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Assessment of the Benefits of Sustainable Residential Buildings in Lagos State, Nigeria

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Abstract
The harmful effect of buildings on the environment has triggered a need for sustainable buildings. While some of the benefits of sustainable buildings are well known and can easily be identified, there are other benefits, which are still vague or unknown. This study aims to identify the benefits of sustainable residential buildings in Lagos State, Nigeria. Based on a structured questionnaire and literature survey, broad data for the study were gathered, and 20 benefits of sustainable residential buildings were identified, categorized into 4 groups, evaluated, and ranked according to the participants' perceptions. A population of practicing professionals was gathered from a list of registered Architects, Quantity Surveyors, and Builders. A purposive sampling technique was used; 73 questionnaires were collected from the respondents. The respondents include 25 Architects, 27 Quantity Surveyors, and 21 Builders. Using the measure of relative importance index formula, the results showed that all the respondents agreed that all the listed factors were possible benefits of sustainable residential buildings. However, the major benefits of sustainable residential buildings were to conserve natural resources, enhance and protect ecosystems and biodiversity, improve water and air quality, and enhance occupant comfort and health. This study recommends that the government leads in the campaign to promote and raise awareness of the benefits of sustainable buildings.

Keywords: Construction Industry, Benefits, Lagos State, Sustainability, Sustainable Building

Introduction
In simple terms, sustainability means the processes and actions taken to avoid the depletion of natural resources (which is influenced by the way societies are organized) to maintain ecological balance (Youmatter, 2019). Achieving sustainability has become a critical issue in every industry. However, the construction industry has been criticized for its unsustainable developmental model (Dobson, Sourani, Sertyesilisik & Tunstall, 2013). Construction activities consume about 15% of global freshwater, 40% of global energy, and produce 30% of global greenhouse emissions (Reddy, 2016). In the UK, buildings are responsible for nearly half of the country's carbon dioxide emissions, and half of the nation's water consumption and account for around one-third of waste sent to landfills (Vadera, Woolas, Flint, Pearson, Hodge, Jordan & Davies, 2008). In the European Union, buildings are responsible for consuming about 40% of energy and 36% of CO_2 emissions, making them the highest consumer of energy in Europe (European Commission, 2016). Sustainable building focuses on the construction of structures that have minimal impact on the environment and optimizes the use of materials, water, energy, and other resources, which also prevents the negative effect of building on the health and well-being of occupants (Waniko, 2012).

Sustainable buildings have numerous benefits in terms of economic benefits. It has the potential to reduce the amount of money spent on lighting and water supply in buildings (Jacomit, Da Silver & Granja, 2015). The lighting can be generated by the energy from the sun that had been stored and

the water supplies can come from rainwater harvesting (Shabrin & Kashem, 2017). Besides these, considering the relationship between work environment and productivity, sustainable buildings can boost a company's profits (Shabrin & Kashem, 2017). The inclusion of better air quality makes sustainable buildings contribute to improved comfort and productivity (Jacomit *et al*, 2015). In terms of cost, sustainable buildings provide financial benefits that conventional buildings do not. These benefits include; reduced waste by the utilization of fewer materials through efficient design and elimination of unnecessary materials, and lower operation and maintenance costs through sustainable design, which aims at increased durability and ease of maintenance (Reddy, 2008). In addition, the cost of poor indoor environmental and air quality including allergies and asthma, higher absenteeism, increased respiratory ailments etc. can be reduced in sustainable buildings (Kats, 2003).

In Nigeria, green concepts, sustainability, and environmental issues are hardly put into consideration when designing a new building or renovating an old one (Otegbulu, 2011). These result in a shortfall in user satisfaction, functional space planning, and service type (Otegbulu, 2011). Despite the glaring benefit of sustainable buildings and the problems associated with traditional buildings, traditional buildings are still popular and often preferred in Nigeria. Moreover, little or no effort is being made to champion sustainable building construction and development in the Nigerian construction industry (Dalibi, Feng, Shuangqin, Sadiq, Bello & Danja, 2017). To this effect, this study aims to identify the benefits of sustainable residential buildings through a literature review and questionnaire survey. It is hoped that this study will help identify the benefits considered most important by various professionals, aid in the understanding of the benefits of sustainable buildings, and therefore, encourage stakeholders to adopt sustainable building concepts.

