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Enhancing the use of sustainable construction materials in southwest Nigeria: exploring the roles of quantity surveyors

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Introduction: This study investigates the role of Quantity Surveyors (QS) in promoting the adoption of sustainable construction (SC) practices in Nigeria, to improve construction project performance in developing economies. Despite increasing awareness of the benefits of SC, its adoption remains low in Nigeria. Thus, this study advocates for a more active role of QS professionals in enhancing SC adoption and integration in construction activities.

Methods: The study employs a mixed-methods approach to data collection. In the first stage, a questionnaire was administered to 82 randomly selected professional registered Quantity Surveyors from Ekiti and Osun States, Nigeria, to gather quantitative data. In the second stage, structured interviews were conducted with 12 respondents from the initial survey, chosen for their high knowledge of SC, to gain in-depth insights and personal experience on the subject matter having obtained the participants' written informed consent to participate in this study. Data were analyzed using descriptive statistics (frequency, percentage, mean item score) and inferential statistics (t-test), as well as content analysis for the qualitative data.

Results: The findings reveal that while Quantity Surveyors possess significant knowledge of sustainable construction, their roles in facilitating the adoption of SC materials is low. The study identifies several key roles that QS professionals can play in enhancing SC adoption, including: driving stakeholder awareness, promoting life cycle costing, advising on alternative materials and their cost implications, contributing to policy formulation, advancing research and development initiatives, and conducting feasibility studies for sustainable development.

Discussion: The study is limited to data collected from Quantity Surveyors in two Southwestern Nigerian states, which may not fully represent the broader national context. The sampling method might introduce a level of limitation as regards the sample size and true representation of the target population. Future research could expand the sample size and geographic scope to gain a more comprehensive understanding of the role of QS in SC adoption across Nigeria and other developing countries. This research contributes to the literature on sustainable construction by highlighting the critical, yet under-explored, role of Quantity Surveyors in improving SC adoption in developing economies. The study emphasizes the potential for QS professionals to drive significant

improvements in the sustainability of the construction sector, offering valuable insights for policymakers, practitioners, and the construction industry at large.

KEYWORDS

adoption of sustainable construction, materials, developing economy, Nigeria, quantity surveyors

Introduction

The importance of the construction industry to the economy of nations has been emphasized (Agyekum-Mensah et al., 2012; Aghimien et al., 2018a). The essentiality of the construction industry is multifaceted in its contribution to the economy, society, and livelihood of citizens. In terms of economic contributions, the construction industry has been lauded as a major contributor to the gross domestic product of nations (Adindu et al., 2019). However, this contribution varies from nation to nation depending on whether the nation is developed, developing, or underdeveloped. Notwithstanding, whichever classification a nation may fall under, a healthy construction industry is essential to supply all the accommodation needs of the populace, including commercial, industrial, religious, and residential buildings. Going by the importance of the construction industry and its contributions to nations, the issue of sustainability of construction activities cannot continue to be jeopardized due to the documented low adoption (Adindu et al., 2019; Amuda-Yusuf et al., 2020) of sustainable construction and poor sustainability practices of construction activities (Aje, 2015; Baron and Donath, 2016), especially in developing nations like Nigeria.

The clamor for sustainable development has reached a crescendo in developed economies (Sabini et al., 2019; Amuda-Yusuf et al., 2020). Despite this, little has been achieved in concrete terms in developing nations (Tomislav, 2018). While the study has affirmed sustainable construction practices would foster the achievement of sustainable development (Aghimien et al., 2018b), the need for sustainable construction is eminent as the present generation cannot continue to hamper the chances of the next generation to meet theirs (Brundtland Report, 1987; Aghimien et al., 2016).

The construction industry is pivotal to achieving sustainable development, because the number of resources that are being consumed because of construction activities is enormous. Zhou et al. (2018) opined that the Chinese construction industry exhausts around one-third of the nation's raw materials and energy to accomplish its functions. Heijden and Bueren (2013), corroborating Baloi (2003), asserted that the global consumption of sand, gravel, and energy for building construction stands at 40%. The study further opined that one-quarter of virgin wood and 16% of water is consumed for construction activities yearly all over the world. This high resource and energy consumption need to be met sustainably; otherwise, the resources may be depleted by this generation, hindering the upcoming ones from meeting their needs. Aside from the high level of energy and resource consumption, the negative impact that construction activities pose to the environment in terms of pollution of different types, generation and improper disposal of degradable and non-degradable waste materials, destruction of the natural habitat of animals, desertification, and soil erosion (Tiwari et al., 2016) are some other construction essentialities that necessitate the adoption of sustainable construction. The most quoted definition of sustainable development in literature was offered by the Brundtland Report (1987), the foremost pioneering report on the concept of sustainability and sustainable development. It defined sustainable development as the one that meets today's needs without hampering the coming generations from meeting their own needs.

