AWARENESS AND ADOPTION OF PREFABRICATED POLYURETHANE IN SUSTAINABLE BUILDING CONSTRUCTION IN ABUJA METROPOLITAN AREA COUNCIL (AMAC)

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ABSTRACT

Sustainable building construction increasingly relies on innovative materials, yet the awareness and adoption of prefabricated polyurethane remain unclear in Nigeria. This study investigated the awareness and adoption of prefabricated polyurethane in sustainable building construction among building experts and contractors within Abuja Metropolitan Area Council (AMAC), Nigeria. Using a descriptive survey design**,** data were collected from 50 respondents through structured questionnaires and analysed with means, standard deviations, independent samples t-tests and effect size. Results indicated a moderate level of awareness and moderate adoption**,** with materials such as sandwich panels and insulation boards recognized but spray foam underutilized. The findings highlighted a gap between knowledge and practice, influenced by economic, technical, and policy constraints. The study concluded that while polyurethane is acknowledged for its sustainability benefits, its full utilization is limited. Recommendations include targeted training programs and policy support to enhance both awareness and adoption, thereby promoting the integration of prefabricated polyurethane in a sustainable building construction.

Keywords: Prefabricated Polyurethane, Sustainable Construction, Awareness, Adoption

INTRODUCTION

Sustainable building construction has emerged as a global imperative in addressing the multifaceted challenges of environmental degradation, energy consumption, and rapid urbanization. Sustainable building aims to meet current housing and infrastructural needs while preserving the integrity of environmental, social, and economic systems for future generations (World Green Building Council, 2020; Manu, 2024). One major approach that supports these goals is the utilisation of prefabricated building components, which enable more controlled, waste

reduction, shorter construction timelines, and overall improved environmental performance (United Nations Environment Program (UNEP), 2021; Ogunnaike, 2025).

Prefabricated construction, particularly with the integration of innovative materials such as polyurethane (PU), reduce operational costs, increase building value and boost occupancy values (Modular Building Institute (MBI), 2017; Gan, 2021). These benefits are largely due to the ability to streamline construction processes, reduce material wastage, and improve thermal and energy performance. In industrialized nations, such prefabricated technologies are widely adopted and have become an integral part of sustainable building strategies. While, low awareness, are critical barrier to the diffusion of prefabricated building materials in sustainable construction projects (Ifije & Aigbavboa, 2020; Khahro, 2023). There is increasing demand for affordable and eco-friendly housing, which has further necessitated the exploration of alternative building materials like prefabricated materials that offers both environmental and economic advantages (Baoquan, 2020, Engineering, Construction and Architectural Management (ECAM), 2025).

Polyurethane (PUR or PU) require adequate schedule and understanding by the building experts and contractors to be successful (Akintola & Nwa, 2024). PU is a polymer composed of natural units joined by urethane joins with an assortment of applications in industry. Prefabricated polyurethane materials used for sustainable construction include; polyurethane sandwich panels, rigid polyurethane foam core, polyurethane spray foam, polyurethane insulation board, polyurethane foam blocks and slabs, polyurethane sealants and adhesives and prefabricated polyurethane components. PU foams cover a wide range of stiffness, hardness and densities. Highly resilient and flexible foam seating, rigid foam insulation panels, durable elastomeric wheels and tires, automotive suspension bushings, gaskets, airspace, seals and hard plastic parts

are some examples of the application of PU in the industry (Covestro U-SKIN Technology, 2020). Most of the global consumption of polyurethane products is in the form of foams.

Additionally, PU products are strong, durable, lightweight and easy to install, making them an excellent choice for homes and building constructions. The use of foam-filled composite panels with polyurethane foam-core and facing materials such as gypsum, engineered wood or some composite materials, as efficient building elements are becoming significant players in modular construction with several applications in buildings structures (Musa, et al., 2024). These attributes align with the goals of the European Union's Energy Performance of Buildings Directive (EU EPBD, 2024), emphasizing insulation, durability, and low emissions. In spite of these benefits of prefabricated polyurethane, Nigeria's construction sector, particularly in urban centers like Abuja Metropolitan Area Council (AMAC), continues to lag in adoption and awareness of polyurethane. Therefore, understanding the current level of awareness among construction professionals and the factors' influencing adoption is a crucial first step toward promoting sustainable construction practices in Nigeria.

