Issues and Challenges Involved In Green Building Concept Innovations Adoption In Construction Practice

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Amusan Lekan M[1], Michael Oluwakorede[2], Oloke Clement[3], Adelakun Adegbenjo[4] Garba Rishi[5]
1-2 Building Tech. Dept. Covenant University. PMB 1023.Ota. Ogun State.Nigeria.
3 Estate Management Dept. Covenant University. PMB1023. Ota. Ogun State. Nigeria.
4 Building Tech. Dept. School of Vocational and Technical Education.Azare. Bauchi State. Nigeria.
5 Building Tech. Dept. Oke Ogun Polytechnic. Oyo State. Nigeria.
Email:1 lekan.amusan@covenantuniversity.edu.ng,

Abstract. Green concept is globally creating impact with diverse application at various facet of human endeavour. The concept involved the practice whereby energy is utilized in a way that it would not jeopardise continuity of energy usage in the environment. The aim of this study is to explore the issues and challenges that surround the adoption of green concept in Nigeria focusing on built environment with a view to enhancing the rate of adoption of the concept for an increased healthy environment. The study adopted convenience sampling method to pick the population for the study, which comprised of picking construction companies that engaged on a project that involved green building features. Population frame of 250 professionals that are registered with professional bodies that cut across 20 selected construction firms was used for the study. A structured questionnaire designed in Likert scale of 1 to 5 was distributed among 50 respondents for data collation. The data was later processed using content analysis, descriptive statistics and relative agreement index. Data was collated on parameters that include evaluation of existing issues and challenges involved in green building concept innovations adoption in construction practice, current green concept practice in construction, challenges involved in adoption of green concept in construction, critical issues involved in green concept adoption, drivers for success in the adoption of green concepts in construction, challenges involved in adoption of green concept in construction. Innovative illustrations of integration of green concepts in buildings. Mean Item Score was used with relative agreement index, this was used to rate the perception of respondents on parameters calibrated for respondents to answer. Categorical regression analysis was used to carry out comparative analysis of respondents' submission on success factors that influences the adoption of green building concept and challenges involved in the adoption of green building. Some other parameters were further explored, they include, innovative approach to sustainable construction practice and perspectives to green building practice. The analysis of the study brought to fore factors to be taken into consideration for effective adoption of green building concept. The challenges such as thought reengineering and philosophical and cultural adjustment need to be further harnessed for people to leave the built environment better than it was met.

Key words: Green-building, Innovations, Energy , Impact. Challenge

1. Introduction

These Green environment is highly desirable for every individual especially across the globe. The desire is often reflected in the choice they makes daily in the choice of type of habitation, internal and external decoration of such habitation and the interaction of the habitation with environment. The type of interaction with the environment is often dependent on the choice of input and output of activities to the immediate environment. However, the concept is not new to European and Asian countries. For instance in China the mediaeval construction which involves surrounding habitation with vegetation that replenishes the depleted oxygen due to human environmental interaction has been reenacted. Often times, human activities tend to overuse the environment resulting into environmental abuse such

as constructing non-ecofriendly houses, energy non efficient houses and non-green building compliant buildings. Similarly the low and moderate income population who can afford to construct low cost, sustainable, and eco-friendly houses are not always very keen in constructing such houses. Reasons for these kinds of attitudinal issues are to be tested using scientific and empirical studies. Thus, strategies for faster and equitable development of green buildings could be formulated. The study therefore assesses the level of development of Green building practice in the built environment of Nigeria. The aim of this study is to explore the issues and challenges that surround the adoption of green concept in Nigeria focusing on built environment with a view to enhancing the rate of adoption of the concept for an increased healthy environment.

1.1 Understanding Green Concepts In Built Environment

Green concepts in ecological parlance entails leaving an environment in a stable ecological condition without jeopardizing the biomass balance. In environmental protection parlance, green concept involve having zero emission to the environment in way that atmospheric air mass within such environment is maintained. In construction parlance, green concept starts from design stage, construction stage and up to the point of handling over to the client. In design, green concept involve the use of green material and green design concept. In construction it involve the use of eco-friendly materials with low emission of unusable energy [1] and [2].

