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Evaluation of the use of Green Façade in Residential Buildings in Kubwa, Abuja, Nigeria

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Abstract-

Housing development in Nigeria has constantly been carried out by the private sector as well as the government at various levels in time past. The use of sustainable elements and materials globally in recent years in meeting housing needs has indicated a progressive shift in the approach to design by architects and the built environment professionals around the world. But little has been seen in building developments in Nigeria both from the public or private sectors. The purpose of this study is to evaluate the use of the green façade as a sustainable element in constructing residential buildings. The study used Kubwa district in FCT Abuja as the study area. Primary data was derived by the administration of structured questionnaire to residents living in Kubwa. The data was analysed using the descriptive statistical tools of frequency and percentages of the Statistical Package for Social Sciences (SPSS). Findings from the research indicated that they are social and physical factors that have hindered the use of green façade in the study area. The major factors responsible for this include difficulty in getting professional help and low financial status. It is therefore recommended that both the government and the private sectors intensify efforts towards enforcing housing policies, creating incentives and delivering regular symposiums that will encourage green architectural practices such as the use of green façade in residential building and all its benefits in the built environment.

Key words: Residential Buildings, Housing, Green Facade, Sustainable Elements, Kubwa, Abuja, Nigeria

1. Introduction

Sustainability is one of the major subject of concerns in the world today. Sustainability should be examined as the supreme purpose of humanity in terms of achieving a balance between the existence of man and the natural environment [1]. It has brought about varying solutions which all aim at making the environment better by using various methods of green solutions. One of the solutions to sustainable design in architecture is the use of green façade in buildings and it is becoming popular in building designs. This style of design is referred to with different names by different authors. Green façades in buildings are described as vertical greening systems (VGS) and defined as partially or completely covered greenery walls that include a growing medium [2]. The study highlights the enormous importance of having green façade in buildings, from helping in the thermal comfort of the interior of a building, energy consumption reduction, improving its aesthetics and absorption of carbon monoxide from the building. It was specified that the possible influences of green facades in architectural practice



on the environment and on buildings include; green façade being an indicator of sustainability practice, water and energy conservation, indoor air quality improvement, production of less

waste, recycling or reuse of materials and being one of the eliminators of adverse effects of weathering on a building [3]. Green and sustainable architecture interest is increasing globally, even in developing countries like Nigeria. Due to the increasing concerns on environmental issues like global warming, different countries have set up policies in favor of sustainable building technologies and styles. This is in order to optimize its benefits and create a better living standard for her citizens. As a result, professionals in the building industry have continued to examine strategies for integrating sustainable elements into housing delivery. This is because until these measures are discovered, it would be impossible to aspire towards the goal of sustainable living [4]. With the growing environmental issues, green architecture has become a necessary practice. There have been limited steps taken in that direction in Nigeria and this can be due to the absence of policies to incentivize green architecture practices. There is need for Nigerian professionals in the building industry and the government to look in the direction of sustainability in the provision of housing. Based on this premise, this study aims at evaluating the use of green façade in residential buildings in Kubwa area of Abuja, Nigeria, with the view to identify the factors that contributed or had hindered the use of green facades in the study area. The practice of green design should be considered as often as possible in building construction, especially in countries with tropical climates. The scope of this study evaluated the use of green façade in Kubwa, Nigeria. The study evaluated the social and physical factors that have influenced the adoption of green facades in Kubwa. It is targeted to make recommendations on how much more or less green facades should be taken into consideration.

1.1 Problem definition and formation

Sustainability is one of the most popularly coined words that is frequently discussed and debated in the world today. As a policy concept, it bears origin from the Brundtland Report for the World Commission on Environment and Development. Sustainability as a socio-ecological process is characterized by the attainment of a common idea [5]. Sustainability is also defined by the United Nations General Assembly as the development that meets the needs of the present without compromising the ability of future generations to meet their own needs. However, it is argued that the idea of sustainability should not be attained by definition, but as a result of a determined and strategic approach for human health and environmental quality [6]. This study posits that the general concept of sustainability is a series of actions that ensures proper management of resources and environmental development in consonance with both present and future human needs and ambitions. In an evolving world with ever evolving technology, leading to changes in the environment, with the effects more negatives than positives. This has brought about constant search for solutions and one of such is sustainability. There are various articles on the different aspects of sustainability. Environmental sustainability must be properly understood and its ramifications should be measured so as to ensure its operational implementation. However it is posited that this goal is faced with challenges in developing countries, most of which are unable to integrate sustainability into the urban development [7]. An understanding of green design is vital for sustainable construction to thrive in these countries [8].

