSB9	.908	--	--	--	--	--	--
CSB10	.744	--	--	--	--	--	--
CSB11	.636	--	--	--	--	--	--
CSB12	.713	--	--	--	--	--	--
CSB13	.601	--	--	--	--	--	--
CSB14	--	--	--	.886	--	--	--
CSB15	--	--	--	.895	--	--	--
CSB16	--	--	--	.608	--	--	--
CSB17	--	--	--	.478	--	.449	--
CSB18	--	--	--	.401	--	.419	--
CSB19	--	--	--	--	--	.947	--
CSB20	--	--	--	--	.646	--	--
CSB21	--	--	--	--	.683	--	--
CSB22	--	--	--	--	.859	--	--
CSB23	--	--	--	--	.784	--	--
CSB24	--	.756	--	--	--	--	--
CSB25	--	.799	--	--	--	--	--
CSB26	--	.816	--	--	--	--	--
CSB27	--	.734	--	--	--	--	--
CSB28	--	.583	--	--	--	--	--
CSB29	--	.704	--	--	--	--	--

Extraction Method: Principal Component Analysis

Rotation Method: Promax with Kaiser Normalization

a. Rotation converged in 6 iterations

Table 6 shows the components, corresponding variables and the suggested themes. Naming is done by observing each component and the underlying group variables. We interpreted the ideas of the behaviours relating to each component, listed out possible connotations, and relied on the importance of the related variables in naming the components. Thus, the suggested themes for components 1-7 include support for local economy, manpower and social norms; value for human and nature; reduce resource consumption and waste

generation; use integrated design approach and building site assessment; recycle and reuse materials, attention to land use; and green technology integration.

Table 6: *List of components, corresponding variables, and suggested themes*

Component	Corresponding variable with strong correlation	Suggested themes for components
Component 1	• Ensuring that constructions are in compliance with relevant legislations and regulations • Manufacturing or sourcing construction materials locally as a standard • Retraining and upskilling available manpower in sustainable construction methods • Avoiding the disposal of debris from broken walls in any nearby bush or river • Improving prior experiences and performance in construction management	Support for local economy, manpower and social norms
Component 2	• Treating others respectfully during collaborative projects whether we are using computer or mobile to work, just as I would in real life • Supporting organisation or environmental group that are active in achieving sustainability • Showing same respect to men and women, boys and girls in building construction sites, irrespective of cultural differences • Volunteering to work for a company that is geared towards providing free accommodation to help poor people • Purchasing buy-back or second-hand building materials for construction • Observing company's attention towards employees and sustainability before buying goods	Value for humans and nature
Component 3	• Reducing 10% extra materials bought to account for waste in construction • Reusing broken debris and excavated soils for fillings • Choosing recycled and recyclable materials for constructions • Designating a particular place for concrete mixing • Insisting on off-site construction over on-site	Reduce resource consumption and waste generation
Component 4	• Early assessment of land, environment, and proposed construction activities • Using integrated design approach in construction • Retaining nature as much as possible in construction sites	Use integrated design approach and building site assessment
Component 5	• Creating avenue for water storage and recycling • Recycling building materials as much as available • Sorting waste before putting out the rubbish when I have the chance • Adjusting personal lifestyle in order to reduce waste in and out of building construction sites	Recycle and reuse materials
Component 6	• Restoring brownfields, and contaminated fields for low-cost habitable buildings	Attention to land use
Component 7	• Insisting on green technologies, judging on quality over cost • Integrating renewable energy sources over the non-renewable, aside initial cost	Incremental green technology integrations

Discussion

This study delved into a critical aspect of sustainable development within the context of building construction and education in Nigeria. This research appears to be of great significance due to the growing emphasis on sustainable practices worldwide and the role that education plays in shaping the future of construction.