However, some of the aspect of integration of green building concepts in building construction includes the following: Use of Solar system to heat water, use of glass panels for daylighting, harvesting rain water for storage, the use of environmentally friendly building materials and specifications. Also, waste minimization, healthy indoor air movement, minimizing and maximizing the use of energy in buildings and manufacturing and use of equipment and tools that are energy compliant and sufficient.

2. Review of Related Literature

Review of selected literatures was presented in this section. The selected presentation includes: [3],[4], [5] and [6].

In [6], a study was conducted on smart car parking system. The aim of the paper is developing a smart parking system. The intelligent features were incorporated in the car park system for prompt notification for opening and closing of the gates.

Also, in [5], an investigation was carried out on smart home security, issues, challenges and countermeasures involved. The study identified the significance of home security using green concepts approach. The study later recommended application of sensor based application to create home green home solutions

Similarly, a study was carried out by [4], on sustainable green smart buildings. The author submitted that the gateway to unlimited innovations adaptation in buildings construction and design is giving room to innovative approaches in design process and construction. This could be achieved by taking multi-perspective approach to the choice of design concept, choice of materials particularly eco-friendly materials. This approach would afford the building occupants access to luxury that accompanies green design concepts. The study access among other things The Gulf Energy Council Energy situation, Sustainable buildings solution and what should be a sustainable building objectives, high rated building systems and services.

Finally, [4] researched on Intelligence of Intelligent Building, the study was focussed on exploratory approach to green buildings. The study was carried out as a survey on projects at Technical research centre Finland VIT Building Technology in 1993 to 1997. The feasibility of integrating green component to building was explored. The study recommended inclusion of multi criteria concept in integration of functions in an intelligent building.

3. Methodology of Research

The study adopted convenience sampling method to pick the population for the study, which comprised of picking construction companies that engaged on a project that involved green building features. Population frame of 250 professionals that are registered with professional bodies that cut across 20 selected construction firms was used for the study. A structured questionnaire designed in Likert scale of 1 to 5 was distributed among 50 respondents for data collation. The data was later processed using content analysis, descriptive statistics and relative index. The data was analysed using Mean Item Score, Simple percentages and regression analysis. The study used questionnaire survey to collate information from respondents. The collated data was examined using content analysis method by classifying the information and categorised them under appropriate headings. Data was collated on parameters that include evaluation of existing issues and challenges involved in green building concept innovations adoption in construction practice, current green concept practice in construction, challenges involved in adoption of green concept in construction, critical issues involved in green concept adoption, drivers for success in the adoption of green concepts in construction, challenges involved in adoption of green concept in construction. Innovative illustrations of integration of green concepts in buildings. Mean Item Score was used with relative agreement index, this was used to rate the perception of respondents on parameters calibrated for respondents to answer.

3.1. Presentation of Data and Results of Data Analysis

Retrieved questionnaires were subjected to content analysis and revalidation, analysis was carried out on them and results presented in the Tables 1 to 5.

3.2. Current Green Concept Practice In Construction

Table 1 Existing Application of Green Concept Practice In Construction Field

S/N	Existing Application of Green Concept	R.A.I	Rank
1	Green Design and construction practice	0.87	1
2	Integration of Eco-friendly material in building design	0.87	1
3	Highly ergonomic design that reduces building operation cost	0.86	3
4	Highly ergonomic design that reduces energy consumption cost	0.83	4
5	Adoption of non-environmental pollution prone items	0.79	5
6	The use of system that reduce energy use in Buildings	0.78	6
7	Integration of features that improve indoor air quality	0.77	7
8	Recycling system for domestic generated building waste	0.76	8
9	Waste reduction in building	0.75	9
10	System that conserve natural resources	0.72	10

