EVALUATION OF BUILDING REGULATIONS IN NIGERIA AS REGARDS ENERGY EFFICIENCY

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Abstract
Sustainable development has become very important in the world we live in today, prompting building and construction designs to be energy efficient, particularly, in the face of anthropogenic climate change. This study evaluates the regulations in Nigeria governing building energy efficiency compared to international standards, specifically the regulations found in the United Kingdom. Furthermore, this paper employed and analysed data obtained from different and relevant construction professionals to investigate the extent to which professional building firms in Abuja, Nigeria implements the different energy efficiency design strategies at their disposal. A mixed method (quantitative and qualitative) analysis approach was employed with a structured questionnaire used to gather and analyse data from 120 professionals in various architectural and engineering firms in Abuja, Nigeria. The results indicated that both the awareness and implementation levels of energy efficiency design strategies by the firms were encouraging. However, there is a need for a structured framework governing energy efficiency, especially in the high cost and luxury market. Moreover, the study result, indicated that the energy efficiency strategies that the firms were most familiar with were site planning, natural ventilation and building orientation.

Keywords: Energy Efficiency, Building Regulations, Sustainable Development, Building Energy Use, Smart Buildings

Introduction
In today's world, governments and institutions are facing growing pressures to improve on energy consumption. This stems from the obvious correlation between energy efficiency through energy resource reductions and the decrease of carbon emissions (Ganda & Ngwakew, 2014). Recent studies around the world have shown that the building sector accounts for a significant amount of the energy consumed compared to other sectors (Ochedi & Taki, 2022). Consequently, there is a significant negative impact on the environment and people's wellbeing as a result of the energy consumption of buildings. Studies in developed countries have shown the building sector accounting for up to 40% of energy consumption. Therefore, the efficient usage of energy in building must be regarded as a crucial undertaking, and the importance of energy efficiency in buildings cannot be over emphasised (Killian & Kozek, 2016). A crucial element of any economy which also has an enormous impact on the environment is the building industry. Thus, developing energy efficient structures is now vital in today's world. Subsequently building construction and designs are expected to be sustainable and smart, showcasing lower environmental impacts and sustainability.

Most agree that the concept of sustainability is aimed at satisfying the environmental, social and economic goals of the society (Labuschagne & Brent, 2005). Sustainability can be defined as "development that meets the needs of the present without compromising on the ability of future generations to meet their own needs". Energy efficiency is regarded as one of the cornerstones of sustainable development, although there is significant potential for improvement particularly as the buildings sector has a major contribution to energy consumption. This is clearly highlighted in Europe where the building sector accounts for about 40% of the total energy consumption (Ionescu et al., 2015). There is a unique opportunity for

the professionals in the building sector to embed and implement sustainability in construction works. This implementation of sustainability objectives throughout the lifecycle of a project will serve to reduce the negative environmental impacts of the building sector.

In 2016, with the financial assistance of the European Union, The Federal Ministry of Power, Works and Housing released "Building Energy Efficiency Guideline for Nigeria" (Arup, 2016). This provides a framework for establishing and ensuring energy efficiency in the housing sector especially in low-cost housing. Unfortunately, there is a glaring omission of higher cost housing and addressing this is vital, particularly in a city like Abuja, where there are a lot of developers who deliver high-cost housing in various estates. This research has addressed that knowledge gap and ascertained the current state of affairs regarding energy efficiency in the Abuja building sector with an emphasis on estate developers. There was a comparison between the well pronounced regulations existing in the United Kingdom and those in Nigeria with a view to assessing improvements that can be achieved in the Nigerian building sector.

The Nigerian building industry is rife with many problems. Nigeria is facing rapid population growth, migration from low energy consuming rural dwellings to urban centres, and improvements in living standards. These facts highlight the inevitable increase that will be seen in electricity consumption of which the building sector accounts for the majority. On the other hand, there is a chronic shortage of electrical generation and transmission capacity. Therefore, energy efficiency measures represent the cheapest and most reliable method of improving energy supply in Nigeria both currently and in the future (Arup, 2016). Even with all the issues surrounding the building sector in Nigeria, it is glaringly obvious that there is little regard for the environment throughout the lifecycle of buildings.

Furthermore, the rapid increase in population and global warming, it can be regarded as very reckless that no major steps have been taken in Nigeria to address environmental impacts from building and construction works. This is especially so when major cities in Nigeria such as Abuja, Lagos, Kano and Port Harcourt are all faced with the growth of the residential housing sector due to an increase in urbanisation and population. Despite all of these there is very little practice in terms of sustainable measures and it is quite alarming (Osuizugbo et al., 2020). Furthermore, there is a need for in depth studies in order to ascertain the barriers to the adoption of sustainable construction.

The next section of this paper re-examines works on building regulations in Abuja, Nigeria, building energy usage, energy management schemes and regulations, building control laws and how local authorities are enforcing laws for building control within their jurisdiction.

