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Investigating the Regenerative Architectural Concepts: Principles and Practices of Selected Architects in Lagos, Nigeria.

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Abstract

The issue of regenerative design in buildings has been continually emphasized amongst architects and professionals of the built industry, hence, various methods of achieving regeneration in buildings have currently become the focus of researchers, especially in the developed nations. However, in developing nations such as Nigeria, there are very few empirical studies on the adoption of regenerative principles in design. The aim of this research, therefore, is to identify the and analyze the predominant regenerative architectural principles being adopted by architects in Lagos, Nigeria to promote sustainable development. Quantitative method of research was adopted for the study by administering questionnaires to a sample size of 170 within the area of research study to gather data. Data gathered was analyzed using statistical package for social sciences software (SPSS) while results were presented in tables and descriptive format. The findings of the study imply that the predominant strategies of regenerative architecture employed in Nigeria are those that promote and cater to energy efficiency, whilst other strategies of regenerative architecture were barely acknowledged. Responses from the architects reveal that the prospects for this concept of architecture is high. Conclusively, the paper recommends that, in order to properly achieve regenerative buildings in Nigeria, architects and other professionals involved in the design and construction of the built environment should be more enlightened on the concept. Furthermore, professionals should endeavor to integrate the principles of regenerative architecture into their design.

Keywords: Environmental preservation, Regenerative architecture, Regenerative architectural principles, Architects, Lagos.

1. Introduction

Humanity is currently being faced with the challenges of urbanization and development as it concerns its impact on the environment. This impact includes, but is not limited to, climate change, pollution, and environmental degradation (Ahmed, Islam Khan, & Aboh, 2018). The increase in population, requires an increase in the number of buildings and constructions. Thereby putting pressure on the environment to satisfy the increased demands of the population. Naboni & Garcia (2017), stated that just as plants and vegetation are involved in the process of preserving the ecosystem, buildings should also contribute and regenerate their environments rather than deplete it. This suggests that buildings should also be able to contribute positively to whatever environment they are built in or, at least, minimize the negative impacts which they are known to have on this environment.

Sustainability seeks to prevent further deterioration of the environment, in other to ensure future generations are still able to meet their own needs. However, this has been speculated to be a slow and ineffective solution to the challenges being faced by the environment and the current rate of deterioration (Littman, 2009). It has been noted that sustainability, as it is being addressed currently, only focuses on the net – zero impact on the environment (Carbonnier & Babtiwale, 2018).

Regenerative architecture, on the other hand, goes further by attempting to introduce the concept of a net positive impact on the building environment. This suggests that buildings do not only autonomously produce what they consume, but also produce enough to meet the needs of the surrounding environment and adjoining buildings (Littman, 2009). It also comprises of the concepts of a closed loop system of resource management and enhancing the environmental condition of the surrounding among others.

Whereas the ultimate goal of sustainability is to meet the basic human needs of today without tampering with the ability and provisions required by future generations to meet their own needs, the highest goal of regenerative architecture is to create systems that co-exist and are able to provide more than is required to meet their needs thus having a net positive effect on the environment. Thus, regenerative architecture goes a step further in ensuring environmental preservation and advancement.

It is against this background that this study aimed at analyzing the different principles of regenerative architecture employed in the design of buildings in order to identify and analyze the predominant strategies of regenerative architecture which are being adopted by architects in Lagos, Nigeria. The scope of the study is limited to Lagos state and focuses on registered architects within the study area. This is premised on recent research by authors which points that Lagos state experiences several environmental hazards and this research is focused on mitigating these issues, hence the choice of the study area.
This study contributes to the body of knowledge by extending its frontiers on the various principles of regenerative architecture and their benefits if properly utilized. Furthermore, the findings from the study are expected to act as a resource base for researchers and scholars alike, and also create awareness amongst policy makers and professionals in the built industry.

2. Literature Review

2.1. Regenerative Architecture

Regenerative architecture is a concept that was introduced to speed up and enhance the restoration and healing process. It is the "practice of engaging the natural world as the medium for, and generator of the architecture. It responds to and utilizes the living and natural systems that exist on a site that become the building blocks of architecture" (Littman, 2009, p. 1). This suggest that the architecture is informed by the site on which it is to be built which is simultaneous considering the site as an equal partner in the development. This helps to cater for the natural as well as the built environment.

