Environment and Ecology Research 10(3): 414-426, 2022 http://www.hrpub.org
DOI: 10.13189/eer.2022.100309

Building Professional Practices Knowledge and Integration Levels of Energy Efficiency Design Features in Selected Office Buildings in Abuja, Nigeria

E. M. Erebor*, E. O. Ibem, I. C. Ezema, A. B. Sholanke

Architecture Department, Covenant University, Ota, Ogun State, Nigeria

Received April 6, 2021; Revised July 22, 2021; Accepted April 15, 2022

Cite This Paper in the following Citation Styles

(a): *[1] E. M. Erebor, E. O. Ibem, I. C. Ezema, A. B. Sholanke , "Building Professional Practices Knowledge and Integration Levels of Energy Efficiency Design Features in Selected Office Buildings in Abuja, Nigeria," Environment and Ecology Research, Vol. 10, No. 3, pp. 414 - 426, 2022. DOI: 10.13189/eer.2022.100309.*

(b): *E. M. Erebor, E. O. Ibem, I. C. Ezema, A. B. Sholanke (2022). Building Professional Practices Knowledge and Integration Levels of Energy Efficiency Design Features in Selected Office Buildings in Abuja, Nigeria. Environment and Ecology Research, 10(3), 414 - 426. DOI: 10.13189/eer.2022.100309.*

Abstract This study investigated the extent to which building professional practices in Abuja, Nigeria are knowledgeable and integrate 29 energy efficiency design features in selected office buildings in the study area, with a view to making contributions on how to enhance users' comfort and satisfaction within office environments. A structured questionnaire was used to gather data from 80 participants drawn from architectural and engineering design firms in the study area. The survey data were analysed by descriptive statistics, and the key finding is that the knowledge and integration levels of the energy efficiency design features in the selected office buildings by the sampled firms, are high. Appreciably, 71% of the respondents declared that they are aware of the energy efficiency design features in question, while only 29% of them acknowledged having little or no knowledge of any of the features investigated. On the level of integration of the features in office buildings, 64% of the firms stated that they have integrated some of the features, while 35% of them declared not to have integrated any of the features under investigation in this study. One of the recommendations of the study is that relevant professional bodies of the building industry should provide forums such as seminars and training workshops towards promoting the benefits of energy efficiency design features in communities, thereby fostering better understanding and wider deployment of the features by more building design and construction professional practices. This will ultimately help in reducing global warming and the adverse effects of buildings on the environment, both locally and globally in the long run.

Keywords Energy Efficiency, Design Features, Office Buildings, Abuja and Nigeria

1. Introduction

The building construction industry is both unique and dynamically constituted, forming a significant part of the larger economy of any nation. It is of utmost significance in Nigeria, accounting for over 1.4% of its GDP and being a huge employer of labour according to [1]. Office buildings abound in the cityscape of most modern cities locally and internationally. These buildings comprise of existing stocks and new builds. This has resulted in most city planning authorities developing energy efficiency building standards and building codes towards enhancing reduced energy dependence and energy consumption which adversely cause office building structures to affect their immediate vicinity. As a result of these effects of buildings on the environment in Nigeria due to high energy consumption and dependence, the Government of Nigeria - while collaborating with the German Development Agency (GIZ) - came up with the energy sector support programme which places more importance towards achieving energy efficiency in office buildings with more reliance on renewable energy generation.

The government of Nigeria has also developed a three pronged approach towards energy efficiency, namely a guideline that consists of codes which is the Action Plan 2015-2030 and a Code for the country. Of major significance in this code (Federal Government of Nigeria Building Energy Efficiency Code, 2017; 1) is the specific deliverables that can translate to energy savings in office buildings by 40 per cent. Among the several measures identified that can be engaged in achieving this are the placement of windows to shade the interiors of buildings, and a significant reduction of installed lighting power density. Other measures towards achieving further energy savings in office buildings include having a minimum requirement for roofing insulation, improving on specified air conditioning performance and having an installation of non-inverter split units to be restricted (Federal Government of Nigeria Building Energy Efficiency Code, 2017;1).

According to [2], generally speaking, saving energy use in buildings seeks to ensure usage of power within office buildings in such a way that they meet the office users' comfort level. This is followed by enhancing health and safety of office users, and at the same time reducing the harm which offices have on the surrounding environments. The authors further observed that certain energy efficiency design features and principles that enable office designers achieve energy efficiency in office buildings are usually based on two major principles and strategies, namely: firstly, passive design strategies and secondly, active design strategies. Whereas the former consist of strategies that take advantage of the bioclimatic environment of buildings, the latter are based on mechanical systems and fixtures on the buildings. On the one hand, [3] have suggested that energy efficiency design features in office buildings can be achieved by using alternative sources of energy in the form of going green with natural ventilation and electricity systems.

Based on this understanding, several research works have been published on integrating energy efficiency design features in office buildings internationally and in Nigeria. For example, [4] argued that the use of energy efficient design features that rely on improved covering efficiencies of cladding materials used in buildings plays a very important role in office buildings user comfort. The author further argued that there should be more training in the skills in the areas of energy efficiency in buildings. [5] were of the view that being able to insulate buildings by the type of insulation used, the type of urban and architectural design and also placing a high level of design that promotes sustainability, will enhance the thermal comfort for occupants. [6] have also argued that design features when carefully selected and applied in office buildings will further reduce the cooling loads in them, while [7] insisted that introducing landscape design in the scheme of works is a very vital constituent in the development of energy efficient buildings and therefore, more work needs to be done in order to understand the use of landscape in providing thermal comfort in office buildings. Furthermore, [8] examined the perceptions of architects on energy efficient decisions required for the Ghanaian building industry and concluded that there should be a policy by its government to enforce the Leadership in Energy and Environmental Design (LEED) framework which is appropriate in improving the performances within commercial buildings in Ghana. In their study on sustainable hospital architecture, [9] revealed the potentials underground spaces possess towards improving energy efficiency, environmental friendliness and harmonization of healthcare facilities with the artificial and natural environment. They argued that locating hospital functions at underground levels, helps to maintain stable natural temperature and reduce noise from the environment, amongst others.

In Nigeria, [10] examined electricity use in mechanically cooled commercial office complexes in five major cities in Nigeria using computer software packages. It was observed that there was difficulty in achieving thermal comfort in office buildings in Abuja without mechanical cooling. The authors therefore noted that applying phase change materials like ice which absorb or release latent heat as they change in their physical structure from solids to liquids provide cooling in these building types and user comfort can be improved within them. [11] highlighted the need for using energy efficiently in buildings in Nigeria because according to this author, renewable energy use is completely absent in the Nigerian Building Industry. The author therefore suggested that governments at all levels in Nigeria should embark on enlightenment campaigns on the importance of using energy efficiently within office buildings. Another study by [12] identified the passive and active design features that were used in areas with extreme weather conditions of the North- Eastern part of Nigeria. [13] recommended in a research on a building in the Federal Capital Territory (FCT) Abuja, a successful sustainable improvement of existing public office buildings where facilities should be given more attention from the users' perspective than the other design variables.