Literature Review

Building Regulations

Studies regarding building regulations have been carried by several authors across the globe. Building regulations are legal tools used to ensure socially acceptable efficiency in construction and in the health and safety of the surroundings of its users (Emodi & Yusuf, 2015). Building regulations are the forms of laws provided by government to public officials in the construction sector (Ezema, 2015). Ezema et al., (2016) postulate that building users' safety and health are ensured due to building regulations which set legal criteria and specifications for building design and construction. The objectives of construction regulations are to ensure compliance.

Building regulations need to be sensitive to dynamic, technical and market conditions while regulating building erection and usage (Olayemi, 2012).

The British Building Regulations, for example, are mandatory quality requirements and are mainly designed to protect general interests, including 'the well-being, protection, and convenience of people inside and around buildings (Mu'azu, 2011). Building regulations set minimum standards for ensuring compliance during the construction process in order to achieve affordability, sustainability, accessibility and resource efficiency. Furthermore, the customer will be protected from individual and corporate violations as a result of the due process embedded in such regulations (Naibbi & Healey, 2013). The implementation of the practice of building control and regulations is an innovative solution that will help to enhance the expertise of the designers' as well as the constructors' teams and allow the construction sector to produce construction works that are construction-friendly and failure-free and thus achieve environmental and climate growth goals.

Policy, legislation and regulations on energy use in buildings

Recently there has been massive gain in interest to reduce energy consumption in buildings. This might stem from the global agreement to curb greenhouse gas emissions as well as recent studies that show the effect of construction on global energy use (De Decker, 2013). Therefore, there is a growing trend with emerging energy policies which have now been expanded to include buildings, so that a sort of cohesive strategy can be met in Green House Gasses mitigation strategies (Omenihu, et al., 2016). Additionally, countries such as Sweden and Germany have been involved in building energy laws since the 1970s when the oil crisis was experienced and the subsequent environmental agenda (Nasirov et al., 2015). However according to Adunola (2014), it is a mischaracterization to apply the term "energy policy/law" at any time before the mid-1970s. He argued that crises in oil supply following the 1973 Arab embargo and the revolution by the Iranians in 1979 upshot into a stream of rules, creating revolutionary models for today's energy policies. In addition, the overarching change in the emerging forms of energy can be said to define progressions in energy policy (Ezema et al., 2016).

In the 1970s there was a pattern of change in international procedures aimed at energy stability and sustainability which was triggered by the oil crisis as well as issues of urban air pollution and an additional purchase and usage of cars (Akinnuoye, 2013). In recent times, the area of energy policy dominates the debate on changing climate conditions, clean fuels and the low carbon future (Adeponle, 2013; Alvi, 2016). Under these conditions the clean energy policy of the UK government has been built under response to climate change and environmental concerns. It is noteworthy that the problems of climate change, sustainability and the depletion of resources are key drivers of energy policy in the present time.

Recently sustainability and energy efficiency are commonplace in international climate regulations as environmental protection and clean energy concerns drive policy. On the other hand, many of the mechanisms used to promote a reduction in buildings' energy consumption are voluntary. The United States' energy star system is one of the ground-breaking programs to investigate energy-saving efficiency, demonstrating savings of up to 30% on office equipment (Ezema et al., 2016). There is also the ranking scheme for Leadership in Energy and Environmental Design (LEED), a United states program that assesses sustainability for buildings in the country. While it remains a freewill scheme, its rapid development and broad

use continues to place it as a regional standard for evaluating buildings' sustainability credentials. Many countries have emulated these campaigns, some evidence is the creation of National Green Building Councils. Which encompass, among others, Canada in the early 2000's, New Zealand and the United Arab Emirates in the late 2000's, Germany and the United Kingdom also in 2007, the Netherlands in 2008 and Russia in 2009 (De Decker 2013). It is worth reiterating that back in 2016 The Federal Ministry of Power, Works and Housing released "Building Energy Efficiency Guideline for Nigeria" and subsequently the first edition of "Federal Republic of Nigeria National Building Energy Efficiency Code (Arup, 2016). The most recent energy policies demonstrate continuity with the need to reduce GHG emissions by reducing energy consumption. For example, the "zero carbon home" strategy adopted by the UK in 2008 aimed to reduce the carbon emissions of buildings to zero by 2016, which they have largely achieved. Gyoh & Hugo, (2013) reported that maybe the UK has the most aggressive strategy in Europe to minimize energy usage and carbon emissions.

On their part, Peres, et al., (2016) maintained that mechanisms and policies such as Buildings Energy Performance Directive-EPBD, an EU decree that was enforced in 2002 and was designed to reinforce energy and carbon abatement must be in place in order to further reduce energy consumption. It aims at increasing awareness about energy usage and encouraging investments in building energy efficiency steps. The Directive requires all EU States to implement the law while they all continue to establish its own initiatives and the methodological framework for energy conservation, depending on local needs. It suggests a change from cooperative programs to enforceable regulations/policies. Another significant element of the law is the debate on energy building certificates.

