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Consciousness and Prospects of Autoclaved Aerated Concrete Blocks for Wall Construction: A Comparative Study of Nigeria and South Africa

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Abstract

Autoclaved Aerated Concrete Block (AACB) is a viable, sustainable walling material for building projects but has not been given the attention it deserves in developing countries. To increase the usage of AACB on building projects, this study examines the consciousness and prospects for its use in Nigeria and South Africa. The objectives are to evaluate the degree of knowledge about AACB in both countries; and to assess the likelihood of adopting AACB in Nigeria. The study centres on Lagos and five provinces in South Africa. Lagos was chosen in Nigeria because the State is the only place in Nigeria where AACB have been used. A total of 145 questionnaires were administered to professionals who had been involved in AAC projects. In contrast, 17 South African respondents familiar with AACB in construction projects were contacted. Convenience and snowball sampling techniques were used for construction professionals in Nigeria and South Africa respectively. Data were analysed using Statistical Package for Social Sciences (SPSS) version 23.0. Statistics such as percentages and mean scores were explored in addition to analysis of variance (ANOVA) and the Mann-Whitney U test. Findings indicate that construction professionals in Nigeria know very little about 19 of the 20 documented AACBs. However, the South African professionals are very knowledgeable about AACB grade 42.5 OPC and AACB of AP/RHA and fully aware of AACB with grade 52.5 OPC, though they know nothing about the Bamboo Leaf Ash (BLA) AACB. This means that Nigerian professionals have a moderate stance on using AACB. The study concludes that South African professionals are more aware of AACB and its variants than Nigeria. This implies that AACB manufacturing in Nigeria would not thrive in the construction market due to poor patronage since patronage is directly related to product awareness. The study therefore suggests that construction professionals should increase their understanding of AACB through continuous development training, workshops and seminars on environmentally friendly building materials. Another suggestion is for consultants, clients, developers, contractors, governments and research institutions to continuously conduct research and embrace findings on AACB and new building construction materials regarding usage, wear, tears and durability.

Keywords: Autoclaved aerated concrete block (AACB), Awareness, Professionals, Prospects, Sustainability

1. Introduction

Over the past decades, the construction industry has consistently adopted and developed sustainable building materials and technologies (Shon et. al., 2021). One of such material is Autoclaved Aerated Concrete Block (AACB), which has been gaining popularity in construction since the mid-1900s (Saad et al., 2022). AACB is adjudged an innovative material that offers features such as good strength-to-density ratio, thermal insulation capabilities, lightweight, fire resistance capacity, excellent sound insulation and simplicity of cutting and fixing (Gyurkó et al., 2019; Wang et al., 2022). These AACB attributes have enhanced widespread application and popularity in many parts of the world, including the United States, Europe and Asia (Mollaei et al., 2022). Jerman et al. (2013) posit that AACB is a structural material widely used in Europe and other developed economies, owing to its ease of manufacture, usage with mechanical and thermal qualities superiority over other materials. For these reasons, AAC is commonly used as a construction material in concrete masonry units, such as blocks (Ulykbanov et al., 2019).

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Moreover, Desani et. al. (2016) noted that lightweight concrete (LC) contains no coarse particles and is either aerated with mortar that includes gas bubbles or infused air-entraining agents. In terms of densities, Falade (2009) grouped concrete blocks into three: (i) lightweight, ranging from 300 to 1950 kg/m3; (ii) moderate weight, 2200 to 2500 kg/m3; and (iii) heavyweight, 3360 to 3680 kg/m3. LC blocks are frequently employed in the construction of high-rise buildings to reduce the dead load and distribute less weight to the foundation (Amran et al., 2020). Narayanan and Ramamurthy (2000) found that the characteristics of aerated concrete block depend on the composition and microstructure (void paste system) affected by the curing procedure, the binder used and the mechanism of pore-formation. AACB production process comprises slurry preparation where the constituents react chemically, rising or foaming, sawing and autoclaving (Cheran et al., 2017).

