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Original Article

Level of Awareness on the Usage of Thermal Insulation among Building Professionals: Case of a Tropical City in Nigeria

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ABSTRACT

Adoption of buildings' thermal insulation in Nigeria is still at the developmental stage; evidence of its usage for high thermal performance buildings and energy efficiency connotes a very low rate as there is very little evidence-based research in this regard. This paper seeks to evaluate the level of awareness on the usage of building thermal insulation among professionals in the building construction sector within Akure, a tropical city in Nigeria, to identify factors that deter its adoption and raise the level of commitment of the professionals within the building construction sector to sustainable practices of reducing buildings' energy consumption. This is to create a resilient built environment against the challenges of climate change. Well-structured questionnaires were administered to gather data for the investigation. Jupyter Notebook version 6.4.12 was employed for the analysis. Results indicated a fairly good level of awareness among the building professionals while the barriers that affect the level of usage of thermal insulation within the study area are the high cost of procuring thermal insulation materials, non-compliance to building regulations, and governmental policy on construction. The research concluded that a good number of professionals have a high level of awareness of the usage of building thermal insulation, but the cost of the materials and government policy deterred its level of usage in the study area. Consequently, propagation of the usage of thermal insulation should be done through education and training of the stakeholders. Furthermore, the government needs to strengthen policies that support the usage and availability of thermal insulation within the study area.

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INTRODUCTION

The application of thermal insulation is a sustainable building practice by which heat transfer through the building envelope is minimised to enhance the thermal comfort of occupants within the interior space while cutting down on cooling energy demand. Thermal insulation of contemporary tropical buildings is gaining more attention as a result of the need for low-energy to near-zero-energy buildings to reduce cooling energy demand and thereby cut down on carbon emissions (BPIE, 2011). The Nigerian Energy Support Programme (NESP, 2016) encouraged the use of thermal insulation as a sustainable building practice in energy-saving measures; this forms part of the energy efficiency plan for the country (Geissler et al., 2016).

Since the building construction industry is one of the largest consumers of global natural endowment and resources as well as the highest contributor to pollution in varying degrees within the environment; it is expected that the sector would also aid in the reduction of building energy consumption and thereby aid building sustainability. This is to improve the lives of upcoming generations through building a world with the use of eco-friendly construction methods, meeting the needs of the expanding population, and supporting the environment in the long term without negative impacts (CITB, 2020).

Moreover, sustainable building practice is a strong force in the construction industry to ameliorate the negative impacts of the industry on the natural environment, such as global warming, environmental degradation, and depletion of natural resources as corroborated by Ahn et al. (2013). Ijjada and Nayaka (2022) assert that the usage of building thermal insulation can meet the cooling and heating demands, thereby promoting energy efficiency and sustainable building practices. Awareness regarding this practice among the professionals in the building construction sector is essential to understanding how fragile and vulnerable the built environment is to global issues and challenges and the importance of its protection by ecological thinking and consciousness (Raymundo et al., 2019).

A high level of awareness is a strong propelling force for sustainable practices in the building construction sector. Government policies on enforcement of building codes and improving economies to uphold this practice are also key to achieving sustainable practices. Babalola and Harinarain (2021) posit that lack of governmental and regulatory policies are among the barriers that hinder the propagation of sustainable practice within the building construction sector in Nigeria. Ridwan et al. (2020) argued that a high level of awareness will exert a positive effect on sustainable practices within the construction sector in the long run.

This study focuses on the awareness among building construction professionals on the application of thermal insulation in building design to achieve thermal comfort and sustainability in the building construction sector. The study is limited to the tropical climate of Nigeria, using Akure as a case study, to sensitise the implementation of this practice among the professionals in the building construction sector. Although, the practice of thermal insulation implementation in building design is not commonplace in Nigeria; there is a need to research how well to better manage the built environment and create awareness among building construction professionals since the devastating effects of climate change resulting from energy consumption are felt the same way in Nigeria as in the other parts of the world.

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2.0 LITERATURE REVIEW

2.1 Usage of Thermal Insulation as a Sustainable Building Practice

Thermal insulation in a building is one of the sustainable strategies for building envelopes within tropical regions to minimise external heat gains and maintain internal surfaces at a lower temperature, thereby improving occupants' comfort levels (Brophy and Lewis, 2011). In sustainable building practices, it is expected that there should exist a very strong link between the design of the building envelope and thermal performance where the effects of climate on the users and the energy systems are mediated. The usage of thermal insulation for a better envelope has been identified as a means to this end. Although it may be expensive to install initially, it improves the balance between heat gain and heat loss; thereby eliminating the need for cooling as well as savings in the operational costs of buildings in the long run (Brophy and Lewis, 2011).

