INVESTIGATING FACTORS AND REASONS FOR THE ADOPTION OF GREEN RETROFITTING TECHNOLOGY IN NIGERIA

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Abstract

Green retrofitting technology (GRT), which has revolutionized the construction industry of several nations has been poorly implemented in Nigeria. This research investigates issues on the adoption of GRT within the Nigeria built environment. The specific objectives are to examine the factors affecting the adoption of GRT; and find out the reasons for the adoption of GRT. Questionnaires were administered electronically to 100 construction industry professionals in Ekiti State Nigeria, selected via purposive sampling technique. Data were analysed using descriptive statistics tools. The study reveals nine factors affecting adoption of GRT in the research area and shed light that improved building performance is the topmost reason for the adoption of GRT. The study concluded that although there are several factors affecting adoption of GRF, nonetheless, limited knowledge of the technology is topmost among them. It implies that the adoption of the technology could also be limited in scope in the Nigerian construction industry. It is recommended that construction professionals and customers should be holistic in their reasons for the adoption of GRF. This can be done by attaching equal importance to all the reasons for the adoption of GRF.

Keywords: Adoption, Factors, Green Retrofitting Technology, Nigerian Construction Industry, Renewables.

INTRODUCTION

The construction industry has been criticized as a threat to the global community because of the nature of its activities. Darko (2019) observed that the industry through its activities and operations generate large quantities of hazardous waste; and also consumes an appreciable proportion of the global raw materials, resources, water and energy. These challenges, coupled with the problem of climate change, influenced research into more environmentally friendly and sustainable construction processes and technologies. One of such rapidly emerging technology is green building technology (GBT), which according to Simpeh and Smallwood (2015), and Darko *et. al.* (2017) has revolutionized the construction industry of several nations. Chan *et. al.* (2018) studied that green building could ameliorate these negative impacts on the environment. Lockwood (2009), in alluding to the U.S. Green Building Council [USGBC], views green retrofits as any kind of upgrade at an existing building that is wholly or partially occupied to improve energy and environmental performance, reduce water use, and improve the comfort and quality of the space in terms of natural light, air quality, and noise—all done in a way that it is financially beneficial to the owner. Then, the building and its equipment must be maintained to sustain these improvements over time.

The report of The Technology Strategy Board (2014) defined retrofit as the introduction of new materials, products and technologies into an existing building to reduce the energy needed to occupy that building. Bhagwan and Binayake (2022) defined retrofitting as changing, modifying certain parts, aspects of a structure with new or better parts which will prove to be beneficial for the user of the building and the building itself. The study further states that Green Retrofit can be done by replacing certain parts of building that damage the environment with sustainable alternatives which will increase the life of the building and reduce its life-cycle cost. In the view of Wang *et. al.* (2022), green retrofit is regarded as an effective environmental measure to reduce greenhouse gas (GHG) emissions in high energy-consuming commercial buildings.

Several research works have attempted to categorize retrofit technologies along common identifying features. Ahmad *et. al.* (2016) divided 36 green building technologies into seven groups of indoor illumination systems, control systems, energy and water conservation systems, renewable energy systems, energy and water recovery systems, systems to ensure air quality and systems to maintain comfort zone temperatures. Similarly, Benzar *et. al.* (2020) categorized retrofit technologies into four main technical systems, namely, mechanical, plumbing, electrical and building envelope systems. In the same vein, The Delphi Group (2022) identified 27 retrofitting technologies and categorized these under four building systems of electrical, mechanical, renewables and enclosure systems.

This aim of this study is to investigate the implementation of green retrofitting technologies in the Nigerian construction industry. The specific objectives are to examine the factors affecting the adoption of green retrofitting technologies among professionals in the Nigerian construction industry; and to determine the reasons for its adoption. The study is significant because it will aid in better adoption of the technology in construction development in Nigeria.

LITERATURE REVIEW

Reasons for Retrofitting in the Construction Industry

The issues of climate change and global warming have generated several discussions amongst agencies of government, philanthropists, academia, non-government organizations (NGOs), diplomats and a wide range of groups/associations studying global trends. Cirman *et. al.* (2009) observed that the global climate system has changed notably on both global and regional scales since the pre-industrial era, noting that some of these changes are directly or indirectly attributable to human activity. It observed that industrialization and other human related activities have led to the release of anthropogenic greenhouse gases as a result of combustion of fossil fuels, agriculture and land-use changes. This human activity has led to high atmospheric concentrations of carbon dioxide (CO_2) and other greenhouse gases. Due to a growing public concern about these impacts nowadays, much attention has been paid to implementing sustainability or sustainable development within the construction industry. Green building is considered the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's lifecycle (United States Environmental Protection Agency (USEPA), 2016).