Curing is a significant aspect of concreting that impacts the physical and mechanical characteristics (Ikponmwosa et al., 2014; Desani et al., 2016). Based on the curing technique, Autoclaved Aerated Concrete (AAC) may be classified into Autoclaved Aerated Concrete (AAC) and Non-Autoclaved Aerated Concrete (NAAC). Modern technical advancements and innovative construction techniques have made various walling materials available, with concrete blocks, bricks, wood and glass taking centre stage (Olawuyi and Babafemi, 2013). However, in Nigeria, blocks occupy over 90% of the walling units (Baiden & Tuuli, 2004). Singh et al. (2017), in their study on innovative and environmentally friendly building materials found that conventional brick material produces significant amounts of carbon dioxide (CO2) and other greenhouse gases, many of which are hazardous or toxic, contributing to environmental pollution and health-related challenges.

According to Oo and Hlaing (2018), early bricks were sun-dried mud, while burnt bricks were subsequently discovered to be more resistant to severe weather conditions. This made them far more reliable than the early bricks used for wall construction. Fired clay bricks absorb heat during the day and release it at night. It also has naturally sustainable qualities like high-temperature resistance and durability. Notwithstanding, the kilning process has some sustainability issues emanating from brick's greenhouse gas emissions and high energy usage.

Similarly, firing of clay bricks produces significant amounts of CO2 and other hazardous gases, which increases the threat of climate change and global warming (Gautem and Sexena, 2013). Rathi and Khandve (2015) found that clay bricks are not ecologically sustainable and should be substituted with AACB. There are no documented AAC studies in Nigeria and South Africa, but AACB has been used on several buildings in both countries. Therefore, this study aims to compare the usage of AACB in Nigeria and South Africa to ascertain awareness and expose the potential of its usage in construction in Nigeria to improve patronage. The objectives are to find out the awareness of AACB variants in both countries and examine the likelihood of using AACB in Nigeria. The study also hypothesized whether the opinion of experts in Nigeria and South Africa about awareness of AACB and its variants is significantly different; and whether there is substantial variation in the potential of AACB adoption among Nigerian construction professionals.

The study is significant because it will hopefully lead to the construction of sustainable buildings in terms of materials' environmental friendliness and affordability.

2. Physical Properties and Environmental Friendliness of Autoclaved Aerated Concrete (AAC)

AAC is also known as Autoclaved Cellular Concrete (ACC), Autoclaved Lightweight Concrete (ALC), Autoclaved Concrete (AC), Cellular Concrete (CC), Porous Concrete (PC) and Aircrete. It is a low-density load-bearing construction material due to more significant porosity than other load-bearing wall construction materials (Narayanan & Ramamurthy, 2000). AAC is produced in various manufacturing parameters; the density ranges from 93 to 1800 kg/m3, though the component particle density is approximately 2,600 kg/m3. The pores account for 30% to 90% of the volume (Kadashevich et al., 2005). AAC is thus adjudged a sustainable construction material.

Sustainable construction materials are those that perform better compared to predetermined standards. Factors taken into consideration in choosing sustainable construction materials are the cost of transportation, environmental impact, availability, thermal efficiency, financial viability, occupant's needs, health considerations, recyclability from a demolished building, manufacturing process, energy consumption, waste and pollution generated in the manufacturing process, toxic emissions from the construction process and the use of renewable resources (Patil & Patil, 2017).

Construction materials play a fundamental role in infrastructural sustainability and assisting in the flourishing of the national economy. The use of eco-friendly building materials has negative impact on the environment in various dimensions due to the extensive use of non-renewable resources and the quantity of debris and pollutants produced during the material's life cycle (Ofori, 2002). This informed Boido and Caldera's (2002) research on AAC's potential, limitations and sustainability in phases. AACB production processes were assessed: the colour, prism arrangement, face flatness, edge straightness and presence of fractures, protuberances, chipping and departure from specified nominal dimensions. The chemical composition, density, capillary absorption and freeze-thaw resistance of three samples of AACB were subjected to laboratory testing as part of the study's second phase. The edges of the Type A and Type B blocks remained firm after investigation.