However, understanding sustainability is important as it is a means of meeting the needs of the present generation without compromising the ability of the future generation to meet their own needs [9]. Also, protecting resources and giving the future a chance is an objective of sustainability. The importance of sustainable practices in buildings is that it could lead to the

accomplishment of resource efficiency in terms of wastewater management; using green facades and other landscape elements as self-closing systems for harnessing grey water which can be used for toilet flushing and irrigation [10]. Furthermore, Cost effectiveness can also be achieved in buildings when sustainable practices such as reducing waste generation from materials and technologies, improvement of indoor air quality, natural lighting and adaptability to on-site conditions are considered [11]. When a building is designed to conform to on-site conditions like existing features on site and proximity to services such as electricity, waste management systems and water supply, it tends to promote cost savings, which is an important part of green design.

Environmental Protection

Environmental protection is described as a measure achieved when the ecosystem and its constituent parts are protected from unwanted natural changes associated with anthropogenic activities [12]. The environment consists of various factors, such as air quality, that contribute to the health of humans and plants and with the sporadic increase in population and continuous growth of technology, the environment continues to get affected. Urbanization comes as a residual effect of population increase, which is characterized with urban development and increase in housing provisions. The global sustainable development report by the United Nations in 2019 projected that more buildings will be constructed within the next 50 years than it has been throughout human history. The negative impacts of this growing emergence include environmental pollution, increased energy demand and climate change. These will aggravate the already existing problem of low biodiversity in urban areas in the upcoming decades [13]. As such, there has been a progressive shift in the approach to design by architects and the built environment professionals around the world. This is imperative because the criteria for meeting housing needs should be defined by how adequate the physical environment includes: presence of amenities such as water, sustainable infrastructure and facilities around the neighbourhood such as parks and green spaces [14]. The past few years have seen designers take up a responsible role and imbibe measures that significantly reduce the carbon footprints by creating buildings with lesser water consumption, integrating natural elements, compact development by building in proximity to raw materials and harvesting water run-offs through the use of bioswales.

Sustainability and Its Effects on Global Warming

The continuous depletion of the ozone layer and natural resources due to human activities and developing technologies serves as the precipice for global warming. Carbon emissions have harmful repercussions on the climate, which accelerate the depletion of the ozone layer and cause global warming [15]. Further insights on ozone depletion and global warming posited that this has been caused by unprecedented advancements in the area of technology and commerce around the globe from decades past and still on-going [16]. Although technology contributes to human comfort, it poses a threat to the environment through activities such as the disposal of non-biodegradable elements which can lead to environmental degradation.

Another cause of global warming is that it results from the massive inflow of people attracted from rural areas into cities in search of a better life [17]. As such, the urban environment should be designed in a manner that will mitigate the effects of human activities in urban areas. This calls for better planning, construction and adherence from developing countries to these warnings by emulating the practice of sustainability adopted in advanced societies, where the

use of green design strategies such as green facades to propel a positive influence on climate change is carried out [18].

Furthermore, the 20th century has seen building construction use up close to a third of the earth's resources (which is equivalent to 16% of the drinkable water in the earth), 50% of all energy supplies and half of all the raw materials gotten naturally and the built environment constitutes about 30% greenhouse gases that are emitted [19]. Human activity is a leading cause of global warming [19]. The intergovernmental Panel on Climate Change (IPCC) stated in its fifth report that anthropogenic activities over the past half a century has resulted in environmental degradation, which is apparent in the change of climate experience globally. More so, building construction accounts for almost half of all greenhouse gas emissions (GHGs), according to the Global Alliance for Building and Construction. However, degradation in the environment can be avoided when we consciously integrate natural surroundings with urban dwelling [20]. This research explores ways through which man's experience can be synthesized with nature. It calls for an approach to architecture that will facilitate sustainability through the use of plant-covering on the building façade.

Adaptation of Green Facades for Residential Buildings

A green façade can be described as a wall system that is formed when plants climb or cascade over vertical supporting frameworks or an existing wall until the surface of such vertical element is covered extensively by the plant species [11]. The concept of green facades being adopted when providing residential buildings stems from the realizable benefits green facades stand to offer [18]. They are both public and private benefits. These benefits are social, ecological, environmental and aesthetical in nature. The use of green facades contributes to the enhancement of sustainable practices in the built environment [18]. When green façades are implemented in buildings, ecological and aesthetic value of the facade is upgraded. The integration green façade systems in buildings is seen as a design approach that is energy conscious and leads to the preservation of densely populated urban locations from being transformed into degenerated habitats [21]. The study seeks possible means of creating a healthier and more purpose-built human habitat that would cost the environment less from the period of construction and at the same time prevent a lifecycle of environmental degradation. Adoption of the green façade system is therefore suggested for its numerous benefits that range from economic, ecological and aesthetic purposes [11].