Utilisation of thermal insulation offers reduced thermal comfort cooling energy demands. It also impacts positively on the environment and carbon footprint of buildings, (Latha et al. 2015).

Thermal insulation materials are in different categories, though they all fulfill similar purpose of reducing the amount of heat gain or heat loss rate through the desired enclosed space. Some specific materials serve an explicit role and they are classified according to function, form, and composition. Some insulation materials are categorised based on their function in mitigating the effect of heat transfer: these are mass and reflective insulation. Mass insulation impedes the rate of heat flow by conduction, while reflective insulation reduces the rate of heat transfer by radiation. The performance of mass and reflective insulation are based on the heat exchange properties of the materials, (Brophy and Lewis, 2011).

The four fundamental types of insulation materials based on the form are identified as loose-fillers spray foam, batts, blankets, and rigid board**.** Many factors are considered while making a selection of building thermal insulation, such as construction type, building code requirements, renovations, and rehabilitation plan, (Latha et al., 2015).

Driver to the Adoption of Thermal Insulation in Building Design

The main driver for the adoption of thermal insulation in buildings is the performance of the framework highlighted by the Kyoto Protocol of the United Nations Framework on Climate Change, urging nations of the world to cut their greenhouse gas emissions in order to forestall climate change. The framework also mandated developing countries like Nigeria to address climate change and adapt to its impacts (UNFCC, 2023). This action led to the development of strategies and guidelines to achieve the requirements of the framework. Sustainable practices in the building sector were a means to meeting the target of the Kyoto Protocols. In order to make the concept of sustainable buildings pragmatic and operable, developed countries set up the sustainable building rating framework which can be adapted to various characteristics around the world (Sinha, et al., 2013).

The United Nations on Environment Programme (UNEP, 2023) stated that efficiency policies in building construction can cause a reduction in greenhouse gas emission by up to 90% in developed countries and up to 80% in developing countries; these conditions will lead to sustainable buildings. Although, the sector has not achieved full mitigation potentials; it still accounts for 37% of energy and process-related CO2 emissions as well as over 34% of energy demand globally as of the year 2022. Buildings are still a significant source of greenhouse gas emissions. By 2050, 1.6 billion people in urban cities will be regularly exposed to extremely high temperatures, while over 800 million people in more than 570 cities will be vulnerable to sea-level rise and coastal flooding (UN DESA, 2018).

Since the impacts of climate change are likely to increase in the coming decades, future buildings

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will need to reduce carbon emissions and be resilient against natural disasters. This would be a great opportunity to enhance people's well-being and cause economic growth (UNEP, 2023). It is in light of these that thermal insulation will be adopted to reduce cooling energy demand in buildings and thereby enhance sustainable buildings and the environment.

Barriers to the Adoption of Building Thermal Insulation in Building Construction

Thermal insulation materials have some persistent challenges and barriers to overcome. The barriers can be classified as business-related, technology-related, and legal policy-related (Hao, Weng, et al., 2018). According to Ahn et al. (2013), premium expenses, long payback periods, and higher costs of products and materials for construction and implementation are barriers to the adoption of thermal insulation. The higher cost of procurement is a significant barrier fundamental to the adoption of thermal insulation technologies in the construction industry to achieve sustainability. Consequently, the cost has a significant role in thwarting processes to help adopt and carry out building thermal insulation technology in building construction. According to Hao Weng, et al. (2018), the challenges and barriers of implementation of thermal insulation materials in a building can be summarised as indicated in *Table 1*.

Table 1: Barriers to implementation of thermal insulation materials

Categories	Challenges and Barriers
Business-related barriers	The products of the technology are more costly. The market demand for the products is relatively not as high as expected. The decision of building materials is generally decided by cost rather than environmental advantages. The different products have no good connectivity.
Technology related barriers	The quality of materials and sources is not stable. The technology is not perfect thus it undergoes continual refinement. The lack of complete information disclosure on technology innovation
Legal policy-related barriers	The lack of implementation of education to promote innovative technology or advocacy work. Not following the construction or building regulations The lack of incentives for innovative technology supplier

Source*:* Hao Weng et al., 2018

MATERIALS AND METHODS

Study Area

This study was carried out in Akure, a tropical city within the rainforest zone of Nigeria. The city is characterised by hot thermal distress with high temperature and high humidity almost throughout the year. Akure is the capital city of Ondo State. It is situated within 7°15'North of the equator and 5° 15' East of the meridian. The city enjoys two seasons: a rainy season from April to October and a dry season from March to November. Mean annual temperature ranges from 20.6-34.1 °C and mean annual relative humidity also ranges between 39.1-98.2 %, (Olabode, 2015).

