

Socio-Economic Benefits of using Green Materials for the Construction of Low-Cost Buildings in Nigeria

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Abstract

It is explicit that earth and other green materials as been in use from time immemorial for construction of building at an affordable price before civilisation and adoption of conventional materials for construction works. However, in the resent era, the price of housing as increased to the extent that it is beyond the capacity of lower and middle class to construct or buy building of their own. Therefore, this paper is assessing the socio-economic benefits of using green materials for erection of structure at affordable prices. A quantitative method was adopted in carrying out this study using purposive sampling approach in data collection. Four hundred structured survey instruments circulated among the construction professionals in the north-central part of Nigeria, seeking their views on the benefits of using green materials towards provision of building at reasonable price. The responses received (76.20%), were analysed using analysis of moments (AMOS) via structural equation model (SEM). The results show that green material is cost-effective, readily available, energy efficiency, reduced cost of construction, reduced waste, improved the economy of the community promotes cultural heritage, adaptable to the environment, eco-friendly, enhance social wellbeing, and reduced carbon dioxide emission. Therefore, it is recommended that an integration of green materials will promote provision of more buildings to the citizenry at affordable rate.

Keywords: Green materials; Affordable price; Socio-economic benefits; Purposive sampling; Structural equation model; Nigeria.

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1. Introduction

The aspiration of people to build the house of their own or ability to own residential property is very high, but this remains a mirage due to the high cost of conventional materials. There are different versions of the definition of green materials by various scholars, and some defined it as sustainable environmentally friendly materials, while others feel that they are materials that are natural and subjects to reuse and recycle in building construction. Green materials are sustainable material, give high performance and save the precious environment [1], said as long as materials have a favorable effect on the environment that materials considered as green. Since building with conventional material at affordable rates becomes an issue in recent times, thus re-introducing green materials as alternative material will no doubt ease the flight of low-income earners in the country. Green materials are natural and recycled materials such as earth bricks, bamboo, recycled materials from waste, and others that are readily available within our environment. The socio-economic benefits of these materials assessed in this paper and the results of the Structural Equation Model (SEM) subsequently discussed.

1.1. Affordable building

Building construction cost in the current century remained rocketed to the extent that it is now difficult for the low and middle-income earners to facilitate or construct the building of their own at an affordable rate; as a result of this there a lot of abundant or uncompleted buildings are within the community across the nation. The perception of building at a reasonable and economical cost is a challenging matter and remains a persistent and extensive difficult for several nations [2]. Internationally, accommodation affordability defines in many ways. The most common definition of affordable building refers to the housing affordability is taken as a measure of spending on construction or buying housing to income of the household [3]. Wikipedia defines affordable building as an element that can be afforded by that segment of people whose revenue is lower than the intermediate household revenue, the Us and Canada defined it as the ability of potential owner to have a building of his own at a cost not more than thirty per cent of his income annually [4,5], described an inexpensive building as a notion that is used to describe socio-economic and growth environs, that purpose of certifying if building to be developed for people can be achieved at an affordable cost by the target group of people within the low and middle-income earners. According to [6], there is major problem in the provision of adequate housing to the populace globally. It reveals that many people across all types of urban centers could not afford to have a building of their own or even afford the cost of paying rent [7], discovered that materials and construction methods adopted in accomplishing the building have a significant effect on the expensiveness and unaffordability of building to members of the society. In Malaysia, Reference [8] concluded in a study that notwithstanding the existence of inexpensive housing strategy for the State of Johor, housing cost remains at higher cost which makes difficult for majority of the people to achieve the aim of having personal house, and this reflected in the fact that the housing index for some of the area was harshly excessive amounts and mainly tricky for the people of the state to accommodate.

1.2. Green Building materials

The building materials are one of the significant components in the construction industry that determines the

overall total cost of constructing the building as it constitutes the most significant single input in executing a project [9]. Due to the escalated price of the conventional materials, stakeholders in the building industry now suggest alternative materials known as green materials to reduce the overall cost of construction[10,11,12,13]. Accordingly, potential green materials are materials that are locally oriented and renewable that are environmentally friendly; they composed of renewable rather than non-renewable resources [14]. It was further revealed by [14] that mixing of the natural materials into the construction of housing could mitigate the effect of the environment problem links with the production, conveyor, processing assembly, construction, recycle, reuse, and discarding of these materials.