The result of this process is a net positive impact on the environment. The earth has existed for about 4.5 billion years and has therefore adopted natural processes and systems that have the carrying capacity for sustenance and development. Therefore, architecture that models itself after these natural processes and systems will tend to be regenerative in nature, producing more resources than it consumes. Alignment with these processes also eliminates the impacts of tampering with them, thus protecting the environment.

2.2. Principles of Regenerative Architecture

Littman (2009), developed a set of principles that focus on regeneration in terms of architecture. The principles attempt to create a fusion between the human and natural world indefinitely and are derived from various fields of study such as “permaculture design, regenerative design, architectural design, cradle-to-cradle principles, biodynamic design and biophilic design”. There are a total of nine principles and each principle can be further broken down into guidelines that are geared towards regeneration in architecture. The principles are as follows.

2.2.1. Whole Systems Design Integration

The focus of this principle is on the understanding of the site as a system. There are four guidelines for the adoption of this principle. The guidelines suggests that when designing the site or ‘place’ should be identified and studied as a system, with various elements and entities.

2.2.2. Integration into the Landscape

The focus of this principle is on the relevance of adequate analysis of the site. There are three guidelines for the adoption of this principle. The guidelines suggests that a thorough study and analysis of the place, such that the introduction of the design is perceived as a continuation of the site and not as a separate entity.

Fig 2.1: Integration of landscape in the Nigerian Institute for Oceanography and Marine Research building

2.2.3. Principle of Bold Ecology

The focus of this principle is on ecology and ecological systems, especially the organisms, species and their environment. There are five guidelines for the adoption of this principle. The guidelines suggests that the system should be designed to produce more than it consumes, especially in term of energy. Spaces in the building are designed to maximize, to an extent, the use of day lighting and natural ventilation for thermal comfort within the spaces.

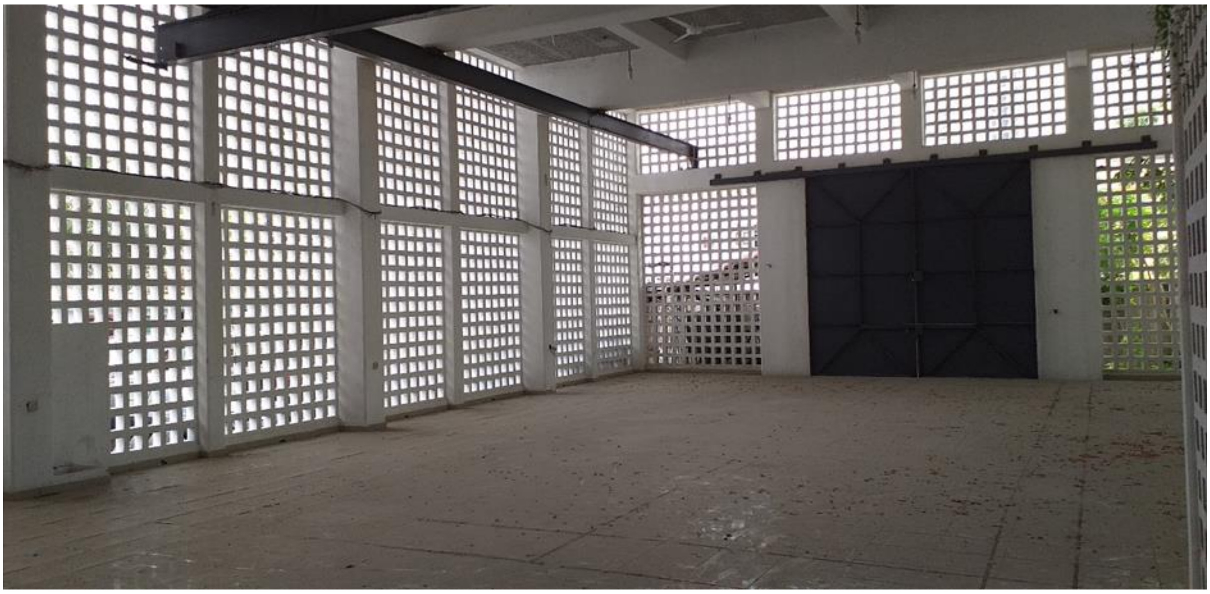

Fig 2.2: Daylight and Natural Ventilation in Spaces Nigerian Institute for Oceanography and Marine Research building

2.2.4. Principle of Intelligent Limits

The focus of this principle is on the potential of the entities and the system as a whole. There are three guidelines for the adoption of this principle. The guidelines suggests that each material and space that is to be introduced in the design must be created in such a way that it has the maximum positive contribution to the system. The adoption of passive design strategies in the building can be seen as a measure of achieving this principle.