Research Methodology

This study adopted a quantitative research design, obtaining data through a well-structured questionnaire. The research population for the study was drawn from the relevant respondents among the building professionals, Architects, Quantity surveyors, Structural Engineers, and Builders within the area of study. The sampling frame is shown in *Table 2* as obtained from the professional bodies (Nigerian Institute of Quantity Surveyor (NIQS); Nigerian Institute of Architects (NIA); Nigerian Structural Engineer (NSE) and Nigerian Institute of Builder (NIOB), 2020).

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Table 2: Sampling frame for questionnaire survey among the building professional

Professionals	Sampling Frame
Quantity Surveyors	1080
Architects	1700
Engineer	1850
Builders	700
Total	5330

Source*:* NIQS, NIA, NSE, NIOB (2020)

The sample size was determined by applying a formula derived by Yamane in 1997,

$$n = \frac{N}{1+N(e^2)}$$

Where, e= level of precision or standard accuracy which is 20%; n = sample size; N = total population

Microsoft Excel version 2016 was used to compile the data while statistical analysis was carried out through Jupyter Notebook version 6.4.12 (Python-based interactive computing notebook environment). Mean Item Score (MIS) and Spearman's rank correlation coefficient were computed to achieve the objectives of the study. Results were presented in tables showing frequencies, percentiles, and Mean Item Score (MIS).

The questionnaire was divided into sections (A), (B), (C) and (D). Section A sought to find out the respondents' demographic information. The questions in the preliminary section were expressed in frequency terms. The other sections - B, C, and D - were designed to provide information about the awareness of the building construction professionals on the concept of building thermal insulation; the benefits of incorporating thermal insulation materials in buildings; barriers that affect the adoption of building thermal insulation in building constructions in the study area; the features and key performance of thermal insulation on building with the climatic conditions in the study area. A total of 100 questionnaires were administered, 80 were retrieved and analysed. This represents an 80% response rate.

RESULT AND DISCUSSION

Demographic Information of the Respondents

The demographic information of the respondents comprises general background information such as gender, level of education, years of experience, professional qualification, etc. Based on the analysis of the data, it was observed that there were 85% male respondents to 15% female respondents (*Table 3).* This indicates a higher level of involvement of males to females as professionals in the building construction industry.

Analysis of the academic qualification of respondents showed that 56.25% had a BSc. or B. Tech qualifications, 18.75% had ND/HND/PGD, 15% had M.Tech/M.Sc while 3.75 % had PhD qualifications (*Table 3*). This shows that a good number of respondents have quality education which may positively influence their awareness of the usage of thermal insulation in buildings. The results of the findings on the firm specialisation as indicated in *Table 3* show that 41.25% of the respondents were developers, while 25% were working at a contracting firm. 17.5 % are into Consultancy and professional services, 12.5% are into sub-contracting while 3.75% of the respondents are not with any established firm. This outcome indicated that many of the building professionals are capable of influencing the usage of thermal insulation as a result of their involvement in the building construction process.

Table 3 shows that 65% of the respondents specialised in residential building construction while 8.75% of the respondents were in non-residential buildings. 10% of the respondents were involved with industrial building construction; 12.5% on infrastructural construction and others were 3.75%.

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Professionals that specialise in residential buildings have the highest percentage; this could have been an avenue to influence the adoption of thermal insulation in residential buildings within Akure, the study area, and then promote sustainable building practices in the construction sector.

Analysis of the years of experience of respondents as shown in *Table 3* indicated that 65% of the respondents have 1 – 5 years of working experience, 20% of the respondents have 6 – 10 years of working experience, 7.5% of the respondents have 11 - 15 years working experience, 3.75% of the respondents have 16 – 20 years working experience, while 3.75% of the respondents have above 20 years working experience. These results show that most of the respondents are new to the construction practice and could have had the opportunity to recently learn about sustainable building practices.