All these studies cited here provided insight into the various design features integrated in office buildings towards achieving energy efficiency in them. As a result, energy efficient buildings play a vital role in ensuring good working environments, improving the health of office users thereby accelerating the comfort and productivity of its users. However, [14] noted in their study that there was a paucity of research which had not adequately investigated energy efficiency in office buildings especially in countries in Sub-Saharan Africa, and thus argued that more work needs to be done on the subject of energy efficiency and the integration of energy efficiency design features and their effects on users' comfort in office buildings. Moreover, [15] also observed that in Nigeria there was a lack of awareness among building professionals of the various energy efficiency design features that are applicable to office buildings.

From the above, it can be inferred that empirical studies on adoption of energy efficiency design features in office buildings are rare in Nigeria, and that building professionals including Architects and Engineers may not have adequate knowledge of these features. Furthermore, no research work was found to have been carried out to investigate the extent to which building design and construction firms that work in Nigeria know about the various energy efficiency design features which are applicable in office buildings design and construction, especially in a fast growing city like Abuja. In addition, it was also observed that there is paucity of empirical studies on the extent to which energy efficiency design features influence users' comfort in office buildings, especially in Nigeria. These imply that adequate research attention is yet to be given to investigations into energy efficiency design features and how these impact on users' comfort in office buildings in Nigeria. This has partly obscured our understanding of the specific contributions building professionals are making in Nigeria to achieve energy efficiency in office buildings and by extension slowing down the attainment of the eleventh goal of the sustainable development goals (SDGs), which specifically deals with sustainable cities and communities. This has become very important due to the effects of global warming on the environment which has resulted in understanding whether design and construction professionals in designing energy efficient buildings, are aware of the various design features available in delivering energy efficient buildings. As a result of this identified gap in literature, [15] further observed that it had become expedient that this study should investigate and understand the extent to which Architectural and Engineering practices in Abuja, Nigeria, were knowledgeable and integrated the different energy efficiency design features that were available for attachments in office buildings towards achieving user comfort within them. In order to achieve this aim, the fundamental objectives developed for the study were firstly, to investigate the awareness levels of architects and engineers in the study area of the several identified energy efficiency design features necessary for deployment in office buildings. Secondly, and of most significance was to understand the extent of integration of the different energy efficiency design features in the office buildings designed and constructed by the design and construction experts.

The study area was strategically selected due to the following reasons. Firstly, is Abuja's current status as the fastest growing urban city in Nigeria which has a high volume of office buildings situated in one location. Secondly, due to the fast pace of development of buildings and infrastructural facilities in the city, it has become the Eldorado of most design and construction firms where they can earn a measurable level of income. Thirdly, Abuja is situated in the North Central Geopolitical zone, its central nature makes for a cross fertilization of design and construction ideas from different design and construction professionals. The research scope was limited to architectural and engineering practices domiciled in the city of Abuja that designed and constructed the office buildings selected for the study that place emphasis on achieving energy efficiency in office buildings. The central business district of Abuja was the primary area of focus with an emphasis on selecting practices that placed emphasis on design and construction, and had been involved in designing and constructing buildings in this vast area. Furthermore, the study was carried out with a focus on 29 energy efficiency design features identified from literature.

According to [16] efforts should not be spared in the field of research and development towards the reduction of energy consumption and wastes as a result of their harmful environmental consequences. This calls for studies such as this whose findings will contribute to existing literature on ways of developing sustainable office buildings, improving green building design, mitigating the effects of buildings on the environment and enhancing user comfort within office buildings. The study is further itemised and subdivided into: literature review, methodology, results and discussion, conclusion, acknowledgments and references.

2. Literature Review

2.1. Benefits of Energy Efficiency in Office Buildings

According to [1], sustainability and green design practices are being used as solutions to issues relating to environmental sustainability in developing climes like Kenya, South Africa and Ghana. [17] argue that energy efficiency serves a fundamental in all climes due to its cost benefit analysis and its ability to offset the need for some generation capacity. It is the belief of [18] that energy efficient buildings could offset the global energy demand that could have emanated from the commercial sector by 40 percent. Again, they argue that it is the Architect that will play a strategic role in the process of mitigating this energy efficiency menace of buildings. [19] found that there are advantages and savings/profits gained from adopting features that reduce and enhance energy usage within buildings. They further defined these as long term benefits which are quantifiable and they have identified the following benefits to support their submissions.

Firstly, they identified a high price premium for energy efficiency and competitions that will arise from multiple suppliers of energy efficient materials and components. Secondly, they believe there will be improvements in the perception of the public towards construction professionals that design their buildings in an energy efficient manner, as well as improvements in the productive capacity of workers within the office buildings who no longer call in sick from work due to the “sick building” syndrome. Thirdly, there will be benefits gained in the health and comfortability of office building users, which are an advantage within the buildings and are also increasing the benefits of energy security by relying less on fossil-based fuels for energy generation.

On the economic side of the value chain, there would be an increase in availability of jobs for skilled professionals to be engaged in new office building construction and renovation works. This is as a result of the value chain having the ability to provide products and services that enable the reduction of the negative effects of construction/building towards mitigating climate change by an efficient use of resources and preventing unnecessary demolitions of buildings that contribute to construction waste and the protection of the environment.

2.2. Enablers of the Integration of Energy Efficiency Design Features in Office Buildings

[20] identified enablers that promote the integration of energy efficiency design features in office buildings at the third (COP-3) to the United Nations Framework Convention on Climate Change held in Japan in 1997 to negotiate a legally binding treaty to reduce greenhouse gas emissions into the environment. Of major importance and significance to this convention was the reduction of carbon dioxide from the atmosphere to which office buildings are believed to contribute majorly. As a result, one of the fall outs of this meeting was the identification of the approaches towards promoting energy efficiency in buildings, and the following were steps suggested towards solving this major problem of energy efficiency in office buildings namely regulatory instruments, voluntary instruments, management and leadership related factors, skills and knowledge factors and market factors.

Regulatory instruments are means that governments use in intervening in the markets towards achieving positive gains in the society. These could include imposing bans on energy consumption or bans on importation and exports of certain building materials that could be harmful to the environment. Therefore violations of these regulations are subject to penalties and sanctions as imposed by government. Governments can enforce these regulatory instruments by coming up with methods such as imposing mandatory codes, carbon/energy tax policies, tradable permits.