Several research efforts have been made to bring to the fore issues relating to sustainability and sustainable development since the Brundtland Report (1987) exposed the need for sustainable development to the world. In developed nations, some of the research directions on the concept of sustainable construction include sustainable construction in public procurement (Sourani and Sohail, 2013; Kurniawan et al., 2024), sustainable construction materials and barriers to their usage (Provisa et al., 2010; Miqueleiz et al., 2012; Thomas et al., 2013; Maraveas, 2020; Gounder et al., 2023), challenges of sustainable construction (Bon and Hutchinson, 2000; Ayalp and Metinal, 2024), sustainable practices in the construction industry (Akadiri and Fadiya, 2013), and models for sustainable building construction management (Hemanth and Padala, 2024).

However, the majority of the research in developing nations has been on the benefits and challenges of sustainable construction (Elmualim and Alp, 2016; Aghimien et al., 2018a; Aghimien et al., 2019; Hoxha and Shala, 2019), barriers to sustainable construction (Aghimien et al., 2018b; Khural et al., 2024; Omopariola et al., 2024), awareness of sustainable construction, its practices and implementation (Adindu et al., 2019; Amuda-Yusuf et al., 2020; Tunji-Olayeni et al., 2020), and frameworks for sustainable construction practices (Athapaththu and Karunasena, 2018). From these research directions, it is obvious that previous studies have not been focusing on empirically examining the roles of stakeholders in the construction industry in enhancing the low adoption of sustainable construction (Tomislav, 2018; Adindu et al., 2019). Despite this, Fei et al. (2021) has affirmed that the construction industry and its stakeholders have critical roles in achieving sustainable construction. Omotayo et al. (2023) investigated the versatility of the quantity surveying profession and sustainable construction in Singapore and found that the preparation of bills of quantities for green buildings, feasibility studies, carbon cost planning, and sustainable cost estimating are the most common services rendered by quantity surveyors in Singapore. In developing economies, and most especially in the study area, no known study has examined the roles of Quantity Surveyors in enhancing and fostering sustainable construction best practices. This study in bridging this research gap, therefore, investigated the intricate roles of Quantity surveyors in enhancing the effective adoption of sustainable construction in Nigeria. The specific objectives

were to examine the extent of Quantity Surveyors' knowledge of sustainable construction in Osun and Ekiti State, Southwest Nigeria, to investigate the extent of Quantity surveyors' fostered adoption of sustainable construction materials, and to determine the roles of Quantity Surveyors in enhancing the adoption of sustainable construction best practices in the study area. The motivation for the study stemmed from a futile search for empirical documents detailing the roles of stakeholders in achieving sustainable construction in Nigeria. This study therefore bridged this gap in literature by exploring the roles of Quantity Surveyors in enhancing the adoption of sustainable construction in Southwest, Nigeria.

Literature review

Sustainable construction

Sustainable construction has been defined as the process of achieving a balance in the intervention of environmental, social, and economic factors in the design, construction processes, use, and maintenance of buildings and other infrastructural development (Aghimien et al., 2018a; Hemanth and Padala, 2024). The definition of sustainable construction offered by Construction Excellence (2004) is judged to be more encompassing. The study described sustainable construction as the built environment application of sustainable development in which improved quality of life is ensured for everyone, both the current and future generations, by ensuring a social order that accommodates the needs of all, maintaining uniform and high economic growth through employment, while protecting and enhancing the environment and making prudent use of natural resources. Studies have seen sustainable construction as a major pathway for the construction industry to achieve sustainable development (Akbiyikli et al.,2009; Udomsap and Hallinger, 2020). Irrespective of the individual author and scholar's perspective and definition of the concept, the fundamental philosophy of the concept is that Sustainable construction is a calculated attempt to minimize the negative effect of human activities on the physical environment to ensure socially responsible economic development (Coskun et al., 2023). Researchers on the concept of sustainability and sustainable construction have used phrases like green building, sustainable building, and high-performance building as synonyms for sustainable construction in recent times (Gunatilake and Liyanage, 2010; Ade-Ojo and Awodele, 2020; United Nations Environment Programme, 2022).