In a study, Reference [15] indicates the following as promising building materials for the construction of affordable housing:

- Bamboo/Timber
- Compressed earth bricks
- Adobe blocks
- Recycle materials
- Improved concrete panel



Figure 1: Various sizes of planks

Figures 1, 2, and 3 show some of the available green materials in Nigeria. Bamboo are materials that are generally available in Nigeria, they are multi purposely use in construction of building at various stage of the building projects, in addition is it tension strength that has been established by materials expert to be more than that of mild steel[16,17]. According to [18] , bamboo is known to be one of the most fasted growth plants in the world and now considered as a replacement of steel and wood in construction activities. Timber is also a common material that is used for formwork, support, roof trusses, etc. in building construction process, it is

available in various sizes and types (see figure1) at a reasonable price depending on the specification required[19,20,21].

Compressed earth brick is made from selected soil and has been the first building materials since the existence of humans. The technology of compressed earth bricks has, in recent times, increased and may be used to produce housing at affordable, durable, and robust [22]. According to[23], the materials for bricks are readily available, produced in mass, and required little or no maintenance with high durability and load-bearing capability.



Figure 2: Earth brick column and the materials that used to made it.



Figure 3: Thatches in stock with roof in place

1.3. Benefits of green materials

The benefits of green materials are numerous and readily available in most of the countries across the globe. The

introduction of green materials brings the cost of constructing a structure to the barest minimum and more cost-effectiveness as well makes accommodation affordable for more people in society [9]. Furthermore, Reference [24] reveals that rammed earth wall is 40% lower than the cost of a standard stud wall, including labour cost [24]. stressed that there are other benefits such as pleasant comforts and energy efficiency and unseen ecological benefit like enhance more oxygen to the environment [25], also postulates that green materials such as earth has a comparative environmental advantage over the building constructed of conventional material In the study carried out by [26], obtainability and affordability, among other advantages, are some of the significant benefits of using green material in building construction in Ghana [26]. Concludes that the flexibility and simplicity in technology of the usage of green materials promote the transfers of knowledge between the stakeholders in the building industry, individuals and communities at large can easily participate in the activities of constructing their building at an affordable cost. The summary of the previous study on the benefits of green materials presents (Table 1).

Table 1: Previous study on the benefit of GMs

No	Author(s)	Objectives of the study	Benefits of Green Materials
1	Gohnert, Bulovic, & Bradley (2018) South Africa	The need to develop low cost housing alternatives to make housing more affordable to people	Green materials as an economical solution to the provision of building at affordable cost
2	Danso H. (2013) Ghana	To examine and analyse the benefit and problem of houses constructed with local materials in developing country	Promotion of cultural heritage, readily available, temperature regulation, affordable and cheap
3	Kumar, Gupta, Sagar, Singh, & Haroon, (2017) India	To review the alternative construction materials and techniques for building design	was established that fly ash brick, one of the green materials is comparatively low cost than the conventional bricks
4	Adegun & Adedeji, (2017) Nigeria	To review the economic and environmental advantages and disadvantages of earthen materials for housing in Nigeria	The earthen construction material discovered to have benefit of cost and cost to the environment.
5	Shen, Yang, Zhang, Shao, & Song, (2019) China	Assessment of bamboo benefit and barrier for promoting bamboo as a green material in china	The benefits of using bamboo summarised as; low cost, large scale and fast growth, lightweight and high strength, environmentally friendly, and socio benefit.

2. Methodology

In carrying out this study, a purposive sampling was adopted, and survey questionnaire were distributed to Nigerian Building Construction professionals, such as; the Architects, Quantity surveyors, Building engineers,

Civil engineers, and others that were recognised associates member of their respective organisation's body in Nigeria. Out of the four hundred survey forms dispersed in the north-central states of Nigeria, 95 were inappropriate responses either by incomplete filling or wrongly filled by respondents, therefore, make it unusable for the intended purpose. Thus, the 305 representing 76.20% questionnaires, which were suitable after the screening, were used for the data analyses. Table 2 shows the percentage distribution and the suitability of the responses accommodated in this research.

Table 2: Total number and percentage of overall responses

Sample	Number of responses	Percentage %
Building Professionals	400	100.0
Unsuitable questionnaires	95	23.8
Suitable questionnaires	305	76.2
Overall response rate		76.20

2.1. Analysis and Result Discussion

The structural equation model (SEM) used in carrying a confirmatory factor analysis (CFA) of the constructs. The construct, which was on socio-economic benefit (economic viability) of green materials, contains 15 indicators that evaluated in confirmatory factor analysis. The 15 observed variables derived from two sub-scales in part D of the survey (Figure 4), was the first measurement model for the concept of economic viability of green materials, and (Table 3) the displays for the first measurement model for economic viability of GMs construct.