From a wider viewpoint, most of the policy priorities to improve energy saving capacity were supporting a controlled demand approach or in different wordings a "demand-side management strategy" (Humphreys et al., 2013) in building construction that will apply to both new and existing buildings. But, a comprehensive look at buildings and the construction process shows that buildings will continue to be designed on the basis of existing architecture, construction and then occupation traditions. However, these models have shown various sustainable approaches to design, construction and material selection, while other examples demonstrate how structures can be built or placed in a way that the physical structure itself can contribute to the partial or complete independence of structures (Malgwi & Musa, 2014). Such solutions should be pursued aggressively instead of relying heavily on electricity grid regulations.

It is clear that the adopted regulations and legislation are intended to make a reassessment of the possible negative energy and environmental effects of buildings in the light of the sustainability and relative permanence of the currently developed environment. Therefore, building professionals must constantly consider their energy design and their use of energy and environmental effects (Nasirov et al., 2015). Conversely, in developing countries, especially Africa, there has been small progress in initiatives regarding energy efficiency regulation. This in turn leaves such nations behind in the development of energy efficient and sustainable buildings (Iwaro & Mwasha 2010).

The discussion above shows how energy production, protection and sustainability have had an impact on energy policy as well as divisions among developing and developing countries on energy systems and environmental issues. Obviously, a comprehensive and proactive energy policy is needed for most developing countries, especially sub-Saharan Africa, which must

absolutely consider the effect of construction activities on energy and all related environmental issues. This would be satisfactory considering the political, socio-economic and technological contexts; and the dynamic interaction between sustainability and the global climate.

Energy Efficiency of Buildings

About 30% of the global energy demand and 33% of energy related CO2 emissions are taken by the construction industry. Therefore, to reduce building energy consumption and greenhouse gas emissions, energy efficient buildings have become a necessity (Hassan et al., 2013). Such energy efficient solutions help increase the level of comfort in a building while minimising energy use. Some projections indicate that there is tremendous potential for improving the efficiency of building energy and thereby reducing CO2 emissions (Ofoegbu, & Emengini, 2013).

Olayemi (2012) argues that it is possible to achieve up to 46% reduction in global energy consumption by using state of the art approaches and innovations in the construction industry. It was projected by Olugbenga et al., (2013) that by 2020 efficient building technologies will have achieved a cost-effective reduction in greenhouse gas emissions. However, it can clearly be seen that a lot of effort and work is still required before that target is achieved. Nonetheless energy efficient buildings can still be achieved by using better technological measures, which include high efficiency building insulation, advanced heating technologies etc. (Holte & Kjestveit, 2012).

Several strategies can be implemented for enhancing the energy efficiency of a building. Looking at the LCA, like stated earlier, various techniques can be used from as early as the design stage to make a building more efficient. However, measures and procedures may be different for existing buildings. The complexity of the construction structure and the age of the building itself would then have a role to play. Various studies have shown that a building's energy efficiency can be improved by various measures which include efficient air conditioning and ventilator systems, enhancing the performance of the building envelope system, green technology applications etc. (Obia, 2013; Okedu, et, al., 2015; Ojo-Fajuru & Adebayo, 2018).

The following approaches can be used to enhance a building's energy efficiency:

- Up to 60% of power supplied to buildings is used up by the heating, ventilation and air conditioning (HVAC) system (Obia, 2013). Studies have shown that following the strategy of not providing such ventilation when the residence is empty can greatly enhance energy efficiency (Okedu, et al., 2015).
- Lighting is a vital component of energy use, especially in large office buildings, consuming up to 30% of overall energy use (Oseni, 2012). Energy-efficient lighting systems, such as high-performance fluorescent lamps and compact fluorescent lamps, will increase an illumination system's energy quality (Sangroya & Nayak, 2015). Energy savings of up to 30% can be saved by usage of various sensors which are now available and can be used under different occupant circumstances (Rosenberg, 2014).
- As the environment and location of a building plays a vital role in controlling heat and temperature, measures can be taken to that effect. Shaban & Petinrin (2014) postulate that tight construction design, including energy efficient windows, well-sealed doors and additional thermal insulation for walls, basement slabs and foundations can minimise hear loss of up to 50%. Furthermore, many approaches are now used in the

design and operation process to improve the thermal performance of structures and their energy efficiency. These include low emission glazing, reduced air leakage and thermal insulation for building surfaces (Sangroya & Nayak, 2015; Tasantab, 2016).

In Nigeria, building efficiency guidelines mostly recommend the aforementioned strategies. Therefore, in assessing the regulations in Nigeria, these approaches and how they are implemented would need to be critically analysed (Arup, 2016).