Legend: R.A.I. …… Relative Agreement Index

In Table 1, Existing application of green concept practice in construction field was presented. Some of the current practice presented is as reflected in the Table 1. Green Design and construction practice top the list with RAI value 0.87 ranked 1st alongside Integration of eco-friendly material in building design with RAI value of 0.87. Similarly, highly ergonomic design that reduces building operation cost was ranked 3rd with RAI of 0.86. Highly ergonomic design that reduces energy consumption cost with RAI 0.83 was ranked 4th Adoption of non-environmental pollution prone items with RAI 0.79 was ranked 5th , The use of system that reduce energy use in Buildings RAI 0.78 ranked 6th, Integration of features that improve indoor air quality RAI 0.77 was ranked 7th. Recycling system for domestic generated building waste was ranked 8th with RAI 0.76 while waste reduction in building RAI 0.75 and System that conserve natural resources with RAI 0.72 was ranked 9th and 10th respectively.

3.3. Critical Issues Involved In Green Concept Adoption

Table 2 Issues Involved In the Adoption of Green Concept

S/N	Critical Issues In Green Concept Adoption	R.A.I	Rank
1	Expensive nature of the eco-friendly materials	0.88	1
2	Expensive nature of the whole green building concept implementation.	0.88	2
3	Non-proliferation of Green building design codes	0.87	4
4	Lack of technical capability	0.83	5

5	Government reluctance in supporting of the spread of the concept	0.73	6
6	Need for professionals and artisan to upgrade their knowledge	0.72	7
7	Lack of green building projects that could serve as case study for referral purpose	0.71	8
8	Contractors' inadequate experience in the implementation of the green building practice.	0.70	9
9	Limited technology for green building practice	0.67	10
10	Challenge of availability of capacity to maintain green buildings	0.62	11

Legend: R.A.I. …… Relative Agreement Index

Table 2 presents critical issues involved in the adoption of green buildings which form one of the focal points of this study. Top on the list of the issues is Expensive nature of the eco-friendly materials ranked 1st high with RAI value of 0.88 alongside with Expensive nature of the whole green building concept implementation with RAI value of 0.88. Also, Non-proliferation of Green building design codes ranked 4th with RAI 0.87, Lack of technical capability RAI 0.83 ranked 5th, Government reluctance in supporting of the spread of the concept RAI 0.73 was ranked 6th, Need for professionals and artisan to upgrade their knowledge with RAI 0.72 was ranked 7th. The need to provide green project prototype as referral was ranked 8th with RAI of 0.71, while Contractors' inadequate experience in the implementation of the green building practice with RAI value of 0.70 and Limited technology for green building practice with RAI value of 0.67 were ranked 9th and 10th respectively.

3.3.1. Critical Success Drivers In Green Concept Adoption

Table 3a Drivers for Success In The Adoption of Green Concepts In Construction

S/N	Success Driver Parameters	R.A.I (Average)	Rank
1	Availability of standard codes for green building component implementation	0.79	1
2	Establishing training and skill acquisition centre for green building related empowerment	0.75	2
3	Green concept value reorientation	0.75	2
4	Developing sense of value of giving back to the ecosystem.	0.75	2
5	Provision of relevant technologies for green building practice	0.73	5
6	Provision of an affordable green building materials	0.72	6
7	Ergonomic design	0.70	7
8	Environmental regeneration conscious philosophy	0.70	8

Legend: R.A.I. …… Relative Agreement Index

In Table 3 critical success factors and drivers of effective adoption of green concepts was presented in Table 3. Availability of standard codes for green building component implementation was ranked 1st with RAI of 0.79, follow with Establishing training and skill acquisition centre for green building related empowerment which was ranked 2nd, Reorientation towards green concept value inculcation was ranked 3rd with RAI of 0.75, while developing sense of giving back value to the ecosystem with RAI 0.75 was also ranked 2nd . Similarly, Provision of relevant technologies for green building practice RAI of 0.72 was ranked 5th, Provision of an affordable green building materials with RAI 0.72 was ranked 6th. , Ergonomic design with RAI 0.70 ranked 7th while Environmental regeneration conscious philosophy was ranked 8th with RAI value of 0.70.