Voluntary instruments include offering rebates to suppliers and building professionals who make it a point of duty in making their buildings comply with energy efficient standards regarding the types of energy efficient materials they acquire and use on their building projects. As a result, steps towards achieving this could take the form of unilateral agreements, negotiated agreements, voluntary programmes on the parts of all those involved in the construction process. This further involves development and selection of the right personnel during construction and also the motivation of personnel towards new methods. Skills and Knowledge factors deal with increase in the awareness and education of management and personnel, new construction methods and technology adoption, proper application of right tools and techniques. Again, Market factors have to do with the increasingly competitive economic market. This factor can encourage construction companies to adopt energy efficiency design features technology so there is great competition in the market.

2.3. Empirical Studies on the Integration of Energy Efficiency Design Features in Office Buildings across Countries and Long-Term Trends

Literature search has revealed the research interest in this area of study on energy and energy reduction around the world which have highlighted energy conservation and efficient design features which have been adopted in office buildings towards enhancing users comfort within such buildings. [21] observed that the interest in energy efficiency in buildings has become important amongst governments and construction professionals within the same period because of the importance that has been placed on energy efficiency in buildings. This has been an ongoing measure within the last three years and was recently made a standard based effort due to the sudden interest in environmental damage issues and how this affects buildings and the environment. Arising from this, building regulation standards that lay emphasis on green buildings used in different climes possess green buildings standards on energy efficient designs like LEEDs in the USA. Others are BREEAM (Building Research Establishment Environmental Assessment Method) used in Britain and the green building label of China and until recently the energy efficiency codes and standards in Nigeria.

Firstly, in a study on encouraging the adoption of green technologies in building construction in Ghana, [22] observed that setting standards, improvements on energy efficiency and occupants’ health and well-being, conservation of non-renewable resources and a reduction in the whole lifecycle cost were the key deliverables in adoption of green building technologies in Ghana. Secondly, in another study conducted by [23] on reduction of energy usage in the work place and at home of users of such buildings in the United Arab Emirates, the authors observed that energy efficiency actions adopted at home by the building occupant more than doubles the likelihood of the same action being taken at work, and vice versa.

Furthermore, in studies conducted in the United States of America by [24], it was observed that in understanding the energy conservation patterns and attitudes towards this in the workplaces in America as being a threefold concept of motivation, opportunity and ability, opportunity was first on the list of effects, followed by motivation and ability. In another study conducted by [25] on energy consumption in Caribbean office buildings, the authors argued that short term solutions to energy concerns in typical office buildings in the Caribbean Islands have an inherent 10% inefficiency.

There are also researches that were conducted by [26] on encouraging the adoption of the principles of energy efficiency in buildings in China through clean development mechanisms where they discovered that there was limited awareness of clean development mechanisms in the building sector in China due to identified limitations that exist in the Chinese construction industry. Also, [27] in a study conducted on climate change effects, implications and impacts on building energy use in different climatic zones in China, observed that adopting the use of energy-efficient lighting and raising the summer set point have good mitigation potentials with regard to office buildings in China. Thereafter, there was another research conducted by [28] on the effects of green building incentives and skills and supply factors that affect green commercial property investment in Malaysia. The authors argued that by applying green skills such as green design, green construction, green maintenance and green procurement are major factors that could improve green commercial building investments in Malaysia.

Further empirical studies conducted by [29] on understanding the effective usage and efficiency of steady electricity in developing countries, with Kyrgyzstan as the main focus revealed that energy efficient light bulbs can indeed lead to significant reductions in energy efficiency. Also, [30] in a research conducted in Hong Kong on the optimization of low/zero energy buildings using both single and multiple optimization methods, observed that there was a higher performance obtained from buildings that adopted the renewable energy systems optimized by both methods than that of the benchmark building in most scenarios. In a similar research on adoption of energy efficiency in office buildings in South Africa by [31] on cost and benefits analysis of sustainable building production in the Western Cape province of South Africa, it was observed that achieving sustainability in buildings depends on the collaborative efforts of all construction stakeholders. [32] in conducting a research in Ethiopia on the current and future States of Ethiopia’s Energy Sector also observed that there is a huge renewable energy potential in Ethiopia that has been under-utilized, and could be useful as a major resource for rural energy access. Finally, in a research study conducted by [33] in New Zealand on the comparison of construction costs between green and conventional buildings, it was observed that green buildings are not inherently expensive because of the use of sustainable materials and systems.

Nigeria is highly vulnerable to the impact of climate change according to [34]. In Nigeria, in a study conducted by [35] on the extent of incorporation of green features in office properties in Lagos, Nigeria, observed firstly that there was a low integration of green features into existing office properties, and secondly that green features relating to material use and conservation is the most incorporated green feature in office buildings in Lagos, Nigeria. [12] observed that comfort in spaces can be enhanced through the use of adequate energy conscious design elements. They further observed that buildings in Nigeria currently lay more emphasis on aesthetic values with little or no consideration for energy efficiency so more research should be carried out on energy efficiency in office buildings in Nigeria.

3. Research Methods

The materials of data collection used for this study were sourced from an on-going research thesis centred on energy efficiency design and users’ comfort in office buildings. The research further sought to investigate the implementation of energy efficiency design strategies, the integration of energy efficiency design features in office building design and construction and their effects on users’ comfort within these office buildings. The study therefore adopted a quantitative research methodology by collecting data by the administration of structured questionnaires to architecture, civil, electrical, mechanical and structural engineering firms in Abuja, Nigeria. The sample frame was comprised of architects, civil, mechanical, electrical and structural engineers working for architectural and engineering firms that designed and constructed 16 selected office buildings in the central business district of Abuja. Quota sampling technique was used to select 16 out of 79 office buildings for the study. The 16 buildings that constitute the sample size were those found to have sufficient number of energy efficiency design features integrated in them. Their selection was based on the type of office building and the number of floors in them. The adoption of quota sampling technique was to ensure that each category of office buildings ranging from 1 and 2 floors, 3 to 5 floors, 6 to 9 floors, 10 to 13 floors and those of between 14 floors and above were represented in the study as shown in Table 1.

The Data collection instrument used for the study was designed by the researchers and divided into sections covering six key components. However, only data retrieved from three sections of the questionnaire that are in line with the objectives of this present study are presented in this article. The sections from where the data were drawn from are, firstly, Section A, which covers the respondents' firms and number of floors the buildings they designed and constructed comprise. Secondly, Section B was used to collect data regarding the level of knowledge of energy efficiency design features. In this Section, the respondents were asked to indicate their level of knowledge of the 29 energy efficiency design features identified in previous literature based on a 5-point Likert type scale ranging from "1" that represents *No Knowledge* to "5" for *Very High Knowledge.* Section C was used to gather data on the extent to which the firms have integrated the 29 energy efficiency design features in the selected office buildings using a 5-point Likert type scale similar to the one used in Section B. The surveys took place in Abuja between February and June 2020. In each of the selected firms, 5 building professionals (architects, civil, mechanical electrical and structural engineers) were given a questionnaire to complete. In total, 80 copies of the questionnaire were administered and all were retrieved and useful. The (SPSS) software was used to analyse the data obtained from the survey and subjected to descriptive statistics and content analysis which involved the calculation of percentages and frequency distribution. The results are presented using tables and charts.