Statement of the Problem

The construction industry in Nigeria is increasingly confronted with the challenges of rapid urbanization, rising energy demand and the urgent need for sustainable building practices. Globally, the sector has shifted toward environmentally friendly and energy-efficient materials to mitigate climate change and reduce resource consumption. However, despite growing international emphasis on sustainable construction, the adoption of innovative building materials within the Nigerian construction industry remains relatively low (Manu, 2024; Springer, 2024; Oke *et al.,* 2025). This situation raises concerns about the industry's preparedness to meet

sustainability targets and address the environmental implications of conventional construction practices.

Prefabricated and innovative construction materials, including polyurethane-based products, have been identified as viable solutions for enhancing energy efficiency, reducing construction time, and improving overall building performance. Polyurethane, in particular, has demonstrated significant potential in improving thermal insulation and reducing carbon footprints in buildings (Akintola *et al.,* 2024). Nevertheless, the level of awareness and practical utilization of such polyurethane-based products among construction professionals in Nigeria is not clearly established (Olatayo, 2024; ECAM, 2025; Ogunnaike *et al.,* 2025).

Despite the growing market potential for prefabricated construction in Nigeria, as evidenced by projected industry expansion, the integration of advanced materials like prefabricated polyurethane into mainstream construction practices remains uncertain (Research and Markets, 2026). This uncertainty underscores the need for empirical investigation into the current state of awareness and adoption among construction professionals. Therefore, there is a need to systematically examine the level of awareness and extent of adoption of prefabricated polyurethane in sustainable building construction in Nigeria.

Purpose of the Study

The main purpose of this research study is to create an awareness and adoption of prefabricated polyurethane in sustainable building construction in Nigeria. The study aimed specifically to:

1. determine the level of awareness of prefabricated polyurethane in construction of sustainable building.

2. examine the level of adoption of prefabricated polyurethane in construction of sustainable building.

Research Questions

The following research questions were answered in order to achieve the objectives of the study:

1. What is the level of awareness of prefabricated polyurethane in construction of sustainable building?
2. What is the level of adoption of prefabricated polyurethane in construction of sustainable building?

Hypothesis

The following null hypothesis guided the study and were tested at 0.5 level of significance to guide this study:

H_{01}: There is no significant difference on the level of awareness among building experts and contractors of prefabricated polyurethane.

H_{02}: There is no significant difference on the level of adoption of among building experts and contractors of prefabricated polyurethane.

METHODOLOGY

This study adopted a descriptive survey research design. The choice of this design is appropriate because it enables the collection and analysis of data that describe the current levels of awareness and adoption of prefabricated polyurethane in sustainable building construction within the Abuja Metropolitan Area Council (AMAC). The study was conducted in Abuja Metropolitan Area Council (AMAC) which comprises of Central Area, Maitama, Wuse, Garki, Asokoro and parts of Nyanya and Karu. The population of the study comprised of 40 building experts and 10 contractors who are actively and directly engaged in building construction projects within AMAC

using prefabricated polyurethane structural materials. The selection of these respondents was based on the requisite knowledge and experience to provide reliable data regarding the prefabricated polyurethane in construction. Sample and sampling technique was not needed, since the population size is small and manageable.

A structured questionnaire titled “awareness and adoption of prefabricated polyurethane in sustainable building construction in Abuja Metropolitan Area Council” was used for data analysis. The questionnaire consisted of three sections: Section A: Demographic information. Section B: items that collected data on the level of awareness of prefabricated polyurethane with ranking responses (Highly Aware (HA) = 3.50 – 4.00, Moderately Aware (MA) = 2.50 – 3.49, Aware (A) = 1.50 – 2.49 and Not Aware (NA) = 1.00 – 1.49. While Section C: collected data on the level of adoption of prefabricated polyurethane using a scale of (Highly Adopted (HA) = 3.50 – 4.00, Moderately Adopted (MA) = 2.50 – 3.49, Adopted (A) = 1.50 – 2.49, Not Adopted (NA) = 1.00 – 1.49. The items were adapted and developed based on relevant literature from Darko & Chan (2017).