In contrast, Type C displayed substantial degradation and spalling in tests for dimensional stability, capillary absorption and freeze-thaw resistance, with the edges eroding to the point where they entirely break off. A microscopic examination revealed that the Type C block's porosity is a primary weakness. The assessment factors covered in the third phase of the inquiry were the manufacturing process, transport, fixing, durability and maintainability. These show that AAC possesses the required features of a sustainable material.

AAC is ecologically beneficial because it entirely constitutes natural resources without pollutants (Subash et al., 2016); therefore, it contains no dangerous or damaging materials. Moreover, it requires little energy to produce, uses few raw materials, simple to use in construction, has high energy efficiency, improves indoor air quality and is highly recyclable. In the same vein, aerated lightweight concrete is categorised by Hamad (2014) into foamed concrete and autoclaved concrete. For both foamed and autoclaved concrete, the production process is categorised. Prakash et al. (2013) focused on calculating the physical, strength and elastic parameters of aerated concrete block units. These included the initial rate of absorption, modulus of elasticity, water absorption and density tests, compressive strength and flexural strengths of the units.

AAC production technologies are energy-efficient and use fewer raw materials than other construction materials. This can be attributed to AAC's low-density, waste-free, environmentally friendly production model. AAC offers specific advantageous properties in the context of sustainable development in the construction industry (Domingo, 2008). In dry conditions, AAC typically has a density ranging from 300 to 1,000 kg/m3. The lightweight concrete mortar is aerated with tiny bubbles from a chemical process or an air-entraining agent. Aerated concrete contains no coarse particles in its combination. Aluminium powder, cement, silica sand, quick lime and gypsum constitute AAC (Ismail et al., 2004).

Several studies have investigated the possible use of AACB as a technically viable alternative building material for construction. AACB has been successfully used as a walling material to construct residential and hotel buildings in Nepal (Khanal et al., 2020). Sarma et al. (2017) revealed a compressive strength statistic of 2.86 N/mm2 during the 28 days of normal curing for a 617.6 kg/m3 density. It however recorded a strength of more than 20 N/mm2 with the addition of silica fume, polypropylene fibre and steel mesh reinforcements. Khanal et al. (2020) discovered that the compressive strength of the AACB to be 4.324 N/mm2 even with a density as low as 617.6 kg/m3 when compared to a 3.402 N/mm2 average compressive strength of brick of 1,685.8kg/m3. According to Narayanan and Ramamurthy (2000), AAC contains tobermorite, which is much more solid than the products made in usually cured aerated concrete and, therefore, more durable.

AAC offers a microclimate since it is a sustainable material. According to Rathi and Khandve (2015), AACB meets the thermal performance standards of buildings, hence, thermally efficient. As a result of the lightweight property of AACB, it reduces the cost and robustness of foundation reinforcement significantly. This claim is supported by Rathi and Khandve (2015), who noted that the product is lightweight, easy to cut and work with, and saves steel, cement, mortar and plastering expenses. Despite the extensive research reports on the viability of AACB for buildings, Nigeria has no policy governing its use. The absence of information on eco-friendly, sustainable materials in the 2006 Nigerian National Building Code and a lack of technical know-how in processing AACB for housing supposedly explains its low awareness and acceptance as a walling material in Nigeria. Currently, the awareness of AACB as a walling material in other African countries apart from South Africa can be said to be in its infancy or non-existent. The industry's reliance on traditional bricks and blocks and its aversion to change for adopting sustainable materials such as AACB makes it challenging to accept.

3. Research Method.

The study adopted a cross-sectional survey research design. The study population was drawn from construction professionals based in Lagos State, Nigeria and five provinces of South Africa (namely Western Cape, Gauteng, Free State, Eastern Cape, and KwaZulu-Natal). Structured questionnaires were used to source data from the Nigerian construction professionals in Lagos. In contrast, online Google Forms questionnaires collected data from South African construction professionals. The study used a multi-sampling methodology, convenience sampling technique was employed in Nigeria and snowball sampling in South Africa using experts familiar with the subject matter and involved in its application in construction projects. The questionnaire items were closed-ended to source data relevant to the study objectives from the respondents. The first questionnaire obtained data on 20 AACB variants sourced from the literature. This compared the degree of knowledge of the 20 AACB variants between construction professionals in the two countries. Each variant was presented on a Likert scale of 1 to 5. On the scale, 1 denoted 'No Awareness', 2 'Slight Awareness', 3 'Moderate Awareness', 4 'High Awareness', and 5 'Full Awareness'. The second part of the data collection instrument assessed the likelihood that AACB would be adopted in Nigeria's construction sector. This was achieved from participants who were asked again on a Likert scale of 1 to 5: 1 for Very Poor, 2 for Poor, 3 for Average, 4 for Good, and 5 for Very Good. The Nigerian respondents received 145 copies of the questionnaire, while 99 properly completed questionnaires were received, representing a response rate of 68.3%. Given the challenges of collecting survey responses in Lagos state, this is a reasonable response rate. Furthermore, 17 responses were received from South African construction experts who were familiar with the material and had been involved in its usage on building projects in five South African provinces.

