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Evaluating the Implementation of Green Construction (GC) within Kaduna Metropolis in Nigeria

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Abstract

The increasing rate urbanization is coupled with some problems such as; loss of arable land, material and water crisis, and serious environmental problems like air pollution, noise pollution and waste generated from buildings. Perhaps, this could be as a result of some activities of the construction industry. Despite all these glaring challenges and drastic measures, Green Construction developments and sustainable practices are embraced very slowly and practiced at slow pace in developed and developing cities. This development is worrisome and may be as a result of some factors and barriers affecting the sustainable practices within the built environment. GC reduces or eliminates negative impacts of construction activities on the environment, and can create positive impacts on our climate and natural environment. This study evaluates the implementation of GC in Kaduna metropolis based on the following objectives: the identification of concepts and principles of GC; determination of the barriers hindering the implementation of GC in Kaduna metropolis; and determination of the drivers enhancing the implementation of GC. A total of 1,067 questionnaires were administered to consultants, contractors, clients/end-users and staff of development agencies out of which 486 questionnaires were returned representing

45.55% valid response rate. Subsequently, they were analysed using descriptive statistics. It was established that the barriers of GC can be overcome by changing the thinking of stakeholders of the CI from cost to value, and from short-term to long-term. A way forward to an effective implementation of GC requires a multifaced collaboration among the key stakeholders of the CI by focusing on drivers that will drive its utilisation.

Keywords: *Green Construction (GC), Drivers of GC, Barriers of GC, Implementation of GC, Construction Industry.*

Introduction

The continued growth of the world's population has led to the implementation of resource-efficient measures in all areas of human activities especially in the built environment (BE) which has a significant impact on all resources while also affecting the air quality and transportation patterns of communities, both the present and the future generations (Michael Schwarz, 2007). The friendliest way to handle the environment is not to build. However, without construction, life can be miserable and threatening. What is needed is a dynamic equilibrium without any form of threat especially to the environment. The combination of these challenges gave birth to a new concept in design, construction/renovation, operation and maintenance of buildings in conformity with "sustainable practices for buildings" known as Green Construction (http://epp.eurostat.ec.europa.eu/statistic, 2011).

Green construction (also known as sustainable building) refers to a structure that in its design, construction, operation, maintenance, renovation, and demolition reduces or eliminates negative impacts and can create positive impacts on our climate and natural environment (http://www.epa.gov/greenbuilding/pubsabout). In other words, green construction design involves finding the balance between home building and the sustainable environment. This requires close cooperation of the design team, namely: architects, the engineers, quantity surveyors and the client at all project stages. Green Construction practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. GBs are environmentally friendly which encompasses energy use, water use, and storm-water and wastewater re-use (Satterfield, 2009). GBs combine energy and water efficiency systems, day lighting strategies, Indoor Environmental Quality (IEQ) systems and efficient building envelope system to provide comfort and positive impact to the occupants and the environment. Sustainability in construction is all about following suitable practices in terms of choice of materials, their sources, construction methodologies, as well as design philosophy so as to be able to improve performance, decrease the environmental burden of the project, minimize waste and be ecologically friendlier (Energy Policy, 2016). It enhances the environment against the negative side effect of construction activities; a clear answer to health, economic and environmental challenges; maximizes the resource savings, protects the environment, reduces pollution, provides people with healthy, comfortable and highly efficient space, and exist harmoniously with nature". The term "green construction", or "more sustainable building", does not have an exact definition, but, nevertheless, these terms have been used frequently (Qian & Chan, 2015). These clearly indicate that GB is a major response to ensure environmental sustainability globally within the construction industry. However, countries like China, USA, UK, Germany, Japan, Korea and other developed nations have embraced the concept fully; while other countries are prioritizing which feature to incorporate in to their buildings; whereas other countries are ignoring or slowly embracing the concept due to some reasons (Berardi, 2013).

This increasing urbanization is associated with loss of arable land, material and water crisis, and serious environmental problems like air pollution, noise pollution and waste generated from buildings (WU, 2010). The construction industry is guilty of many practices in this regard and it responded with a concept called Green Construction to ensure and promote environmental sustainability. Despite all these glaring challenges and drastic measures, Green Construction developments and sustainable practices are embraced very slowly and practiced at slow pace in developed and developing cities (Shanghai EXPO, 2010). This is worrisome and may be due to some factors and barriers affecting the sustainable practices within its built environment. Such factors may also be attributed to project stakeholders or the concept itself.