Literature Review

Sustainable building has to do with ways of designing, constructing, and maintaining a building in a way that reduces cost, energy, and water consumption as well as improves the efficiency and longevity of the building systems and also reduces the negative effect of the building on the environment and public health (Singh, 2018). However, the concept of sustainable building goes beyond these (Turcotte, Villareal & Bermingham, 2006). Many cities around the world have saved money and gained other important benefits by adopting sustainable building programs (Turcotte *et al*, 2006). Building development Stakeholders in Lagos State Nigeria can also benefit by adopting and demanding sustainable building design and construction.

The benefits of Sustainable Buildings can be defined as the overlap of the environment, economy, and society (Widok, 2009). These benefits can be grouped into three categories (World Green Building Council, 2020):

- **Environmental benefits**
- **Economic benefits and**
- **Social benefits**

Environmental benefits

According to Odeyinka (2019), although a sustainable building should bring benefits in all three areas of economic, social, and environmental aspects, the potential environmental benefits are more difficult to identify. There has long been recognized, as a natural conflict between economic and environmental factors (Odeyinka, 2019). By generating its energy, sustainable buildings contribute positively to the environment. They reduce or eliminate negative impacts on the environment by the consumption of less energy, water, and other natural resource (World Green Building Council, 2019). Protecting the environment is the primary benefit of sustainability in the construction industry (Neyestani, 2017).
Environmental friendliness was pointed out by Zuo & Zhao (2014), as an important benefit of sustainable buildings. Unlike conventional buildings, sustainable

buildings are accountable for a major improvement in comfortability and vitality, reduction in carbon dioxide emission, and water usage. Zuo and Zhao (2014), opined that a high volume of carbon dioxide released may perhaps be decreased (Resulting from vitality sparing) if Leadership in Energy and Environmental Design (LEED) assessment are realized in totally new advanced segments.

Waste Reduction

Decreasing waste is one of the biggest environmental problems we face today (Qureshi, 2018). Sustainable builders deliberately design and construct with a focus on minimizing waste and optimizing efficiency (Qureshi, 2018). They create their designs to use the minimum amount of materials possible to remove potential waste (Qureshi, 2018).

Inward environment quality

A one-of-a-kind genuine portion of human payback connected with green building is the internal natural quality (Ojo-Fafore, Aigbavboa & Remaru, 2018). The inward environment quality, together with unreliable carbon-based composite releases additional waste, which is more stressful in structures (Yu and Kim, 2010).

Economic Benefits

There are several economic and financial benefits offered by sustainable buildings which are relevant to a range of different people or groups of people. These include cost savings on utility bills for tenants or households (through energy and water efficiency); lower construction costs and higher property value for building developers, increased occupancy rates or operating costs for building owners, and job creation (World Green Building Council, 2020). According to the Institute for Local Government (2013), some of the economic benefits of green buildings consist of improvements in the economic growth, competitiveness, and vitality of a community. It also states that sustainability best practices are associated with green buildings and generate savings for residents and businesses through reduced expenditures on water, energy, gas, and other resources. According to the institute, these savings go in cycles by making funds available to support additional local investments and economic activity (Institute for Local Government, 2013). These investments can increase local economic activity and employment by saving time and money for employees and employers alike. The economic benefits include lower healthcare costs for businesses, employees, and public agencies, more productive employees, and students better prepared to learn (Institute for Local Government, 2013). Rughooputh, Cheeneebash & Mungroo (2014) further opined that the economic benefits of green buildings include reduction of operating costs, enhancement of asset value, services, and profits, improvement of occupant productivity and satisfaction, and optimization of life-cycle economic performance. Shabrin & Kashem (2017) identified operation cost, higher building value, and payback for green buildings as some of the economic benefits of green buildings. In terms of Operating Costs, sustainable building is popular and well known because of its cost savings quality. It saves money through reduced energy, and water use, and lower maintenance costs of the building itself.