4. Results and Discussion

4.1. Information on the Selected Office Buildings

In total, 80 hardcopies of the questionnaires were distributed to the building professionals of the firms that designed and constructed the sixteen selected office buildings. All the administered questionnaires were retrieved and were found useful and analysed, meaning a 100% retrieval rate was achieved in total. The data in the following Table 1 show relevant information on the selected office buildings that the firms designed and constructed which constituted the selected office buildings used in the research.

The data in Table 1 show that the first office building, the Shehu-Musa Yar'Adua Centre was designed by Julius Berger Nigeria Ltd in collaboration with its in-house engineering subsidiaries. The majority of the buildings were designed by El-Mansur Atelier, who also worked with their in-house engineering subsidiaries. Two of the buildings, Nigerian Society of Engineers and Nicon Insurance, were designed by Archon in collaboration with their in-house engineering firms. Each of the other buildings were designed by Custom Realties, Archiform Consultants, Belel Abdullahi and Associates, Interstate Architects, Silverbird Properties, SI-SA, Sterling Properties and Design Group, all in collaboration with their in-house engineering firms.

Table 1. Information on the Selected Office Buildings

S/N	Office Buildings	Architectural Firms Involved	Engineering Firms Involved	Number of Floors
1	Shehu Musa Yar'Adua Centre	Julius Berger	In House	1-2 Floors
2	Nigerian Bar Association	Custom Realties	In House	3-5 Floors
3	Edo State Liaison Office	Archiform Consultants	In House	3-5 Floors
4	Nigerian Society of Engineers	Archon	In House	3-5 Floors
5	NICON Headquarters	Archon	In House	6-9 Floors
6	Nig. Elect. Regular Comm.	El Mansur Atelier	In House	6-9 Floors
7	Adamawa Plaza	El Mansur Atelier	In House	3-5 Floors
8	Coscharis Office	El Mansur Atelier	In House	3-5 Floors
9	AFDB Building	Interstate Architects	In House	6-9 Floors
10	Plateau State Liaison Office	Belel Abdullahi and Associates	In House	6-9 Floors
11	PPPRA Building	El Mansur Atelier	In House	6-9 Floors
12	Silverbird Galleria	Silverbird Properties	In House	6-9 Floors
13	Bank of Industry Building	SI-SA	In House	10-13 Floors
14	Sterling Bank Building	Sterling Properties	In House	3-5 Floors
15	PTDF Building	Arabi Bello and Associates	In House	10-13 Floors
16	Churchgate Building	Design Group	In House	14 Floors and Above

4.2. Knowledge of the Firms on Energy Efficiency Design Features employed in Office Buildings

This section is a presentation of the results on the level of knowledge of the professionals sampled in the architectural and engineering firms regarding energy efficiency design features used in office buildings. 29 identified Energy Efficiency Design Features were used for this purpose. Table 2 is a representation of the Type of organisation and Energy Efficiency Design Features identified from existing literature.

Table 2. Descriptive Statistics on Knowledge Level of the Firms on Energy Efficiency Design Features

S/No	Energy Efficiency Design Features	Types of Organisations					Chi Square (X^2)	Asymp Sig
		Architects n(%)	Civil Engrs n(%)	Elect Engrs. n(%)	Mech Engrs. n(%)	Struc Engrs. n(%)		
1	**Colours as Design Features**	8(54.66)	4(29.56)	5(33.41)	6(41.84)	6(43.03)	12.112	.017*
2	**Window Size**	8(50.88)	7(47.91)	4(25.13)	6(38.91)	6(39.69)	13.147	.011*
3	**Wall Cladding**	7(47.69)	6(41.81)	4(30.66)	6(39.47)	6(42.88)	5.557	.235
4	**Heat Sink**	7(46.56)	6(37.63)	6(44.50)	4(23.59)	8(50.22)	15.018	.005*
5	**Trombe Walls**	7(44.41)	6(35.78)	5(32.31)	6(36.44)	8(53.56)	9.767	.045*
6	**Autoclaved Aerated Concrete Walls**	6(41.38)	7(49.59)	5(31.69)	5(32.38)	7(47.47)	10.012	.040*
7	**Double Skin Facades**	8(50.22)	7(49.72)	5(30.06)	4(29.09)	6(43.41)	13.742	.008*
8	**Ventilated or Double Skin Walls**	8(53.28)	8(56.13)	5(31.84)	4(28.44)	5(32.81)	22.221	.000*
9	**Climate Adaptive Shells**	7(48.22)	8(51.25)	5(31.94)	5(35.31)	5(35.78)	10.385	.034*
10	**Kinetic Facades**	7(48.56)	7(46.75)	6(36.25)	4(24.75)	7(46.19)	14.994	.005*
11	**Energy Efficient Ceilings**	6(38.91)	7(49.50)	4(26.75)	6(38.75)	7(48.59)	11.107	.025*
12	**LED Lighting**	5(35.16)	8(53.84)	4(29.06)	5(37.06)	7(47.38)	13.233	.010*
13	**Low Emissivity Window Glazing**	6(40.53)	8(50.41)	4(28.22)	5(33.28)	8(50.06)	12.612	.013*
14	**Energy Recovery Vent Systems**	6(41.63)	10(65.56)	4(28.41)	6(39.88)	4(27.03)	31.491	.000*
15	**HVAC Systems**	6(40.44)	8(51.78)	5(32.28)	6(40.44)	6(37.56)	6.561	.161
16	**High Efficiency Solar Water Heater**	6(38.63)	8(51.13)	5(36.13)	6(41.44)	5(35.19)	5.532	.237
17	**Energy Efficient Landscaping Elements**	6(40.53)	8(53.63)	4(29.94)	6(38.44)	6(39.97)	9.072	.059
18	**Layer of Insulation**	8(51.50)	8(53.28)	5(32.53)	6(38.31)	4(26.88)	17.315	.002*
19	**Structural Insulated Panel**	7(48.69)	7(49.19)	5(35.28)	5(34.94)	5(34.41)	9.059	.060
20	**Insulated Block Wall**	8(51.81)	7(49.19)	5(31.56)	5(34.75)	5(35.19)	11.962	.018*
21	**Wide Overhangs**	8(53.56)	7(48.69)	4(28.25)	6(38.66)	5(33.34)	13.970	.007*
22	**Sun Shading Device**	6(41.94)	8(50.41)	4(27.94)	5(35.78)	7(46.44)	10.005	.040*
23	**Smart Windows**	6(43.69)	7(49.56)	4(28.31)	5(32.59)	7(48.34)	11.659	.020*
24	**Smart Doors**	6(38.91)	8(50.75)	3(24.25)	5(34.03)	8(54.56)	19.235	.001*
25	**Solar Panels**	7(44.19)	7(46.22)	4(28.91)	5(35.88)	7(47.31)	7.857	.097
26	**Wind Mills**	7(44.63)	(49.94)	4(27.28)	5(36.50)	7(44.16)	9.816	.044*
27	**Green Roofs**	6(43.63)	6(45.88)	4(29.75)	6(39.22)	7(44.03)	5.301	.258
28	**Vents in the Roof**	7(45.06)	7(49.28)	4(26.38)	5(35.44	7(46.34)	11.448	.022*
29	**Atria as a Design Feature**	6(38.31)	7(46.06)	6(37.09)	6(39.09)	6(41.94)	1.633	.803

