Determinants of sustainable building materials (SBM) selection on construction projects

Emmanuel Chidiebere Eze, Quantity Surveying Department, Federal University of Technology, Owerri, Nigeria.

Rex Asibuodu Ugulu, Quantity Surveying Department, Federal University of Technology, Owerri, Nigeria.

Onyealilam Peter Onyeagam, Quantity Surveying Department, Federal Polytechnic, Nassarawa, Nigeria.

Adesoji Anthony Adegboyega, Quantity Surveying Department, Waziri Umaru Federal Polytechnic, Birnin Kebbi, Nigeria.

emmanueleze001@gmail.com

ABSTRACT

The complexity and fragmented nature and the multiple stakeholders in the construction industry often make it difficult to come up with a firm decision regarding sustainable building materials selection. The wrong choice could negatively impact the project objective and performance outcome. This study assessed the critical factor influencing the choice of sustainable building materials (SBM) selection on construction projects in the Southeast geopolitical zone of Nigeria. Data were collected using a well-structured questionnaire, non-probability (purposive and snowball) sampling techniques, and an internet-mediated survey. Data analyses were carried out using the appropriate descriptive and inferential statistical tools and exploratory factor analysis (EFA). The study revealed recycled plastic, natural clay and mud, stone, bricks and tile, cellulose, stray bales, grasses, limestone, and wood timber, are the commonly used sustainable building materials. Also, their level of awareness is high while their adoption is moderate. EFA revealed that the major clusters of determinants of the choice of green building materials are: emissions minimisation, low running cost and reusability, low thermal and energy consumption efficiency, low cost and high health and safety consideration and waste minimisation. The key factors influencing the choice of sustainable building materials selection in construction are: reducing greenhouse gas emissions from buildings, materially embodied energy cost, operating and maintenance costs, non-toxic or low toxic emissions generated by the products/materials, recyclability of the building materials, availability of the technical skills, renewable (reusable) properties, inhibiting the impact of buildings on the environment, safety and health of the occupants, and appearance and aesthetic. It is recommended that consideration be given to these factors in selecting sustainable/green building materials in the designs and specifications of construction projects.

KEYWORDS: Construction industry, Construction project, Green building, Nigeria, Sustainable building materials.

INTRODUCTION

The construction industry of any country drives infrastructure development and by extension, reinforces economic development. According to Onyeagam *et al.* (2019), the construction industry stimulates and influences employment creation and national economic growth. In the quest of both the developed and developing countries to meet the infrastructural needs of their citizenry, they utilise the construction organisations in the industry to provide roads, rail tracks, recreational facilities, bridges, residential and commercial buildings, and other infrastructures. These physical and social infrastructures are developed in response to the ever-growing human population (John *et al.*, 2019), and their needs. In the same vein, Enshassi *et al.* (2016) submit that additional infrastructure and facilities are required to support the economic development of growing economies. Thus, a large quantity of water, energy, and material resources are consumed (Ding *et al.*, 2010; Ogunkah & Yang, 2013) to provide for the infrastructural needs of the citizenry.

However, despite the importance of the construction industry, and owing to its huge energy, water, and materials resources requirements, its activities contribute massively to unsustainable development, which heavily impacts the environment and by extension, the economy (Alsanad, 2015). The global environmental issues experienced by nations are caused by building and construction-related activities (Hwang & Tan, 2012; Zhang *et al.*, 2011). Construction activities put more pressure on natural resources, and according to Majdalani *et al.* (2006), this extra pressure severely affects the environment and living organisms. The environmental impact results in loss of bio-diversity and imbalance in the ecosystem (Oke *et al*., 2019). Aside from the activities of the built environment, the transportation and industrial process involved have a significant share in the environmental impact (Ahn *et al.*, 2013). The processes and products used in conventional construction methods have been blamed for these issues (Baloi, 2003). This implies that the traditional conventional construction processes use unsustainable and eco-unfriendly materials, and the products are not friendly to the environment.