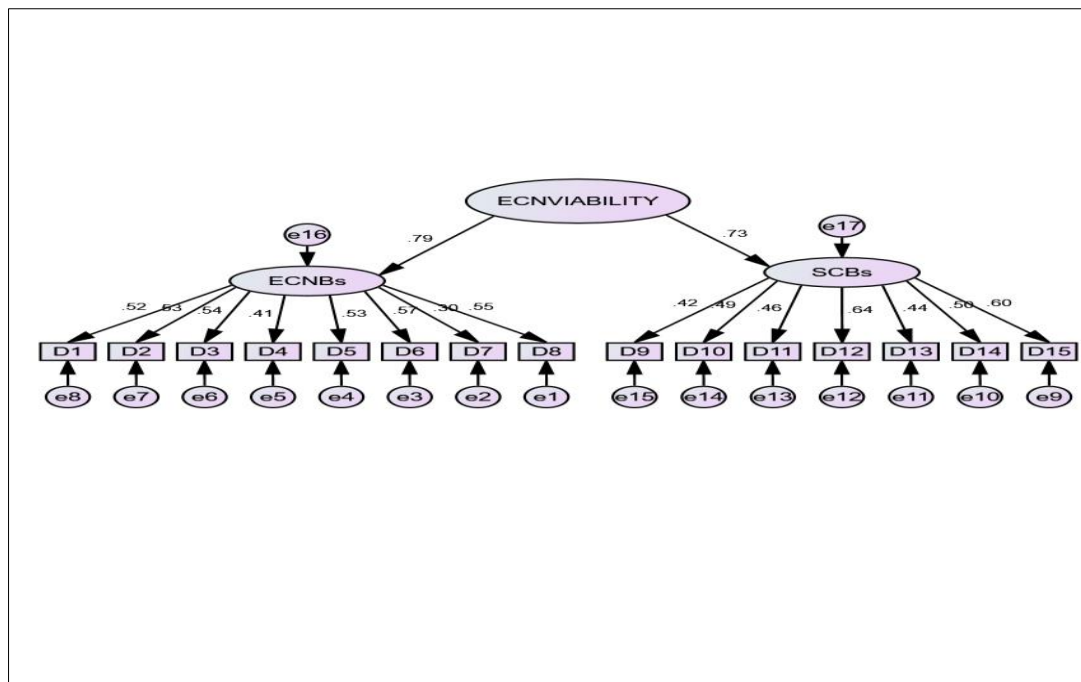


Figure 4: first measurement model (CFA) for construct on socio-economic benefit

Table 3: Details of the first measurement model for concept on socio-economic benefit of GMs

Construct	Sub-construct	Code	Indicators
Economic Viability of GMs	Economic Benefits	D1	Cost-effectiveness
		D2	Readily available
		D3	Energy efficiency
		D4	Create a job for people
		D5	Reduced cost of construction
		D6	Reduced waste
	Socio-benefits	D7	Aesthetics /beautification
		D8	Improved the economy of the community
		D9	Promote cultural heritage
		D10	Improved occupant productivities
		D11	Adaptability to the environment
		D12	Eco-friendly
		D13	Improved social capital
		D14	Enhance social well being
		D15	Reduced CO2 emission

The parameter of the suitability index (Figure3), specifies the unfitnes of the initial measurement model, with indices results of ChiSq/df 2.331 less than 3.00, with AGFI, CFI, TLI and NFI all less than 0.90 except GFI of 0.916 which is greater than the specified 0.900, and (RMSEA=0.066 < 0.08). Thus, the model required adjustment by trimming the variables that less than 0.50 to accomplish a suitable index. The revised model for the construct on the socio-economic benefit of GMs, once low load items excluded, the final model (Figure 5) satisfied all the indices parameter for the acceptance of the results: P-value =0.041, RMSEA=0.046, GFI=0.977, AGFI=0.957, CFI=0.954, TLI=0.93, NFI=0.900 and ChiSq/df = 1.63. (Table 4) displays the indicators for the modified measurement model for concept on socio-economic benefit of green materials for affordable housing in Nigeria.