The face and content validity of the instrument were carried by five experts: three in building construction industries and two in the Department of Industrial and Technology Education, Federal university of Technology, Minna. Their observations and suggestions were used to develop the final instrument. A pilot study involving 5 building experts and 2 contractors was conducted in Jahi district which is not part of area of the study. Cronbach’s alpha was computed to test internal consistency of the instrument. The reliability coefficients for the awareness and adoption sections were found to be 0.82 and 0.85, respectively, indicating good reliability. A total number of 50 questionnaires with 14 items was distributed to building experts and contractors

specialized in prefabricated polyurethane in AMAC and $100^0/_0$ of the questionnaires were retrieved two days later from the respondents by the researchers.

Descriptive statistics in form of mean and standard deviation was deployed to address the two research questions while independent sample t-test was used to test the hypotheses at 0.05 level significance. The decision rule for the mean was based on the real limit of numbers on the four-point likert rating scale. The study also analyzed the effects size for the two research questions using Cohen's d, Glass's delta, and Hedge's g to determine the magnitude of the differences observed. The interpretation of these effect sizes follows conventional benchmarks: small effects: $0.2 \leq d < 0.5$, medium effect: $0.5 \leq d < 0.8$ and large effect: $d \geq 0.8$.

Results

Research Question 1

What is the level of awareness of prefabricated polyurethane in sustainable building construction?

Table 1: mean responses of building experts and contractors on the level of awareness of the prefabricated polyurethane and its roles in sustainable building construction.

			N_1 =40	N_2 = 10
S/NO	**ITEMS**	**$\bar{x}$**	**SD**	**REMARK**
1.	Awareness of polyurethane sandwich panel	2.52	1.074	Aware
2.	Awareness of rigid polyurethane foam core	2.60	1.069	Aware
3.	Awareness of polyurethane foam blocks and slabs	2.50	.953	Aware
4.	Awareness of polyurethane insulation boards	2.56	1.181	Aware
5.	Awareness of polyurethane spray foam	2.60	1.030	Aware
6.	Awareness of polyurethane sealants and adhesives	2.80	1.224	Aware
7.	Awareness of prefabricated polyurethane components	3.10	1.008	Aware
Cluster Mean/ grand standard deviation		**2.67**	**1.080**	**MA**

KEY: N: 50, **N_1:** No. of building experts, **N_2:** No. of contractors $\bar{X}$: Mean of respondents and **SD:** Standard deviation of respondents

The result from Table I showed that the mean scores of the seven items range from 2.50 to 3.10, giving a range of 0.60, which indicates a relatively small dispersion among the responses and suggests consistency in respondents' ratings. The cluster mean ($\bar{x}$ = 2.67) lies within the interval $2.50 \leq \bar{x} \leq 3.49$, which corresponds to the "Moderately Aware (MA)" category based on the decision rule. The standard deviation values, which range from 0.953 to 1.224, are all less than 1.96 (the benchmark for comparing SD), indicating a moderate spread of responses around the mean. Furthermore, the grand standard deviation of 1.080 confirms a moderate and acceptable level of variability, indicating general agreement among respondents with only slight differences in their awareness levels.

Research Question 2

What is the level of adoption of prefabricated polyurethane in sustainable building construction?

Table 2: mean responses of building experts and contractors on the level of adoption of prefabricated polyurethane in sustainable building construction

		N_1 =40	N_2 = 10	
S/NO	**ITEMS**	**$\bar{x}$**	**SD**	**REMARK**
1.	***Polyurethane sandwich panels*** have been adopted in building projects for their lightweight nature, strength, and energy efficiency.	2.76	1.188	Adopted
2.	***Rigid polyurethane foam core*** has been adopted in construction for thermal insulation and moisture control.	2.88	1.062	Adopted
3.	***Polyurethane foam blocks and slabs*** have been adopted for prefabricated construction to provide both structural support and insulation.	2.60	1.143	Adopted
4.	***Polyurethane insulation boards*** have been adopted in walls, roofs, and floors to enhance thermal efficiency.	2.58	1.071	Adopted
5.	***Polyurethane spray foam*** has been adopted to improve the airtightness and energy performance of building envelopes.	2.44	1.091	Not Adopted
6.	***Polyurethane sealants and adhesives*** have been adopted for improving bonding strength and durability in sustainable buildings.	3.03	1.025	Adopted
7.	***Prefabricated polyurethane components*** have been adopted as part of efforts to reduce on-site construction waste and promote faster, cleaner construction processes.	3.03	1.000	Adopted