This study evaluates the implementation of GC in Kaduna Metropolis focusing on these objectives: the identification of concepts and principles of GC;

determination of the barriers hindering the implementation of GC in Kaduna metropolis; and determination of the drivers enhancing the implementation of GC.

LITERATURE REVIEW

SUSTAINABLE DEVELOMENT

Sustainability is a major concept underlying a variety of efforts to ensure a good quality of life for future generations. Sustainability in this way expresses solutions with regard to a whole system, with an entire combination of outcomes as expressed by a variety of comments and conclusions (Ferng and Price, 2005). The Bruntland Report (1987) defines sustainable development as "… meeting the needs of the present without compromising the ability of future generations to meet their needs". This definition indicates that the environment and social issues are as paramount as economic issues, and suggests that human, natural, and economic systems are interdependent. It also involves intergenerational justice, highlights the liability of the current situation of the state for the wellbeing of thousands yet unborn, and involves the idea that present generation are borrowing the planet, its resources, and its environmental function and quality from future generations (Kibert, 2005). The term Sustainable Construction (SC) is generally used to describe the application of sustainable development in the construction industry. In 1994, the Conseil International du Batiment (CIB) defined sustainable construction as "…creating and operating a healthy built environment based on resources efficient and ecological principles" (Kibert, 1995). Hill and Bowen (1997) extend the definition to four pillars: social, economic, biophysical and technical. Du Plessis (2002) defined it as "a holistic process aiming to restore and maintain harmony between the natural and built environments, and create settlements that affirm human dignity and encourage economic equity". The CIB postulated seven principles of Sustainable Construction (SC) which inform decision makers during each stage of the design and construction process persisting throughout the whole life cycle of a building which are: reducing resource consumption, reusing resources, using recyclable resources, protection nature, eliminating toxics, applying life-cycle costing and emphasizing quality (Kibert, 2005). To obtain optimal solutions to current difficult construction and infrastructure problems, it is vital to consider environmental technical, social, political and economic aspects, their synergies and the inevitable balances between them.

A Sustainable Construction (SC) does not simply mean to continue its business and growth, but also needs to meet the principles of sustainable development, which mean it may need, in some cases, to stop growing or grow in different ways (Du Plessis, 2002) until such ambitious technicality is being achieved.

CONCEPT OF GREEN CONSTRUCTION

The term green construction is generally used to describe the application of sustainable development in the construction industry. In 1994, the Conseil International du Batiment (CIB) defined sustainable construction as "creating and operating a healthy built environment based on resources efficient and ecological principles" (Kibert, 1995). Hill and Bowen (1997) extend the definition to four pillars: social, economic, biophysical and technical. Du Plessis (2002) defined it as "a holistic process aiming to restore and maintain harmony between the natural and built environments, and create settlements that affirm human dignity and encourage economic equity". To obtain optimal solutions to current difficult construction and infrastructural problems, it is vital to consider environmental technical, social, political and economic aspects, their synergies and the inevitable balances between them. Sustainability in this way expresses solutions with regard to a whole system, with an entire combination of outcomes as expressed by a variety of comments and conclusions (Ferng and Price, 2005).

PRINCIPLES OF GREEN CONSTRUCTION

Site and Land Use

Land is one of the most essential elements that support the life of human, animal and plant. Human activities can give significant impact to the environment and have to be strategized properly to support flora and fauna. It is important to choose the most suitable site and create a sustainable building planning to enhance the land use as well as improving the site surrounding.

A "brownfield" site is one of best way in reducing the negative impact as well as to conserve the environment ecosystem. Brownfield sites are previously used sites. Previously used can include any type of built structure, including industrial uses associated with contamination (Sassi, 2006).

All of the natural elements should be considered and the building design must be properly executed in creating a harmony development with nature.

Energy Conservation

Zero energy building is not a realistic solution but low energy building design would be the most possible target to achieve in sustainable building design. Every building needs energy to operate and effective energy management will be the best method in reducing the negative impact to the environment. At the same time, active and passive sustainable building's elements should operate together which may also depend on criteria such as climate, site location, social activities, economic issue, season and building use.