Methodology

The literature review has highlighted how there is scarce research regarding energy efficiency in buildings in Nigeria. Therefore, this research aims to provide data in that regard, especially in the luxury housing market in Abuja where data is sparse. This section discusses the different techniques that have been adopted for this research study, methods of data collection, samples used, various sources of data and methods of analysing these data. Both qualitative and quantitative methods of data collection and analysis were used in order to achieve a credible result. This method is appropriate for the study owing to its effectiveness in survey of most academic studies.

The study area for this research is Nigeria's capital, the FCT. The choice of Federal Capital Territory as the study area is because, since its establishment and relocation of the seat of government therein, it has naturally enjoyed the benefits of being the pivot of the country where many infrastructures are built. As the infrastructure mentioned are all construction oriented, this enabled the researcher to critically analyse the trends regarding energy efficiency in the Abuja construction sector. Furthermore, there are a lot of construction companies and estate developers in Abuja and this in turn provided adequate data to answer the research questions of which there is currently lack of data. The population of the study consisted of staff of prominent real estate developers in Abuja who have first-hand information on their own behaviours regarding energy efficiency on their projects. Therefore, the targeted population for this study was the one from which the study eventually wants to generalize the outcome. Based on this submission, the population of the study was 120 employees of Construction companies and Estate Developers. The chosen population comprised of Civil Engineers, Architects, Surveyors, and Project Managers.

This study adopted the multistage random sampling to make clusters and sub clusters to reach the desired sample size, using the sample unit based on some crucial criteria. For the purpose of this study, the population was divided into two categories; customers and management employees. The population involved was not bulk and thus, the sample size remains the same as the population of the study. A well-designed questionnaire was used for the collection of the primary data which the researcher used for collection of the needed information from the respondents. In administering the research instrument, copies of the questionnaire were administered to the staff of the selected companies. The basis of distribution of the questionnaire was based on the sample size. From the literature, research questions were derived in order to address the gap found therein and consequently a questionnaire was formulated to address these research questions. Interview sessions were also utilised to collect first-hand information from some of the respondents. The secondary data were obtained from books, journals, previous researchers, etc.

The specific objectives and research questions of the study were the centre of focus in analysing the data that was collected from the field survey. To capture the qualitative and quantitative responses as expected from the respondents, the questionnaire items will be extended evenly. Conversely, the data presented were also analysed using simple percentages. Pertinently, the use of simple percentage is to evaluate the rate or percentage of the response related to the questions asked. Chi-Square was employed to test the stated of hypotheses.

Validity and Reliability of Research Instrument

In validating the instrument for data collection, the researcher was concerned with establishing the content validity to ensure that it measures what is expected to be measured. The ability of a research instrument to produce same outcome constantly over some time when employed to the same data is known or referred to as reliability (Golafshani, 2003). Reliability means consistency and it is the uniformity of the test in evaluating whatever it is meant to evaluate. A test-retest reliability of the research instrument was carried out. Approximately, 91% of the research items had reasonable or best degree of reliability (uniformity overtime). Using the Cronbach's Alpha test, Scale reliability was calculated and the result was about 0.72**.** Cronbach's Alpha is regarded largely as appropriate tool for statistical test when it comes to reliability, taking into cognizance the responses used to design the scales.

Results and Discussion

This section shows the results of data that was generated from the administered questionnaire. A total of one hundred and twenty (120) questionnaires were distributed of which 82 respondents were used for this study.

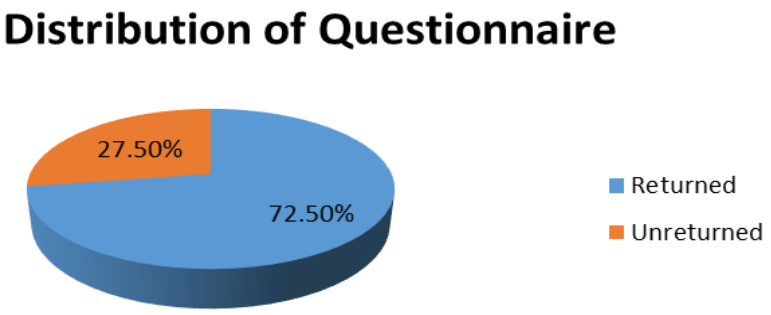
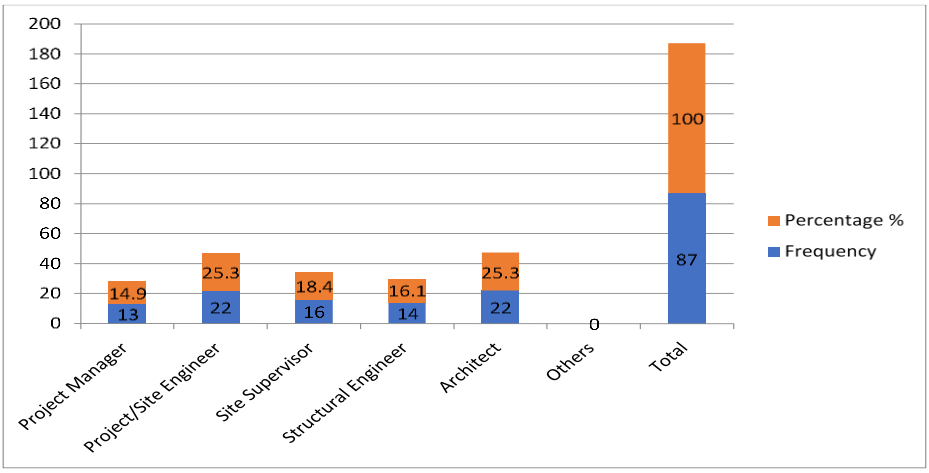