Statistical Package for Social Sciences (SPSS) version 23.0 was used to analyse the data received from participants. Specific tools used were percentage, mean scores, analysis of variance (ANOVA) and Mann-Whitney U test. ANOVA, typically used to compare the means of multiple groups on several variables, was used in this study to compare the mean scores (MSs) of construction professionals on the potential of AACB adoption among Nigerian construction organisations. Similarly, the Mann-Whitney U test, generally used for comparing the mean scores (MSs) of two groups, was used in this study to compare the mean scores (MSs) of the Nigerian and South African professionals on the awareness of AACB variants (Hanneman et al., 2013).

4. Findings and Discussions

4.1 Demographic Characteristics

The demographic characteristics of Nigerian professionals in their organisations are shown in Table 1.

Table 1: Demographic Characteristics of Nigerian Respondents

Description	Frequency	%
The Profession of the Respondents and Registration with Professional Associations		
Architecture (NIA)	7	7.07
Building (NIOB)	38	38.38
Civil Engineering (NSE)	45	45.45
Quantity Surveying (NIQS)	9	9.09
Total	**99**	**100.00**
Highest Academic Qualification		
OND	0	0.00
HND	10	10.10
BSc/B.Tech	55	55.56
MSc/MBA	31	31.31
PhD	3	3.03
Total	**99**	**100.00**
Years of Experience		
1-5 Years	25	25.25
6-10 Years	29	29.29
11-15 Years	26	26.26
16-20 Years	12	12.12
21 Years and above	7	7.07
Total	**99**	**100.00**
Organisation Type		
Consulting	31	31.31
Contracting	45	45.45
Client Organisation	5	5.05
Design & Build	18	18.18
Total	**99**	**100.00**
Organisation Size		
Small-sized with 1-50	43	43.43
Medium-sized with 51-250	47	47.47
Large size with 250 or more	9	9.09
Total	**99**	**100.00**
Ownership and Management		
Fully Indigenous	27	27.27
Fully Expatriate	5	5.05
Partly Indigenous and partly expatriate	67	67.68
Total	**99**	**100.00**
Nature of works undertaken		
New Construction	27	27.27
Renovation	5	5.05
General contracting	67	67.68
Total	**99**	**100.00**

Table 1 shows that in the professional group, 7.07% were Architects registered with the Nigerian Institute of Architects (NIA), 38.38% were Builders registered with the Nigerian Institute of Building (NIOB), 45.45% were Civil engineers registered with the Nigerian Society of Engineers (NSE) and 9.09% were Quantity Surveyors who were registered with the Nigerian Institute of Quantity Surveyors (NIQS). Furthermore, 10.10% of respondents had Higher National Diploma (HND) degree, 55.56% had Bachelors degree (B.Sc./B.Tech.) while 31.31% and 3.03% had Masters and Doctoral degrees respectively. Moreover, 25.25% of the Nigerian respondents had one to five years of post-qualification experience, six to ten years experience by 29.29%, eleven to fifteen years experience by 26.26%, sixteen to twenty years by 12.12% and twenty-one years or more experience by 7.07% of the respondents.