Sustainable development is required in developed nations (Abisuga and Oyekanmi, 2014), with higher imperativeness in developing and underdeveloped countries (Baron and Donath, 2016). The global imperativeness of sustainable development was birthed by the Brundtland Report (1987), which cautioned the world about the necessity of the current generation to ensure the use of natural resources in a sustainable manner to enable the upcoming generations to be able to meet their needs. Attitudinal change in the use of resources from the linear processes to cyclical processes will ensure increased use of recycled, renewed, and reused resources, thereby reducing the consumption of natural resources and the high energy consumption which the construction industry is noted for (Heijden and Bueren, 2013; Eze et al., 2024). Hossain et al. (2020) have noted that the nagging issue of cost and time, environmental pollution, and waste generation management in the construction industry can be significantly managed through sustainable construction.

Previous studies have diverse positions on the low adoption of sustainability and sustainable construction in developing economies, although the majority of studies found that the low adoption of the concept is attributable to the low awareness of the construction stakeholders about the concept (Alabi, 2012; Al-Sanad, 2015; Aghimien and Awodele, 2016). Contrary to this, Baron and Donath (2016) opined that the low adoption of the concept of sustainable construction is not about low awareness but rather incorrect implementation. The study further opined that the adoption of sustainable construction is deliberately neglected in Ethiopia due to budgetary considerations or the absence of alternative building materials. The three main fulcrum on which the concepts of sustainability and sustainable development stand are the environmental, economic, and social dimension paradigms. However, extant literature has opined that much research effort has been concentrated on the environmental pillar (Alabi, 2012; Beheiry, 2006). In contrast to Alabi (2012), Ekung et al. (2016) found that construction professionals in the Nigerian construction industry ranked the social fulcrum of sustainability as the most pertinent sustainability pillar to achieve sustainable construction.

Sustainable construction materials

Over the years, researchers on sustainable building materials have developed many sustainable construction materials that include porous and lightweight bricks (Mucahit and Sedat, 2009). The study by Kumar (2002) used fly ash–lime–gypsum bricks and hollow blocks to produce economical and sustainable materials by utilizing industrial waste. The sustainable bricks developed by Rahman (1987) were a product of clay sand mixed with rice husk ash. Other studies that have produced sustainable bricks include Caroline et al., 2009 and Demir et al., 2005. Provisa et al. (2010) investigated the role of particle technology in producing sustainable construction materials and found the use of fly ash as an effective partial replacement for cement . Maraveas (2020) identified six sustainable construction materials: green concrete, brick/masonry, insulation materials for buildings, reinforcement materials for buildings, particleboards, and bio-based plastics. The sustainable construction materials identified by Khatib (2016) are timber, aggregates, concrete, and cement replacement materials, masonry, metals, bituminous materials, glass, industrial by-products, and waste rubber.

Research has established the need for sustainable construction materials to achieve much-needed sustainable construction in developing countries (Aghimien et al., 2019). One study further posited that, even though there appears to be an increase in the number of empirical studies on sustainable development and sustainable construction in developing nations, many developing countries are still far from achieving sustainable construction because, in real terms, the majority of these nations are still using the traditional unsustainable construction materials, thereby maintaining the old construction practice and materials. Extant studies have posited that the major impediment to the adoption of sustainable construction materials is the high initial cost (Häkkinen

and Belloni, 2011; Zhang et al., 2011; Isa et al., 2013; Ametepey et al., 2015; Darko and Lowe, 2016; Kissi et al., 2018; Nnaji and Uzorh, 2019). However, the fear of high initial costs has been dispelled by the incorporation of life cycle costing rather than concentrating on the initial cost (Shi et al., 2013).