Figure 1: Chart for Questionnaire Distribution

Above is the chart showing distributed, returned and unreturned questionnaire out of the one hundred and twenty (120) questionnaire that were distributed to respondents as broken down below. The high response rate of 72% was deemed sufficient enough to make reliable conclusions. Most of the responses were from young professionals in the construction industry and there was a good spread between genders. This was very encouraging as a study suggested that younger workers were more innovative in the construction work place (Holte & Kjestveit, 2012).

The highest majority of responders were Site Engineers and architects. This is noteworthy as those were professionals who were in critical positions to make decisions regarding sustainability. Furthermore, studies have shown that site engineers even early in their work life possessed enough information to make decisions from a sustainability perspective (Hanning et al., 2012).



SOURCE: *(Author, 2020)*

Figure 2: Distribution of Respondents according to position

The researchers conducted a survey with the aim of ascertaining the current trends in Abuja regarding sustainability in the construction sector. This section gives a quantitative breakdown of the responses that were given to that effect.

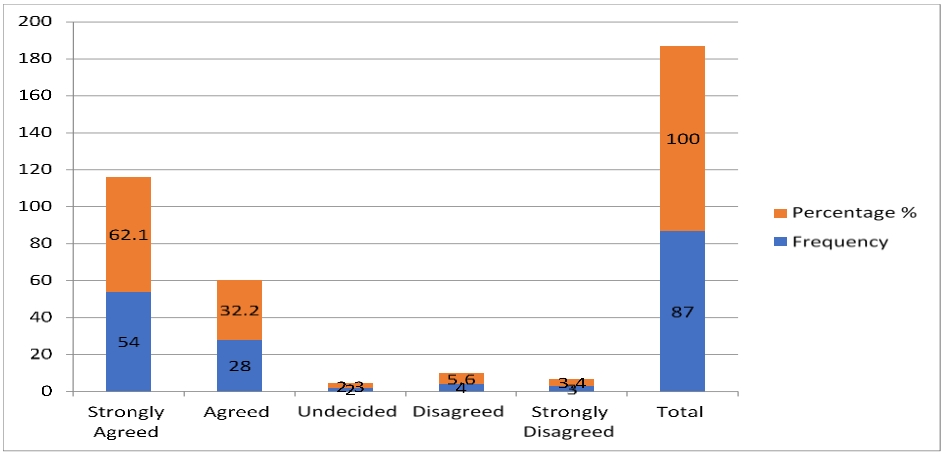


Figure 3: Distribution of knowledge about the building regulations in Nigeria concerning sustainability and energy efficiency.

Most of the professionals surveyed were highly positive that they had knowledge about the building regulations in Nigeria regarding sustainability and energy efficiency. However, there is a huge possibility that these respondents misconstrue these regulations for basic building regulations provided by the Federal Capital Development Authority (FCDA) which majorly tend to address issue of structural integrity, aesthetics and use of land. This is in stark contrast from the United Kingdom, where there is very strict policy implementation as a result of the commitment by the government to reach net zero emissions by 2050 (Mohamed & O'reilly, 2009).

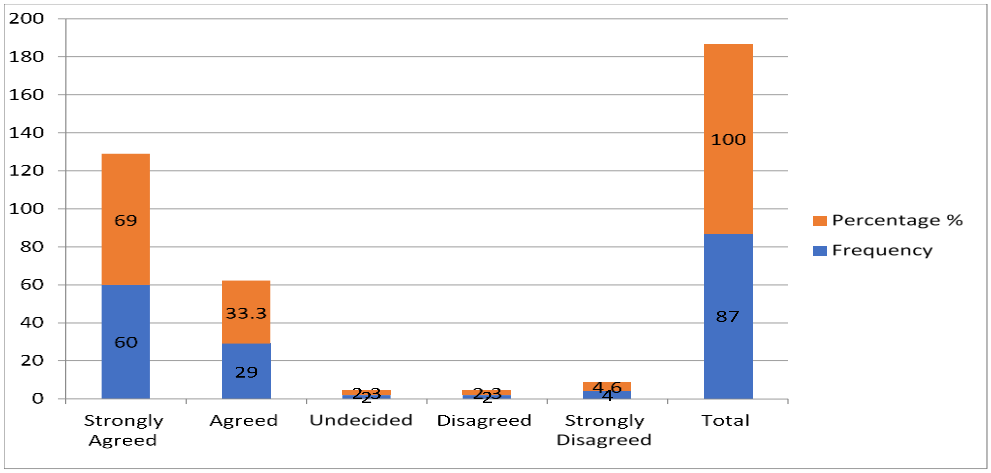


Figure 4: Distribution of usage of smart technology in buildings.