a. Kruskal Wallis Test
b. Grouping Variable for Type of Organisation
*Statistically Significant

n=frequency, %=percentage

The results in Table 2 shows that regarding the differences in knowledge about the 29 energy efficiency design features among the professionals, the descriptive analysis shows that among the architects in the sample, the highest proportion (54.66%, 50.88%, 50.22%, 53.28%, 51.50%, 51.81% and 53.56%) know very well about colours as design features, window size, double skin facades, ventilated or double skin walls, layer of insulation, insulated block walls and wide overhangs, respectively as energy efficiency design features in office buildings (Table 2). For the civil engineers sampled, the highest proportion of them have known very well about ventilated or double skin walls (56.13%), climate adaptive shells (51.25%), LED lighting system (53.84%), low emissivity window glazing (50.41%), energy recovery vent systems (65.56%), HVAC systems (53.78%), high efficiency solar water heater (51.13%), energy efficient landscaping elements (53.63%), layer of insulation (53.28%), sun shading device (50.41%), and smart doors (50.75%). Whereas the results (Table 2) show that a majority of the electrical engineers and mechanical engineers sampled claimed to know little or have no knowledge about each of the 29 energy efficiency design features investigated in the current research, greater proportion (50.22%,53.56%, 53.56%, 50.06% and 54.56%) of the structural engineers sampled responded that they knew about heat sink, trombe walls, low emissivity window glazing, and smart doors, respectively as energy efficiency design features in office buildings.

Furthermore, of the 29 energy efficiency design features investigated, the highest proportions of the professionals who know very well about colour, window size, double skin facades and wide overhangs were the architects, while highest proportions of the professionals who knew about ventilated or double skin walls, climate adaptive shells, LED lighting systems, low emissivity window glazing, energy recovery vent systems, HVAC systems, high efficiency solar water heater, energy efficient landscaping elements, layer of insulation and sun shading device were civil engineers as shown in Table 2. However, a high proportion of the structural engineers stated that they knew about heat sink and smart doors as energy efficiency design features in office buildings. These results show that a higher proportion of the civil engineers sampled apparently knew more of the energy efficiency design features in office buildings than the other professionals, closely followed by the architects and structural engineers, respectively.

Kruskal-Wallis tests of significance were conducted to investigate whether the observed difference in the knowledge of energy efficiency design features among the professionals was statistically significant, and the results are also presented in Table 2. A kruskal-Wallis Test or the one way Anova test is usually a rank based non parametric test usually used to determine statistically differences between two or more groups of an independent variable on a continuous or ordinal dependent variable. The test results revealed that apart from difference in knowledge on eight design features, including wall cladding (X^2 = 5.56, p=0.235), HVAC Systems (X^2= 6.56, p=0.161), high efficiency solar water heater (X^2 = 5.56, p=0.235), energy efficient landscaping elements (X^2 = 9.07, p=0.059), structural insulated panel (X^2 = 9.06, p=0.060), solar panel (X^2=7.86, p=0.097), green roof (X^2 = 5.30, p=0.258) and atria (X^2 = 1.63., p=0.803), which is not statistically significant because they all emerged with $p>0.05$, the difference in knowledge about the other 21 design features with $p<0.05$ is statistically significant (Table 2). This result means that differences as demonstrated by the professionals in their knowledge about the 21 energy efficiency design features with $p<0.05$ was because of their different roles as architects, civil engineers, electrical engineers, mechanical engineers and structural engineers in the design of the office buildings investigated.

The results in table 2, for clarity’s sake, are summarized in Figure 1 for concise understanding.

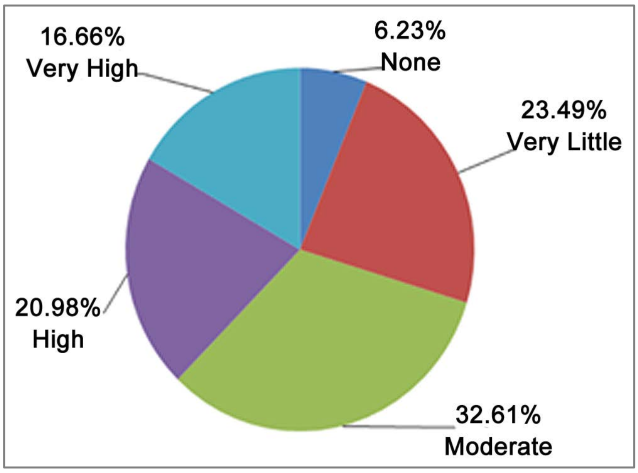

Figure 1. Summary of the Awareness Level of the Sampled Professionals employed by the Sampled Firms regarding Energy Efficiency Design Features employed in Office Buildings.

The descriptive analysis shows that the majority (32.61%) of the professionals declared to have moderate knowledge, some (20.98%) stated a high knowledge and few (16.66%) professed to a very high knowledge as shown in Figure 1. However, a minor proportion (6.23%) of the professionals has apparently no knowledge of energy efficiency design features at all. This result indicates that the professionals who participated in the research mostly have knowledge about the existence of different energy efficiency design features that was investigated. This implies that most of the professionals are competent enough to provide valid data on their integration in the design of the office buildings investigated in this study.

4.3. Integration Level of the Firms of Energy Efficiency Design Features in Office Buildings

This section presents the results on the extent to which professionals in the architectural and engineering firms investigated integrated energy efficiency design features in office buildings. The result of the descriptive analysis conducted in this regard is presented in Table 3.