Higher Building Value

Most Building owners report that new or renovated sustainable buildings command a 7 percent increase in asset value over traditional buildings (World Green Building Council, 2020). Modern sustainable buildings help their owners earn higher rents, higher values, and higher occupancy rates than non-sustainable buildings (Chong, 2010). In Malaysia, buyers are prepared to pay at least 5% more for sustainable buildings, because of their environmental friendliness, quality, comfort, and natural lighting (Shabrin & Kashem, 2017). However, Bertrand finds that the gap between the cost of sustainable buildings and non-sustainable buildings is fairly close (Bertrand, 2010).

Payback Period for Green Buildings

Sustainable buildings are known to cost more at the initial stage than conventional buildings, but the saving is created in green buildings by the reduction in the consumption of energy, water, and health costs, gives a quick return on the investment and makes an effect in revenue (Shabrin & Kashem, 2017). According to The Business Case for Green Building (2015), a definitive cost-benefit analysis of sustainable building based on a review of LEED-certified buildings states that a 2% nominal increase in sustainable building design would save 20% of total construction costs over the life of the building which is more than ten times the initial investment (The Business Case for Green Building, 2015).

Lifecycle Cost Savings

Life Cycle Costing (LCC) is the quantification of the total costs and benefits over the life of a particular product, technology, or system (Kat, 2003). In addition, RS Means (2011) states that the savings realized from green buildings are mainly realized through reduced utilities costs and savings in operations and maintenance. According to the Author, the calculation for this is a simple act of subtracting the projected utilities and maintenance and operations costs savings over the useful life of the building from the total direct costs associated with the building components and subsystems (RS Means, 2011).

Utility Savings

An increase in the cost of energy and water leads to more economic motivation by the owner to reduce utility costs over the lifetime of the building (Nalewaik & Venters, 2008). A reduction in energy use (both gas and electricity) and both internal and external water consumption (including sewerage) may reduce operational costs (Nalewaik & Venters, 2008). Lockwood (2006) found that in the first year of operation, a company's headquarters building used 42 percent less energy and 34 percent less water than standard buildings of comparable size.

Social Benefits

The 'Feel-Good' Factor

Feel good factor is a 'benefit' of sustainable construction, which is of social value. This is a compound function of public image, marketability, resource conservation, and corporate responsibility (Nalewaik & Venters, 2008). In a literature report by Darko, Chuen Chan, Owusu & Antwi-Afari (2018) on the benefits of green building, reduced life cycle costing was found to be the most important benefit of sustainable buildings to the owner.

Employment

According to Construction World (2019), the sustainable energy sector creates job opportunities on the market today and there is a need for people with adequate expertise when it comes to sustainable solutions in the construction industry; some of them include environmental health engineers, solar energy experts, and efficient lighting experts as well (Construction world, 2019).

Tax Incentives

Construction World (2019), added that buildings that have satisfactory green solutions in place, whether residential or commercial, are eligible for government tax rewards in some countries.

Other Benefits

Improvements in Human Performance

Kwong (2010) points out that there is growing evidence that sustainably designed buildings have a positive effect on worker productivity and quality of life. In education facilities, students' retention and learning ability may improve, concerning healthcare facilities, sustainable design may result in faster recovery time for patients (Kat, 2003). Pedini & Ashuri (2010) summarised the benefits of sustainable buildings by categorizing them into the following headings:

Environmental Benefits: Enhance and protect eco-system and biodiversity, improve water and air quality, reduce solid waste, **and** conserve natural resources.

Social (Health and Community Benefits): Improve air, thermal, daylight, and acoustic environments, enhance occupant comfort

and health, minimize strain on local infrastructure, contribute to the overall quality of life, **and** set an example in the community.

Economic (Financial Benefits): Reduce operating costs, reduce life cycle energy costs, enhance access to value and profit**,** improve employee productivity and satisfaction, optimize life cycle economic performance, lower absenteeism / increased productivity, tax abatements at the federal, state, and local level, federal grants used as an enticement to promote green building**.**
Industry Benefits: Create value within the compatible market, higher occupancy rates, less vacancy period, meet growing demands by tenants, company recognition, and lower advertising costs. Shabrin & Abul Kashem (2017) pointed out that the other benefit of sustainable building is that the research and development team will always find a way to improve the building.