The demographic data of the organisations show that construction project consultancy firms employ 31.31% of the respondents, 45.45% work for contracting firms, 5.05% work as clients' in-house construction professionals and 18.18% work for design and build firms. In addition, 43.43% were from Small firms, 47.47% of the respondents were from Medium-sized firms, and 9.09% were from Large firms. Furthermore, 27.27% of the companies are indigenous-owned, 5.05% are foreign-owned, and 67.68% are a mixture of expatriates and Nigerian owners. Besides, 27.27% of the organisations engage in new construction projects, 5.05% in rehabilitation and refurbishment and 67.68% in general contracting. Result of the analysis of data from South African respondents is shown in Table 2.

Table 2 shows that 5.88% of participants had one to five years work experience, 17.65% had six to ten years work experience, 47.06% had eleven to fifteen years work experience, 17.65% had sixteen to twenty years work experience and 11.76% had twenty-one years or more work experience. In addition, 35.29% of the companies were Small, 41.18% were Medium, and 23.53% were Large. Regarding Organization Ownership, 47.06% are indigenous, 17.65% are expatriate-owned and 35.29% are partially indigenous and expatriate. Regarding the nature of the work undertaken, 23.53% of the respondents' companies work on new construction, 5.88% work on renovations and refurbishments and 70.59% work as general contractors. The provinces in South Africa where the professionals were based are 52.94% in the Western Cape. Gauteng, Free State, Eastern Cape, and KwaZulu-Natal each had 11.76% by provincial location.

Table 2: The South African Respondents' Demographic Characteristics

Description	Frequency	%
Years of Experience		
1-5 Years	1	5.88
6-10 Years	3	17.65
11-15 Years	8	47.06
16-20 Years	3	17.65
21 Years and above	2	11.76
Total	**17**	**100.00**
Organisation Size		
Small-sized with 1-50	6	35.29
Medium-sized with 51-250	7	41.18
Large size with 250 or more	4	23.53
Total	**17**	**100.00**
Ownership and Management		
Indigenous	8	47.06
Expatriate	3	17.65
Partly indigenous and partly expatriate	6	35.29
Total	**17**	**100.00**
Nature of works undertaken		
New Construction	4	23.53
Renovation	1	5.88
General contracting	12	70.59
Total	**17**	**100.00**
Provinces		
Western Cape	9	52.94
Gauteng	2	11.76
Eastern Cape	2	11.76
Free State	2	11.76
KwaZulu-Natal	2	11.76
Total	**17**	**99.98**

4.2 Awareness of AACB Variants in Nigeria and South Africa

The respondents' opinions about their degree of awareness of AAC block versions are shown in Table 3. A graduated scale of 1.00 to 5.00 was used to measure the respondent's familiarity with the variations and the mean scores were computed. The following scale was used to interpret the mean values: $1.00 \leq MS < 1.49$ indicates Not at All-Aware; $1.50 \leq MS < 2.49$ indicates Slight Awareness; $2.50 \leq MS < 3.49$ indicates Moderate Awareness; $3.50 \leq MS < 4.49$ indicates High Awareness; $4.50 \leq MS < 5.00$ indicates Full Awareness.