Table 3. Descriptive Statistics on Integration Level of the Firms of Energy Efficiency Design Features in Office Buildings

S/No	Energy Efficiency Design Features	Integration Level (N = 80)					Chi Square (X^2)	Asymp Sig
		Architects n(%)	Civil Engineers n(%)	Elect Engineers n (%)	Mech. Engineers n(%)	Struct. Engineers n(%)		
1	**Colours as Design Features**	6(42.53)	6(40.00)	5(35.44)	6(39.69)	7(44.84)	1.590	0.811
2	**Window Size**	6(39.41)	6(38.56)	5(32.97)	7(45.63)	7(45.94)	3.781	0.437
3	**Wall Cladding**	7(45.78)	6(41.38)	5(37.25)	6(39.59)	6(38.50)	1.368	0.850
4	**Heat Sink**	6(40.34)	3(23.81)	4(30.38)	8(54.72)	8(53.25)	23.462	0.000*
5	**Trombe Walls**	6(38.63)	6(40.56)	4(31.69)	7(44.09)	7(47.53)	4.517	0.341
6	**Autoclaved Aerated Concrete Walls**	6(43.28)	5(36.06)	4(30.25)	7(45.69)	7(47.22)	6.496	0.165
7	**Double Skin Facades**	6(40.69)	5(36.09)	5(33.75)	7(47.25)	7(44.72)	4.125	0.389
8	**Ventilated or Double Skin Walls**	6(42.41)	6(41.03)	4(33.38)	7(47.13)	6(38.56)	3.281	0.512
9	**Climate Adaptive Shells**	6(37.94)	6(38.16)	5(35.53)	7(49.16)	6(41.72)	3.585	0.465
10	**Kinetic Facades**	7(43.81)	5(37.44)	4(28.59)	7(46.09)	7(46.56)	7.409	0.116
11	**Energy Efficient Ceilings**	(42.53)	8(50.34)	4(28.97)	4(34.66)	7(46.00)	9.699	0.046*
12	**LED Lighting**	7(47.22)	5(33.66)	5(33.44)	4(34.97)	8(53.22)	10.646	0.031*
13	**Low Emissivity Window Glazing**	6(42.69)	6(39.75)	4(28.31)	6(42.25)	7(49.50)	7.544	0.110
14	**Energy Recovery Vent Systems**	6(41.59)	5(31.31)	5(33.59)	7(49.19)	7(46.81)	7.766	0.101
15	**HVAC Systems**	6(41.47)	7(44.34)	4(26.19)	7(47.44)	6(43.06)	8.900	0.064
16	**High Efficiency Solar Water Heater**	6(44.66)	(33.63)	5(31.81)	7(46.81)	6(45.59)	6.503	0.165
17	**Energy Efficient Landscaping Elements**	6(43.41)	7(49.31)	5(31.00)	6(43.56)	5(35.22)	7.325	0.120
18	**Layer of Insulation**	7(47.53)	6(38.06)	4(30.50)	7(48.84)	6(37.56)	7.324	0.120
19	**Structural Insulated Panel**	6(40.94)	6(40.25)	5(32.06)	7(48.53)	6(40.72)	4.320	0.364
20	**Insulated Block Wall**	5(36.38)	7(46.13)	5(34.00)	7(45.75)	6(40.25)	3.816	0.432
21	**Wide Overhangs/Roof Eaves**	6(41.00)	5(32.78)	5(31.69)	7(44.75)	8(52.28)	10.560	0.032*
22	**Sun Shading Devices**	6(43.25)	6(39.53)	4(25.84)	7(44.94)	7(48.94)	11.611	0.020*
23	**Smart Windows**	6(38.34)	7(44.44)	5(31.69)	7(44.56)	6(43.47)	3.968	0.410
24	**Smart Doors**	6(43.56)	6(39.81)	5(30.28)	7(44.50)	7(44.34)	5.289	0.259
25	**Solar Panels**	6(40.06)	6(42.75)	5(33.63)	6(42.72)	6(43.34)	2.160	0.706
26	**Wind Mills**	6(43.00)	6(43.63)	5(30.31)	6(44.09)	6(41.47)	4.376	0.357
27	**Green Roofs**	7(46.03)	5(38.28)	5(34.28)	7(43.75)	6(40.16)	2.805	0.591
28	**Vents in the Roof**	6(43.41)	5(37.22)	5(32.00)	7(46.78)	6(43.09)	5.348	0.253
29	**Atria**	7(49.81)	5(31.00)	5(35.19)	6(44.94)	6(41.56)	7.346	0.119

a. Kruskal Wallis Test
b. Grouping Variable for Type of Organisation
*Statistically Significant

n=frequency, %=percentage

Further examination of the results in Table 3 reveals that the highest proportion of the architects (49.81%) and structural engineers (53.25%) declared to have integrated atria as a design feature and heat sink, and the highest proportion of mechanical engineers reported to have integrated heat sink (54.72%), energy recovery vent systems (49.19%) and climate adaptive shells (49.16%). It is also evident in the results that the highest proportion of structural engineers stated that they have integrated heat sink (53.25%) and LED lighting design features (53.22%), while the highest proportion of those who apparently have integrated energy efficient ceilings (50.34%) and energy efficient landscaping elements (49.31%) and insulated block wall (46.13%) were civil engineers (Table 3). In addition, the highest proportion of those who claimed to integrate atria as a design feature (49.81%), layer of insulation (47.53%), LED lighting (47.22%) were architects. The results in Table 3 indicate that the mechanical engineers sampled in the study have integrated more of the 29 energy efficiency design features in office buildings than the other four design professionals investigated. They are followed by the structural engineers, architects, electrical engineers respectively, and lastly by the civil engineers. In addition, these results generally show that there are variations in the extent to which the professionals sampled had integrated the different energy efficiency design features in office buildings.

In view of the above, it was important to investigate whether the observed difference in the integration of the energy efficiency design features across the different professional groups is statistically significant. To achieve this, Kruskal-Wallis Tests of significance were conducted, and the results are also presented in Table 3. A kruskal-Wallis Test otherwise also called the one way Anova test is usually a rank based non parametric test usually used to determine statistically significant differences between two or more groups of an independent variable on a continuous or ordinal dependent variable. The test results revealed that differences in integration of heat sink (X^2 = 23.46, p<0.000), sun shading device (X^2 = 11.611, p<0.020), LED lighting (X^2 =10.646, p<0.031), wide overhangs (X^2 =10.560, p<0.032) and energy efficient ceilings (X^2 =9.699, p<0.046) is statistically significant. However, the differences in integration of the remaining 24 energy efficiency design feature with $p>0.05$ is not statistically significant. These results mean that on the one hand differences in integration of the five previously listed energy efficiency design features with $p<0.05$ is because of differences in the professionals' role as architects, civil engineers, electrical engineers, mechanical engineers and structural engineers in the design of the office buildings investigated. On the other hand, differences in the rating of the extent of integration of the other 24 energy efficiency design features is not due to the different roles the professionals play in the design of office buildings.