Research Method

This research aims to identify the benefits of sustainable buildings in Lagos State. This research was conducted to answer questions relating to the benefits of sustainable buildings. The population of the study includes construction professionals in Lagos State. The samples for this study include Builders, Quantity Surveyors, and Architects actively practicing in Lagos State, Nigeria. This study adopted quantitative survey research and purposive sampling techniques. Both primary and secondary data were used to carry out the research study. The sources of the primary data were structured questionnaire issued to selected professionals such as Builders, Quantity Surveyors and Architects. The questionnaire contained close-ended questions aimed at answering the research question. To arrive at the mean values, respondents were asked to rank the variables measuring their perceptions on a five-point Likert scale, with weight 1 representing "least important"; 2, "fairly important"; 3, "moderately important" 4, "important" and 5, "very important". The weights assigned to each attribute were multiplied by the frequency of response to the attributes. This is in turn summed together to get the total weight value (TWV) for each feature.

Relative Importance Index (RII)
The formula used was obtained from the one previously used by Megha & Rajiv (2011) using the relative importance index formula to calculate the level of importance of the benefits of Sustainable building projects in Lagos State, Nigeria.

The Relative Importance Index method has been used to determine the relative importance of the various benefits of Sustainable buildings. This method is adopted in this study to rank various groups (i.e. Economic, Social, Environmental and Industrial benefits). The five-point scale ranging from 1 (least important) to 5 (very important) was adopted and will be transformed into Relative Importance Indices (RII) for each factor as follows:

$$RII = \frac{\sum W}{A*N}$$

Where W is the weighting given to each factor by the respondents (ranging from 1 to 5), A is the highest weight (i.e. 5 in this case), and N is the total number of respondents.

Results and Analysis

Background Information

This section presents the findings and analysis of the data obtained from the distributed questionnaires**.**
The charts in Figures 1 and 2 show the biography of respondents and Tables 1 and 2 present the categories and combined results and ranking of the benefits of sustainable buildings in Lagos State, Nigeria.

The bar chart in Figure 1 shows the number of respondents who completed the questionnaire and their various positions, which means their current job roles in the construction industry. It shows that 25 Architects, 27 Quantity Surveyors, and 21 Builders participated.

Figure 2: Shows the number of years of experience the various respondents have had in the construction industry. 13 % of the

Architects had less than one year of work experience, 21% had up to one to two years of construction work experience, 25% had two to three years of construction work experience, 17% had three to four years of construction work experience and 25% had more than 4 years of construction work experience. 11 % of the Quantity Surveyors had less than one year of work experience, 11% had one to two years of construction work experience, 21% had two to three years of construction work experience, 11% had three to four years of construction work experience and 46% had more than 4 years of construction work experience. None of the Builders who responded to the questionnaire had less than one year of work experience, those with one to two years of construction experience 20%, 10% had two to three years of construction work experience, 40% had three to four years of construction work experience and 30% had more than 4 years of construction work experience.