Table 3b. ANOVA Test on Differences in Opinion of Professionals on Drivers for Success in the Adoption of Green Building Concepts.

Levene Statistics	Sum of Squares	df	Mean Square	F	Sig. (2 tailed)	Remark

Between Professional groups Censored	.680	135	.967	3.193	0.669	NSD

Levene's test for equality of variance was carried out on the data extracted from companies' professionals and the Levene Statistics analytical output was presented in the 1.5.3b. Categorical regression analysis was carried out on the tested parameters using an independent sample t-test in order to determine the level of significance difference in opinion among professionals sampled in the study area on the critical success factors that influence the adoption of green building concepts in construction work. Certain criterion were used they are criterion for effective size, .01 =small effect, .06 =moderate effect, .14 =large effect. S contained in a study carried out by [5] and [6].

The above table shows that all the variables that have their level of significant below 0.05 based on Levenes' Statistical values and ANOVA rule. There is no significant difference in opinion among the professionals on the identified factors since the Sig. Value of 0.669 was greater than Sig.Value 0.05, it shows no clear difference in the opinion of construction professionals as regards the adoption of green building concepts in building instruction.

3.3.2. Challenges Involved In Adoption of Green Concept In Construction.

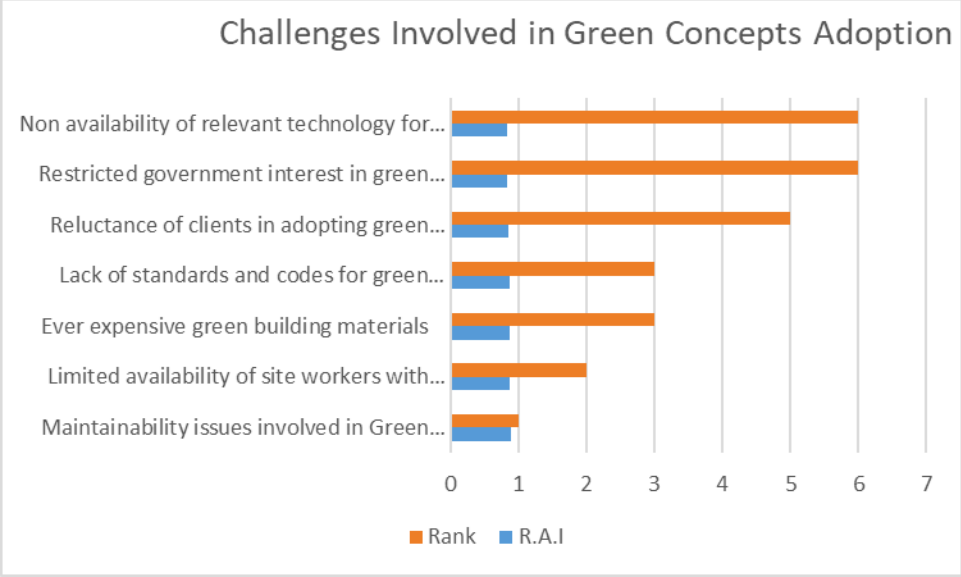

Fig 1. Challenges Involved in Green Concepts Adoption in Construction.

Legend: R.A.I. …… Relative Agreement Inde

Challenges involved in green concept adoption in building was presented in Table 4. Some of the challenges identified include, Maintainability issues involved in Green building components and Limited availability of site workers with green building skills which was ranked 1st and 2nd with Relative Agreement Index Value (RAI) of 0.88 and 0.87. Also, Ever expensive green building materials RAI 0.86,ranked 3rd, Lack of standards and codes for green

building practice RAI0.86 ranked 3rd , Reluctance of clients in adopting green building concepts with RAI 0.85 was ranked 5th , Restricted government interest in green building practice was ranked and Non availability of relevant technology for capacity development were ranked 6th with RAI value of 0.83 respectively