Most of the respondents confirmed that they used smart technology such as smart sensors for air conditioners, cookers, heaters and energy consuming appliances. Although this was highly encouraging, it is noteworthy that the companies surveyed were established fairly recently and staffed with younger professionals who usually tend to be geared more towards innovative solutions. In the United Kingdom, smart home technology is looking to become the new normal. Although commercial desire for technical innovation rather than explicit user needs is often the motivator behind these smart home products, their impacts can clearly be seen and they are indeed efficient (Victoria et al., 2007).

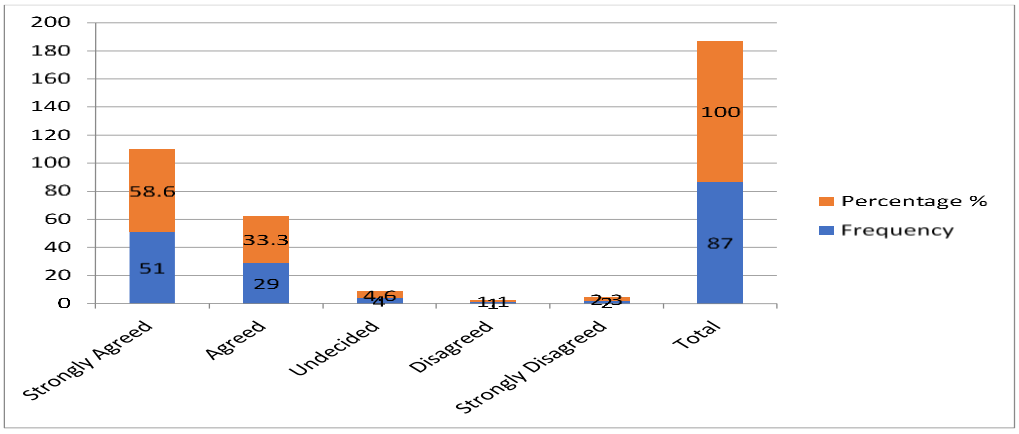


Figure 5: Distribution of incorporation of energy efficiency and sustainability in designs

Continuing with the trend of the survey most of the respondents were positive that they ensured elements of energy efficiency and sustainability right from design. Even though there are little regulations guiding them, the companies surveyed were incorporating sustainability in their designs. Moreover, even the UK which has established building regulations still experiences some challenges and shortcomings when it comes to sustainability in design. According to Carter & Fortune (2007), there is still a gap between policy and practice in the UK. A study was conducted with a randomized sample of 338 registered landlords where it was found that only a minority have developed sustainable development policy and economic, environmental and societal aspects of sustainability were not given as much attention.

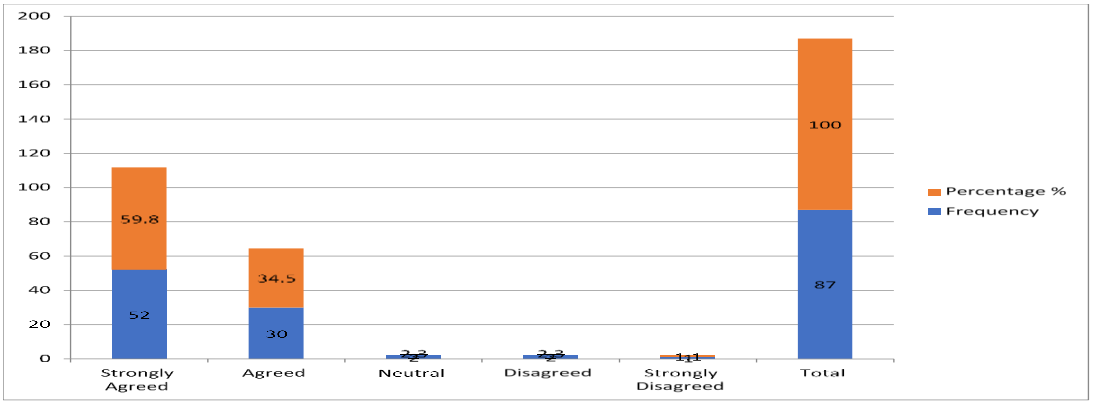


Figure 6: Distribution of good recycling policies in place during and after construction.