Sustainable building materials are special materials adapted to achieve sustainable construction (Sheth, 2016). They are environmentally responsive and can mitigate environmental problems such as greenhouse gas emission, pollution, imbalance in the ecosystem, and other issues being experienced with the conventional types. These materials are reusable or recyclable and have zero effect on the environment; as such are known as 'friends of the environment' (Oyegiri & Ugochukwu, 2016). It was submitted by Aghimien *et al*. (2016) that SBM meets the need of the present generation without compromising the needs of future generations. Therefore, it follows that securing the needs of both the generation of people living now, and those of the future is a key driver for SBM popularity and adoption. Overall, Ogunkah and Yang (2012) argued that incorporating sustainability in the material selection exercise requires an assessment of the significances of prospective material options on the environmental, economic, social, sensory, and technical dimensions.

In Nigeria and other developing countries, extant literature has shown that the level of awareness of SBM is high, but their adoption is low (Aghimien *et al.*, 2018a; Alabi, 2012; Alsanad, 2015; Anzagira *et al*., 2019; Aje, 2015; Baron & Donath, 2016; Susilawati & Al-Surf, 2011). The low adoption level has been blamed on a lot of factors which include: awareness and knowledge issues (Aghimien *et al.*, 2018), lack of holistic understanding of the green concepts (Baron & Donath, 2016), poor coordination of research efforts (Gomes &

Silva, 2007), poor attention to sustainability agenda (Oni, 2015), lack of attention on sustainability agenda (Davis & Davis, 2017), among others. Aghimien *et al.* (2018) further posit that the operational mode and process used in the construction industry of Nigeria is unfavourable to the attainment of sustainability. However, in a recent study by Jimoh *et al*. (2020), it was found that materials sourced locally were used at the construction phase of construction projects.

There is, however, growing attention on sustainability, as efforts toward eliminating the environmental damages inherent in construction activities have drawn attention to the need to scrutinise designs and materials choices (Ogunkah & Yang, 2013; Trusty, 2003) before actual construction. The choice of building materials and components has an impact on the performance of the building. Thus, Architects and design engineers have a lot of work to do when writing materials specifications. According to Zhou *et al.* (2010), accentuate that the level of awareness of the extent of the implications of the design decisions of the building design professional, utilising material information and techniques available, is dependent on several variables. With the presence of a variety of materials and products in the market, the choice of selecting befitting materials for building and their components becomes a complex task (Ogunkah & Yang, 2013; Zhou *et al.*, 2010). Thus, the job of materials evaluation and selection during specification becomes difficult with a wide range of choices, leading to wrong choices. The consequence of which is materials failure and underperformance of the building (Ding, 2008). Furthermore, at the early design stages, a lot of factors are not considered in the course of deciding on materials type, and the impact of this is additional expenses in terms of time and cost, general project performance issues (Ding, 2008; Gluch & Baumann, 2004).

Castro-Lacouture *et al.* (2009) opined that there are many factors to consider by construction experts when choosing materials. This choice, however, is influenced primarily by cost, appearance, and availability (Ogunkah &Yang, 2013). There is usually a conflict of criteria prioritisation when faced with multiple factors, which makes it difficult, complex and challenging for building and construction project designers to make a satisfactory choice of material selection. Innovation in materials and products development has led to so many suitable and eco- and health-sensitive materials and products with varying properties in the market. Jahan and Edwards (2013) posit that new and improved materials with superior properties and performance are constantly being developed, thus, increasing materials alternatives available for the designers and other professionals to choose from. Wastiels & Wouters (2008) have earlier submitted that the selection process of materials is made complex as it is determined and influenced by abundant prerequisite, decisions and consideration of building construction materials options. According to Akadiri (2018), at the design stage, parties such as the client, consultants, contractors, quantity surveyors, civil engineers, and the government department responsible for legislation; are involved and influence the decision to use a certain type of materials. These, however, make the materials selection process and decision even more difficult.