3.3.3. Inovative Approaches to Green Concept Integration In Building

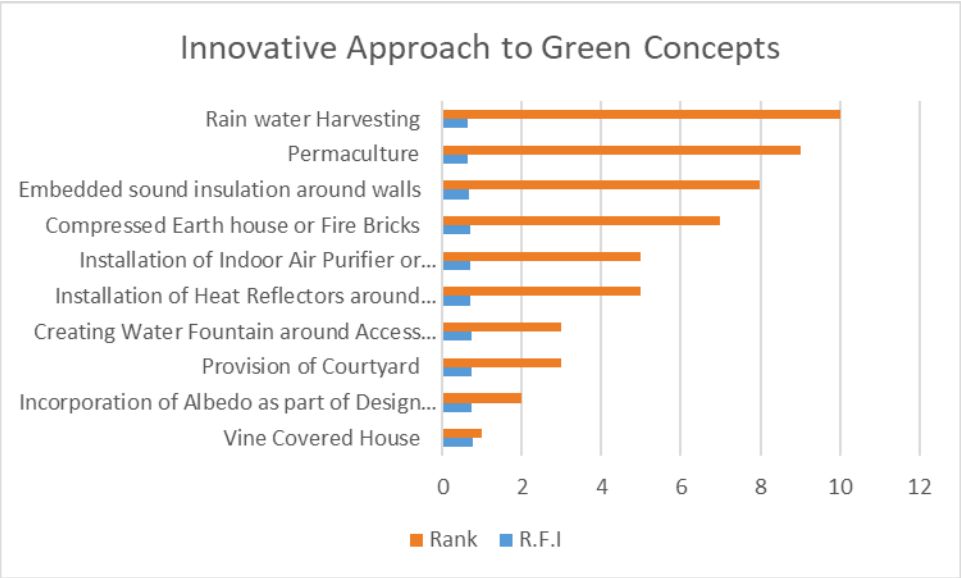

Fig. 2 Innovative Approach to Green Concepts
Legend: R.A.I. …… Relative Agreement Index

Innovative approaches that could be used in green building construction was presented in Table 5. The innovations were subjected to familiarity test among the focused professionals, this assisted in determining the type of innovations that could be used to aid green concept compliance of buildings. Vine coverage and incorporation of Albedo as part of design in building was suggested, they were ranked 1st and 2nd with relative familiarity index (RFI) of 0.76 and 0.74 respectively. Courtyard provision, Inclusion of water fountain around courtyard or foyer were also suggested and ranked 3rd with RFI values 0.73 respectively. Others with their RFI values and ranks include installation of heat reflectors around building, installation of indoor air purifier or dehumidifiers, compressed earth house or fire bricks, embedded sound insulation around walls, permaculture and rain water harvesting.

3.4 **Innovative Approaches That Could Be Adopted In Green Building**

3.4. 1 Perspectives to Innovative Strategies in Green Building Management

In furtherance to presentation in Table 5, the issue of innovation in green project management is viewed in this study from the perspectives of technological innovation and non-technological innovations(Energy conserving design and innovations).

a. Technological-based Innovation: The configuration design and production process involved in green project execution is basically technological oriented. Therefore, management of the quality of end-product is largely determined by the interplay of actors and the process adopt. Actors refer to the professional involved in the project design and configuration. However, technological-based innovations in this context consist of Energy conserving design and innovations.

b. Energy conserving design and innovations: Traditionally, industrial pollution should be addressed right from the production process rather than the end-of-pipe approach which has proved to be ineffective, thus pollution and energy conservation process should form part of production process of organization. Environmental impact programme on the product of the organization should be carefully observed throughout the product lifecycle, through integrating environmental strategies and practices into the management of the production systems. Negative environmental impacts resulting from building elements are basically assumed to occur as a result of energy consumption in construction, renovations and maintenance works. The negative impacts are attributed to the emissions released due to the energy and material used for heating cooling and lighting of building and the renewal of the element at the end of its lifetime [5]. Waste and indoor air quality issues are also connected to the emissions released during use and renewal of building element. Therefore the negative environmental impacts of the emissions and 5 resource depletion can be grouped as: global warning, mineral depletion water depletion, acidification, fossil fuel depletion, human toxicity, smog, insolation, radiation effect and others. The negative impacts of energy consumption and activities in the built environment can however be taken care of, through the following suggested innovative approaches: vine covered-solar house, solar-paneled house, compressed-earth block-walls house, rainwater harvesting, albedo, permaculture, agri-aqua-culture.

