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Awareness, benefits and drawbacks of net zero energy building practices: construction industry professional's perceptions

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Abstract. In a bid to overcome climate change and global warming, the adoption of net zero energy building (nZEB) practices in construction projects has become a viable measure of reducing energy consumption and CO₂ emissions in buildings. nZEB is a facility with a significantly lowered energy needs such that the rest of the energy requirements can be supplied by on-site or off-site renewable technologies. The present study therefore investigated the awareness, benefits and challenges confronting the actualization of nZEB in Nigeria construction industry. A cross sectional survey design was adopted wherein a close ended questionnaire was purposively administered online to construction industry professionals who have understanding of nZEB initiatives. Descriptive statistical tests were conducted, with the results showing about 9% and 25% of the selected professionals been not aware of nZEB concepts and have not been involved in the concept in their professional career. Further details revealed that reduction in the land use effect, reduction in vulnerability of power infrastructures to vandalism and economic competitiveness were dominant benefits of nZEB practices. However, low return on investment, conflict with public policy regulation and policy clarity, lack of evaluation and valuation processes were perceived as the top hindering factors to nZEB practices. The implication for practice is for construction stakeholders to participate and develop effective implementation strategies towards nZEB for could be ecological and economical friendly.

Keywords: Construction industry, Construction professionals, Descriptive statistics, Sustainable buildings, Zero energy buildings

1. Introduction

There have been constructive attempts aimed at reducing carbon emissions and energy use during the building's lifecycle. The major reason for the estimation and reduction attempts of these greenhouse gases can be ascribed to their contributions to climate change and global warming [1]. Globally, it has been shown that the CO₂ emissions from buildings accounts for between 23% and 50% of total emissions [2,3]. Similarly, energy usage in both residential and commercial facilities accounts for about 20 - 40% over its life span [4, 5]. Lai and Yik [6] reported that energy cost is a significant portion of operation cost for hotels. Oyedepo [7] recognizes electricity as the predominantly used and attractive type of energy while noting that energy consumption per capita is a conventional indicator for assessing standard of living. In addition, Luen [8] views the absence of energy in any economy as indicator for



economic development impediment, human survival jeopardy and national security compromise. Hence, adoption of sustainable practices (such as zero energy) could be a viable approach for sustainable development of the built environment in the wake of current challenges associated with global warming. In recent years, the concept “Net-zero” and its associated practices (e.g. net-zero energy, nearly-zero energy, zero carbon, etc.) are getting acceptance within the practice and research group. These terms are used to denote low-energy buildings as defined in EU Energy Performance of Buildings Directive (EPBD) and US net-zero legislation. Berry and Davidson [9] define nZEB as “an energy efficient building that generates sufficient energy on-site over the course of a year to supply all expected on-site energy services for the building users”. The minimal amount of energy needed by nZEB is significantly provided from renewable energy sources generated either on-site or off-site [10]. Notable benefits of this practice include: financial effectiveness, use of limited funds for growth, ecological attribute and energy guarantee [11]. Accordingly, effective evaluation of nZEB policies and adoption strategies in developing nations will provide clean energy, viable source of energy to meet shortfall in national grid and new stream of income generated from sales of carbon credits.

Based on the foregoing, it is apparent that the practice of net-zero is beneficial to the economy and sustainable use of the environment. Developed nations have initiated and effected several policies aimed at encouraging the adoption of nZEB practices. For instance, the US Energy Independence and Security Act of 2007 is targeted at creating expertise and skill base for cost-efficient nZEB commercial buildings by 2025 [12]. Furthermore, Marzal *et al.* [13] pointed out that EPBD 2010 policy is positioned towards the goals and the actualisation of nZEB in Europe. Zhang *et al.* [12] identified California as a leading market for nZEB built projects in the US while Denmark was the first EU member state to establish a national progressive energy and climate policies towards nZEB plan. Yang, Zhang and Xu [14] expressed Asian countries readiness in pursuing nZEB initiatives in their regions with Japan instituting energy policies and expecting all recently built public buildings and houses to be net zero by 2020 and 2030 respectively. In the same way, Chinese government currently instituted 2025-2035-2050 medium - long term building energy policy irrespective of the existing 10 million m² of ultra-low building and nZEBs 2020 policies. As this concept emerges as a front burner in the developed world, developing countries are still lagging behind in setting targets, creating enabling environment and implementing policies that will enhance building performance and encourage the adoption of nZEB practices.