Roles of quantity surveyors in enhancing sustainable construction practices

Extant studies have agreed that all construction stakeholders have roles to play in achieving sustainable construction in the built environment. Gan et al. (2015) mentioned the roles of engineer and architect; the roles of the construction client were highlighted in the study by Athapaththu and Karunasena (2018). The significant roles of contractors in achieving sustainable construction were mentioned by Tan et al. (2011). The profession of quantity surveying since its evolution in the 1820s is primarily to estimate the materials, labor, and equipment, required for construction projects, as well as manage the cost of construction activities in the construction industry (Bolade-Oladepo et al., 2020). Studies have affirmed that quantity surveyors' roles in the construction industry due to their dynamic nature have shifted from the initial traditional technical roles to managerial (Noor et al., 2020; Yap et al., 2021). Fisher et al. (2008) submitted that the roles of quantity surveyors in the construction industry to ensure sustainable construction include advising on the sustainable use of resources, promoting reduced waste generation and environmentally friendly waste disposal, promoting a decrease in energy consumption, and enhancing sustainable design, development, and construction practices, including whole-life costing. Omotayo et al. (2023) found that the role of quantity surveyors in sustainable construction in the construction industry includes sustainable projects, quantification, cost estimates and cost plans for sustainable projects, life cycle cost analysis, and green building performance reporting.

Research methodology

The study used a mixed research method to explore the roles of Quantity Surveyors in enhancing the use of sustainable construction materials in Nigeria. This approach was adopted to provide a complete and holistic picture of the issue at hand. This is because, as posited by Creswell (2003), adopting a mixed research method ensures a complete analysis that deals with the drawbacks of either a qualitative or quantitative approach only. The study area for data collection was Ekiti and Osun states within Nigeria. The study area was selected due to its proximity to the researchers and because the two states have similar attributes, being predominantly agrarian and core civil servants dominated states, as these characteristics were thought to influence the decision to use sustainable construction materials. This is because their agrarian nature is thought to make the agro-waste a sustainable construction material. In the same vein, the dominance of civil servants is expected to be advantageous to them as they should be enlightened enough in the choice of sustainable construction materials. While Osun state has a population of 4,234,394 and 14,875Sq.Km surface area, Ekiti State's population is 3,398,177 with a 6,353 Sq.Km surface area (National Population Commission, 2023). The two states are located in the Southwestern region of Nigeria and share a border. Ekiti state was part of the old Ondo and Osun States before its creation in 1996 (Dadamola et al., 2021). Osun State is located at Latitude 7° 30′N (North of the Equator), Longitude 4° 30′E (East of the Prime Meridian); Ekiti State is located at Latitude7° 30′N to 8° 30′N (North of the Equator), Longitude 4° 30′E to 5° 30′E (East of the Prime Meridian). There has been a surge in construction activities within the study area in recent times, most especially in urban areas, facilitated by the increase in government funding as evident in the construction and rehabilitation of roads, upgrades of public infrastructure, and increased investment from the private sector in construction activities (Olatunde et al., 2025).

A random sampling technique was used to select 126 professionally registered Quantity Surveyors from the study area for the administration of the questionnaire. Thus, 82 (65%) responses were received and screened for completeness of responses and judged fit to be used for analysis. The questionnaire administration was done using three main methods: physical distribution by the researchers, sharing through WhatsApp, and sharing through e-mail. The high response rate was achieved due to persistent calls, WhatsApp message reminders, and e-mail reminders, as well as giving sufficient time of up to 3 months for data collection. The design of the questionnaire was ensured after a thorough review of relevant literature. The questionnaire design was piloted for accuracy and comprehensiveness by two experienced practicing quantity Surveyors and two established researchers who were not part of the research team. Their comments and observations were used to improve the questionnaire before administration to the respondents. The questionnaire designed for the data collection was segmented into two sections: the first section required information about the respondents' characteristics and attributes, while the second section sought information about the objectives of the study using a 5-point Likert scale. Data analysis was done with the use of frequency and percentage for the background information of the respondents. The Mean item score was used for the quantitative analysis and a t-test was used to test the hypotheses.