i). Vine-covered House: This is an innovation will keep off poisonous gas from surrounding of a building through carbon dioxide gas emissions from house interior will be absorbed by the plant around the House. The idea behind this kind of house will be constructing a house that will be able to keep occupant free of any sort of heat stressor. Therefore the glass panes will be reflective type and solar reflective in nature. The house will as well have a waterfall, this is to absorb moisture from the air, dry air feels more comfortable, so there will be less need for air-condition. Therefore, this innovation will reduce energy consumption required in cooling house interior.

ii). Permaculture: This is the art and science that applies pattern found in nature to the design and construction of human and natural environments. Sustainable living system can truly be achieved when such patterns and principles are applied to the built environment. The elements should be designed in a way that will not disturb the natural environment. A balanced ecosystem can be created around the house to allow for exchange of resources from plant to human and the living things around.

iii). Compressed-Earth House: This is the situation whereby compressed earth block-wall which have been reinforced with wire and parched with plaster, with about 2 inches space between the facing walls are used in house construction. Recycled polystyrene materials like nylon or pure-water sachet, or even recycled styro-foam can be used to fill the 2inches gap.

iv). Solar Paneled House: Solar panel could be used as an alternative to power engine that combusts fossil fuels that result in environmental air pollution. Energy from the sun can be tapped by carefully installing the photo-voltaic system on the building for electricity. The panels can be installed at locations that are not in direct angle with isolation effect, since the photovoltaic panel functions best at fairly high temperature.

v). Rainwater Harvesting: This is another new option which can reduce urban draining problems which is creating serious challenge to conventional supply programme, however it is limited in that, it does not include rainwater harvesting, utilization of waste water or any programme for ground water recharge, thus the need for its inclusion

In ancient Japan, India and China and some other Asian countries, tanks, canals, stepwells and check-dam were often built to store excess rain water in flood prevention. The importance of this system lies in the charging of surrounding soil with water for later collection, water supply, storing of water in area where the groundwater is already toxified or with polluted surface water. The reviving of this dying old wisdom is necessary; it will help avoid over-flooding that tends to create heat aquifer when undergoing evaporation that often culminates in heat stress on the atmosphere and global warning.

4. Conclusions

The aim of the study that was stated at the beginning of the study has been achieved, that is, to explore the issues and challenges that surround the adoption of green concept in Nigeria focusing on built environment with a view to enhancing the rate of adoption of the concept for an increased healthy environment. The following has been achieved in the study, which includes: finding out the current application of green concept practice in construction field, issues involved in the adoption of green concept, critical success drivers in green concept adoption, challenges involved in green concept adoption in building and innovative illustrations of integration of green concepts in buildings. The

study discovered among other things that Green Design and construction practice and Integration of eco-friendly materials and design during design and construction top the list. As one of the strong factors, integrating green practice while conceptualizing a building project should mark beginning of the implementation of green concept. As long as the practice is being initiated, it is a matter of time for it to be wholly adopted as the times rolls by. Similarly, the expensive nature of the whole green building concept implementation and expensive cost of eco-friendly application are considered as some of the critical factors to be considered in the adoption of the green building concept. The products and materials usually being used in green building application are imported and so the cost should be reduced or subsidized or better being produced locally. Also, there is a need for provision of codes and standards to guide the implementation of green concepts at design and up to post occupancy stage [4],[5] and [6].

However, the following challenges are very crucial if success implementation of green construction is desired, they include maintainability issues involved in Green building components, limited availability of site workers with green building skills, ever expensive nature of green building materials and non-availability of relevant technology for capacity development. The challenges need to be tackled and neutralized for an effective adoption of green building concept innovation in building.

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