The results of the findings on the professional qualification of the respondents as shown in *Table 3* indicate that 60% were practitioners, they seem to have better working experience in terms of construction works; 47.5% of the respondents were members in terms of their professional qualification, 12.5% of the respondents were senior professionals, while 5% of the respondents were principal professionals. A good number of the respondents had professional qualifications which enabled them to practice and have a good influence on the adoption of thermal insulation in buildings within the study area.

The results of the findings as shown in *Table 3* indicate that 36.25% of the respondents are not aware of the usage of building thermal insulation, while 18.75% of the respondents have low awareness of building thermal insulation. 12.5% of the respondents have a very high level of awareness of building thermal insulation, while 25% of the respondents have a high level of awareness of building thermal insulation. There is an indication of very low awareness of the usage of thermal insulation by 7.5% of the respondents. The total number of professionals who are not aware of the usage of thermal insulation in buildings and those with low levels of awareness shows that the use of thermal insulation as a sustainable practice is still at the lower ebb in the study area; it has not been given adequate publicity. Few professionals have basic knowledge about the usage of building thermal insulation, even though it is not a common practice in the study area within Nigeria.

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Table 3: Demographic information of the respondents

Demographic Variable		Frequency	Percentage
Gender	Female	12	15
	Male	68	85
	Total	80	100
Academic Qualification	ND/HND/PGD	15	18.75
	B Tech. / B Sc.	45	56.25
	M Tech. / M Sc.	12	15
	PhD	3	3.75
	Others	5	6.25
	Total	80	100
Firm Specialization	Contractor	20	25
	Consultancy	14	17.5
	Sub-contracting	10	12.5
	Developer	33	41.25
	Others	3	3.75
	Total	80	100
Area of Specialization	Residential	52	65
	Non-residential	7	8.75
	Industrial	8	10
	Infrastructure	10	12.5
	Others	3	3.75
	Total	80	100
Years of Experience	1 – 5 years	52	65
	6 – 10 years	16	20
	11 – 15 years	6	7.5
	16 – 20 years	3	3.75
	Above 20 years	3	3.75
	Total	80	100
Professional Qualification	Member	38	47.5
	Practitioner	48	60
	Senior	10	12.5
	Principal	4	5
	Total	80	100
Awareness of thermal insulation	Very low	6	7.5
	Low	15	18.75
	Not aware	29	36.25
	High	20	25
	Very high	10	12.5
	Total	80	100

Source*:* Field Survey, 2021

Level of Application of Building Thermal Insulation

The questions posed to the respondents were to determine their level of application of building thermal insulation to building design and construction. As indicated in *Table 4*, based on the analysis of the data from the field study, it can be inferred that with a mean value of 4.44, most of the respondents were in agreement with the fact that building thermal insulation helps to manage indoor temperature.

Respondents agreed to the fact that installation of building thermal insulation would help to reduce the level of energy consumption within the building with a mean value of 4.08, while responses to thermal insulation materials are more economical than using mechanical systems had a mean item score value of 4.00. This shows that respondents are familiar with the benefits of using

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thermal insulation in buildings. This could promote the usage of thermal insulation and sustainable construction. Further analysis of the data gathered as indicated in *Table 4* whether respondents advise clients on the importance of thermal insulation materials usage has a mean value of 3.92 This ascertains the level of knowledge of the respondents on the use of building thermal insulation. Assessments on the opinion of the respondents on whether they agree with the fact that all houses needed building thermal insulation were also put forth with a mean score of 3.72.

From all the indications concerning the analysis of the research data, it can be inferred that while the respondents have basic knowledge of the use of building thermal insulation, not much can be said about the technical knowledge as evidenced by the mean score of 2.59 on the question asked about building thermal insulation requiring maintenance *(Table 4).* This result conforms with Aghimien (2018) that priority should be given to educating various stakeholders of the construction industry on the benefits of sustainable construction such as the usage of thermal insulation in buildings.

In the same vein, Momoh and Folorunsho, (2018) remarked that the high cost of insulation materials, the cost of transportation, and the non-availability of the material prevented building construction professionals from recommending and adopting insulation materials. Moreover, Tunji et al. (2018) stated that the major factor affecting the usage of thermal insulation as a sustainable building practice is the lack of technical knowledge and skills; professionals need to be rigorously educated on sustainable construction practices where emphasis should be laid on its principles, tools, and applications.