Findings on the relative importance index (*RII*) show behaviours that hold the most weight among respondents and can inform targeted educational interventions and policy measures. For instance, findings of this study on "restoring brownfields, and contaminated fields for low-cost habitable buildings", and "retraining and upskilling available manpower in sustainable construction methods", being the sustainability practices that are of topmost importance, imply that people want more housing projects to be part of the sustainability movement and also indicate the willingness of the respondents to be trained. This finding could serve as a guide to curriculum development in building technology education programmes towards sustainability in Nigeria. Also, by pinpointing the behaviours that matter most for sustainable construction, educators can tailor their courses to address these aspects more effectively. This could involve integrating practical exercises, case studies, and real-world projects that emphasise the identified key behaviours. On the other hand, behaviours found to be underemphasised or overlooked could indicate gaps in the current educational approach. Addressing these gaps through awareness campaigns, workshops, and interactive learning experiences could help bridge the knowledge-action gap. Ultimately, the RII underscores what is known against the unknown or unfamiliar practices capable of fostering sustainability constructions. Hence, the PCA analysis further highlights areas requiring immediate attention according to the suggested themes.

Theme one, "Support for Local Economy, Manpower, and Social Norms" underscores the multifaceted nature of sustainability, encompassing economic, social, and cultural dimensions. By promoting the utilisation of local resources, and skilled labour, and respecting cultural norms in construction practices, this theme aligns with the principles of sustainable development. Moreover, local sourcing of materials and labour can have a substantial impact on community empowerment and economic resilience (Ma Uly, 2011), and honouring social norms and cultural practices within construction activities reflects a commitment to social responsibility and inclusivity (Kim & Seock, 2019; Morris et al., 2015). Following the classification of components, this study shows the importance of harmonising construction with local economies, fostering local skills, and respecting the cultural fabric of communities as a worthy approach towards sustainability.

Second in the themes suggested is "Value for Human and Nature" which encapsulates the essence of sustainability, emphasising the imperative of fostering a harmonious coexistence between humanity and the environment. This theme equally aligns with the principles of sustainable development, highlighting the significance of making choices that not only benefit human well-being but also uphold the integrity of the natural world. As

reasoned by Aguilar-Luzón et al. (2020), Bennett et al. (2018) and Dietz et al. (2005), true sustainability necessitates a comprehensive consideration of ecological and social factors. It recognises that promoting human welfare should go hand in hand with environmental stewardship. In exemplifying this theme, one may point to practices that prioritise clean energy sources, environmentally responsible construction techniques, and community well-being. This approach harmonises with international sustainability goals, particularly the United Nations' Sustainable Development Goals, which address a wide array of human and environmental challenges with the aim of fostering a more equitable and ecologically sound future.

Thirdly, "Reduce Resource Consumption and Waste Generation" is a fundamental tenet of sustainability, emphasising the necessity of using resources efficiently and minimising waste. This concept aligns with the principles of a circular economy which upholds practices capable of ensuring resources are conserved, reused, and recycled to reduce environmental impact (Siew, 2019). As demonstrated by research (Amaral et al., 2020; Guo et al., 2022; Ma Uly, 2011), adopting this theme can have profound ecological and economic benefits, by not only reducing the strain on natural resources but also lowering waste disposal costs, which is essential for long-term sustainability. This theme further buttresses the notion that building construction professionals can contribute to a more sustainable future by decreasing their ecological footprint and enhancing resource efficiency.

In addition, the fourth theme suggested "Use Integrated Design Approach and Building Site Assessment", underscoring the critical importance of a holistic perspective in construction practices. By integrating design and site assessment, it becomes possible to optimise not only the building's performance but also its environmental impact. As advocated in studies like Kibert (2013) and Kibert et al. (2001), this theme promotes a comprehensive understanding of the site's context and requirements, which in turn can lead to more efficient resource utilisation, lower energy consumption, and minimised environmental disturbances (Kibert, 2013). This theme aligns well with sustainability goals with an emphasis on minimising the environmental footprint while optimising the functionality and efficiency of the built environment.

The fifth theme "Recycle and Reuse Materials", like the third theme, epitomises the essence of sustainability by minimising resource consumption and waste generation. Studies like that of Llatas et al. (2022) emphasise the significance of recycling and reusing materials in construction not only for conserving natural resources but also for reducing the environmental impact associated with manufacturing new materials. As already highlighted, the aim of keeping resources in use for as long as possible, thereby reducing the need for constant extraction and production of new materials, is an approach in support of the circular economy agenda (Siew, 2019).