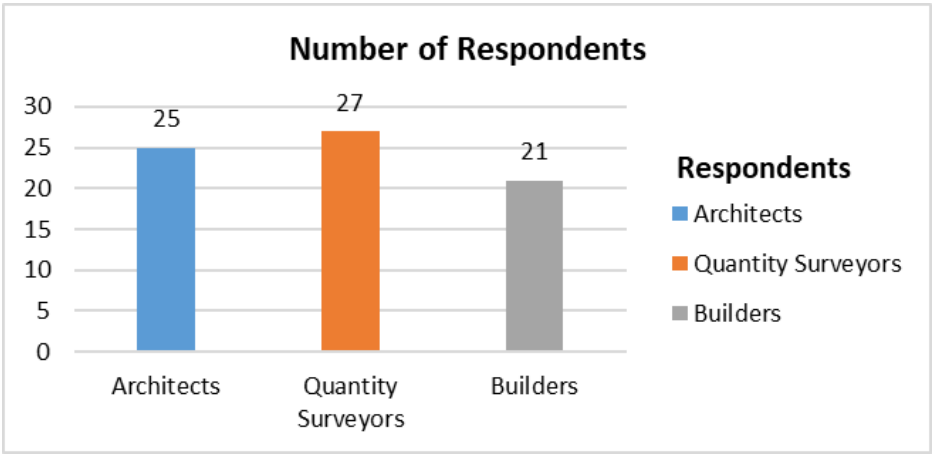

Figure 1: Number of Respondents

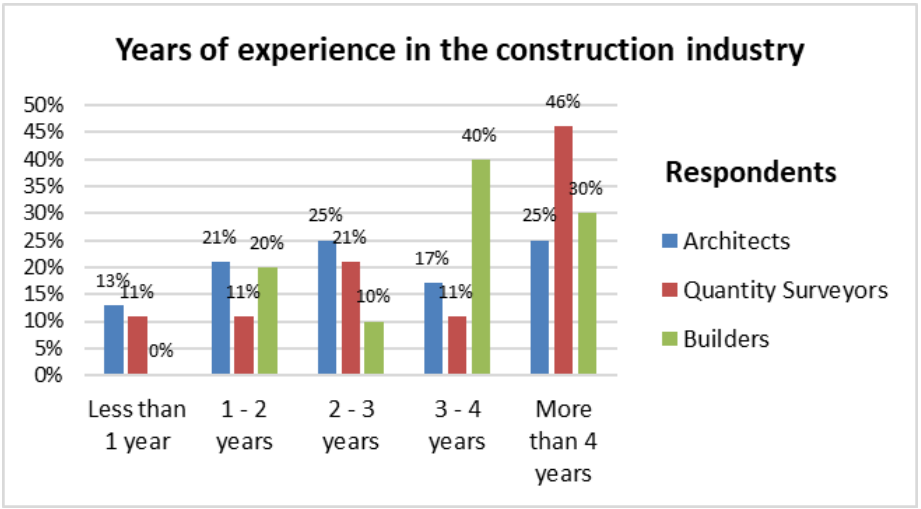

Figure 2. Years of Experience

Analysis of Data and Discussion of Findings

Table 1 presents the benefits of sustainable residential buildings in Lagos State, Nigeria categorized into groups of environmental, social (health and community), economic (financial), and industry benefits. The table reveals that on average, professionals consider the environmental (0.834) and social (0.787) benefits of sustainable buildings to be the first and second most important benefits respectively. This might imply that the professionals have become more aware of the environmental impact of buildings on the environment and therefore care about the environment as compared with social (health and community benefits). Komolafe & Oyewole (2018)'s study also has a similar finding. On the other hand, industry benefit is considered the least important category of benefits.

Table 2 shows the combined benefits of sustainable buildings in ascending order. The study shows conservation of natural resources (0.87) as the most important benefit of sustainable buildings, followed by enhancing and protecting eco-system and biodiversity (0.86), improving water and air quality (0.86), and enhancing occupant comfort and health (0.86). This finding suggests that the majority of the respondents consider the conservation of natural resources important. This is in contrast to the findings of Ojo-Fafore, Aigbavboa & Remaru (2019), where; 'Provide better health for building occupants due to the improved indoor air quality and leads to the development of more energy-efficient products and services' both ranked first. Furthermore, although not the same, however, it is similar to the findings of Nduka & Sotumbo (2014), in the sense that, the conservation of natural resources is ranked second to pursuing active recycling. It is also similar to the findings of Dahiru, Bala & Azeez (2016), which ranked health and productivity gain, preserving natural resources, and attracting and retaining employees at first, second, and third respectively. Conservation of natural resources stands out in these findings, indicating its level of importance. The table further reveals that company recognition (0.64), meeting growing demands by tenants (0.64), and lower advertising cost (0.59) are the least benefits of sustainable residential buildings. This is likely since most people are likely to prioritize affordability in place of sustainability.