The results in table 3, for clarity's sake, are summarized in Figure 2 for concise understanding.

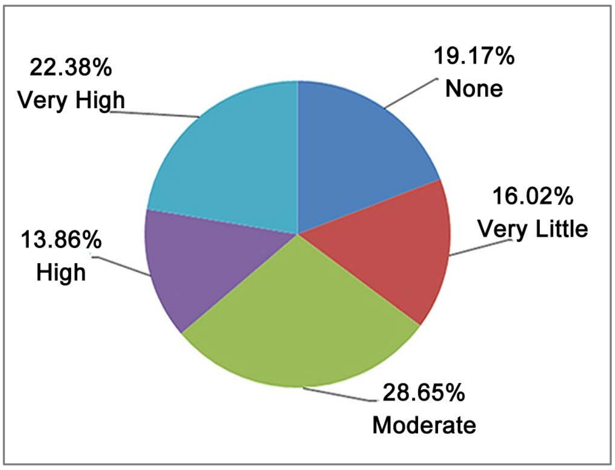

Figure 2. Summary of the Integration Level of the Sampled Professionals employed by the Sampled Firms regarding Energy Efficiency Design Features in Office Buildings.

The descriptive analysis shows that most (28.65%) of the professionals stated to have moderately integrated energy efficiency design features, few (13.86%) stated to have highly integrated them, whereas some (22.38%) stated to have very highly integrated them. However, a significant percentage (19.17%) professed to have never integrated any energy efficiency design feature in any office development. This result also indicates that most of the professionals who participated in the research apparently have integrated the different energy efficiency design features investigated in this study. This implies that majority of the professionals are competent enough to provide reliable data on their level of integration of these design features studied in these office buildings in Abuja.

4.4. Discussion

Ensuring Energy Efficiency in office buildings is an uphill task, locally, nationally and internationally. This is also true for the Nigerian design and construction industry that is currently in its infancy with regard to the latest modern trends. Barriers exist that prevent the attainment of energy efficiency in Nigeria but government policies that will aid in achieving this are currently been drawn up as a starting point, such as the provision of the Building Energy Efficiency Guideline for Nigeria (2016). In their study on contributions of sustainable buildings to meet the European target 20-20-20 targets, [36] also noted that since integrated design processes are now the norm in building construction, adhering to energy efficiency standards should be the principle priority of a building project team. Again, the authors suggested that project team members should start considering energy and performance issues earlier and all through the design process and also the operational phases of the building. Therefore, there should be a close collaboration between the different design professionals on how to choose, use, implement and integrate the various energy efficiency design features during the design stage of the project. In addition, building facades - which is one of the energy efficiency design features known across the different professional groups sampled - according to [37] are one of the most technologically challenging, multifaceted and interdisciplinary components of a building from both architectural design and engineering perspectives. This is so because façades are firstly responsible for the appearance of buildings and secondly, for how they perform. The authors further believe that building façades can impact the level of users' satisfaction from their indoor living and/or working environment. The above may help to account for the knowledge base of these professionals on these aspects of energy efficiency design features in office buildings as reported in this study.

5. Conclusions

In this study, the levels of knowledge and integration of energy efficiency design features by firms in the design and construction industry in Abuja, Nigeria, was studied. The study identified two major findings. Firstly, it was observed that most of the professionals in the firms investigated have expert knowledge about energy efficiency design features in office buildings. Secondly is that this research reveals that the highest proportion of the architects (49.81%) and structural engineers (53.25%) sampled reported to have integrated atria as a design feature and heat sink, and the highest proportion of mechanical engineers reported to have integrated heat sink (54.72%), energy recovery vent systems (49.19%) and climate adaptive shells (49.16%). From the research, it is evident that although the level of knowledge of energy efficiency design features among firms in the Nigerian building industry apparently is on the high side, the level of integration of the features is still relatively low. As a result, it is most likely that the Nigerian building industry is yet to reap the full benefits of energy efficiency design features in office buildings. To reverse this trend, it is suggested that the relevant stakeholders in the building industry in the country should provide platforms from time to time for promoting the benefits of energy efficiency design features in the country. This calls for awareness programmes on energy efficiency design features practices by professional associations in the Nigerian building industry such as the Architects Registration Council of Nigeria (ARCON) and the Council of Registered Engineers of Nigeria (COREN).

The authors of this present study are aware that the scope of the study was only limited to design and construction firms in Abuja, this could pose a limitation for the findings of the study. It is therefore suggested that a wider scope should be embarked upon with more Nigerian cities and states included. As a direct fall out of this is that further studies can be carried out on a more international and global scale worldwide. More studies can be carried out on other existing office buildings and extended to other design and construction firms both locally and internationally. Whilst the research was conducted on a particular location in Nigeria, the research nonetheless is helpful for local researchers and for other researchers worldwide.

Acknowledgements

The authors acknowledge the efforts of Covenant University Centre for Research, Innovation and Discovery (CUCRID), in driving research in the institution. We are also grateful to the management of the institution for providing the funds and other necessary infrastructural facilities needed to conduct the research. We further acknowledge the anonymous reviewers whose suggestions contributed in improving the quality of the initial manuscript.

REFERENCES

[1] Ezema, I. C. (2013, August). Operation Green Lagos programme and its implication for sustainable development. In *Proceedings 5th West Africa Built Environment Research (WABER) Conference* (pp. 12-14).

[2] Shoubi, M. V., Shoubi, M. V., Bagchi, A., & Barough, A. S. (2015). Reducing the operational energy demand in buildings using building information modeling tools and sustainability approaches. *Ain Shams Engineering Journal*, *6*(1), 41-55

[3] Siew, C. C., Che-Ani, A. I., Tawil, N. M., Abdullah, N. A. G., & Mohd-Tahir, M. (2011). Classification of natural ventilation strategies in optimizing energy consumption in Malaysian office buildings. *Procedia Engineering, 20*, 363-371.

[4] Harvey, L. D. (2009). Reducing energy use in the buildings sector: measures, costs, and examples. *Energy Efficiency*, *2*(2), 139-163.

[5] Li, J., & Colombier, M. (2009). Managing carbon emissions in China through building energy efficiency. *Journal of Environmental Management*, *90*(8), 2436-2447.

[6] Ahsan, T., & Svane, O. (2010). Energy efficient design features for residential buildings in tropical climates: The Context of Dhaka, Bangladesh. *Sustain. Archit. Urvan Dev*, *4*, 183-202.

[7] Ramesh, S. (2016). Energy efficient landscape for thermal comfort in buildings and built-up areas. *International Journal of Engineering and Technology*, *8*(5), 338.