Several studies [4, 9,15,16,17] have reported the economic, environmental and social benefits of nZEB across the globe. These gains are evident with increased energy building regulations and demonstrated nZEB projects in nations and regions. The economic potentials of nZEBs as reported by Adhikari *et al.* [4] in a qualitative study in Italy inferred that the economic payback of nZEB construction with feed-in-tariff on Photovoltaic (PV) is below 14 years. Hamdy *et al.* [15] studied the cost-optimum method for cost effective nZEB in agreement with EPBD. It was found that the transfer of PV surplus to grid yield annual energy rating of 70kWh/m²a. ALAjmi *et al.* [16] used EnergyPlus simulation tool to analyse the annual and monthly nZEB exiting building energy in hot and arid climate of Kuwait. It was concluded that the energy efficiency measures implemented in existing buildings follows an annual energy savings of about 658.8 MWh which is comparable to 27% of building consumptions while 545.6 tons of CO₂ emissions were avoided.

There exist dearth of research works on building energy efficiency in both developing and least developed economies of Africa [18] Studies identified in Nigeria have geared towards systematic energy reviews and building energy performance prediction. At the pre-design stages, the use of Mahoney tables was emphasized by Ukaonu [19] as an evaluation tool, which provide design recommendations on the building design using climatic data that will guarantee thermal comfort and the efficient use of energy and material resources. Oyedepo [7] reviewed the energy (fossil and renewables) crises and the potentials in Nigeria economy. Similarly, Bakare and Ogedengbe [20] adopted EnergyPlus tool in predicting energy demand in existing Engineering Lecture Theatre of University of Lagos. Baba *et al.* [21] studied building modelling tools used at the design phase to support energy decision process. The energy prediction tools identified include but not limited to the following: EnergyPlus, eQUEST, Design Advisor, Autodesk green building Studio, Design Builder and DOE-2. Odunfa *et al.* [18] studied the

use of universal design perceptions, basic cooling load equations and the recommendations set by the American Society of Heating, Cooling and Air Conditioning Engineers (ASHRAE) in investigating the influence of building orientation on energy demand in buildings at post construction.

Evidence from studies [18 – 21] suggest that the use of tools and practices aimed at efficient energy use is still low among practitioners. Furthermore, Odunfa *et al.* [18] reported the inability of Africa both at the developing and the least developed in carrying out research work on building energy efficiency practices notwithstanding the depleting nature of fossil fuels. Similarly, Abdul Majid and Hussaini [22] inferred that built environment professionals in Nigeria are not keen in energy efficient practices despite the global concern. This may be linked to lack of technical know-how and/or lack of incentive, formal policies/strategies for implementation by the government or respective professional associations. From the studies identified, it can be seen that none of the studies have addressed the use of net-zero energy practices in Nigeria. Hence, this study will address this gap by assessing the awareness, benefits and drawbacks of this nZEB in developing country like Nigeria.

2. Review of Literature

2.1 Concept of Net Zero Energy Building

It is generally recognised among scholars and experts that nZEB thoughts began from the US [11,23]. Though, the drive for the concept decreased in 1980s due to decline in energy prices. The ratification of the Energy Independence and Security Act of 2007 stirred the drive for federal buildings in US to feature nZEB design factors for better levels of functioning by 2025 [24]. Also, Department of Energy (DOE) in its report prepared a national goal in 2010 to achieve nZEB in 50% of all commercial buildings by 2050. The establishment of EPBD recast of 2010 furthers the attempts in European countries by promoting nZEB. Also, in UK there exist regulatory target set to realise zero carbon for new dwellings by last 2016 [9]. The study also reported that nearly 300 nZEB and energy-plus buildings have been commissioned globally. Conversely, Pan and Ning [24] pressed that lack of clarity and appropriateness, low level of awareness and recognition by market participants to have challenged the implementation of nZEB polices in many climes. Consequently, the timelines and implementation of nZEB polices will encourage its practices in every nation.