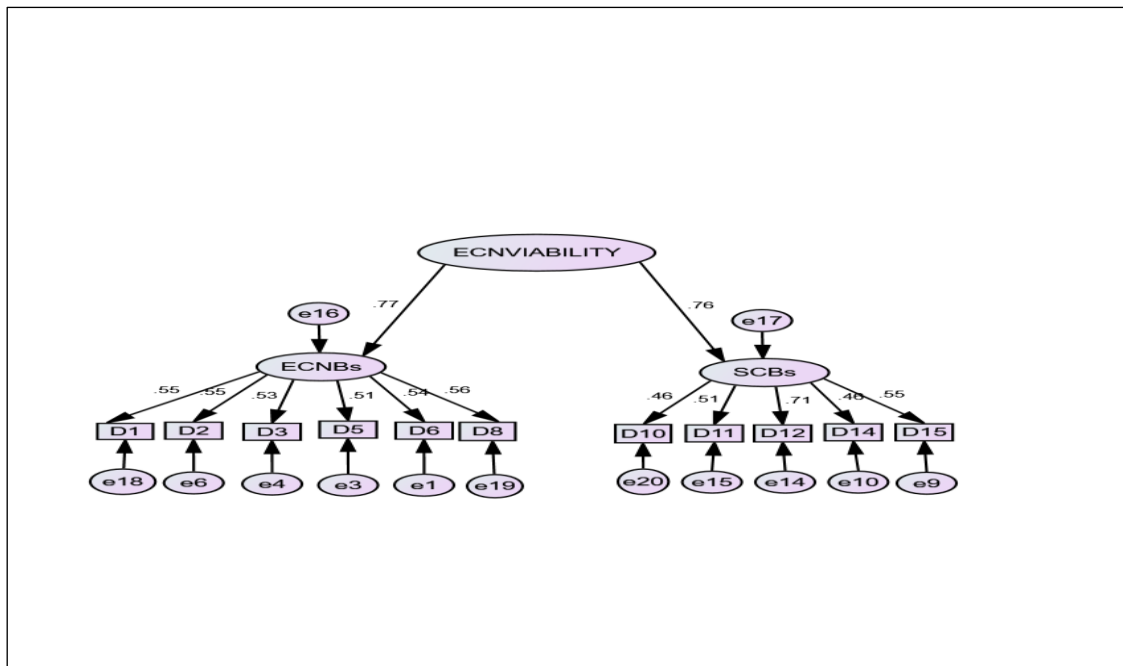


Figure 5: Modified measurement model for construct on socio-economic benefits

Table 4: Details for the modified model for construct on socio-economic benefits of GMs

Construct	Sub-construct	Code	Indicators
Economic Viability of GMs	Economic Benefits	D1	Cost-effectiveness
		D2	Readily available
		D3	Energy efficiency
		D5	Reduced cost of construction
		D6	Reduced waste
		D8	Improved the economy of the community
		D10	Improved occupant productivities
		D11	Adaptability to the environment
	Socio-Benefits	D12	Eco-friendly
		D14	Enhance social well being
		D15	Reduced CO2 emission

The composite reliability and convergent validity for the model also realised with the CR value of 10.8, and 7.20 (≥ 0.6) and an AVE value of 1.80, and 1.44 (≥ 0.6). The overall fitness parameter accomplished. Table 5 displays information on the reliability and validity evaluation for the model.

Table 5: Validity and reliability assessment for economic viability of GMs measurement model

Constructs	Sub-construct	Items	Factor Loading (≥ 0.5)	AVE (≥ 0.6)	CR (≥ 0.6)
Economic Viability of GMs	Economic Benefits	D1	0.55	1.80	10.80
		D2	0.55		
		D3	0.58		
		D4	deleted		
		D5	0.51		
		D6	0.54		
		D7	deleted		
		D8	0.56		
	Socio-benefits	D9	deleted	1.44	7.20
		D10	0.46		
		D11	0.51		
		D12	0.71		
		D13	Deleted		
		D14	0.46		
		D15	0.55		

3. Conclusion

This study assessed the socio-economic benefits of using green materials for the realisation of affordable buildings for the average citizen of society. Analysis of moment structure (AMOS) a statistical software was used to carry out the structural equation modelling (SEM) on the useable data collected; the finding reveals

that there are sound benefits of using green materials for construction of low-cost housing. The benefits include; cost-effectiveness, readily available energy efficiency, reduce waste, improve the economy of the community, improve occupants' productivity, adaptability to the environment, eco-friendly, enhance social wellbeing and reduce the emission of carbon dioxide. This outcomes of this study closely related to the results of [22, 9,25,27,28,29] on the advantages of using green materials. Thus, it is recommended that the adoption of green materials for construction works will promote the provision of more buildings at affordable prices in the developing country.

4. Acknowledgement

Gratification goes to the Malaysia Ministry of Education (MOE) through the Research University Grant (RUG) funding number 1501, and the government of Nigeria that established Tertiary Education Trust Fund (TETFUND) for financial assistant while conducting this research project.

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