Currently, people have to spend extensively to receive good energy supply as well as to assure their buildings are well operated. Minimizing energy usage would be one of the best solutions to tackle some issues which related to the cost and maintenance.

Due to the unrealistic effort to achieve a zero-energy building, method called as zero-CO2 would be another way to contribute towards a sustainable building design. At the same time, we must understand the difference between zero-CO2 and renewable energy. Some energy sources such as river, wind and sun which are considered as renewable energy are not included as zero-CO2. Renewable energy needs some applications which are related with technology and system such as photovoltaic, solar thermal and wind energy.

Water Management

Water is one of the important elements that contributes towards a sustainable building design. "Contemporary problems in water resources management and resources management in general, are characterized by increasing complexity (Pahl-Wolst et al, 2007). The big issues related with this element include water treatment, minimizing water usage and waste water discharge should be considered. Both passive and active sustainable strategies can be applied simultaneously but still restricted to certain criteria.

In reducing the amount of wastewater produced, the first step is to reduce the amount of water used by means of various types of water facilities and methods. To achieve this, one of the best ways is to minimize the need of water. Users also need to be educated about water facilities in their building and strategies to save water usage.

Sustainable Materials

Sustainable materials give a big impact to building design starting from the aesthetic value to its cost and built ability. The impacts associated with material to building design and environment should be taken at the early stage in producing a sustainable building. Besides, the impact from the natural world should also be considered to create a sustainable building material. "The natural world has an immense amount to tell us about how to achieve sustainability. It uses energy far more efficiently and effectively and is capable of producing materials and structures that are far more benign than anything we have achieved in industry (Godfaurd John et al, 2005). All factors in choosing building materials such as manufacturing process, transport requirements, final disposal and material's resources contribute in recognizing a sustainable building material. It is essential to know about the impacts of building materials and one materials assessment known as Life Cycle Assessment (LCA) can evaluate the impact of construction elements to the environment. Life Cycle Assessment (LCA) is the assessment of the impacts associated with materials from their resourcing and manufacturing to their disposal (Sassi, 2011).

All of building's products come from natural sources and need suitable manufacturing process to produce it. Every single building's product possesses different method which related with its embodied energy.

Indoor Environmental Quality

Indoor environment quality is another essential factor to create a sustainable building design. This factor can influence especially human's health which most of us do not realize. Deaths can happen due to the unhealthy indoor environment. Many kinds of development can affect our indoor environment which can give a negative impact without noticeable.

A healthy indoor environment can influence people's activities. A term known as Sick Building Syndrome which mainly associated with office building usually occurs in most building design. It happens due to certain problems associated with improper building design such as poor air quality, building control and limited natural light act. "This syndrome, known as Seasonal Affective Disorder (SAD) manifests itself through the occurrence of sleepiness, fatigue, depression, carbohydrate, carving and weight gain. In some individuals SAD has been successfully counteracted with the use of full-spectrum artificial lights (Sassi, 2011).

Good lighting either natural or artificial lighting is necessary element for a sustainable building design.

Innovation

Innovation functions as the compliment element to create a sustainable building design. It would be an element to encourage people and professionals to apply sustainable approach during construction process as well as in their daily life. Professionals such as architects, engineers, quantity surveyors and are encouraged to implement sustainable work environment as well as a positive strategy to attract people to be involved. Besides, government should encourage professionals, clients, contractors and suppliers to implement sustainable approach as part of their work ethics.

FACTORS TO CONSIDER IN GREEN CONSTRUCTION

Energy Efficiency

According to Santoli and Matteo (2003), the energy performance of a building must be calculated using standards that indicate the insulation of the buildings, the characteristics of technical systems and installed equipment, the position and orientation of the building in relation to other climatic aspects, exposure, its own capacity for renewable energy sources and other factors, such as indoor environmental quality, that could influence the energy requirements of the building.

Integrated Design

Reed and Gordon (2000) emphasized that the integrated design process encompasses cross-disciplinary team work enabling the improved integration of buildings, community, natural and economic systems and therefore, is a key to sustainable design.

There is considerable agreement among those in the field of sustainable design that cross-disciplinary team work early in the design process is essential to achieve the successful integration of building, community, natural and economic systems. Without the process of integration, systems are over designed and commonly function in conflict with one another.