KEY: N: 50, **N_1:** No. of building experts, **N_2:** No. of contractors $\bar{X}$: Mean of respondents and **SD:** Standard deviation of respondents

The results in Table 2 revealed the level of adoption of prefabricated polyurethane in sustainable building construction by building experts and contractors. Specifically, items such as polyurethane sandwich panels ($\bar{x}$ = 2.76), rigid polyurethane foam core ($\bar{x}$ = 2.88), foam blocks and slabs ($\bar{x}$ = 2.60), insulation boards ($\bar{x}$ = 2.58), sealants/adhesives ($\bar{x}$ = 3.03) and polyurethane components ($\bar{x}$ = 3.03) were reported as moderately adopted, while spray foam ($\bar{x}$ = 2.44) was not adopted, suggesting limited use in improving airtightness and energy efficiency. Prefabricated polyurethane materials are being embraced in several areas of sustainable construction, their adoption is not yet uniform, and targeted awareness, technical training, and policy support may further enhance utilization.

Hypothesis 1:

H_{O1}: There is no significant level of awareness of prefabricated polyurethane in sustainable building construction practices between building experts and contractors.

Table 3: Summary of t-test Analysis of the main responses of building experts and contractors on the level of awareness of the prefabricated polyurethane and its roles in sustainable building construction.

Respondents	N	$\bar{X}$	SD	Df	t-value	P-Value Sig. (2-tailed)	Effect Size	Alpha Level	Remark
Building experts	40	2.69	.583	48	0.945	0.350	0.34	0.05	NS
contractors	10	2.65	.589						

Key: $\bar{X}_1$**=** mean of **building experts,** $\bar{X}_2$ = mean of **contractors,** N_1 = No. of **building experts,** N_2 = No. of **contractors,** SD_1 **=** standard deviation of **building experts**, SD_2 **=** standard deviation of **contractors, NS**=Not Significant**, S**= Significant, Df = Degree of freedom

The results presented in Table 3 showed the t-test analysis of the level of awareness of prefabricated polyurethane in sustainable building construction practices between building experts and contractors. The mean score for building experts ($\bar{x}$ = 2.60, SD = 0.583) is slightly higher than that of contractors ($\bar{x}$ = 2.40, SD = 0.589), indicating a small difference in perceived awareness. The computed t-value (t = 0.945, df = 48) with a p-value of 0.350 is greater than the 0.05 alpha

level, signifying that the difference in awareness between the two groups is not statistically significant**.** The effect size of 0.34 suggests a small practical difference in awareness levels between the respondents.

Hypothesis 2:

H_{O2}: There is no significant difference in the level of adoption of prefabricated polyurethane in sustainable building construction between building experts and contractors.

Table 4: Summary of t-test Analysis of the main responses of building experts and contractors on the level of adoption of prefabricated polyurethane in sustainable building construction

Respondents	N	$\bar{X}$	SD	Df	t-value	P-Value Sig. (2-tailed)	Effect Size	Alpha Level	Remark
Building experts	40	2.67	.622	48	0 .761	0.685	0.12	0.05	NS
contractors	10	2.60	.499						

Key: $\bar{X}_1$**=** mean of **building experts,** $\bar{X}_2$ = mean of **contractors,** N_1 = No. of **building experts,** N_2 = No. of **contractors,** SD_1 **=** standard deviation of **building experts**, SD_2 **=** standard deviation of **contractors, NS**=Not Significant**, S**= Significant, Df = Degree of freedom

The results in Table 4 presented the t-test analysis of the level of adoption of prefabricated polyurethane in sustainable building construction between building experts and contractors. The mean score for building experts ($\bar{x}$ = 2.67, SD = 0.622) is slightly higher than that of contractors ($\bar{x}$ = 2.60, SD = 0.499), indicating a marginal difference in reported adoption. The computed t-value (t = 0.761, df = 48) with a p-value of 0.685 is greater than the 0.05 alpha level, indicating that the observed difference is not statistically significant**.** The effect size of 0.12 suggests a very small practical difference in adoption levels between the two groups.