Amoah and Smith (2022) noted that buildings experience continuous change and hence, must be processed, rehabilitated and transformed throughout time to meet

the user's requirements specified at a certain point. Buildings are at the heart of the European Union's (EU) energy efficiency measures, accounting for over 40% of final energy consumption and 36% of GHG emissions. Around 75% of buildings are inefficient in energy use (European Commission, 2020). According to recent applications and research, green retrofitting has improved energy efficiency, improved building performance, increased tenant happiness, and increased economic return while lowering GHG emissions (Al-Kodmany, 2014). Retrofitting refers to changing the systems or structure of an existing building after its initial construction and occupation, while green retrofitting refers to the change in the existing building to make it more environmentally friendly, reducing negative impacts and reducing operating costs. Green retrofitting existing building stocks is necessary to meet national energy efficiency goals, achieve climate change's medium and long-term objectives and shift towards a sustainable, low-carbon economy by 2050 (European Commission, 2020). Ogunjuyigbe *et. al.* (2020) opined that the general goal of retrofitting is to create a high-performance building by applying integrated, whole building design process with the objective of reducing the overall operational cost, decreasing environmental impact, improving building adaptability, reliability, durability and resiliency.

He *et. al.* (2019) observed retrofitting is imperative in urban development because it is more resource efficient and sustainable than developing new green buildings. The study observed that at present, most existing buildings suffer from issues such as functional degradation, high energy consumption, high emissions and large negative environmental impact, asserting that if these no green buildings continue to be used, their negative impact on the environment will continue, meanwhile, the demolition of existing no green buildings not only involves a huge waste of resources and energy but also causes secondary pollution and damage to the ecological environment. He *et. al.* (2019) concluded that through retrofitting, demolition and reconstruction can be avoided, thereby reducing the generation of construction waste and the consumption of materials and other resources to promote the sustainable development of the society.

Factors affecting the adoption of green retrofitting technologies in buildings

Benzar, et. al. (2020) pointed out that lack of information about the retrofit process and the selection of retrofit technologies to be used in the retrofit process are important factors responsible for successful sustainable retrofit activities. In the same vein, Sundus *et. al.* (2021) and The Delphi Group (2022) identified factors affecting the adoption of green retrofitting technology in buildings as education and awareness; technology; finance; policy; and availability.

a) Education and Awareness: With respect to the issue of knowledge and awareness, the study noted that knowledge and understanding of language around green retrofits is limited. Most of the stakeholders in the application of retrofitting in buildings are yet to get familiar with the terminologies and concepts in use within the retrofitting business case. There is still a serious lack of knowledge and experience among contractors and building owners about green retrofit technologies, specifically in heat pumps and air tightness. Lack of practical experience; resistance to change of both building owners and tenants to engage in a new technology and process; and lack of sustainability knowledge are also critical in the application of green retrofitting technology.
b) Technology: there is supply chain availability and volatile cost. Highly variable prices and volatile

costs usually arise due to high demand across the globe to meet climate targets. It is also important to establish enabling technologies and infrastructure for the effective delivery of retrofitting systems.

c) Finance: high initial cost of green retrofitting projects; high cost of skilled labour and green retrofit technologies; lack of standardized information about the return on investments (ROI) on retrofit projects; and lack of funding are important factors in implementing green retrofitting technology
d) Policy: Lack of national and provincial green retrofit policy and regulation; and low investment and involvement from the government and private sector are the issues in policy.
e) Availability: It has been observed that there is inadequate availability of building materials and technologies used in green building development.

RESEARCH METHOD

Survey research design was employed for this study (Adenuga *et. al.*, 2008). The population of the study were construction professionals in Ekiti State, Nigeria. Questionnaires were administered to 100 sampled professionals, with a response rate of 60% (Simeon *et. al.,* 2023). The questionnaire used Likert Scale 1= strongly disagree to 5 = strongly agree (Lekan *et. al.,* 2020) to determine the factors affecting and reasons for the adoption of green retrofitting technologies in building enclosures in Nigeria. The questionnaires were administered online through various WhatsApp platforms of groups and individuals within the construction industry. Samples were selected using purposive method (Afolabi *et. al.,* 2020). The retrieved data as presented in charts via Google forms were discussed and inferences obtained. Frequency, percentage, mean and rank were used for the analysis.