In this concept, the client takes a more active role than usual, the architect, the structural, mechanical, and electrical engineers as well as the quantity surveyors take active roles at the early design stages. The team includes an energy specialist (simulator) and hopefully, a bio-climatic engineer, depending on the nature of the project, a series of additional consultants can be added.

Indoor Air Quality

The quality of indoor air depends on the concentration of pollutants at a particular moment in time. The perceived air quality is also dependent on the air temperature and the relative humidity which, in turn are linked. Health problems from inferior air quality include lung cancer, sick building syndrome (SBS), symptoms and discomfort problems like bad smells and experience of dry air.

Thermal Comfort

Creating thermal comfort for man is a primary purpose of the heating and air conditioning industry and this has a radical influence on the whole building industry. Comfort is not a product which is provided for building occupants, it is a goal which they achieve provided they are able to exert the necessary control over their environment (Shove et al., 2008). The control they exert over the environment will partly be decided by the building they occupy and its services and, may be subject to constraints (Cole et al., 2008). The aim of the building must be to allow occupants to achieve their comfort goal. People adapt more readily to thermal environments with which they are familiar. The building should therefore be designed to provide a thermal environment that is within the range customary for the particular type of accommodation, according to climate, season and cultural context.

Visual comfort

Visual comfort is brought about by having good lighting which is adequate both in quality and quantity. The source of light may either be natural or artificial or a combination of both. In any case, windows have distinct advantages. Today there are still many new buildings that do not fully utilize the benefits derived from using natural light. Efficient day lighting considers heat gain, glare, different light levels, uniformity and solar penetration.

The three basic rules of good day lighting are: avoid direct sunlight on heavy viewing tasks to prevent glare, let natural light in through skylights and good-sized windows that give deeper penetration and better distribution and filter daylight and bounce it off surrounding surfaces with the use of vegetation, curtains, sunscreens and shades. When locating buildings in a particular site, correct spacing, together with proper orientation must be maintained to enhance natural lighting. Adequate window openings must be maintained to ensure that building interiors get enough natural lighting.

Site Suitability

Site suitability enquiry is essential as this ensures that the site can legally and physically accommodate the type and size of project being envisaged. When selecting sites for developmental purposes avoid sites in noisy areas and ensure compatibility with existing facilities. Determine what else is planned for the site in the future.

Acoustic Comfort

Sleeping disturbances are commonly reported as an important problem related to traffic noise (Griefahn and Spreng, 2004). Apart from secondary stress effects from sleeping disturbances, there are studies that suggest an association between residential road traffic noise exposure and hypertension.

Spatial Comfort

This is a concept that is used to express building layouts that are designed to maximize the space use and improve accessibility within the buildings such that the occupants derive comfort from such arrangements (Hiller and Hanson, 1984). The building should be spacious to enhance the free circulation of air.

Building Integrity

The crippling costs of corruption in the practice of sustainable construction can be reduced significantly through the application of proven principles and mechanisms such as building integrity. The basic approach is to stipulate actions that are corrupt both morally and ethically.

Table 1: DRIVERS OF SUSTAINABLE CONSTRUCTION

S/N	Drivers of SC
1	Educational programs for developers, contractors, and policy makers related to GBTs
2	Public environmental awareness creation through workshops, seminars, and conferences
3	A strengthened GBTs research and communication

4	Availability of better information on cost and benefits of GBTs
5	Financial and further market-based incentives for GBTs adopters
6	Environmentally-friendly energy technologies
7	Land use regulations and urban planning polices
8	Sustainable construction materials
9	Re-engineering the design process
10	Incentive program
11	New cost metrics based on economic and ecological value systems,
12	Performance-based on standards

Source: Manoliadis and Tsolas (2006); Ashe, 2003); Hayles (2004)

Table 2: BARRIERS TO SUSTAINABLE CONSTRUCTION

S/N	Barriers to SC
1	Lack of knowledge on green technology
2	Perceived high cost
3	High initial costs
4	Lack of a legal requirement to report sustainability, poor support from senior management, no demand from shareholders for sustainability reporting
5	Additional cost
6	Incremental time
7	Limited availability of green suppliers and information
8	Inadequate Increased Market Value of Sustainable Buildings to Cover the Extra Initial Costs.
9	Lack of funding, restrictions on expenditure and reluctance to incur higher capital cost when needed
10	Unwillingness to Pay the Additional Initial Costs of the Green Buildings.
11	Durability of green materials
12	Difficulty of Providing Special Expertise for Sustainable Construction.
13	Decelerated Construction Speed to Fulfill the Added Sustainability Requirements