Fig 2.3: Cooling tower system in Federal Institute of Industrial Research

2.2.5. Principle of Concentration

The focus of this principle is on space and spatial relationship between entities. There are three guidelines for the adoption of this principle. The guidelines states that "each system element has a relative location or locations within the site and it is often overlooked that the special relationship between system elements can have enormous impacts on the operation of the system and each space is accounted for and is necessary and less is more". The building spaces are adequate for the proposed functions and flexible to accommodate various functions.

Fig 2.4: Flexible spaces in Covenant University Center for Research, Innovation and Discovery

2.2.6. Principle of Intelligent Construction

The focus of this principle is on construction and construction processes and materials. There are four guidelines for the adoption of this principle. The guidelines states that “the system is constructed using natural and artificial processes, the construction is designed to maximize material efficiency, each material is implemented to its maximum potential and the architectural image is embodied in construction and materiality”.

2.2.7. Principle of Community

The focus of this principle is on communities and their connectedness to one another and their environment. There are three guidelines for the adoption of this principle. The guidelines states that “scale is irrelevant to the importance of an entity or group, support for the exchange of experience and social practice is embodied and all members of the community are participants in and influencers of the design”.

2.2.8. Experience of Place

The focus of this principle is on the uniqueness and specificity of the place. There are five guidelines for the adoption of this principle. The guidelines states that “the image of the place formulates positive experience, the experience is driven by clear systemic form, the place is experience able by the individual and by the communities alike, the experience of the place is positive and the place describes a story”. Buildings can be oriented to maximize experience of users with the presence of courtyards at strategic location to maximize connection with nature and improve experience of place and interaction with the community.

Fig 2.5: Presence of courtyard in the Nigerian Institute for Oceanography and Marine Research building

2.2.9. Principle of Culture

The focus of this principle is on the cultural identity of the place and elements within the site. There are five guidelines for the adoption of this principle. The guidelines states that "the social history of the place is present in the design, the geological history is complimented and preserved, all present cultures are constituents of the place, cultural permanence is accommodated and the quality of life for all cultures is enhanced by the design and intervention".

2.3. Regeneration-Based Checklist for Design and Construction

This checklist was developed by Malcolm Wells in 1969 as the "Wilderness-Based Checklist for Design and Construction". These ratings serve as a checklist for design to ensure that adequate requirements are met. According to Wells (1978), a wilderness, will get a score of 1500 while a "suburban research lab" would probably get a negative score. This checklist was, however, revised by the Society for Building Science Educators (SBSE) in 1999. They adjusted the checklist to include trends in sustainability that have occurred. They also divided the checklist into features of the site and of the buildings. Another major revision was that the features were analysed in a continuum from the worst possible effect (degeneration) to a state where it breaks even (sustainability) and finally to the best possible effect (regeneration).

2.3.1. The Site

These are the issue that should be considered when designing to determine how it affects the site. The issues relating to the site are as follows:

i. Pollutes Air - Cleans Air: Activities such as combustion pollutes the air, with indoor air pollution 25-100 times higher than the outdoor air (Kumaran, 2014). Instead, adopt the use of native vegetation to absorb the carbon dioxide from the air.
ii. Pollutes Water - Cleans Water: Impervious surfaces tamper with the water cycle and waste pollutes the water. According to Singh & Gupta (2016), water is an easy to manage resource and can, therefore, be maximized by the introduction of green and porous surfaces and adopt water treatment.
iii. Wastes Rainwater - Stores Rainwater: Consider strategies for collection, treatment, distribution and conservation of rainwater on site, which is relatively free of impurities.