The concept "nZEB" has been operationalized in various ways by several researchers. Similarly, literature has shown that there is absence of generic definition or interpretation of "nZEB" [10]. The study of Marszal *et al.* [13] pointed out that the disparity in meaning are due to project goals and diverse interests and values of building owners and designers. Also, nation's diplomatic objectives and given condition attribute to the variations in nZEB definitions [16]. Despite the differences in definitions, nZEB falls into four groups: net zero site energy, net zero source energy, net zero energy cost and net zero energy emission. Mohammad and Nafiseh [11] defines "nZEB as a residential or commercial building with greatly reduced energy needs through efficiency gains such that the balance of energy needs can be supplied with renewable technologies." Similarly, Adhikari *et al.* [4] seem ASHRAE definition of nZEB to be more effective and direct. According to them ASHRAE views "nZEB as building which on an annual basis, uses no more energy than is provided by on-site renewable energy sources". nZEB is a common label employed to a building with zero net energy consumption and zero carbon emissions, analysed over a period of time [10]. Accordingly, it can be said that nZEB is a form of facility with a significantly lowered energy needs via efficiency attributes such that the rest of the energy requirements can be supplied by on-site or off-site renewable technologies.

2.2 Energy Efficiency Measures towards Zero Energy Building

Actualization of nZEB is substantially based on energy efficiency practices. Energy efficiency attributes in nZEB construction also improves comfort and functionality [25]. As highlighted in Chleda *et al.* [26], Harvey [27] and Ardenne *et al.* [28] energy efficient practices are in two folds namely passive and active. Passive means include: building form, orientation, self-shading, height-to-floor-area ratio, window-to-wall area ratios, insulation levels, window properties, building envelope, reflectivity, colour and trees.

The active element involves installation of energy efficient appliances and equipment. At the design phase, Adhikari *et al.* [4] posit that different evaluations of the building envelope should be carried out. These evaluations will ascertain the thermal transmittances of the building envelope with a view to decreasing the thermal load of the building. The energy performance of the facility can be simulated using any of the energy software mentioned at the introduction section.

Furthermore, Ruparathna *et al.* [29] asserts that the upgrading of existing mechanical systems (HVAC) in buildings to energy efficient technology is paramount in improving energy performance of an existing building. They opine that HVAC systems are the main energy utilising components in buildings. Other means of achieving nZEB is through incorporation of human behaviour and needs during the whole lifecycle assessment. Design, construction, maintenance and operation phases are required to provide information that will assist building users in understanding nZEB concepts. Providing relevant and logical information and design practice inspires consumers in participation and performance monitoring [23]. Therefore, adoption of energy efficiency practices will help in meeting up with the energy needs of consumers.

2.3 Renewal Energy Source and Technologies available for Net Zero Energy Practices

Various studies have noted several renewable sources and technologies in attaining nZEB [4, 10,11, 16, 25]. The identified sources and technologies include: solar-: PV and solar hot water heaters; wind-: wind turbines; plant and animal residue-: biomass; hydro -: hydroelectric; microturbines-: natural gas and digester gas; fuel cells-: natural gas and hydrogen and combines heat power (CHP) with varied fuel source. These studies also reported the gains and pitfalls in each of these sources and technologies. Noted advantages of photovoltaic are its ability to be integrated into the building and longevity [10]. Variation in intensity within location, season, day of the month, time of day, instantaneous cloud cover and other environmental factors are noted limitations of solar radiation incident on the earth's surface. In wind source technology, wide availability and declining costs are seen as comparative advantages while the structural load, noise, and wind pattern considerations limit its wide applicability. Biomass such as human and animal wastes, waste vegetable oil from waste streams and methane are usually imported for on-site processes and pollute air [4,10]. The preference of PV over all other forms of renewables comes from its applicability across many climatic conditions, architectural integration and solar potentials of the site.

2.4 Factors Affecting the Implementation of Zero Energy Building

There are myriads of interrelated and interconnected challenges that are impeding the possible applicability and actualization of nZEB design and construction in built environment. These challenges when addressed would encourage nZEB practices. These challenges as identified by McNabb [23]; Pan and Ning [24]; Stefanović *et al.* [30] and Mohamed *et al.* [31] are as discussed here:

- i. Policy implementation challenges and lack of clarity:** In spite of policy campaign for nZEBs in developed nations, it still suffers policy implementation challenges. Pan and Ning [24] relate lack of clarity and appropriateness of policies as major concern for nZEB. In their view, various definitions of nZEB in different zones have contributed to the limitations of wide acceptability. The varied definitions create diversities in development and application of technologies, equipment and designs that defines nZEB [23]. The author also noted the absence of guidelines, standards and codes for design, installations and operation of renewable technologies across practicing nations as a major setback. Suitability of different metrics such as site, source, emissions and cost used in defining nZEB are also common argument among research community [31].
- ii. Lack of awareness and Aversion to change:** There is low level of awareness of the practice among stakeholders. McNabb [23] reported that nearly all homeowners are not knowledgeable

of the energy and carbon footprint of their proposed or present home and how to reduce it. Stefanović *et al.* [30] viewed that the study of nZEB cost facilities has not received much considerations in literatures. In developing nations, many still has the notion that the concept is foreign and not to be incorporated yet into their system. The reluctance shown by designers, builders and contractors in incorporating new technologies with unfamiliar histories are major setbacks of nZEB [23]. He attributed this challenge to reduced means to determine the performance and benefits of the technology. The difficulty in communicating the usability, consistency, financial and other gains of nZEB to users and other financial communities was also noted as critical barriers. Hence, awareness formation will go a long way to help people know the idea and change their conducts.

- iii. **Initial high cost:** The initial cost of the practice creates fear for many investors in terms of recouping of investments when compared with convectional construction. Lingering monopoly in the design and construction of large-scale renewable technologies has been identified as major obstacle to nZEB [3].
- iv. **Inadequate trained personnel and professional:** Another factor hindering the development of nZEB and energy efficiency practices is linked the dearth of personnel and professionals. Inadequate skilled workforce and workers awareness of nZEB and inadequacies of professional permits and education at vocational/technical schools and universities contributes to poor development of nZEB [23]. Other barriers noted are the lack of competent enforcement and inspectors to confirm facilities are functioning up to design expectancies.
- v. **Lack of unique incentives and Tax credits:** High cost of nZEB technologies and energy efficient appliances and lighting inhibits the development of the practice. Unique incentives such as tying consumers' carbon credit to personal benefits (e.g. education credits) will make nZEB attractive [23]. Incentives and tax credits should be made available for developers who install ZEB technologies and energy efficiency appliances.
- vi. **Lack of consistent evaluation and valuation processes:** There are unconsolidated home scores that enable easy evaluation by consumers. Lack of unified method for evaluating the performance of new or existing building makes it difficult to observe how nZEB differ with fluctuating patterns of behaviour and energy use. The exclusion of energy performance during valuation makes it difficult for users to have embrace nZEB.

3. Research Methodology

This section addresses the method used in conducting the study. Lagos, Nigeria is the location of the study and is the business hub centre of Nigeria that accommodates a number of construction professionals due to continuing degree of construction undertakings. A close-ended on-line survey was adopted as research design for the need to harvest ample data from substantial population in lieu of generalizing the findings. Furthermore, Eyisi [32] assert that studies that use quantitative technique can be repeated and related. The sample frame consists of built environment professionals involved in infrastructural development. The built environments professionals were purposely selected because of their knowledge on the energy requirements in buildings.

A total of 119 online questionnaires were received which was prepared with google form tool. The questionnaire contains four parts. Part A addresses the demographics attributes of the respondents. Part B consists of awareness questions on nZEB practices such as information sources of nZEB, years of involvement in nZEB practices, roles played in nZEB construction and level of interest in nZEB practices in Nigeria. Part C and D detailed 11 and 12 benefits and drawbacks of nZEB practices respectively. The respondents were obliged to show their level of knowledge on the listed benefits and

challenges of nZEB practices on a five Likert scale (i.e. 1= not beneficial, 2= slightly beneficial, 3= moderately beneficial, 4= beneficial 5= highly beneficial. 1= not challenging, 2 = slightly challenging, 3 = moderately challenging, 4 = challenging, 5 = highly challenging). Descriptive statistics of frequency, mean scores and standard deviations (SD) were used in ranking the variables in descending order.

4. Results and Discussion

4.1. Personal Data of Respondents and Organizational Details

The study pursued to understand the personal data of the respondents and that of their organization details. This is represented in Table 1. The examination of the respondent's academic qualifications shows that 32.8% held BSc/BTech degree, 30.3% held MSc/MTech degree, 21.8% held HND certificate and 15.1% obtained PhD degree. In terms of working experience in construction firm, 42.9% had 6 – 10 years, 35.3% had 11 - 20 years, and 26.6% had 1 -5 years while the remaining 9.3% had 21 - 40 years of construction experience. Their professional background revealed that 27.7% were building production experts, 21.8% were architecture trained, 19.3% were civil engineering trained, and 17.6% were trained in electrical/mechanical engineering discipline while quantity surveying trained discipline were 13.4%. In regards to professional attainment, 63% have attained corporate membership, 23.5% attained associate membership and 6.7% have reached to fellow and graduate membership cadres respectively. This implies that the respondents have practical perception of construction trades and therefore, information on zero energy building gotten from them will be reliable.