Regarding recycling policy in place during and after construction, the responses were mostly positive. From this data, it is evident that the companies these respondents work for employ efficient waste disposal techniques.

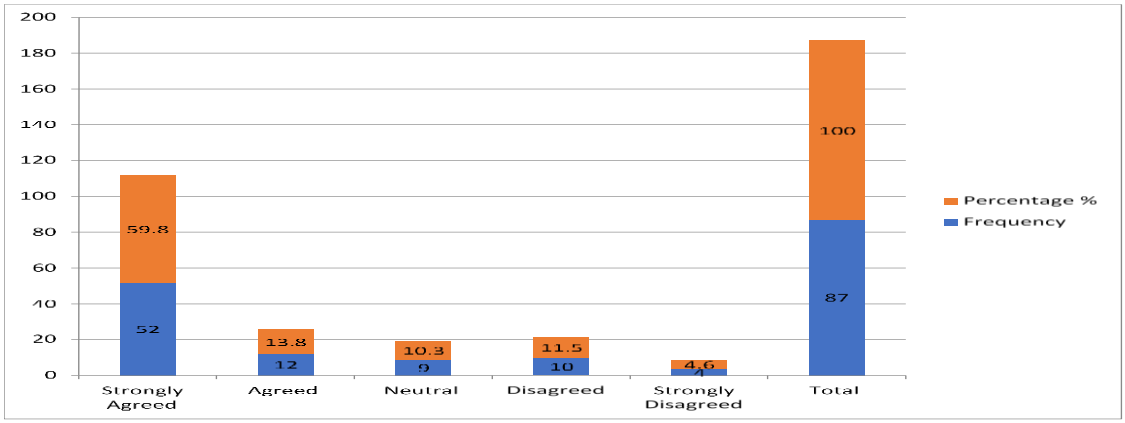


Figure 7: Distribution of efficient waste disposal techniques

Most of the professionals surveyed confirmed that they used efficient waste disposal techniques. However, the responses here were not as positive as they were for other indicators. Initiatives, such as the cash4trash initiative in the FCT, have been playing a tremendous role in helping construction workers get rid of recyclable materials. A lot more are coming up as the battle against unregulated waste disposal continues to take shape.

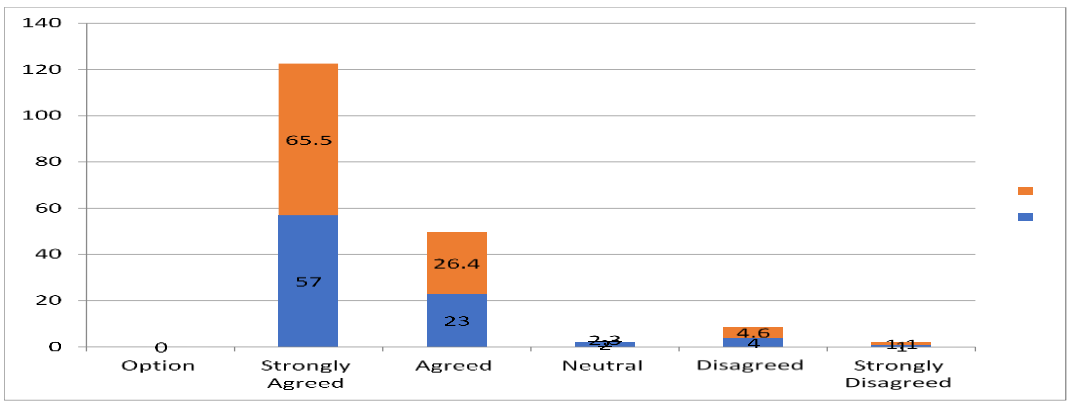


Figure 8: Distribution of regulators in charge of compliance to sustainability laws often visiting sites.

Most of the respondents indicated that regulators in charge of compliance to sustainability laws visit their sites often. However, as we have very little regulators in charge of compliance to sustainability, the respondents must have misunderstood the actual work of these regulators that do visit them so often. Looking at London, building supervision and evaluation visits takes up a significant amount of time of construction regulators.