In addition to the foregoing, there is a dearth of studies regarding the variables or factors that influence, and are considered during the selection process of sustainable building materials on construction projects in Nigeria. Most especially in the geographical area of the current study. With this knowledge, this study aims to assess the factors influencing the choice of sustainable building materials selection in the construction industry of Nigeria. It seeks to identify some of the commonly used materials and determines the level of awareness and adoption in construction projects in the South-Eastern geopolitical zone of the country. To achieve the aim, the study assesses the views of clients, consultants, and constructor/sub-contractors within the study area, regarding the subject under consideration. The clients, consultants, and contractors are the key stakeholders in every construction projects. Thus, the leadership initiatives of these main contract parties are required to get the needed transformation (that is, from conventional buildings to sustainable ones) (Bennett & Crudgington, 2003). Professionals such as Quantity surveyors, builders, Engineers (civil and services engineers) and architects; have roles to play in materials selection. It follows that the task of achieving sustainability is not a one trade or professional affair. Thus, all hands must be on deck regarding the achievement of sound and more meaningful sustainable construction industry, and projects. The formulated hypotheses that guided this study are:

> H_{01}: There is no significant statistical difference in the respondents' perception regarding the assessed variables within the South-East zone.

> H_{02}: There is no significant correlation between the level of awareness and the level of adoption of the assessed sustainable building materials.

The outcome of this study will be useful to built environment consultants and other development experts in making the appropriate decision regarding materials selection for achieving sustainable construction projects. Corporate client organisations would also benefit from the findings regarding the materials that would benefit the health and comfort needs of the office environment for improved employees' performance and productivity. The study will add to the existing and scarce body of knowledge regarding sustainable and/ or green construction in Nigeria and other world developing economies.

The following sections covered the literature review regarding sustainable (green) building materials and the factors influencing the choice of their selections. The method employed in sampling the target groups of respondents, gathering of data, and tools used for analysing the gathered data are also explained. The results obtained are interpreted and discussed and a conclusion is drawn with relevant recommendations.

LITERATURE REVIEW

Sustainable (Green) building materials

Green building materials are those construction materials that possess at least a constructive environmental feature (Fithian & sheet, 2009). For material or product to be labelled or certified as 'eco' or 'green', they must have been grown or handled under a controlled environment that meets sustainable use standards. Thus, according to Badam (2017), Green building materials evolve from a process that does not cause inequality in the natural system. Peckenham (2016) and Cifani (2017) posit that green building materials production uses raw, harmless and safe inputs. These materials are mostly natural and locally occurring materials that do not cause harm to the environment. Shiva (2011) states that sustainable building materials are those materials that concurrently do the most with the least. These materials fit most pleasantly within ecosystem processes and assist in reducing the use of other materials and energy. Sustainable construction materials contributed to the achievement of a service-based economy.

Green materials are also known as sustainable materials, and they offer high performance and environmental safety. These materials meet the need of both present and future generals. Green materials are generally local and renewable, reclaimable, recyclable, and non-toxic materials. Green materials and sustainable materials are used interchangeably in this study to mean the same thing based on their contribution to environmental safety, greenhouse gas emission reduction, climate change reduction. They help reduce the carbon footprint of buildings and energy consumption. A summary of the identified green materials from literature and expert discussion are shown in Table 1. The majority of these materials and products were obtained from the review of literature such as (Cifani, 2017; Fithian & Sheets, 2009; Kim & Rigdon, 1998; Patil & Patil, 2017; Peckenham, 2016; The Constructor, 2019). The experts who contributed to the discussion of the study were later sampled at the data collection stage. These experts are consultants, contractors, architects, engineers, project managers, builders, and quantity surveyors; they were purposively selected based on their experience in the subject of this study.