Findings

This section highlights the findings of research questions, hypotheses and effect size as follows:

1. Building experts and contractors are moderately aware of prefabricated polyurethane in sustainable building construction, as the awareness items were rated within the moderate awareness range, indicating a fair level of knowledge across the identified materials.

2. The level of adoption of prefabricated polyurethane materials by building experts and contractors in sustainable building construction showed that prefabricated polyurethane is moderately adopted, as most of the listed items such as sandwich panels, rigid foam core, insulation boards, sealants, and prefabricated components were adopted, while a few items like spray foam were not adopted, indicating variation in the level of utilization across applications.

3. There was no significant difference in the mean responses of building experts and contractors on the level of awareness and adoption of prefabricated polyurethane in sustainable building construction. The effect sizes were very small, suggesting a negligible practical difference. This implies that both building experts and contractors have moderately adopted prefabricated polyurethane materials.

Discussion of the Findings

The results presented in Table 1 revealed the level of awareness of prefabricated polyurethane in sustainable building construction among building experts and contractors. The findings indicated a moderate level of awareness of prefabricated polyurethane among building experts and contractors in Nigeria, with cluster means showing general awareness of polyurethane materials such as sandwich panels, insulation boards, and sealants. The grand standard deviation suggests moderate variability, implying that respondents generally agreed on their knowledge but with slight differences across items. This result is consistent with Oke, Aliu & Duduyegbe (2025); Adegbie & Hammed (2024) who observed that awareness of innovative and sustainable construction materials in developing countries remains moderate due to limited technical knowledge dissemination and professional training. Bello & Ogunsemi (2023); Zhang et al., 2024; García et al. (2025) noted that lack of awareness and inadequate education are key barriers

to the adoption of sustainable construction materials and technologies. The study emphasized that improving awareness to the highest level is essential for accelerating the transition to sustainable construction practices globally

Table 2 showed a moderate level of adoption of prefabricated polyurethane materials, with applications such as sandwich panels, insulation boards, and sealants being adopted, while spray foam was largely underutilized. This implies that adoption is selective and not yet fully integrated across all applications. This finding aligns with the studies of Yuan, (2023); Osunkoya, *et al.* (2025); Ifije & Aigbavboa (2020); Unegbu, Yawas, Dan-asabe & Alabi (2025), who reported that prefabrication and innovative construction materials are gradually being adopted due to their benefits such as efficiency, waste reduction, and improved performance. This finding supports the studies of Mogaji (2023); Oke, *et al* (2025) who reported that adoption remains uneven due to barriers such as high initial costs, lack of technical expertise, and inadequate policy support. Hypothesis testing revealed no significant difference between building experts and contractors in adoption levels of prefabricated polyurethane materials in sustainable building construction.

CONCLUSION

The study concludes that building experts and contractors in Nigeria exhibit **a** moderate level of awareness and adoption of prefabricated polyurethane in sustainable building construction. While respondents aware of polyurethane materials such as sandwich panels, insulation boards, sealants, and prefabricated components for improving thermal efficiency, energy performance, and sustainability, the actual adoption remains selective, with certain applications, like spray foam, underutilized. Hypothesis testing indicated no significant differences between experts and contractors, suggesting that professional specialization does not strongly influence awareness or

adoption patterns. The findings highlight a gap between knowledge and practice, largely driven by economic, technical, and policy-related constraints. Therefore, for prefabricated polyurethane to achieve broader integration in Nigerian sustainable building construction, targeted capacity building, industry advocacy, and supportive policies are essential to translate awareness into consistent and effective adoption across the practices.

Recommendations

Based on the findings of the study, the following recommendations were hereby made:

1. Implement targeted training and capacity-building programs for building experts and contractors to enhance knowledge of prefabricated polyurethane applications, benefits, and sustainable construction practices.
2. Introduce policy incentives and technical support mechanisms to encourage the practical use of prefabricated polyurethane in construction projects, addressing cost, skill, and implementation barriers.

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