For the qualitative data collection, a structured interview protocol was designed and used to elicit information from highly experienced and professional registered Quantity Surveyors who were selected based on their responses to the questionnaire, which indicated a high level of knowledge about sustainable construction practices. The motivation to use interviews alongside the questionnaire for the collection of data stems from the fact that while questionnaires enable the investigator to reach a large number of respondents in practical and more economical terms with greater result validity and generalization, interviews help the researcher to ensure the depth and richness of the information supplied from respondents' personal experiences rather than numerical validity ensured by using questionnaires only (Naoum, 2003). Of the 17 experienced Quantity Surveyors selected for the interview, only 14 of them agreed to interviews. However, only 12 interviews were successful, while the other two interviews could not go through after several postponements at the request of the interviewees. Thus, 7 of the 12 interviews conducted were done physically at the respective venues at the dictate of the interviewees. Three interviews

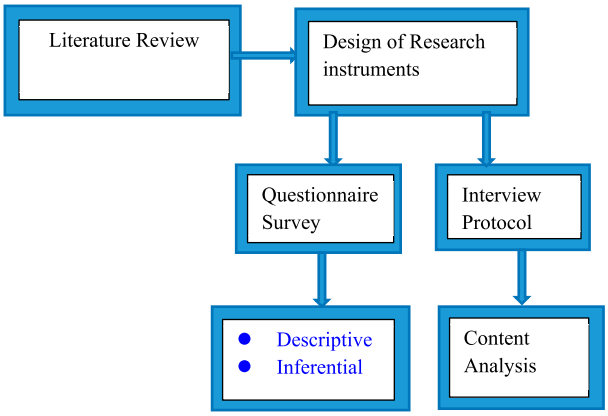

FIGURE 1
Schematic diagram of the research methodology.

were done through WhatsApp calls and two through a scheduled Microsoft teams call; each interview lasted between 37 and 56 min. Having collected data about the attributes and characteristics of the interviewees in the quantitative section, the main question that was posed to the interviewees was, "From your response to the questionnaire on enhancing the use of sustainable construction materials in Nigeria: exploring the roles of Quantity Surveyors which you earlier responded to; you indicated that you have a high knowledge of sustainable construction. Please, can you share with me the intricate roles of Quantity Surveyors in enhancing the use of sustainable construction materials in Nigeria?".

All the interviews were recorded with the permission of each interviewee after guaranteeing the anonymity of their responses as well as the intent of the research. To enhance the integrity of the data collected, the recorded and transcribed versions of the responses of the interviewees were sent to the interviewees to confirm whether their intent was properly captured, to which they responded in the affirmative. Data analysis of the qualitative aspect of the research was done with the use of manual inductive content analysis. The study adopted a four-step thematic approach for analyzing qualitative research, proposed by Petrona (2019). In the first step, the researchers got familiar with the data by repeatedly listening to the recorded audio data. This was aimed at identifying the important information. The second step was to code the data into different themes and coherent groups to address the questions answered in the interviews. The next step was to search for themes that emanate, while the last step was the interpretation and reporting of results. The research methodology is represented in Figure 1.

Research hypothesis

One null hypothesis was formulated to further examine the objective of the study in quantitative terms:

$H_0$1: There is no significant difference in the extent of quantity surveyors' knowledge of sustainable construction and the extent of adoption of sustainable construction materials.

H1: There is a significant difference in the extent of quantity surveyors' knowledge of sustainable construction and the extent of adoption of sustainable construction materials.

Results

The results in Table 1 show that the respondents have adequate working experience in the Nigerian construction industry, as 66% of them have more than 10 years of work experience in the construction industry. All the respondents have the required academic qualifications to supply the information required of them as they possess certificates ranging from a Higher National Diploma to a Doctor of Philosophy. All the respondents were members of the Professional Association for Quantity Surveyors in Nigeria. Their membership categories range from graduate members (6.1%) to Fellows (4.9%). However, the majority (61%) of them were corporate members. These background attributes of the respondents indicated that their responses could be relied upon for informed decisions as they were eminently qualified.

Table 2 indicates the results for the comparison of the extent of Quantity Surveyors' knowledge and adoption of sustainable construction materials. The results indicate that Quantity Surveyors in the study area have a high knowledge of sustainable construction materials, with mean scores ranging from 3.65 for bricks made with partial placement of agro-waste materials to Green concrete (concrete with partial replacement of agro-materials) with a Mean score of 4.16. The extent of adoption or use of sustainable construction materials is low: the mean score ranges from 1.52 for green concrete (concrete with partial replacement of agro-materials) to 2.39 for agro-waste (hemp, straw, flax, etc.) as an insulation material for building. The result of the t-test indicated that there is a significant difference between the extent of Quantity Surveyors' knowledge of sustainable construction and the extent of adoption or use of sustainable construction materials, with a P-value less than 0.05.