4.2. Awareness Level of Zero Energy Building

4.2.1. First Source by which nZEB was discovered

The study examined the first information fonts by which nZEB practices was discovered. The result given in Figure 1 depicts that 22.7% of the respondents discovered nZEB practices through their personal research, 21.0% discovered through higher education training and media/articles channels, respectively. 10.1% discovered through workshop/seminars while 8.4% never came across nZEB practices from any of the sources. Thus, personal research option revealed the highest learning source of nZEB. This may be attributed to the quest for knowledge on innovative energy use in construction projects by the study respondents.

Table 1: Respondents organization details and personal data

Personal Data Characteristics	Frequency (N)	Percentage (%)
<i>Academic Qualification</i>		
HND	26	21.8
BSC/BTECH	39	32.8
MSC/MTECH	36	30.3
PHD	18	15.1
Total	119	100
<i>Years of Working Experience in Construction</i>		
1 – 5	15	26.6
6 – 10	51	42.9
11 – 20	42	35.3
21 –30	7	5.9
31- 40	2	1.7
41 and above	2	1.7
Total	119	100

Profession Background		
Architecture	26	21.8
Building	33	27.7
Civil Engineering	23	19.3
Electrical/mechanical engineering	21	17.6
Quantity Surveying	16	13.4
Total	119	100
Grade of Membership		
Graduate	8	6.7
Associate	28	23.5
Corporate	75	63.0
Fellow	8	6.7
Total	119	100

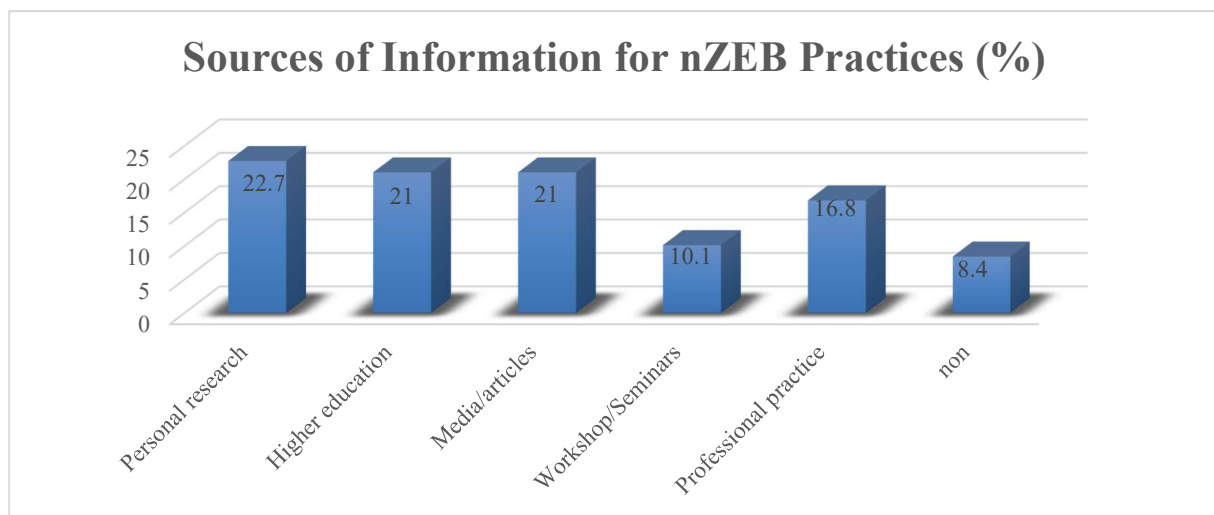


Figure 1. Information sources of nZEB Practices

4.2.2. Years of Involvement in nZEB Construction

The study investigated the years of involvement in nZEB construction by respondents who have learned about nZEB practices in six timelines. A total of 91.6% signalled their percentage input to each timeline of the involvement in nZEB practices based on their years. The outcome of the breakdown given in Figure 2 displays that 29% had involved in nZEB practices in the last 1-3 years, 25% had in the last 4-6 years, 15% had in less than one year, 4% had in the last 7-10 years and minority 3% had been involved in more than 10 years ago while considerable 25% had never involved in nZEB practices in their professional dealings. The import of these results is that quiet a number of the construction professionals practicing in Lagos may have not been participating in nZEB projects within the last ten years.