Table 3: Awareness of AACB Variants in Nigeria and South Africa

		Nigerian Professionals			South African Professionals		
S/N	AAC Versions	N	MS	Rank	N	MS	Rank
1	AAC with 52.5 grade Ordinary Portland Cement (OPC)	94	2.11	1	17	4.94	1
2	AAC with 42.5 grade Ordinary Portland Cement (OPC)	95	2.07	2	17	4.24	2
3	AAC with Aluminum Powder (AP)/ Rice Husk Ash (RHA)	93	2.01	3	16	4.00	3
4	AAC with Self-ignition Coal Gangue (SCG)	95	1.98	4	17	2.47	17
5	AAC with Coal Bottom Ash (CBA)	94	1.95	5	17	2.94	6
6	AAC with Concrete Sandwich Block (CSB)/ Waste Glass (WG)	95	1.94	6	17	2.88	7
7	AAC with Natural Zeolite Additive (NZ)	95	1.94	6	17	2.76	9
8	AAC with Pulverized Fuel Ash (PFA)/ Palm Oil Fuel ash (POFA)	95	1.89	8	17	3.35	4
9	AAC with Copper Tailings (CT)/ Blast Furnace Slag (BFS)	94	1.85	9	17	2.76	9
10	AAC with Efflorescence Sand (ES)	95	1.77	10	17	2.65	12
11	AAC with Silica Fume (SF)/ Fly Ash (FA)	94	1.76	11	17	3.06	5
12	AAC with Air-cooled Slag (AS)	94	1.76	11	17	2.59	13
13	AAC with Perlite Waste (PW)/Polypropylene Fibre (PF)	95	1.71	13	17	2.35	18
14	AAC with Phosphorus Slag (PS)	92	1.70	14	17	2.59	13
15	AAC with Dune Sand (DS)	93	1.68	15	17	2.82	8
16	AAC with Halloysite Powder (HP)	93	1.68	15	17	2.59	13
17	AAC with Coal Gangue (CG)/ Iron Ore Tailings (IOT)	95	1.67	17	16	2.69	11
18	AAC with Incinerated Sewage Sludge Ash (ISSA)	93	1.66	18	17	2.59	13
19	AAC with 32.5 Grade Ordinary Portland Cement (OPC)	97	1.63	19	17	1.94	19
20	AAC with BLA	95	1.36	20	17	1.41	20

The survey showed that the Nigerian respondents, with a mean rating of 1.63 to 2.11, are only slightly aware of 19 of the 20 AAC variations. The top-ranked AAC versions that the experts were only slightly familiar with include AAC with 52.5 grade OPC (MS = 2.11), AAC with 42.5 grade OPC (MS = 2.07), and AAC with RHA/AP (MS = 2.01). The least popular AAC variant, AAC with Bamboo Leaf Ash (MS = 1.36), ranked 20th in both countries, meaning it is entirely unknown to experts, though it has an MS of 1.41 in South Africa. Further questioning revealed low patronage of AAC in Nigeria, as the South African company producing AACB had to relocate due to low patronage. On the other hand, Table 23shows that the South African respondents' mean ratings of AACB alternatives range from 1.41 to 4.94. The AAC blocks manufactured with 52.5 grade OPC are well-known to South African experts. The professionals know AACB manufactured with 42.5 and 52.5 grades OPC and AACB with RHA/AP. Also, the professionals have moderate awareness of 13 out of the 20 AACB-listed variations. The AACB manufactured using SCG has a mean rating of 2.47, PW/PF has a mean score of 2.35, and the 32.5 grade OPC has a mean rating of 1.94. The professionals are slightly aware of these three identified versions of AACB. AACB manufactured using BLA (MS = 1.41) is entirely unknown to construction professionals.

4.3 Potentials of AACB Usage in the Nigerian Construction Sector

The viewpoints of Nigerian construction professionals on the potential of AACB usage in the country's construction sector are shown in Table 4. The following criterion was used to assess the mean score for the likelihood of AACB adoption in the Nigerian building construction sector: $1.00 \leq MS < 1.49$ denotes Very Poor, $1.50 \leq MS < 2.49$ denotes Poor, $2.50 \leq M < 3.49$ denotes Average, $3.50 \leq MS < 4.49$ denotes

Good while 4.50 ≤ MS ≤ 5.00 denotes Very Good. Response rates for the likelihood that AACB variants would be embraced as a walling material for building projects are: 5.2% of the participants see a very poor acceptance of the block in the Nigerian construction sector; 25.8% see a poor potential of the block being adopted in the Nigerian building market; 37.1% see average potential of the block being adopted; 26.8% of participants see the block to have a good potential of being used in the Nigerian building construction sector; while only 5.2% see very good chance of the block usage in the Nigerian building construction market. More Nigerian construction professionals see the average potential for using the AACB in future (37.1%). There is therefore average likelihood that Nigerians will embrace AACB usage. This suggests that there is a chance that the block will someday be widely accepted for wall construction in Nigeria.

Table 4: Potential for Autoclaved Aerated Concrete Block Usage in the Nigerian Construction Sector

Type	Response rate					MS	SD
	1	2	3	4	5		
Prospects	5 (5.2%)	25(25.8%)	36(37.1%)	26(26.8%)	5(5.2%)	3.01	.794

Note: 1 denotes Very Poor, 2 denotes Poor, 3 denotes Average, 4 denotes Good, and 5 denotes Very Good. The terms MS and SD represent Mean Score and Standard Deviation respectively.