iv. Consumes Food - Produces Food: Adopt strategies for on-site food production through edible forests, vertical farming and roof gardens.
v. Destroys Rich-Soil - Creates Rich-Soil: Use of chemicals like pesticides destroy the soil. Rather adopt the use of organic waste and vegetation on the soil.
vi. Dumps Waste - Consumes Waste: Waste generated during construction and lifecycle, from materials, organic substances and water, could be recycled and reused.
vii. Destroys Habitat - Provides Habitat: Design should make provision for habitats of wildlife and other species to ensure the balance in nature.
viii. Imports Energy - Exports Energy: Renewable energy and on-site energy generation should be considered as opposed to the use of fossil fuels to generate energy.
ix. Requires Fuel-Powered Transportation - Requires Human-Powered Transportation: Consider the introduction of bicycle and pedestrian access as opposed to vehicular access.
x. Intensifies Local Weather - Moderates Local Weather: The impact of urban heat island as a result of impervious surfaces. Consider green surfaces and vegetation.

2.3.2. The Building

These are the issue that should be considered when designing to determine how it affects the building. The issues relating to the building are as follows:

i. Excludes Natural Light - Uses Natural Light: The building design should maximize the use of natural lighting. Consider the use of light shelves and adequate fenestrations which can reduce energy utilization on lighting by up to 60% (Moazzeni & Ghiabaklou, 2016).
ii. Uses Mechanical Heating - Uses Passive Heating: The building envelope can be designed to trap heat within the building rather than adopting mechanical heating systems, serving as a more economical option (Gupta & Tiwari, 2016).
iii. Uses Mechanical Cooling - Uses Passive Cooling*:* Make provision for shading devices and cross ventilation to improve thermal comfort within the building.
iv. Needs Cleaning and Repair - Maintains Itself: Protection of materials can help increase their durability. Also, minimize the use of mechanical systems.
v. Produces Human Discomfort - Provides Human Comfort: Consider the thermal and visual comfort of users. Also, consider the innate affinity to nature.
vi. Uses Fuel-Powered Circulation - Uses Human-Powered Circulation: The use of ramps and stairs should be encouraged as opposed to escalators and elevators, even when provided.
vii. Pollutes Indoor Air - Purifies Indoor Air: The materials used in construction and for finishes should be checked for hazardous tendencies.
viii. Built of Virgin Materials - Built of Recycled Materials: The materials used in the construction of the building should be locally sourced and recycled
ix. Cannot be Recycled - Can be Recycled: The material used should the recyclable and the construction methods used should be easily disassembled in case of need for demolition.
x. Icon for Apocalypse - Icon for Regeneration: Building should serve as a role model for regeneration and environmental sustainability.
xi. Bad Neighbour - Good Neighbour: The impact of the building on surrounding buildings and structures should be considered and designed to be positive.
xii. Form is Ugly - Form is Beautiful: The aesthetic appearance of the building should also be considered as it emphasizes the connection to the beauty in nature.

3. Research Methodology

In achieving the objective of the study both primary and secondary data were employed by reviewing literatures, journals and administrating structured questionnaires. According to Architects Registration Council of Nigerian (ARCON, 2017), there are a total of 1279 registered architects in Lagos State. The sample size for this study was therefore derived using Cochran formula: $n = n_o/(1+ (n_o - 1/N))$ … (i) and $n_o = z^2pq/e^2$ … (ii), where n = actual sample size; n_o = required sample size; N= study population; z = 1.96 (gotten from a 'z' table); p = 0.85 (proportion of population with characteristics); q = 1-p = 0.15; e = 0.05 (margin of error based on 95% level of confidence). The sample size of 170 was arrived at, and simple random sampling without replacement was used to select the firms that amounted to the sample size. A structured questionnaire was designed with close-ended questions and administered to these registered architects in the study area. The questionnaire was divided into three (3) units: demographic characteristics of respondents, level of understanding of strategies which promotes environmental sustainability and the extent of adoption of regenerative architecture strategies on site and in buildings.

4. Result, Analysis and Discussion

A total of 170 questionnaires were randomly disseminated to architects in Lagos State and a total of 143 questionnaires were retrieved. Results and analysis of the retrieved responses for each of the sections of the questionnaire survey are discussed subsequently.