Table 1 Benefits of Sustainable Buildings by Category

	Benefits of Sustainable Building	Weighted Average (WA)	Relative Importance Index (RII)	Rank	Relative Importance Index Average
A	**Environmental Benefits**				
1	Conserve natural resources	324	0.87	1st	
2	Enhance and protect eco-system and biodiversity	320	0.86	2nd	
3	Improve water and air quality	313	0.86	3rd	0,834
4	Reduce solid waste	300	0.82	4th	
5	Effect on sub-soil conditions	276	0.76	5th	
B	**Social (Health and Community Benefits)**				
6	Enhance occupant comfort and health	308	0.86	1st	
7	Job Creation	279	0.78	2nd	0.787
8	Minimise strain on local infrastructure	265	0.76	3rd	
9	Set an example in the community	268	0.75	4th	
C	**Economic (Financial Benefits)**				
10	Reduce life cycle energy costs	286	0.78	1st	
11	Longer economic life of the facility	276	0.77	2nd	
12	Enhance asset value and profit	275	0.75	3rd	0.730
13	Reduce operating costs	266	0.73	4th	
14	Absenteeism/ productivity and satisfaction	258	0.71	5th	
15	Health-related costs like insurance premiums	259	0.71	6th	
16	Staying ahead of regulations	312	0.66	7th	
D	Industry Benefits				
17	Higher occupancy rates/ Less vacancy period	239	0.67	1st	
18	Company recognition	234	0.64	2nd	0.635
19	Meet growing demands by tenants	230	0.64	2nd	
20	Lower advertising costs	211	0.59	4th	

Table 2: Combined Benefits of Sustainable Residential Buildings

	Benefits of Sustainable Building	**(WA)**	**(RII)**	**Rank**
1	Conserve natural resources	314	0.87	1
2	Enhance and protect eco-system and bio-diversity	320	0.86	2
3	Improve water and air quality	313	0.86	2
4	Enhance occupant comfort and health	308	0.86	2
5	Reduce solid waste	300	0.82	5
6	Reduce life cycle energy cost	286	0.78	6
7	Job creation	279	0.78	6
8	Longer economic life of the facility	276	0.77	8
9	Effect on sub-soil condition	276	0.76	9
10	Minimize strain on local infrastructure	265	0.75	10
11	Enhance asset value and profit	275	0.75	11
12	Set an example in the community	268	0.75	11
13	Reduce operating cost	266	0.73	13
14	Lower health-related costs like insurance premium	259	0.71	14
15	Lower absenteeism/incorrect productivity/satisfaction	258	0.71	14
16	High occupancy rate/less vacancy period	239	0.67	16
17	Staying ahead of regulation	231	0.66	17
18	Company recognition	234	0.64	18
19	Meet growing demands of tenants	230	0.64	18
20	Lower advertising cost	211	0.59	20

Conclusion

This research identified the benefits of sustainable residential buildings. From the survey obtained from respondents and literature, sustainable buildings provide many benefits such as conservation of natural resources, enhancement and protect the eco-system and biodiversity, improved water and air quality, enhanced occupant comfort and health, reduced solid waste, etc. These benefits should encourage stakeholders to demand a more sustainable approach in the building construction process. Furthermore, this study discovered that professionals have the impression that the environmental
benefits of sustainable residential buildings are the most important benefit of sustainable buildings. This means that professionals place more importance on the environmental benefits than the financial benefits. The reason for this can be traced to the finding of Komolafe & Oyewole (2018), that most of the information about sustainability is focused on the protection of the natural environment. This also aligns with Neyestani (2017), that protecting the environment is the primary benefit of sustainability in the construction industry.

Recommendation

This study discovered that the environmental benefits of sustainable buildings are rated high by the respondents. It is almost as if the other benefits are overlooked, despite their level of importance. This is typical of the belief in the society. The government, television adverts, etc. all seem to prioritize the environmental benefits of sustainable buildings. Therefore, to encourage sustainable residential building construction and further promote the benefits of sustainable residential buildings, the other benefits of sustainable buildings such as the social and economic benefits must be given an equal level of importance by the government, stakeholders, and promoters of sustainable buildings.

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