"Attention to Land Use" is the sixth theme suggested in this study. This theme underscores the significance of responsible land management practices, which are fundamental to sustainable development. Studies like that by Xiong et al. (2018) highlight the importance of effective land use planning in minimising urban sprawl, protecting natural habitats,

and ensuring efficient use of resources. In line with global sustainability goals, such as the United Nations' Sustainable Development Goal 11, which aims to make cities and human settlements inclusive, safe, resilient, and sustainable, this theme is vital and key. Hence, attention to land use is paramount in achieving more compact, resource-efficient urban environments that enhance the quality of life for inhabitants and reduce the environmental impact associated with uncontrolled land development (Kibert, 2013; Xiong et al., 2018).

Lastly, the theme "Incremental Green Technology Integration" embodies the concept of gradual, step-by-step progress towards a more sustainable future. This theme underscores the initial investment cost challenges towards green technologies (Darko & Chan, 2018), thus suggesting gradual integrations of these technologies, with the intention of full upgrade in the near future. As demonstrated in research such as that by Song et al. (2023) embracing incremental green technology allows for integrating eco-friendly innovations without significant disruptions to existing systems. This approach resonates with the principles of behavioural economics, where small, continuous changes can lead to significant overall improvements in sustainability. Incremental green technology integration also acknowledges that the journey towards sustainability is an ongoing process and that each small step taken can contribute to a more eco-conscious and resource-efficient future (Söderholm, 2020; UNESCO, 2017).

Conclusion

The seven themes suggested in this study collectively encompass a holistic vision of sustainability within the context of building construction and development. The first theme, "Support for Local Economy, Manpower, and Social Norms" emphasises the importance of respecting local communities, traditions, and economic systems. "Value for Human and Nature" recognises the interdependence of human well-being and environmental health. "Reduce Resource Consumption and Waste Generation" underscores the importance of efficiency and responsible resource management. "Use Integrated Design Approach and Building Site Assessment" advocates for a comprehensive, context-sensitive approach to building construction. "Recycle and Reuse Materials" promotes the circular economy and resource conservation. "Attention to Land Use" highlights responsible land management for sustainable urban development. Lastly, "Incremental Green Technology Integration" encourages the gradual integration of eco-friendly innovations to progress towards a more sustainable future.

In the context of building technology education, these seven themes collectively offer a comprehensive framework for training future professionals to champion sustainability both in classrooms and in actual building construction operations. These themes, collectively, provide a well-rounded educational framework that equips future construction professionals with the knowledge and values essential for building a more sustainable, efficient, and responsible future in the construction industry. Thus, this study addressed diverse facets of construction sustainable behaviours using the responses from BTE

students and construction professionals, discovering the multifaceted and interconnected nature of sustainable construction and necessary behaviours.

Limitations of the Study

Despite the insightful findings, the study has several limitations. First, the use of a convenient sampling method may limit the generalisability of the results, as the sample may not be representative of the broader population involved in sustainable construction. Additionally, the relatively small sample size, particularly the 47 building construction experts, might not adequately capture the diversity of perspectives in the field. The study's focus on students in Building Technology Education (BTE) also narrows its scope, potentially overlooking other important stakeholders in sustainable construction.

Also, the reliance on self-reported data from a 29-item questionnaire may introduce potential biases, including social desirability bias, where respondents might overstate their adherence to sustainable practices. On the analysis, limitations of the Relative Importance Index (RII) include reliance on subjective responses, making its accuracy contingent on the respondents' understanding of the questions and the consistency of their rating scales. RII may not adequately capture the complexity and interdependencies of factors in real-world scenarios, as it treats each factor independently, and does not account for the dynamic nature of importance, which can change over time or with varying contexts. Lastly, while Principal Component Analysis (PCA) revealed meaningful themes, its subjective interpretations may equally affect conclusions. These limitations suggest the need for further research with more diverse and larger samples, employing additional methodologies to validate the findings.

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Percentage contribution

Areas of contribution	Author	% Contribution per area, per author (each area = 100%)
Conception or design of the paper, theory or key argument	Chukwu	70%
	Ogbuanya	30%
Data collection	Chukwu	85%
	Ogbuanya	15%
Analysis and interpretation	Chukwu	60%
	Ogbuanya	40%
Drafting the paper	Chukwu	50%
	Ogbuanya	50%
Critical review of paper	Chukwu	45%
	Ogbuanya	55%

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