[8] Mensah, M., Gyamfi, T. A., & Junior, A. A. (2017) Exploration of Architect perception on energy-efficient design decisions for Ghanaian building industry. *American Journal of Engineering Research, 6(9), 44-52.*

[9] Irina Bulakh & Iryna Merylova (2020). Sustainable Hospital Architecture - Potential of Underground Spaces. *Civil Engineering and Architecture*, 8(5), 1127 - 1135. DOI: 10.13189/cea.2020.080539

[10] Batagarawa, A., Hamza, N., & Dudek, S. J. (2011). Disaggregating primary electricity consumption for office buildings in Nigeria. In *Proceedings of Building Simulation 2011:12th Conference of International Building* (Vol. 1416).

[11] Nwofe, P. A. (2014). Need for energy efficient buildings in Nigeria. *International Journal of Energy and Environmental Research*, *2*(3), 1-9.

[12] Haruna, H., Wakawa, U. B., Isa, A. A., & Umar, A. (2017) Energy Conscious Design Elements in Office Buildings in Hot-Dry Climatic Region of Nigeria.

[13] Adeyemi, A., Martin, D., Kasim, R., & Adeyemi, A. I. (2017). Facilities improvement for sustainability of existing public office buildings in Nigeria. *ATBU Journal of Environmental Technology*, *10*(1), 12-34.

[14] Griego, D., Krarti, M., & Hernandez-Guerrero, A. (2015). Energy efficiency optimization of new and existing office buildings in Guanajuato, Mexico. *Sustainable Cities and Society*, *17*, 132-140

[15] Ismail, A. I., Kunle, A. A., & Ronke, O. Y. 1. Department of Architectural Technology Osun State Polytechnic, Iree, Nigeria 2. Department of Architecture, Ladoke Akintola University of Technology, Ogbomoso, Nigeria 3. Department of Architecture, BellsTech Ota, Ogun State.

[16] Abderrahmane Djoher (2020). Desalination Projects in Algeria: What Are the Environmental and Economic Issues of Seawater Desalination? *Environment and Ecology Research*, 8(3), 59 - 69. DOI: 10.13189/eer.2020.080301.

[17] Hor, K., & Rahmat, M. K. (2018). Analysis and recommendations for building energy efficiency financing in Malaysia. *Energy Efficiency*, *11*(1), 79-95.

[18] Musa, A. A. R., & Abdullahi, A. Office Buildings in Tropical Composite Climatic Belt of Abuja, Nigeria. *Dutse Jpournal of Pure and Applied Sciences. 4(2), 551-564*

[19] Schäfer-Sparenberg, C., Tholen, L., Thomas, S., Weiß, U., Dinges, K., & Förster, S. (2017). The future of EU energy efficiency policies: a comprehensive analysis of gaps, shortcomings, and potential remedies. *Europ. Council for an Energy Efficient Economy. 81-91*

[20] Lee, W. L., & Yik, F. W. H. (2004). Regulatory and voluntary approaches for enhancing building energy efficiency. *Progress in energy and combustion science*, *30*(5), 477-499.

[21] Shi, X., Tian, Z., Chen, W., Si, B., & Jin, X. (2016). A review on building energy efficient design optimization from the perspective of architects. *Renewable and Sustainable Energy Reviews*, *65*, 872-884.

[22] Darko, A., Chan, A. P. C., Gyamfi, S., Olanipekun, A. O., He, B. J., & Yu, Y. (2017). Driving forces for green building technologies adoption in the construction industry: Ghanaian perspective. *Building and Environment*, *125*, 206-215.

[23] Lin, M., & Azar, E. (2019). Mixing work and leisure? Energy conservation actions and spillovers between building occupants at work and at home in the UAE. *Energy Research & Social Science*, *47*, 215-223.

[24] Li, D., Xu, X., Chen, C. F., & Menassa, C. (2019). Understanding energy-saving behaviors in the American workplace: A unified theory of motivation, opportunity, and ability. *Energy Research & Social Science*, *51*, 198-209.

[25] Edwards, E. E., Iyare, O. S., & Moseley, L. L. (2012). Energy consumption in typical Caribbean office buildings: A potential short term solution to energy concerns. *Renewable energy*, *39*(1), 154-161.

[26] Zhou, L., Li, J., & Chiang, Y. H. (2013). Promoting energy efficient building in China through clean development mechanism. *Energy Policy*, *57*, 338-346.

[27] Wan, K. K., Li, D. H., Pan, W., & Lam, J. C. (2012). Impact of climate change on building energy use in different climate zones and mitigation and adaptation implications. *Applied Energy*, *97*, 274-282.

[28] Onuoha, I. J., Aliagha, G. U., & Rahman, M. S. A. (2018). Modelling the effects of green building incentives and green building skills on supply factors affecting green commercial property investment. *Renewable and Sustainable Energy Reviews*, *90*, 814- 823.

[29] Carranza, E., & Meeks, R. (2016). *Shedding light: understanding energy efficiency and electricity reliability*. The World Bank.

[30] Lu, Y., Wang, S., Zhao, Y., & Yan, C. (2015). Renewable energy system optimization of low/zero energy buildings using single-objective and multi-objective optimization methods. *Energy and Buildings*, *89*, 61-75.

[31] Fapohunda, J. A., Nicholson, A., Solanke, B. H., & Ganiyu, B. O. Cost and Benefits Analysis of Sustainable Building Production in Western Cape Province, South Africa.

[32] Khan, B., & Singh, P. (2017). The current and future states of Ethiopia's energy sector and potential for green energy: A comprehensive study. In *International Journal of Engineering Research in Africa* (Vol. 33, pp. 115-139). Trans Tech Publications Ltd.

[33] Rehm, M., & Ade, R. (2013). Construction costs comparison between 'green' and conventional office buildings. *Building Research & Information*, *41*(2), 198-208.

[34] Opoko, P. A., & Oluwatayo, A. A. (2014). Trends in urbanisation: implication for planning and low-income housing delivery in Lagos, Nigeria. *Architecture Research*, *4*(1A), 15-26.

[35] Komolafe, M. O., Oyewole, M. O., & Gbadegesin, J. T. (2019). Stakeholders' relevance in sustainable residential property development. *Smart and Sustainable Built Environment*. Journal of Smart and Sustainable Built Environment, 9(2), 112-129.

[36] Bragança, L., Mateus, R., & Pinheiro, M. (2013). Portugal SB13: contribution of sustainable building to meet EU

20-20-20 targets. *International Conference Portugal, pp. 1-912, 978-989-96543-7-2, 2013*

[37] Halawa, E., Ghaffarianhoseini, A., Ghaffarianhoseini, A., Trombley, J., Hassan, N., Baig, M., ... & Ismail, M. A. (2018). A review on energy conscious designs of building façades in hot and humid climates: Lessons for (and from) Kuala Lumpur and Darwin. *Renewable and Sustainable Energy Reviews, 82,* 2147-2161