To finally realize the objective of the study, 12 Quantity surveyors who agreed to an interview from the 15 who indicated that they have very high knowledge of sustainable construction were interviewed, and the following thematic issues emanated from the content analysis of their responses.

Quantity surveyors as key stakeholders to drive awareness of sustainable construction

The first role of Quantity surveyors in enhancing the use of sustainable construction materials in Nigeria as opined by all the interviewees is stakeholders' awareness drive. The interviewees posited that Quantity surveyors have the unique role of increasing awareness to other professional colleagues in the built environment as well as the construction clients of various types. In the opinion of interviewee 3, "*Quantity surveyors are placed in a vintage position to help in the awareness drive about sustainable construction and sustainable construction materials. It is a fact that many built environment professionals, as well as clients of construction projects,*

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TABLE 1 Characteristics of respondents to questionnaire.

Category	Classification	Frequency	Percentage
Years of experience	1–5	4	4.9
	6–10	24	29.3
	11–15	25	30.5
	16–20	23	28.3
	>20	6	7.3
	Total	**82**	**100.0**
Highest academic qualification	HND	4	4.9
	PGD	3	3.7
	B.Sc/B.Tech	46	56.0
	M.sc/M.Tech	25	30.5
	PHD	4	4.9
	Total	**82**	**100.0**
Membership of professional body	NIQS	82	100.0
Type of Membership	Graduate	5	6.1
	Probationer	23	28.0
	Corporate/Associate	50	61.0
	Fellow	4	4.9
	Total	**82**	**100.0**
Knowledge of Sustainable construction	Very High	15	18.3
	High	24	29.3
	Moderate	35	42.6
	Low	8	9.8
	Total	**82**	**100.0**

Source: Researchers' construct (2024). The bold colour indicate the frequency and percentage of respondents.

are not aware of many of the sustainable construction materials that are available for use; as such, to enhance the use of these materials Quantity surveyors need to step up awareness through workshops, seminars, conferences, and one-on-one enlightenment campaigns to identify the sustainable construction materials and its benefits". In the words of interviewee 6, "*the low awareness about sustainable construction in developing countries could be a starting point for Quantity surveyors in their bid to enhance the use of sustainable construction materials. All the built environment professionals (architects, engineers, and builders) must first be fully orientated about these materials. Architects, engineers, and builders even though may have a level of awareness of these materials their confidence to use them for construction may be boosted by the Quantity surveyors' advice most importantly as it relates to the cost of such materials*".

Life cycle costing role and enlightenment

Another major role of Quantity Surveyors in enhancing the use of sustainable construction materials, as mentioned by 92% of the interviewees, is life cycle costing role and enlightenment. Interviewees commented that one of the exclusive roles of Quantity Surveyors is life cycle costing of construction projects. In enhancing the use of sustainable construction materials, Quantity Surveyors will have to evaluate the life cycle cost of each sustainable construction material and enlighten the construction stakeholders on the cost implications of the materials in comparison to conventional alternatives. In the opinion of interviewee 4, "*the decision to use sustainable construction materials will be largely based on the professional service of Quantity Surveyors on life cycle costing of projects. Often times, construction stakeholders usually look up to Quantity Surveyors for cost advice before they make a decision when they are faced with alternatives, as such, it is an indisputable duty that Quantity Surveyors owe the construction industry in this regard to come up with life cycle data for different sustainable construction materials as well as enlighten the public based on the cost information*. According to interviewee 9, "life *cycle cost of materials is a major determinant in decision making of construction materials, hence, there is still inadequate information about the life cycle cost of many of the potential sustainable construction materials which have been one of the bans of their adoption. Therefore, to enhance the use of these materials, Quantity Surveyors must engage in categorical and comprehensive life cycle costing of all the potential sustainable construction materials and familiarize the construction stakeholders with the results*".