RESULTS AND DISCUSSION

Demographic Information

A total of 60 professionals responded to the questionnaire survey. The respondents consisted of professionals from 7 professions in the construction industry. Fig. 1 below shows the data of respondents based on their professional affiliations;

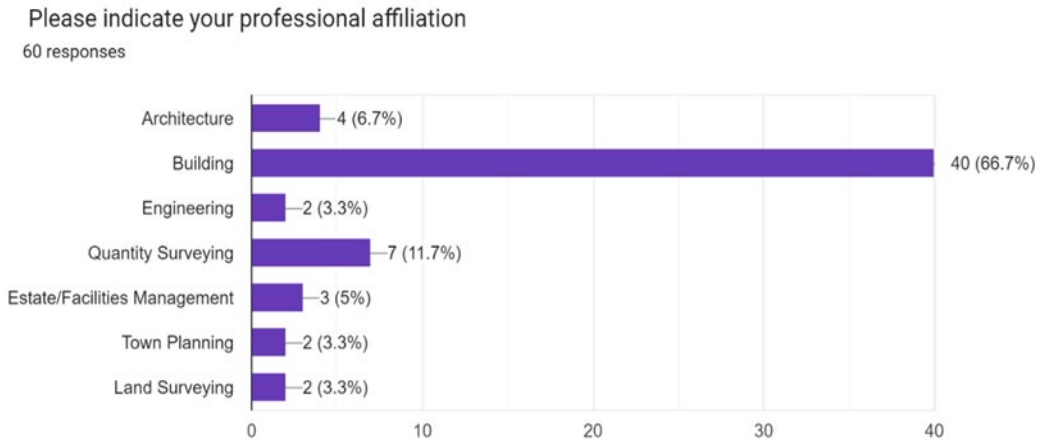

Figure 1: Professional Affiliation of Respondents

Figure 1 shows that builders (40 responses) constitute the highest number of

respondents. Others are quantity surveyors (7), architects (4), estate surveyors/facility managers (3), town planners (2) and land surveyors (2).

The respondents have acquired satisfactory academic qualifications and construction experience to be able to provide accurate responses to the research enquiries. Figure 2 and Figure 3 show the academic qualifications and years of experience of the respondents;

Figure 2: Highest Academic Qualification of Respondents

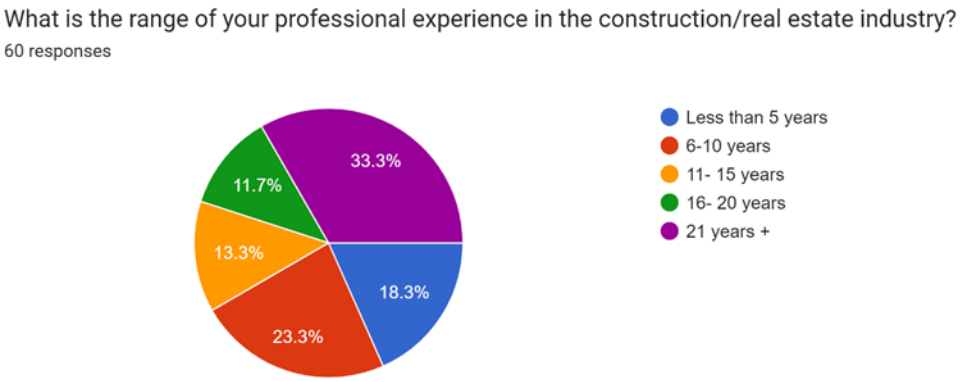

Figure 3: Respondents Years of Professional Experience

From Figure 2, it can be observed that 19 of the respondents have HND qualification, another 19 respondents have Masters degree, 13 have Bachelors degree and 10 have doctorate degrees. Figure 3 shows that 33.3% of the respondents have above 20 years' experience, 23.3% have 6 - 10 years' experience, 18.3% have less than 5 years' experience, 13.3% have 11 - 15 years' experience and 11.7% have 16 - 20 years' experience. Since more than half of the respondents (58.3%) have above 10 years' experience, the responses obtained are expected to be reliable.