14	The Sustainable Building Beneficiary Being Different from those who Pay for the Sustainable Construction
15	Lack of Effective and Sufficient Governmental Support.
16	Difficulty of Providing Special Expertise for Sustainable Construction.
17	Plentiful, Impractical, and Inconsistent Methods, Standards, and Guidelines
18	Difficulty of Providing Special Materials for Sustainable Construction (Cost, Availability, Maintenance).

Sources: Castillo and Chung (2005); Tafazzoli (2018)

MATERIALS AND METHOD

Materials

Conference papers, academic research journals and text books were extensively used in the review of literature.

Methods

Literature review and questionnaire survey

The study adopted two approaches (*literature review* and *questionnaire survey*) in gathering secondary and primary data with a view to achieve the research aim. Extensive *literature review* helps in getting relevant information on concept of green GC, attributes and principles of GC, factors to consider in GC, Sustainable Construction (SC), Drivers of SC and Barriers to SC that are established around the globe. The drivers and barriers identified from literature were employed to construct *questionnaire*. Questionnaire is mostly used for descriptive and analytical surveys to find out the opinions, facts, expectations and aspirations, membership of various groups, and attitudes and perceptions and views of respondents relevant to the study (Siniscalco and Auriat, 1998; Naom 1998; Enshassi et al., 2010). Another reason for adopting questionnaire survey is because it offers researchers the opportunity to reach a large number of potential respondents in different locations (Russell, 2006).

Population of the Study

The population for this study comprises the consultants, contractors, clients/end-users and staff of development agencies involved in the construction business.

Sample

Inferences about the population for this research was made on the basis of a properly designed and well selected sample. Moreover, in this research, samples were drawn from the target population based on a statistically determined, efficient sample size so as to estimate some parameters of the population.

Sample Size Determination

Since there is no documented evidence that indicates or shows the total number of consultants, contractors, clients/end-users and staff of development agencies in Nigeria, therefore, the population for this study is considered as infinite (unknown). Based on the foregoing, Cochran's (1977) formular for the determination of sample size was adopted as expressed below:

<u>Assumption</u>

P = (50%) 0.5

1 – P, 1 – 0.5 = 0.5

Step (2): 0.5 x 0.5 = 0.25

Step (3): Divide $Z_a/2$ by E, 1.96/0.03 = 65.33333333

Step (4): Square step (3), $(65.3333333)^2$ = 4268.4444444

Step (5): multiply step (2) by step (4), 0.25 x 4268.444444 = 1,067

Therefore, 1,067 questionnaires were deemed statistically adequate for the survey.

Data Analysis Techniques

The average index method (A.1) was used herein to determine clients', consultants' and contractors' perceptions of the relative importance of the identified performance factors. The average index was computed based on Abd. Majid and McCaffer, 1997 approach

Average Index (A.1)

$$= \frac{(1x1 + 2x2 + 3x3 + 4x4 + 5x5)}{N}$$

Where N = Total number of respondents

X1 = Frequency of not important response

X2 = Frequency of fairly important response

X3 = Frequency of important response

X4 = Frequency of very important response

X5 = Frequency of highly important response

With the rating scale shown below (Abd. Majid and McCaffer, 1997)

1. = Not important (1.00< Average index <1.50)
2. = Fairly important (1.50< Average index <2.50)
3. = Important (2.50< Average index <3.50)
4. = Very important (3.50< Average index <4.50)
5. = Highly important (4.50< Average index <5.00)

RESULTS AND DISCUSSIONS

Results

Survey on respondents' status in the construction industry

The survey shows that out of the one thousand and sixty-seven (1,067) questionnaires administered, a total of four hundred and eighty-six (486) valid questionnaires were retrieved which represents 45.55% effective response rate. The responses from each category of the respondents are as follows: contractors form 132 (27.16%), consultants form 98 (20.16%), clients/end-users form 149 (30.66%) and staff of the development agencies form 107 (22.02%)

Survey on respondents' qualification

The data collection on respondents' qualification shows that the respondents with Ordinary National diploma (OND) constitute 11%, respondents with Higher National Diploma (HND) form 28%, respondents with Bachelor of Science (BSc) form 36%, respondents with Masters of Science (MSc) constitute 19% and respondents with PhD form 6%. That shows majority of the respondents are educated. That would further authenticate the reliability and validity of data obtained from the survey.