4.1. Demographic characteristics of respondents

The demographic characteristics of respondents were analyzed based on their gender, number of years in practice, employment type and architectural hierarchy and results are presented in Table 4.1.

Table 4.1: Demographic characteristics of respondents

Variable	Frequency	Percentage (%)
Gender		
Male	93	65.0
Female	50	35.0
Total	**143**	**100.0**
Years of Practice		
Less than 1	20	14.0
1-10	92	64.3
11-20	17	11.9
21-30	8	5.6
More than 30	6	4.2
Total	**143**	**100.0**
Employment Type		
Civil Servant	6	4.3
Private-Sector Employed	66	46.8
Self-Employed	61	43.3
Retired	10	5.6

Total	**143**	**100.0**
Architectural Hierarchy		
Senior Principal	20	14.4
Mid -level Principal	6	4.3
Junior Partner	4	2.9
Department Head	2	1.4
Project Manager	19	13.7
Senior Architect	44	31.7
Junior Architect	36	25.9
Intern	12	5.7
Total	**143**	**100.0**

Analysis of responses based on the demographic characteristics of respondents in table 4.1 reveals the male respondents have the greater responses amounting to 65% of the respondents while the female respondents amounted to 35%. This implies all genders being adequately represented in the survey which is reflective of the ratio of male to female registered architects in Lagos. Majority (64.3%) of the respondents have between 1-10 years of working experience while 11.9% have 11 -20 years of experience, and a total of 9.8% have over 20 years of experience in the architectural practice of both design and construction of buildings. This implies that the respondents are knowledgeable, and they have vast experiences in the general practice of architecture.

Furthermore, about 90% of the respondents are either practicing in private sectors or self-employed which suggests that their job experiences cover a wide range of building projects as various forms of clients are known to patronize this set of architects. Finally, senior architects make up the highest number of respondents (31.7%) based on architectural hierarchy which further buttresses the level of experience, qualification and knowledgeability of respondents on general building projects.

4.2. Concept of Environmental Sustainability

This section poses questions to respondents based on their level of understanding on strategies which promotes environmental sustainability. A total of 5 strategies were listed and the respondents were required to select to rate their knowledge base of each concept on a five point Likert scale ranging from 1= Poor (being the lowest), 2= Fair, 3= Average, 4= Good and finally to 5= Excellent (being the highest).

Table 4.2: Strategies of Environmental Sustainability

SN	Environmental Sustainability Strategies	Count	Mean
1.	Green Building Design	143	4.2979
2.	Adaptive Buildings	143	3.9078
3.	Living Buildings	143	3.8029
4.	Autonomous Buildings	143	2.6222
5.	Regenerative Architecture	143	2.0889

Table 4.2 shows the result of the analysis of responses based on the level of understanding of respondents on selected strategies which promotes environmental sustainability to obtain the mean of these responses. Mean result was ranked from the highest to the lowest and

this reveals that most architects have good understanding of strategies of environmental sustainability such as green building design (4.2) while they have an average level of understanding of subsequent concepts such as adaptive buildings (3.9) and living buildings (3.8). Autonomous buildings (2.6) and regenerative architecture (2.0) ranked the least mean signifying that architects have fair level of understanding of these strategies of environmental sustainability. Generally, it is implied that Architects have between an average and fair understanding of these strategies. This is a step forward in achieving environmental sustainability and eventually regeneration within our built environment. Understanding of the concepts is one step, however, conscious and intentional steps have to be made to improve the level of understanding of these concepts and eventually promote their application through the lifecycle of the building project.

4.3. Adoption of Regenerative Architectural Strategies

4.3.1. Adoption of Regenerative Architecture Strategies on Site

This section poses questions to respondents based on the extent to which they employ regenerative architectural strategies in promoting environmental sustainability on the site. Ten (10) strategies were listed and respondents were required to select how often they employ these strategies on a five-point Likert scale varied from 1= Never (being the lowest), 2= Seldom, 3= Sometimes, 4= Often, to 5= Always (being the highest) on their projects' site.