The research enquiry sought to identify the sector within which respondents were employed and their position within their organization as shown in Figures 4 and 5 below.

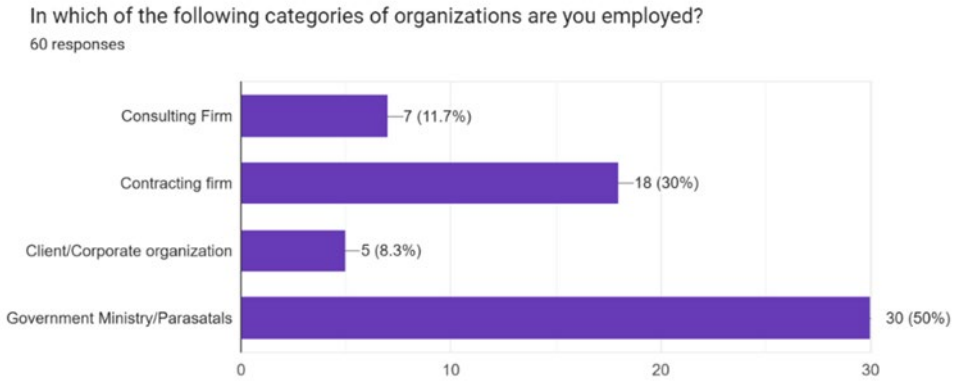

Figure 4: Nature of Employment

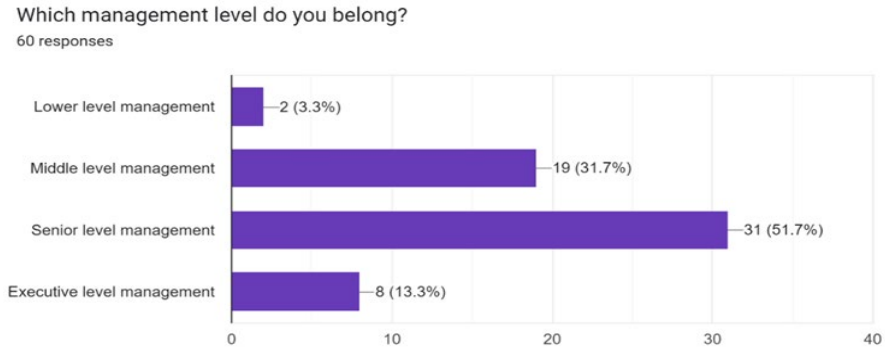

Figure 5: Respondent's Position in Organization

As shown in Figure 4 above, 30 of the respondents (i.e., 50%) are employed in government ministries and parastatals in the public sector. 18 (i.e., 30%) are employed in contracting firms, 7 respondents (i.e., 12%) work with client/corporate organizations and 5 (i.e., 8%) work in consulting firms.

From Figure 5, 31 respondents (51.7%) belong to the senior level management of their organizations, 19 respondents (31.7%) belong to the middle level management, 8 (13.3%) are of the executive level management cadre and only 2 (3.3%) belong to the lower level management position. More than half (68%) of the respondents belong to the Senior/Executive level management; hence they possess requisite experience to provide reliable responses to the research enquiries.

Factors Affecting the Adoption of Green Retrofitting Technologies

The questionnaire highlighted 9 factors affecting the adoption of green retrofitting technology in Nigeria. The analysis on Table 1 below shows the opinions of respondents on these factors,

Table 1: Factors Affecting the Adoption of Green Retrofitting Technologies

Factors	**n**	**(0)**	**(1)**	**(2)**	**(3)**	**(4)**	**MEAN**	**RANK**
Limited knowledge of the business case for green retrofitting technologies	59	6	7	12	15	19	2.53	1st
Cost of green retrofitting technologies	59	5	11	10	16	17	2.45	2nd
Skills gap in retrofitting technologies	58	5	11	8	17	17	2.43	3rd
Reluctance to use new technologies	59	8	6	12	18	15	2.40	4th

Poor infrastructure to support green retrofitting technologies	59	9	8	7	18	17	2.40	4th
Lack of sustainability knowledge	58	7	8	8	21	14	2.38	6th
Lack of green retrofitting technologies	59	8	9	11	12	19	2.38	6th
Inadequate availability of materials used in green building	58	9	6	9	17	17	2.38	6th
Lack of green retrofit policy and regulation	59	6	10	13	15	15	2.35	9th

Source: Field Survey (2023)

Table 1 above shows that limited knowledge, cost, skills gap, reluctance to adapt and poor infrastructure are the topmost factors affecting the adoption of green retrofitting technology in Nigeria. The other identified factors, that is, lack of sustainability knowledge, lack of green retrofitting technologies, inadequate availability of materials used in green building and lack of green retrofit policy and regulation are also factors.