Survey on respondents' experience in the implementation of green construction

Respondents who are below 5 years constitute 18%, 5-10years forms 39%. 11-15years form 18%, 16-20years form 15% and above 20years constitute 10%. That has shown majority of the respondents are highly experienced in the construction industry. That has also helped the validity and reliability of data obtained in this study.

Table 3: Ranking on the Drivers of SC in descending order of influence

S/N	Drivers of SC	Average Index (A.1)
1	Educational programs for developers, contractors, and policy makers related to GBTs	4.6
2	Public environmental awareness creation through workshops, seminars, and conferences	4.56
3	A strengthened GBTs research and communication	4.56
4	Availability of better information on cost and benefits of GBTs	4.48
5	Financial and further market-based incentives for GBTs adopters	4.42
6	Environmentally-friendly energy technologies	4.35
7	Land use regulations and urban planning polices	4.08
8	Sustainable construction materials	4.03
9	Re-engineering the design process	3.98
10	Incentive program	3.60
11	New cost metrics based on economic and ecological value systems,	3.35
12	Performance-based on standards	3.24

Source: Research survey (2021)

Table 4: Ranking on the barriers of SC in order of severity

S/N	Barriers to SC	Average Index (A.1)
1	Lack of knowledge on green technology	4.5
2	Perceived high cost	4.5
3	High initial costs	4.48
4	Lack of a legal requirement to report sustainability, poor support from senior management, no demand from shareholders for sustainability reporting	4.44
5	Additional cost	4.41
6	Incremental time	4.32

7	Limited availability of green suppliers and information	4.06
8	Inadequate Increased Market Value of Sustainable Buildings to Cover the Extra Initial Costs.	4.02
9	Lack of funding, restrictions on expenditure and reluctance to incur higher capital cost when needed	3.67
10	Unwillingness to Pay the Additional Initial Costs of the Green Buildings.	3.63
11	Durability of green materials	3.47
12	Difficulty of Providing Special Expertise for Sustainable Construction.	3.3
13	Decelerated Construction Speed to Fulfill the Added Sustainability Requirements	3.3
14	The Sustainable Building Beneficiary Being Different from those who Pay for the Sustainable Construction	3.21
15	Lack of Effective and Sufficient Governmental Support.	3.17
16	Difficulty of Providing Special Expertise for Sustainable Construction.	3.06
17	Plentiful, Impractical, and Inconsistent Methods, Standards, and Guidelines	3
18	Difficulty of Providing Special Materials for Sustainable Construction (Cost, Availability, Maintenance).	3

Source: Research survey (2021)

CONCLUSION

The implementation of SC within Kaduna metropolis is affected by some barriers which include: *lack of knowledge on green technology, perceived high cost, high initial costs lack of a legal requirement to report sustainability, poor support from senior management, no demand from shareholders for sustainability reporting, additional cost, incremental time* among others. And these barriers hinder the smooth implementation of SC. However, it was found that the following drivers enhance the smooth implementation of SC: *educational programs for developers, contractors, and policy makers related to GBTs, public environmental awareness creation through workshops, seminars, and conferences, a strengthened GBTs research and communication, availability of better information on cost and benefits of GBTs, financial and* *further market-based incentives for GBTs adopters* among others. Although, the drivers influence is in order of priority as ranked by the respondents in table 3. The implementation of the drivers of SC will lead to attaining some certain benefits during life of the green buildings. and these benefits include: *energy efficiency, low impact on environmental pollution and the importance of going green.*

It can be deduced that the barriers of GC can be overcome by changing the thinking of stakeholders of CI from cost to value and from short-term to long-term. A way forward to an effective implementation of GC requires a multifaced collaboration among the key stakeholders of the CI by focusing on the determined drivers that will drive its utilisation. Also, there is the need to educate and sensitize the key stakeholders of the construction industry on the benefits of adopting SC. Subsequent work in this area should validate the findings of this research or otherwise.

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