Furthermore, one benefit of a green wall is that it can serve as an innovative wastewater management tool. The green façade can be used as a medium of treating wastewater or storm water, because plants can be used as natural filters that can clean the water that runs vertically downwards through the façade [22]. The recycled water can be used for a number of purposes including garden irrigation and flushing of toilets.

Also, another benefit that research has specified is that the need for air-conditioning is reduced by green facades which release cold air by transpiration [23]. Green facade provides

additional cooling, which can reduce a building's dependence on mechanical systems of cooling. This is helpful, especially in tropical regions as natural cooling minimizes energy consumption in buildings and eliminates dependency on active cooling systems [11]. More so, the Urban Heat Island Effect which is mostly caused by increase in urban development, is best remedied with the utilization of green facades [24]. Through evapotranspiration of plants on building facades, buildings can be cooled and this can lead to a great reduction in the Heat Island Effect [25].

Green facades also provide clean air by preventing dust which may be accompanied by dangerous air-borne bacteria by means of their roots and leaves [26]. This reduces the chance of building occupants becoming exposed to health risks associated with air-borne transmittance. Additionally, Green facades can be designed to provide the ideal conditions for birds, bees and butterflies to survive by providing water, food and protection for such organisms [11]. The activities of such living organisms can facilitate the availability of certain categories of nourishment and sustenance. It is therefore important to consider to what extent residential building schemes have integrated green façades into design and construction in the past.

2. Methodology

The study was carried out in FCT Abuja, located in the North-central region of Nigeria. Abuja metropolis, which is the capital of Nigeria, consists of six area councils with an estimated population of 6 million people with a total square kilometer of 8,000sq km. Its population density is 3,423km². This research used as case study Kubwa which is a residential district in Bwari (one of the six area councils in Abuja). The research design adopted was a survey method to obtain primary data. Questionnaires were distributed to residents of 150 buildings within the residential district of Kubwa, with one questionnaire representing each building. The survey took place between January and February 2020. It was administered and retrieved by hand. The buildings were randomly selected from 8 streets namely; Gado Nasko road, First Avenue, Second Avenue, Third Avenue, Arab road, Second Gate, Oduduwa Street and John Cardinal Oniayekan Street. To calculate the sample size, the study used the formula of sampling for continuous variable measurements reported by Cochran (1977). The estimation of minimal sample size for a sample analysis in this study is calculated using; $n = Z^2 \times p(1 - p) / d^2$. Where n = required sample size; Z = confidence interval of 1.96 (Considered as 95%); p = population proportion (assumed to be 50% = 0.5) expressed as decimal; d is the accepted margin of error which is 5% expressed as a decimal. Therefore the sample size of 384 was used for the study after adjusting the sample size to the required population of 776,298 in the study area (National Population Commission, 2006). The structure of the questionnaire was divided into three parts. The first part was to obtain data on the respondents' socio-economic profile and the second part of the questionnaire obtained data on building characteristics while the third part collected data on factors that have hindered the use of green façade on residential buildings in the study area. Out of the 384 questionnaire distributed, 324 were returned valid for further analyses, measuring a return rate of 84.4%. Analysis of qualitative data was carried out through content analysis, while analysis for quantitative data was done using descriptive statistics. Quantitative data was processed and analysed using descriptive statistical analytical methods with the use of statistical package for the social sciences (SPSS)

software. The analysed data was assessed, arranged and presented using tables, pictures and numbers.

3. Results and discussion

3.1 Socio-economic Characteristics of Respondents

Table 1 summarizes the socio-economic characteristics of respondents in the study area. The table shows that 10% of the respondents were between ages 40 and 49 years, while 64% were below age 30. Those over 50 years were 4% and those between 30 and 39 years were 22%. This suggests that majority of the residents were youths and provides evidence to support the speculation that the core is mostly inhabited by young people.

The heads of the households were majorly males (66%) and 34% were female. A large quota of the respondents representing 68% was single, 24% were married while 2% did not indicate their marital status. Widows constituted 4% while 2% were divorced. This is in line with what obtains culturally in a household where men are the head of the family even if changes in traditional gender roles see some wives as breadwinners [27].