Advising on alternative materials specification and its cost implication

In the opinion of 75% of the interviewees, Quantity Surveyors have the responsibility to suggest alternative materials and discuss the cost implications. According to interviewee 1, "*quantity surveyors owe the construction industry the duty to conduct cost analyses to assess the financial viability of using alternative materials compared to traditional ones*". According to interview 4, "*Quantity Surveyors prepare budgets that incorporate the costs of alternative materials, including procurement and installation of any material for the construction of any part of a project, as such he is a key professional that is responsible for cost alternatives of sustainable building projects.*" In the words of interview 9, "*Quantity Surveyors assess potential risks associated with alternative materials, such as their availability, performance issues, or regulatory compliance. This is in addition to developing strategies to mitigate the risks identified, which can influence overall project costs and performance*".

TABLE 2 Extent of Quantity Surveyors' knowledge and adoption of sustainable construction materials.

S/N	Sustainable construction materials	Extent of knowledge of SC materials		Extent of adoption of adoption of SC materials		t-stat	P-value
		MS	SD	MS	SD		
1	Bricks made with partial placement of agro-waste materials	3.65	0.65	1.61	0.72	18.02	0.01
2	Green concrete (concrete with partial replacement of agro- materials)	4.16	0.64	1.52	0.77	22.02	0.00
3	Agro-waste (hemp, straw, flax, etc.) as insulation material for building	4.15	0.65	2.39	0.78	17.21	0.01
4	Vegetable fibre (bamboo rebars, sisal, coconut, and hemp) as Reinforcement for building	4.09	0.69	2.10	1.00	13.94	0.00
5	Particle board (made of sugar beet, leaf fibre, coconut pith, cotton stalk	4.01	0.61	2.18	0.76	15.64	0.00
6	Bio-Based Plastics	4.02	0.68	1.89	0.50	21.49	0.02

Key: MS = mean score; SD = standard deviation; SC = sustainable construction.
Source: Researchers' construct (2024).

Policy formulation advisory role

Many of the interviewees opined that the Quantity Surveyors' roles in enhancing the use of sustainable construction materials include an "advisory role in policy formulation". In the opinion of interview 4, "The *Quantity Surveyor is always at the center of policy decision making in enhancing the use of sustainable construction materials. As the cost advisor to project clients at various levels, project-related decisions cannot be taken without recourse to the cost advisor who has expertise in guiding the client in decision making. At a macro level, Quantity Surveyors are expected to guide policymakers in policy decisions-making based on their knowledge and professionalism of material performance about cost*". Interviewee 11 opined that "Quantity *surveyors play a pivotal role as advisors in policy formulation, most importantly on mega projects, local government projects, state projects as well as federal projects that require proper planning, informed decision making, and serious forward thinking before the project is executed*".

Research and development drive and initiatives

Interviewees opined that the role of research and development drives and initiatives for the use of sustainable construction materials is one of the exclusive roles of Quantity Surveyors. According to interviewee 5, "*Quantity Surveyors must as a matter of necessity champion cutting edge research on the use of sustainable construction materials*." Interviewee 9 opined that "*research initiatives that impact the construction industry on the use of sustainable construction materials should be initiated by Quantity Surveyors. This will, in addition to advocacy from the professional perspective, provide an empirical basis for decision making and decision-making advice*." In the words of interviewee 12 "Quantity *surveyors need to come up with cost advice that is a product of empirical research and data-driven. This implies that Quantity Surveyors need to be at the vanguard of research on cost management in the use of sustainable construction materia*ls."

Feasibility and viability appraisal of sustainable development

Feasibility and viability appraisal and reporting of sustainable development are other important roles that 58% of the interviewees mentioned to enhance the use of sustainable construction materials within the study area**.** According to interviewee 3, "T*he starting point in the duties of quantity surveyors in enhancing the use of sustainable construction materials should be feasibility and viability appraisal and reporting. Many of the supposed sustainable projects are only good in theory. In practical terms, however, the quantity surveyors using their professional expertise should ensure a thorough analysis of such a project from the inception throughout its life cycle and report on such for the client and the construction team to have a valid practical document to work with rather than an educated guess based on theory and information that may not have local application.*" In the words of interviewee 8, "Quantity *surveyors are indispensable professionals if the construction industry will enhance the use of sustainable construction materials. On many occasions and instances, most especially on commercial projects, a comprehensive appraisal and reporting for the feasibility and viability of the project is often required before their execution, as such a quantity surveyor will place a significant role in ensuring this.*"