Reasons for the Adoption of Green Retrofitting Technologies

Respondents were required to rank reasons for the adoption of green retrofitting technology in the Nigerian construction industry. Table 2 below shows the responses to the identified reasons.

Table 2: Reasons for the Adoption of Green Retrofitting Technologies in Nigeria

Reasons	**n**	**(0)**	**(1)**	**(2)**	**(3)**	**(4)**	**MEAN**	**RANK**
Improved building performance	59	6	6	8	20	19	2.63	1st
Improved energy efficiency	59	6	7	9	19	18	2.57	2nd
Increased occupant well-being	59	6	7	10	17	19	2.57	2nd
Constitutes no risk to the environment	58	6	8	14	17	13	2.32	4th
Compliance with current developments in the industry	59	7	10	9	22	11	2.30	5th
Costs less than the conventional technology	59	9	15	14	12	9	1.92	6th

Source: Field Survey (2023)

Respondents viewed that the topmost reason for the adoption of Green Retrofitting Technologies in Nigeria is because it results in improved building performance followed by the improvement in energy efficiency it creates and the increase in occupant well-being. Other reasons include that it constitutes no risk to the environment, it ensures compliance with current developments in the industry and it costs less than the conventional technology.

DISCUSSION OF FINDINGS

The field survey showed that limited knowledge, cost, skills gap, reluctance to adapt and poor infrastructure are the major factors limiting the adoption of green retrofitting technology in Nigeria. The other identified factors include lack of sustainability knowledge, lack of green retrofitting technologies, inadequate availability of materials used in green building and lack of green retrofit policy and regulation are also significant factors. Whilst the study by Amuda-Yusuf *et. al.*, (2020) observed that lack of institutions to formulate policies and set guidelines is the most significant barrier to green retrofitting adoption, the same variable ranked lowest in this particular study. This could possibly indicate that there has been certain

improvement in policy formulation since the research work by Amuda-Yusuf, et. al., (2020). This study align with the finding of Benzar *et. al.* (2020) which shed light that inadequate information about retrofitting procedure and selection method affects good implementation of GRF. Similarly, Sundus *et. al.* (2021) and The Delphi Group (2022) both agree with the finding of this study. These studies opine education and awareness, technology, money, policy with availability of materials and components as factors that affect GRF.

This study also noted that that the topmost reason for the adoption of GRFs in Nigeria is because it results in improved building performance. Other reasons include improvement in energy efficiency, increase in occupants' well-being, no risk to the environment, compliance with current developments in the industry and cost reduction. This agrees with Darko *et. al.* (2017), which concluded that greater energy-efficiency is the prime reason for deciding to apply green building technology. Al-Kodmany (2014) also corroborate the findings of this current study, it posit that green retrofitting enhance energy efficiency, improved building performance, increased tenant happiness, and increased economic return while reducing GHG emissions. Similarly, Ogunjuyigbe *et. al.* (2020) agrees with the present study that the general goal of retrofitting is to create a high-performance building by applying integrated, whole building design process with the objective of reducing the overall operational cost, decreasing environmental impact, improving building adaptability, reliability, durability and resiliency.

CONCLUSIONS

This study investigated the factors affecting and reasons for adoption of GRF in Nigeria. The study was carried out empirically among professionals in Ekiti State, Nigeria. The following conclusions are made based on the findings of the study:

1. Although there are several factors affecting adoption of GRF, nonetheless, limited knowledge of the technology is topmost among them. It implies that the adoption of the technology could also be limited in scope in the Nigerian construction industry.
2. Improved building performance is key reason for the adoption of GRF. The implication is that clients whose main objective is cost, particularly the real estate developers, will most likely not favour GRF.

RECOMMENDATIONS

The following recommendations are made subsequent to the conclusions:

1. Construction stakeholders should make concerted efforts in enlightening the populace on GRF. This can be done via seminars, conferences and trainings on GRF.
2. Construction professionals and customers should be holistic in their reasons for the adoption of GRF. This can be done by attaching equal importance to all the reasons for the adoption of GRF.

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