4.2.3. Roles played in nZEB Construction

The perceived role played in actualizing nZEB construction was sought from 78% of those who have been involved in nZEB construction at various times and presented in Figure 3. As revealed, 26.1% was commissioned as a consultant, 24.4% have been engaged in teaching and research development, 15.1% have been engaged as technical staff, 10.1% have been mobilized as contractor, and 24.4% had never played any role in nZEB practices in any construction projects. This result shows an encouraging participation of construction professionals in advancing nZEB initiatives.

4.2.4. Level of Interest in nZEB Construction

Figure 4 shows that 57.1% out of 91.6% of those who have been involved in nZEB practices have high interest in advancing the initiatives, which is followed by moderate interest option of 39.5%. Those that have low interest are within 3.4%. This shows an assuring interest in nZEB practices in construction projects when interested party are exposed to the benefits.

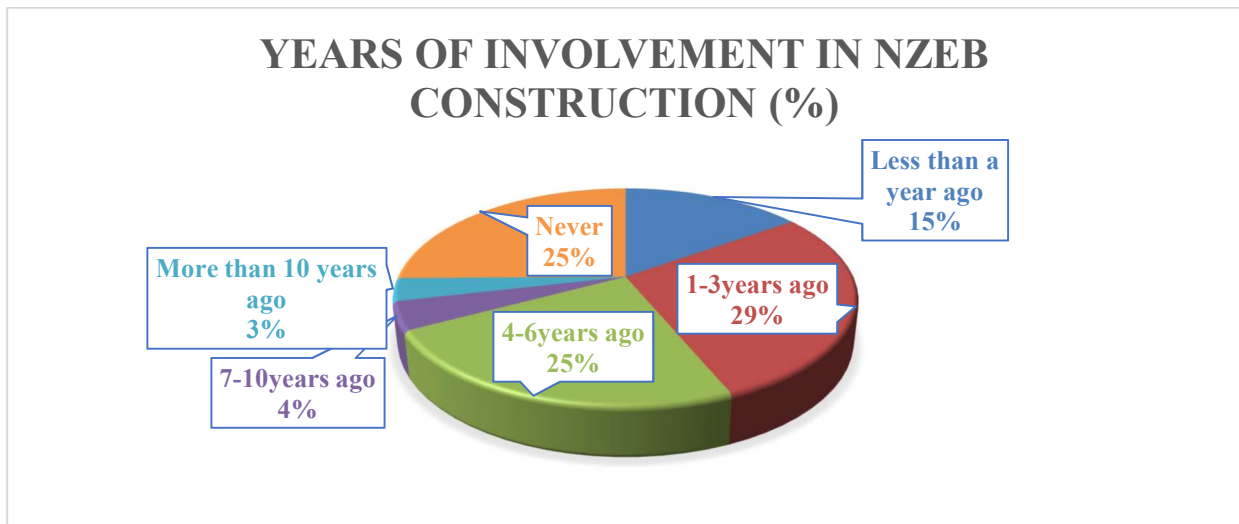


Figure 2. Year’s involvement in nZEB construction

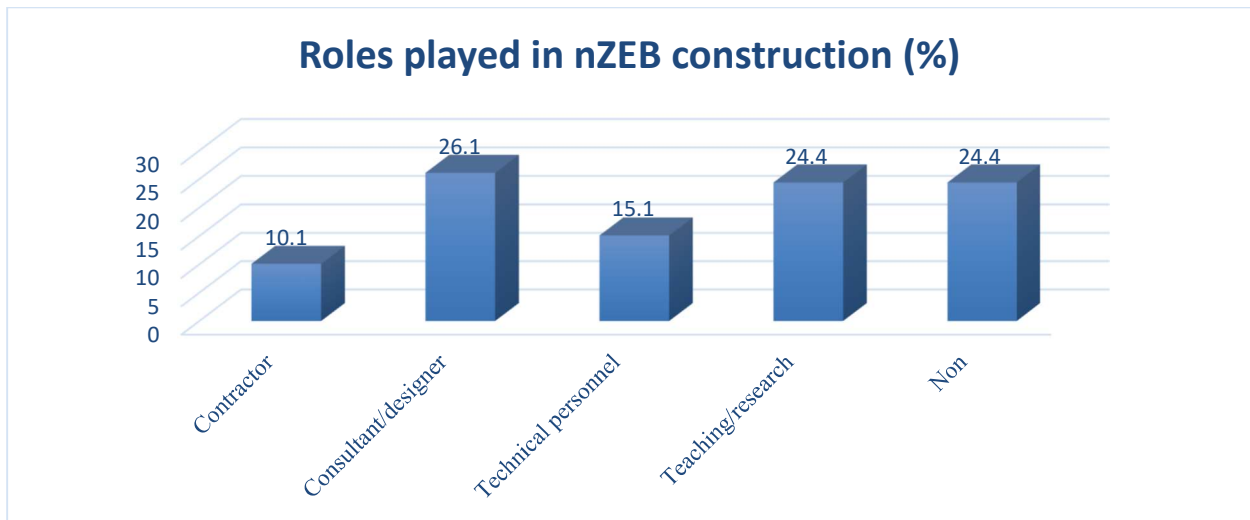


Figure 3. Roles played in nZEB construction

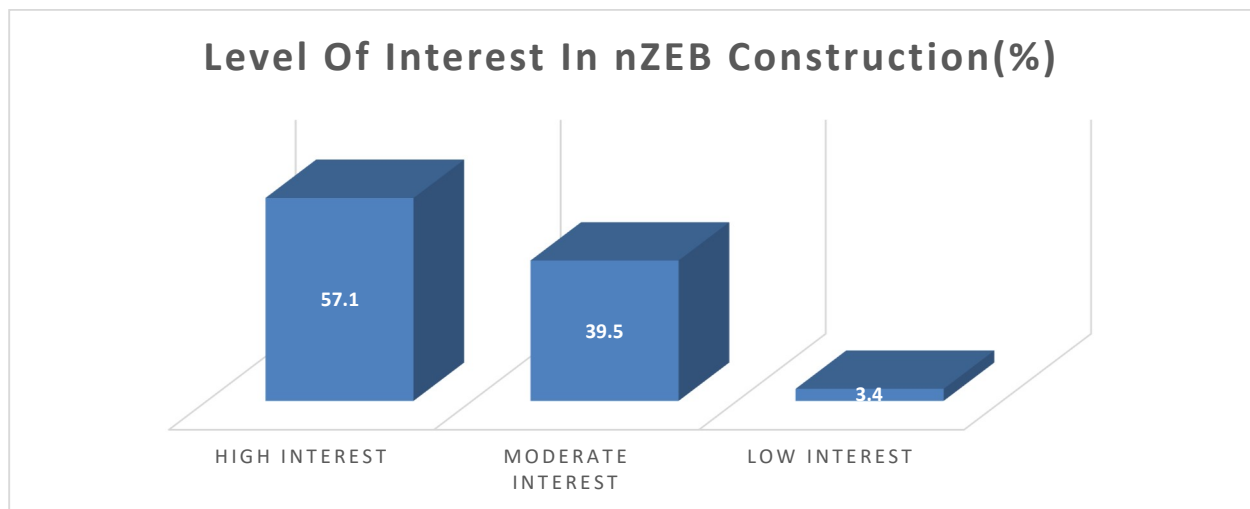


Figure 4. Level of interest in nZEB construction

4.2.5. Perceived Benefits Derived from a Net Zero Energy Practices

The study wanted to realise the most beneficial factors influencing the actualisation of nZEB initiatives as revealed in Table 2. 91.6% of respondents who have been involved in nZEB practices were expected to appraise the classified factors in the sequence of their level of benefits derived from actualising nZEB by acting on a 5-point Likert scale varying from 1 – 5 (1 = “not beneficial”, 2 = “slightly beneficial”, 3 = “moderately beneficial”, 4 = “beneficial”, 5 = “highly beneficial”). The findings disclose that, out of 11 of the very found benefits examined, reduced land use effect dominates the list of the identified benefits of the nZEB practices with a mean score of 1.94. This was trailed by reduced vulnerability to terrorism to power infrastructure with mean score of 1.85, economic competitiveness with a mean score of 1.71, economic social and political development with a mean score of 1.66, environmental quality with a mean score of 1.62, and improvement in power quality with a mean score of 1.61. The findings also show beneficial factors that are identified to have lesser advantages. These are energy security with a mean score of 1.56, increased renewable energy practices with a mean score of 1.45, reduced carbon and emission and promotes energy efficiency in buildings with equivalent mean score of 1.42 each and reduced energy use with mean score of 1.45.