32% of the respondents were self-employed; 28% were employed for wages; 6% were homemakers; 14% were unemployed; 18% were students and 2% did not indicate their occupation. This suggests that a large proportion of the respondents were employed in the informal sector which has always being a significant form of employment in the study area.

A very good percentage of the population (72%) had a Bachelor's degree, 4% had secondary school certificate, while 2% and 6% had Ordinary and Higher National Diploma certificate respectively. 14% of the respondents indicated that they had masters' degrees while 2% had no formal education. This shows that most residents were literates.

A large percentage of respondents (48%) earned less than N50, 000 monthly, while 28% had a monthly income between N50, 000 and N150, 000. About 8% earned between N150, 000 and N250, 000, 10% earned between N250, 000 and N350, 000 while 6% earned above N350, 000. This inferred that the residents of Kubwa were mostly low and middle income earners.

Table 1: Respondents' Socio-economic and Demographic characteristics

Respondents' Characteristics/Variables	Categories	Frequency (N= 324)	Percentage
Sex	Male	214	66.0
	Female	110	34.0
Age	Below 30 years	207	63.8
	30-39 years	72	23.7
	40-49 years	32	9.87
	Over 50 years	13	4.0
Marital Status	Single	221	68.2
	Married	78	24.0
	Widowed	13	4.0
	Divorced	6	1.8
	Missing	6	1.8
Education	No	6	1.8
	Secondary	13	4.0
	OND	6	1.8
	HND	20	6.1

	Bachelor's Degree	233	71.9
	Master's Degree	46	14.2
Employment Type	Employed for wages	78	24.0
	Self-Employed	104	32.0
	Out of work and looking for work	39	12.0
	Out of work but not currently looking for work	6	1.8
	A homemaker	12	3.7
	A student	58	18.0
	Military	15	4.6
	Missing	12	3.7
Monthly Income	Less than N50,000	155	47.9
	N50,001- N150,000	91	28.0
	N150,001- N250,000	26	8.0
	N250,001- N350,000	32	10.0
	More than N350,000	20	6.1

3.2 Building Characteristics

Table 2 shows the result from the data obtained to assess the building characteristics of housing units in the study area. 54% resided in rented houses, 28% dwelled in self-owned residences while 17.9% live in rent-to-own residences. This indicates that most respondents lived in rented apartments and weren't permanent occupants.

A high percentage (39.8%) have spent between 1 and 3 years in their current residence, while 1.8% have lived between 4 to 6 years. 8% have spent 7 - 10 to years. Others (14.1%) of the residents have spent over 10 years. This inferred that most residents of Kubwa were people who recently moved to the core area. 36.1% of the respondents stayed in 3-bedroom housing units; 28% resided in 2-bedroom apartments; 7.7% resided in houses that had above 4 bedrooms while 14.1% stayed in 1-bedroom apartments. This indicates that most of the residents live in 3-bedroom apartments as part of a family or small group of people staying together.

Table 2 further showed that only 26% of the respondents live in homes that had no space or balcony where plants can be put. 70% maintained that they was adequate planting space or balcony where they lived while 1.8% weren't certain. This indicates that most residents have sufficient planting space for green facades in their places of abode.

Table 2: Building Characteristics

Variables	Categories	Frequency (N= 324)	Percentage
Housing type	Self-owned residence	91	28.0
	Rented residence	175	54.1
	Rent-to-own	58	17.9
Duration of stay on the property	Less than 1 year	117	36.1
	1 – 3 years	129	39.8
	4 – 6 years	6	1.8
	7 – 10 years	26	8.0
	Over 10 years	46	14.1
Number of rooms	1 bedroom	46	14.1
	2 bedrooms	90	28.0

	3 bedrooms	117	36.1
	4 bedrooms	46	14.1
	More than 4 bedrooms	25	7.7
Presence of balcony where	No	84	26.0
	Not certain	6	1.8
Plants can be put	Yes	227	70.0
	Missing	7	2.2

3.3 Use of Green Façade in the Study Area

It was observed that green facades are not present in residential buildings in the study area as seen in Fig 1.0 and Fig 2.0 below. Based on this observation, the study focused majorly on investigating the factors that have hindered its use.