Discussion of finding

The low adoption of sustainable construction materials found by the study is in line with extant studies (Tomislav, 2018). This

could be linked to one of the attributes of developing nations as often lagging in embracing innovative solutions compared to their counterparts in developed countries (Osunsanmi et al., 2020; Olatunde, et al., 2022). In the same vein, this finding may be an affirmation of scholars' position on the fact that the construction industry in comparison to other sectors is often rigid in adopting changes (Zhong et al., 2017; Bouras et al., 2016). This notwithstanding, the level of knowledge of quantity surveyors on sustainable construction and sustainable construction materials is high; this revelation is in tandem with Amuda-Yusuf et al. (2020). The knowledge of quantity surveyors about the concept of sustainable construction and sustainable construction materials has not translated to significant adoption, hence the significant difference in the extent of quantity surveyors' knowledge and adoption of sustainable construction materials. The role of quantity surveyors in advising on alternative materials and their cost implications is similar to Fisher et al. (2008), who found that quantity surveyors advise on the sustainable use of resources as a core function in ensuring a sustainable built environment. The low adoption of sustainable construction materials has been linked not to the absence of life cycle costing but rather the initial cost, which is seen to be high (Kissi et al., 2018; Nnaji and Uzorh, 2019), hence the reluctancy of the project stakeholders in adopting them. It is therefore imperative that the quantity surveyors enlighten the construction stakeholders about the life cycle cost implication of sustainable construction materials alternatives. Thus, the industry will start to adopt sustainable materials. This accounts for the study finding that life cycle costing is a major role of quantity surveyors in enhancing the use of sustainable construction materials. Fisher et al. (2008) and Omotayo et al. (2023) also found the same role a very important duty of quantity surveyors in ensuring a sustainable construction industry. This study, while concurring with Omotayo et al. (2023), found feasibility and viability appraisal and reporting a major role for quantity surveyors to enhance the use of sustainable construction materials in Nigeria. Omotayo et al. (2023) also found feasibility studies of sustainable projects an important role of quantity surveyors in sustainable construction in Singapore.

Conclusion

The study used the mixed methods research approach to investigate the critical roles that Quantity Surveyors can play in promoting sustainable construction practices in Nigeria, where current adoption rates remain low despite a high level of knowledge about sustainable methods. By examining the perspectives of quantity surveying professionals in Ekiti and Osun States, the research underscores the potential of these practitioners to drive change in the construction sector. Key roles include advocating for stakeholder awareness, guiding life cycle costing, specifying alternative materials, advising on policy formulation, advancing research and development, and conducting feasibility studies.

The findings suggest that, while QS professionals are knowledgeable about SC, more targeted efforts are needed to leverage their expertise in enhancing the integration of sustainable practices. Thus, the industry and policymakers must recognize the importance of Quantity Surveyors in bridging the gap between knowledge and practice. Strengthening their involvement in sustainability efforts could significantly improve the performance of construction projects in Nigeria, ensuring they are both environmentally responsible and economically viable in the long term. Ultimately, this study calls for a more strategic and proactive role for Quantity Surveyors, positioning them as key agents in the transition towards a more sustainable construction industry in Nigeria.

As with all research, there were a few limitations to the study, including the fact that the opinions expressed were that of Quantity Surveyors only; other stakeholders should be sampled to validate the perspective expressed by the Quantity Surveyors. Similarly, the perspectives expressed were that of Quantity Surveyors within Osun and Ekiti States; widening the study area may result in more robust information. The study therefore suggests that more studies should be conducted across the different regions of the country to empirically examine the roles of other key construction stakeholders to enhance the adoption of sustainable construction practices in Nigeria at large. Also, more studies could be instituted to delineate the extent of knowledge of sustainable construction across the different built environment professionals to increase the adoption of sustainable practices in Nigeria.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Written informed consent was obtained from the individual(s) for the participation in this study and for the publication of any potentially identifiable. images or data included in this article.

Author contributions

NO: Conceptualization, Formal Analysis, Investigation, Methodology, Writing – original draft, Writing – review and editing, Data curation, Funding acquisition, Project administration, Resources, Software, Validation, Visualization. IrA: Formal Analysis, Methodology, Project administration, Supervision, Writing – original draft, Writing – review and editing, Funding acquisition, Visualization, Data curation. ImA: Conceptualization, Funding acquisition, Investigation, Methodology, Resources, Software, Writing – original draft, Writing – review and editing, Data curation, Project administration.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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