Table 2. Benefits derived from zero energy building practices in construction projects

Benefits	Std. deviation	Mean	Rank
Reduced land use effect	0.663	1.94	1
Reduced vulnerability to terrorism to power infrastructure	0.732	1.85	2
Economic competitiveness	0.548	1.71	2
Economic social and political development	0.563	1.66	4
Environmental quality	0.649	1.62	5
Improvement in power quality	0.514	1.61	6
Energy security	0.621	1.56	7
Increased renewable energy practices	0.544	1.45	8
Reduced carbon emission	0.539	1.42	9
Promotes energy efficiency in buildings	0.539	1.42	9
Reduced energy use	0.538	1.41	11

4.2.6. Perceived Challenges Confronting the Implementation of Net Zero Energy Practices

The study took to recognise the utmost challenging factors confronting the achievement of nZEB initiatives as shown in Table 3. 91.6% of respondents who also have been involved in nZEB practices were expected to appraise the known factors in the sequence of the level of challenges confronting nZEB practices by acting on a 5-point Likert scale varying from 1 – 5 (1 = “not challenging”, 2 = “slightly challenging”, 3 = “moderately challenging”, 4 = “challenging”, 5 = “highly challenging”). The results disclose that, out of 12 of the very found challenges examined, low return on investment top the list of the identified challenges of the nZEB practices with a mean score of 2.08. This was trailed by conflict with public policy regulation and policy clarity with a mean score of 1.94, lack of evaluation and valuation processes with a mean score of 1.93, Lack of unique incentives and tax credit with a mean score of 1.89, tendency to maintain current practices with a mean score of 1.84, initial high cost of materials and installations with a mean score of 1.83, aversion to change with a mean score of 1.82. These results are in line with Pan and Ning (2015) views on impeding factors responsible for nZEB implementation in many climes. The findings also show challenging factors that are perceived to have lesser confrontations. Dearth of research and development with a mean score of 1.75, lack of knowledge and understanding of design professionals with a mean score of 1.71, inadequate trained personnel and professionals with a mean score of 1.64, lack of awareness from client townner developer with a mean score of 1.62, lack of laws polices codes and implementation challenges with a mean score of 1.44.

Table 3. Challenges Confronting Net Zero Energy Building Practices in Construction Projects

Challenges	Std. deviation	Mean	Rank
Low return on investment	0.842	2.08	1
Conflict with public policy regulation and policy clarity	0.649	1.94	2
Lack of evaluation and valuation processes	0.766	1.93	3
Lack of unique incentives and tax credit	0.760	1.89	4
Tendency to maintain current practices	0.829	1.84	5
Initial high cost of materials and installations	0.727	1.83	6
Aversion to change	0.555	1.82	7
Dearth of research and development	0.549	1.75	8
Lack of knowledge and understanding of design professionals	0.726	1.71	9
Inadequate trained personnel and professionals	0.695	1.64	10
Lack of awareness from client townner developer	0.594	1.62	11
Lack of laws polices codes and implementation challenges	0.563	1.44	12

5. Conclusions

The present study investigated the awareness, benefits and challenges confronting the implementation of nZEB practices in construction projects in Lagos, Nigeria. A cross sectional survey research design was utilised in eliciting information from built environment professionals who have gained ample knowledge on energy usage in construction projects. Based on the findings, the resulting conclusions can be drawn:

- i. About 65% of selected construction professionals practicing in Lagos learned nZEB practices through personal research, higher education and articles outlets. It was also indicated that they have only been involved in the practice within the last 6years with 26% and 25% participating as consultants and teaching/research facilitators respectively.
- ii. Reduction in land use effect, reduction in vulnerability to terrorism to power infrastructure, economic competitiveness, economic, social and political development, environmental quality,

and improvement in power quality were perceived as the most beneficial factors contributing to the applicability of nZEB initiatives in Nigeria.

- iii. The most perceived challenges of the nZEB practices are low return on investment, conflict with public policy regulation and policy clarity, lack of evaluation and valuation processes, lack of unique incentives and tax credit.

The effect of the current study on construction professionals in Nigeria is to be engaged in international best practices of energy design and practices in buildings and drive the nZEB concepts to both private and public clients for could be economically and ecologically beneficial. The results of the study present compelling prove that each of the gains from literature is significant in pursuing nZEB while the challenges when addressed will be relevant in actualizing nZEB concepts in Nigerian construction space.

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