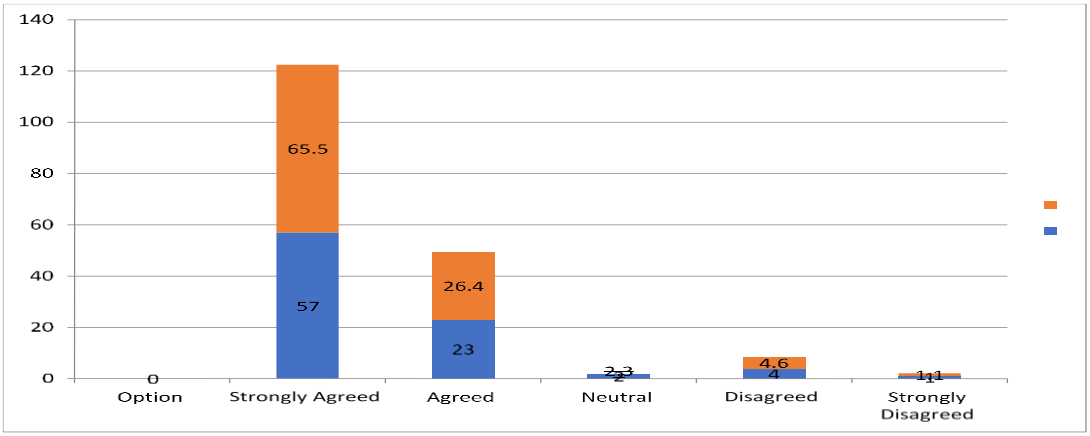


Figure 9: Distribution of ethically sourced materials

Majority of the respondents indicated that they ethically source materials and they even have proof. Given the global construction market is worth approximately 3.2 trillion USD, there is great potential for positive action to be taken in the bid to ensure resources are enjoyed responsibly while considering social, political and environmental conditions around the globe (Stephen, 2006).

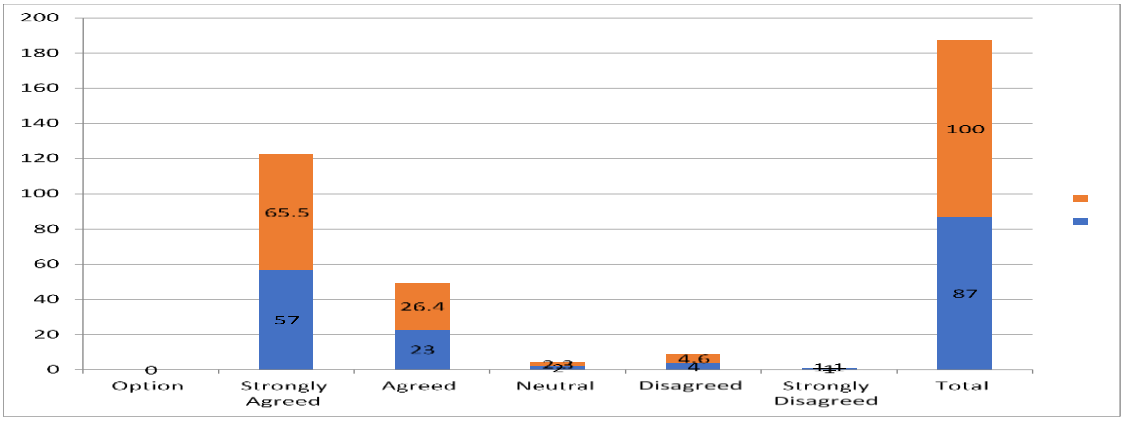


Figure 10: Distribution of clients concerned with energy efficiency

The result of the survey indicated that majority of clients are concerned with energy efficiency. This is highly encouraging as it will ensure developers take sustainability into account knowing there is a market for it. Comparing this consumer behaviour to that in the UK studies found that home and office owners were keen on their contractors using sustainable techniques such as reusing and redevelopment of existing facilities and also found that they keep close tabs on building constructors with frequent visits (Peter, 2007).

Building regulations are intended to regulate building construction and operation while setting rules that are sensitive to changing technical and market conditions (Olayemi, 2012). Therefore, building regulations aim to achieve affordability, sustainability, accessibility and

resource efficiency by setting minimum standards during the design and construction process. However, in Nigeria, there is a clear need for more regulations regarding energy efficiency especially in the luxury market.

Although this study has shown that construction professionals embed sustainability in their design and construction process, there is however little to no regulation and enforcement driving sustainability practices.

Conclusion

As demonstrated by this work, professionals involved in the building process have a unique opportunity to reduce environmental impact by implementing sustainability goals throughout the lifecycle of a construction project. However current sustainability schemes, strategies and processes are more pronounced and properly implemented in more advanced countries. In order to ascertain the current trends regarding sustainability and energy efficiency in the Abuja construction sector, a survey was conducted. The data gathered in the study suggests that although construction professionals are trying to embed sustainability in their projects, there is still a lack of awareness of regulations governing energy efficiency. This is due to the fact that those regulations are mostly tailored to mass and lower cost housings.

The following recommendations were suggested based on the findings of the study;

i. Building regulations regarding sustainability and energy efficiency should be implemented especially in higher cost housings where such regulations are practically non-existent.
ii. There should be a clear effort to incorporate emerging technologies in construction process as these are clearly shown to enhance energy efficiency
iii. Finally, a wider study would need to be conducted in order properly ascertain the trends regarding sustainability in construction industry. This study focused on higher cost housings in Abuja and although this accounts for thousands of houses, there is a need for further studies looking at mass housings. Furthermore, looking at other states and locations within the country will paint a clearer picture of the attitude we have as a nation towards sustainability.

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