4.4 Test of Hypothesis

4.2.1 Hypothesis One

H_0: The opinion of experts in Nigeria and South Africa about awareness of AACB variants is significantly different.

The results of the Mann-Whitney U test comparing the awareness of construction professionals in Nigeria and South Africa on familiarity with 20 AACB variants are shown in Table 5.

The Table shows that the awareness of professionals in both countries is significant in 19 of the 20 AACB variants. In details, AACB variants with significant difference in awareness and the null hypothesis rejected are: (AAC with 32.5 grade Ordinary Portland Cement (OPC); AAC with 42.5 grade Ordinary Portland Cement (OPC); AAC with 52.5 grade Ordinary Portland Cement (OPC); AAC with Coal Bottom Ash (CBA); AAC with Natural Zeolite Additive (NZ); AAC with Self-ignition Coal Gangue (SCG); AAC with Incinerated Sewage Sludge Ash (ISSA); AAC with Silica Fume (SF) / Fly Ash (FA); AAC with Dune Sand (DS); AAC with Rice Husk Ash (RHA)/Aluminum Powder (AP); AAC with Concrete Sandwich Block (CSB)/Waste Glass (WG); AAC with Halloysite Powder (HP); AAC with Air-cooled Slag (AS); AAC with Efflorescence Sand (ES); AAC with Phosphorus Sand (PS); AAC with Coal Gangue (CG)/Iron Ore Tailings (IOT); AAC with Pulverized Fuel Ash (PFA)/Palm Oil Fuel Ash (POFA); AAC with Copper Tailings (CT)/Blast Furnace Slag (BFS); and AAC with Perlite Waste (PW)/Polypropylene Fiber (PF). The null hypothesis is only accepted for AAC variants manufactured with BLA, for which no significant awareness (NS) exists among experts in Nigeria and South Africa.

4.2.1 Hypothesis Two

H0: There is no significant variation in the potential of AACB adoption among Nigerian professionals..

The inferential results are presented in ANOVA Table 6. It can be seen that there is no substantial variation in acceptance of the potential of using AACB in the Nigerian building construction sector (P-value 0.196).

5. Discussion of Findings

According to the assessment, it was observed that the AACB variants are slightly gaining popularity among professionals in the Nigerian construction industry, as the professionals are slightly aware of 19 out of the 20 AACB types investigated. Meanwhile, South African construction industry findings indicate they are more cognizant of most AACB variants.

AACB is not being used in walling and professionals are ignorant of its existence because it is not one of the typical walling components used in building construction in Nigeria. This finding agrees with Ikponmwosa et al. (2014), who found earlier that aerated concrete is not popular in Nigeria. The manufacturing and utilisation of AACB more regularly as a walling material in Nigeria can increase its usage with the consequent popularity.

Table 5: Mann-Whitney U Test results for a significant difference in the level of awareness of AACB between experts in Nigeria and South Africa