Fig 1.0: Showing a 5-bedroom semi-detached in FHA, Kubwa (without green façade)
Source: nigeriapropertycentre.com



Fig 2.0: Showing multiple residences in Arab Road, Kubwa (without green façade)
Source: nigeriapropertycentre.com

Result in Table 3 below shows the social factors that are hindering the use of green façade in the study area. The table shows that financial status is the most influential factor that has stopped the respondents from having green plants on their building frontage. This serves as a hindrance with a 32% acceptance. This indicates that most residents assume that the cost of having a green façade is high and is suitable for use in only high-income homes.

On the other hand, all other social factors including the existing environmental laws and policies from the government or developers; level of awareness about the influence of green plants; spiritual beliefs about the dangers of plants at the front of house; and lack of interest in making positive contributions to the environment didn't pose as social factors that hinder to the use of green façade in the study area.

Table 3: Social Factors Hindering the Use of Green Facades

S/ N	Social factors	Strongly Agree [5]	Agree [4]	Uncertain [3]	Disagree [2]	Strongly Disagree [1]
1	Existing environmental laws and policies from the government or developers	7 (2.2%)	6 (1.8%)	90 (28%)	131 (40.4%)	90 (28%)
2	Financial status	-	104 (32%)	104 (32%)	52 (16%)	64 (20%)
3	Level of awareness about the influence of green plants	13 (4%)	90 (28%)	27 (8%)	97 (30%)	97 (30%)
4	Spiritual beliefs about the dangers of plants in front of house	-	19 (5.8%)	19 (5.8%)	78 (24.2%)	208 (64.2%)

5	Lack of interest in contributing to the environment	7 (2.2%)	7 (2.2%)	13 (4%)	103 (31.7%)	194(59.9%)
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Table 4 below shows the physical factors that hinder the use of green façade in the study area. The results indicate that majority (34%) of the respondents do not use green façade in their frontages because of lack of professional help. 34% agree that they are concerned about the future cost of maintenance of the plants and that is why they don't have any in their frontages. In the same vain, another physical factor hindering the use of green façade in the study area is the fact that respondents are of the opinion that green plants on the building frontage may bring insects and unwanted organisms with a 42% acceptance.

However a large percentage of respondents (48%) strongly disagree that they do not have enough space for planting around the house. This shows that lack of space in residences is not a factor that hinders the use of green façade in the study area.

Table 4: Physical Factors Hindering the Use of Green Facades

S/ N o	Physical factors	Strongly Agree [5]	Agree [4]	Uncertain [3]	Disagree [2]	Strongly Disagree [1]
1	Lack of planting space around the house	13 (4%)	32 (10%)	58 (18%)	64 (20%)	157 (48%)
2	Difficulty in getting professional help	26 (8%)	110 (34%)	52 (16%)	84 (26%)	52 (16%)
3	Concern about the future cost of maintenance	13 (4%)	110 (34%)	117 (36%)	58 (18%)	26 (8%)
4	Concern that green plants bring insects and unwanted organisms	52 (16%)	137 (42%)	64 (20%)	32 (10%)	39 (12%)

4. Conclusion

This study identified the factors that hindered the use of green facades in Kubwa. The results suggest that residents viewed some social and physical factors as influences when it comes to decisions about the use of green facades on their buildings. The approach used was subjective rather than objective as it gathers inferences from people living in the core area rather than expert-opinion in the field of sustainable housing. The study adopts the quantitative research method.

Residents rated financial status as the only social factor that hindered the use of green facades in Kubwa. The study also suggests that the perception that financial status as a determinant in adopting green façade in homes is conjectural. The direct-system of green façade design, which involves using the existing walls in buildings as plant-support, can be adopted to obtain a cheap façade greening [28]. As such, there is an opportunity to improve sustainability in

core-area housing with the use of the direct system and locally grown plants for façade greening.

Other physical factors such as lack of professional help, future cost of maintenance of the plants and concern that plants may bring insects and unwanted organisms were also rated by respondents as some of the reasons why green façade is not used on their buildings. However, these factors can be addressed when stakeholders in the building industry such as designers, practitioners and developers increasingly adopt green façade design to show its potentials as a measure of environmental sustainability. The effect would be such that will impact water and energy consumption and increase conservation of energy thereby leading to smart living [29]. Additionally, when green façade architecture is practiced efficiently, insects and unwanted organisms can be curtailed by using traditionally obtainable means such as lemon grass leaves as a repellent [30].

Based on the foregoing, it can be concluded that the research underscores the limited use of green façade in building in Kubwa, and the underlying factors why the case is so. However, improvements can be made in this area by enforcing housing policies that will encourage green architecture in the built environment.

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