Table 4.3: Adoption of Regenerative Architecture Strategies on Site

SN	Regenerative Architecture Strategies	Count	Mean
1.	Energy Supply	143	4.7810
2.	Human Powered Transportation	143	4.6423
3.	Rainwater Collection	143	3.4326
4.	Water Purification	143	3.4088
5.	Waste Consumption	143	3.2734
6.	Control of Local Weather	143	2.9281
7.	Food Production	143	2.6331
8.	Air Purification	143	2.5892
9.	Provision of Habitat for Local Species	143	2.5683
10.	Soil Enrichment	143	2.4604

Table 4.3 reveals the extent to which respondents employ strategies of regenerative architecture on the design of their projects' site and these responses were ranked from the highest mean to the lowest. The highest mean rate of approx. 4.8 and 4.6 (for energy supply and human powered transportation respectively) implies that architects always employ strategies geared towards energy supply and human powered transportation on the site. Subsequent strategies of regenerative architecture such as rainwater collection and water purification (3.4), and waste consumption (3.2) are often adopted. The least mean rate of strategies like control of local weather (2.9), food production (2.6), Air Purification (2.5), provision of habitat for local species (2.6) and finally soil enrichment (2.5) implies that these strategies are seldom adopted.

Further discussions with respondents reveal that architects are beginning to focus on ways to harness additional sources of renewable energy to power their projects in site design. Finally, it can be inferred that architects tend to focus on strategies that directly affect humans with less interest on the impact on the other species that are part of the entire system.

4.3.2. Adoption of Regenerative Architecture Strategies in Buildings

This section poses questions to respondents based on the extent to which they employ regenerative architectural strategies in promoting environmental sustainability in buildings. Ten (10) strategies were listed and respondents were required to select how often they employ these strategies on a five-point Likert scale varied from 1= Never (being the lowest), 2= Seldom, 3= Sometimes, 4= Often, to 5= Always (being the highest), in their design of buildings.

Table 4.4: Adoption of Regenerative Architecture Strategies in Buildings

SN	Regenerative Architecture Strategies	Count	Mean
1.	Aesthetic Appearance	141	4.6028
2.	Daylight Utilization	139	4.5971
3.	User Comfort	139	4.5540
4.	Human Powered Circulation	141	4.1418
5.	Passive Cooling	141	4.1277
6.	Impact on Surrounding	141	4.0780
7.	Self-maintenance	137	4.0730
8.	Indoor Air Purification	141	3.7872
9.	Use of Recycled Materials in Construction	141	3.0922
10.	Material Recycling	141	2.9929

Table 4.4 reveals the extent to which respondents employ strategies of regenerative architecture in buildings and these responses were ranked from the highest mean to the lowest. The highest mean rate of approx. 4.6 implies that architects always employ strategies geared towards achieving aesthetic appearance, daylight utilization and user comfort in building design. Subsequent strategies such as human powered circulation and passive cooling at 4.1, impact on surrounding and self-maintenance at 4.0 reveal that these strategies are often adopted by architects in building design. This further implies that their building designs minimizes the building's reliance on mechanical systems thereby reducing the energy requirement of the building.

Furthermore, adoption of strategies such as indoor air purification (3.7), use of recycled materials in construction (3.0) and finally material recycling (2.9) show the lowest mean rate implying that they are sometimes adopted . This buttresses the fact that architects focus mainly on strategies that promote energy conservation and utilization. This is as a result of numerous factors with the inadequate energy supply in this region being a major determinant of these strategies.

5. Conclusion and Recommendations

In assessing the regenerative architectural principles employed by architects in promoting sustainable development: a case study of architects in Lagos, Nigeria, it is rather imperative to provide a framework through which variables of regenerative architectural principles can be understood and how its principles can be adapted locally.

A review of relevant literature cited yielded evidential records which demonstrates the benefits regenerative architecture and the adoption of its principles. Furthermore, a general assessment of architects in Lagos, Nigeria identifies the regenerative architectural principles they often employ in their design and findings from the analysis of the survey reveals results that reflect that architects generally adopt strategies that are geared towards regenerative architecture in their design but are however not familiar with the concept by definition. In order to promote and encourage the intentional adoption of these principles and strategies, more research and discussion surrounding the concept as a whole should be supported and organized.

Recommendations suggested by this study includes enlightenment of professional architects on the concept and principles of regenerative design to help in mitigating the declining state of the built environment. Furthermore, regenerative architectural principles should be included in the design and construction of the built environment and a structured assessment method should be put in place to achieve and assess regenerative designs.

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