The question of whether the professionals have an objection to the installation of building thermal insulation if requested by the client had a mean of 2.82. This indicated that most respondents are maintaining a neutral position on the matter raised.

Table 4: Level of application of building thermal insulation.

Level of Application of Building Thermal Insulation	N	Mean	Std. Dev	General Ranking
Installation of building thermal insulation helps to manage indoor temperature	80	4.44	0.75	1
Installation of building thermal insulation will help to reduce the level of energy consumption within the building.	80	4.08	1.11	2
Building thermal insulation materials does not need maintenance	80	2.59	1.16	7
It is more economical to install thermal insulation materials than to use a mechanical system.	80	4.00	0.95	3
All houses need to install thermal insulation materials.	80	3.72	0.96	5
Do you advise your clients on the importance of thermal insulation materials usage?	80	3.92	1.34	4
Do you have an objection to the installation of thermal insulation materials if requested by the client within the building design?	80	2.82	1.02	6

Source: Field Study, 2021

Barriers to the Adoption of Building Thermal Insulation

Table 5 shows the result of the analysis of the responses for assessing the barriers that hinder the adoption of building thermal insulation. The data obtained from the response was analysed and the result generated is displayed in *Table 5*. Based on the analysis with a mean score of 4.00, it could be inferred that most of the professionals agree with the fact that the cost of building thermal insulation material is one of the prominent barriers to its adoption. According to Darko and Chan (2017), Chan et al. (2015*)* cost constraints are the most important factor to be considered when decisions are to be put forth in the construction industry. Moreover, some other barriers to the adoption of thermal insulation in buildings as a sustainable

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practice from the study area as indicated in *Table 5* are Management and Procurement of the material with a mean score value of 3.85; Limitations of the technology in Nigeria resulting from non-favourable government policy (3.87); Satisfaction of the end users (3.90); Health and Safety Barrier (3.69); Competitive Advantage among the Professionals (3.92). These analyses show that professionals in the building sector within the study area have not fully adopted the use of thermal insulation in buildings.

The professionals in the building construction sector within the study area are faced with many barriers to the adoption of thermal insulation as indicated in the analysis. These conditions were also similar to those that affect sustainable development in Nigeria. The Nigerian Construction Sector Summary Report (2012) asserts that despite the growth experienced in the building construction sector; lack of knowledge on technicality and expertise, inefficiency to advance the course of sustainable construction; lack of demand; insignificant level of monitoring and legislation; lack of government incentives were highlighted to be the significant barriers that affect the growth of sustainability in Nigeria, hence sustainable building practices.

Different approaches and practices to improve sustainable building construction are neglected by professionals because of many barriers encountered (Toriola-Coker et al., 2021). Professionals in the building construction sector within the study area are faced with many barriers to the adoption of thermal insulation as indicated in the analysis.

Table 5: Barriers to the adoption of building thermal insulation.

Barriers to the Adoption of Building Thermal Insulation	N	Mean	Std. Dev	General Ranking
Health and Safety	80	3.69	1.10	8
Productivity of thermal insulated buildings	80	3.74	1.02	6
End-users satisfaction	80	3.90	1.02	3
Cost of thermal insulation materials	80	4.00	0.81	1
Management and procurement	80	3.85	0.78	5
Environmental protection	80	3.69	0.98	7
Limitation of the technology in Nigeria	80	3.87	0.92	4
Competitive advantage among building construction professionals	80	3.92	0.87	2

Source*:* Field Survey, 2021

CONCLUSION

This study has examined the level of awareness of professionals in building construction on the adoption of building thermal insulation materials for the thermal comfort of the occupants to achieve a sustainable built environment. It was discovered that a good number of professionals have a high level of awareness of the usage of building thermal insulation. The usage of thermal insulation is not commonplace in the study area due to some impeding factors such as high-cost implication in procuring and managing thermal insulation materials, inadequacy and non-enforcement of building codes, inadequacy in expertise in sustainable construction, lack of interest and support from stakeholders, scarcity of the materials, relevant technical know-how on the usage of building thermal insulation and governmental policy as related to construction and its technology.

The professionals in the Nigerian construction industry should take cognisance of the benefits of adopting building thermal insulation in sustainable construction. Propagation on the usage of thermal insulation should be done through education and training of the stakeholders. Furthermore, the government needs to strengthen policies that support the usage and availability of thermal insulation within the study area.

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