S/N	AAC Versions	Nigerian Professionals		South African Professionals		U	P-value	Decision
		N	MS	N	MS			
1	AAC with 32.5 grade Ordinary Portland Cement (OPC)	97	54.85	17	72.62	567.500	.024	S
2	AAC with 42.5 grade Ordinary Portland Cement (OPC)	95	49.78	17	94.03	160.500	.000	S
3	AAC with 52.5 grade Ordinary Portland Cement (OPC)	94	48.06	17	99.91	52.500	.000	S
4	AAC with Coal Bottom Ash (CBA)	94	51.68	17	79.88	393.000	.000	S
5	AAC with Natural Zeolite Additive (NZ)	95	52.54	17	78.65	431.000	.001	S
6	AAC with Self-ignition Coal Gangue (SCG)	95	53.71	17	72.12	542.000	.023	S
7	AAC with Incinerated Sewage Sludge Ash (ISSA)	93	51.17	17	79.18	388.000	.000	S
8	AAC with BLA	95	55.75	17	60.68	736.500	.457	NS
9	AAC with Silica Fume (SF) / Fly Ash (FA)	94	50.03	17	89.03	237.500	.000	S
10	AAC with Dune Sand (DS)	93	49.42	17	88.76	225.000	.000	S
11	AAC with Rice Husk Ash (RHA) / Aluminum Powder (AP)	93	48.99	16	89.91	185.500	.000	S
12	AAC with Concrete Sandwich Block (CSB) / Waste Glass (WG)	95	52.15	17	80.79	394.500	.000	S
13	AAC with Halloysite Powder (HP)	93	50.88	17	80.79	360.500	.000	S
14	AAC with Air-cooled Slag (AS)	94	51.36	17	81.68	362.500	.000	S
15	AAC with Efflorescence Sand (ES)	95	52.14	17	80.85	393.500	.000	S
16	AAC with Phosphorus Sand (PS)	92	50.36	17	80.12	355.000	.000	S
17	AAC with Coal Gangue (CG) / Iron Ore Tailings (IOT)	95	51.33	16	83.72	316.500	.000	S
18	AAC with Pulverized Fuel Ash (PFA) / Palm Oil Fuel Ash (POFA)	95	51.10	17	86.68	294.500	.000	S
19	AAC with Copper Tailings (CT) / Blast Furnace Slag (BFS)	94	51.41	17	81.35	368.000	.000	S
20	AAC with Perlite Waste (PW) / Polypropylene Fiber (PF)	95	52.43	17	79.26	420.500	.001	S

Note: N denotes the number of respondents, MS denotes mean score, P-value, significant at $P \leq 0.05$, U denotes Mann-Whitney, S denotes Significant Difference, and NS denotes No Significant difference in the awareness level.

Table 6: ANOVA on the Potential for Autoclaved Aerated Concrete Block Usage in The Nigerian Construction Sector

	Sum of Squares	df	Mean Square	F	P-value
Between Groups	3.103	2	1.552	1.659	.196
Within Groups	87.887	94	.935		
Total	90.990	96			

Note: ρ is statistically significant at $P \leq 0.05$.

On the other hand, finding from South African costruction professionals indicated that they are fully cognizant of AACB with 52.5 grade OPC. They also profoundly know AACB with 42.5 grade OPC and RHA/AP. These findings are congruent with those of Rathi and Khandve (2015), Oo and Hlaing (2018) and Manikandan et al. (2018), who discovered that grade 52.5 OPC, grade 42.5 OPC and Aluminum Powder as the primary components used in the production of AACB. However, South African professionals are unaware of using BLA in manufacturing AAC. Table 5 shows no visible difference in the amount of awareness of AACB created using BLA in the two countries. It also implies that the use of BLA as a substitute for cement in the manufacturing of AACB has not been investigated. Furthermore, the results presented in Table 4 show that the awareness of 19 out of the 20 AACB variants is statistically significant.

It can be seen that the professionals' disposition on the potentials and perceptions of the prospects for AACB usage in the Nigerian construction sector is moderate. This implies that experts will likely use the materials as walling modules in future construction projects. Table 5 further revealed no significant disparity in the acceptability of using AACB as a walling material in building projects by the Nigerians.

6. Conclusions and Recommendations

The claim that AACB is a sound and sustainable component but yet to be embraced adequately in Nigeria and South African countries motivated the study. The aim was therefore to investigate the consciousness and prospects of its use, which are likely to enhance its usage. This was conducted in the study area via a survey method using appropriate statistical tools. It was concluded from the findings that South Africa has a greater level of awareness of AACB variants than Nigeria. This implies that lack of awareness would cause poor patronage of AACB makers; therefore, businesses involving AACB would not thrive in Nigeria. Increased patronage requires improve awareness.

Additionally, there is an average propensity in Nigeria for the use of AACB in construction projects. This suggests that experts could embrace the block for construction projects in the coming years. Therefore, The research recommends that professionals update their knowledge of AAC to understand AACB better. Seminars and workshops, training on AACB, and environmentally friendly building materials can be used to accomplish this. Additionally, the study suggests that governments, stakeholders and research institutions exert more effort on manufacturing and optimising AACB to attract the interest of consultants, clients/developers and contractors.

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