Some of these green (sustainable) materials are explained below:

[i] Bamboo: this is a high and rapid renewable green material that architects seem to turn to quickly when a sustainable design is desired, especially for flooring. Bamboo flooring is a popular choice for traditional hardwood flooring. It is locally sourced in most of the countries of the world. This material has good tensile strength and is lightweight as well as its fast-growing renewable nature (Cifani, 2017; Peckenham, 2016; The Constructor, 2019). The high tensile strength of bamboo makes it a suitable substitute for steel reinforcement in concrete (Patil and Patil, 2017). Bamboo is economical, has a good appearance and survives any climatic condition (Fithian & Sheets, 2009).

[ii] Strawbale: this is another green building material that is economical, rapidly renewable, have good insulation property, fireproofing, soundproofing, and lightweight. It is a naturally occurring material used as framing materials and infill materials in non-load bearing walls. Strawbale can be used in place of concrete, wood, gypsum, plaster, fibreglass or stone (Cifani, 2017; Fithian & Sheets, 2009; Peckenham, 2016; The Constructor, 2019).

[iii] Mycelium: mycelium is a building material for the future and they are completely natural (Peckenham, 2016). It is a mushroom-based material that has found use in building and art installation. They are good for high-temperature areas, lightweight and strong, and good for insulation of homes (Peckenham, 2016; The Constructor, 2019).

[iv] Ferrock: Ferrock is a recycled material created with steel dust or ferrous rocks that were left on the landfill from industrial processes. This material is concrete-like and it is more resilient to weather elements than concrete. In the course of drying and hardening, these materials take up Carbon (IV) Oxide (Cifani, 2017; Peckenham, 2016), thus, making them carbon neutral and less injurious to the environment. This material can be used in place of cement and can be mixed to form staircases, pathways, driveways and other structures (Cifani, 2017).

[v] Wood: Wood is a product of properly managed forests that are renewable and provide biodiverse habitats (Peckenham, 2016). Trees absorb Carbon (IV) Oxide as they grow, and the processing of wood does not require a high-energy method. Wastages are encountered in converting raw timber to wood boards and other products, but these wastes can be recycled to make products like doors, walls, boards, among others (The Constructor, 2019).

[vi] Wool: wool is a natural alternative for chemical-laden insulation and requires less amount of energy to manufacture. Wool increases energy efficiency and provides eco-friendly insulation of property (Cifani, 2017).

[vii] Cork: cork is harvested from trees and does not harm the tree cork is highly renewable and have sound hypoallergenic properties (Cifani, 2017; Fithian & Sheets, 2009). Cork has found application in flooring in both residential and commercial buildings. This material insulates during winter, thus, saves electrical energy. Furthermore, they are fire-resistant, liquid resistant and with good soundproofing properties (Cifani, 2017; The Constructor, 2019).

[viii] Stone: stone is a durable building material that has found use in exterior works such as walling, facings, steps, flooring among others.it has good weather resisting property and can last more than 100 years (The Constructor, 2019).

[ix] Recycled plastic: Concrete is mixed with grounded recycled plastics and trash to produce lightweight sustainable materials that can reduce greenhouse gas emissions (Peckenham, 2016). The use of used plastics helps to reduce waste.

[x] Natural clay: with proper workmanship, an interior that is pleasing and aesthetically sound can be obtained using natural clay plaster. The use of natural clay plaster can help to reduce the use of gypsum-based plasters (The Constructor, 2019).

[xi] Cellulose: this material is a product of recycled paper waste. They are cheap, and because of their good insulating properties, have been found to be used globally (The Constructor, 2019).

[xii] Earthbag: this material can be commonly seen around check-points, military-based and around water banks. They are made with polypropylene bags filled with a pile of earth or sand; this material can be used for the construction of walls (The Constructor, 2019).

[xiii] Lime: Lime is a suitable replacement for cement in building construction; it purifies the air by absorbing Carbon and giving out Oxygen. It is less expensive than cement and buildings made with lime are more durable than cement made buildings (Patil & Patil, 2017). Colour lime plaster used as paint is waterproof and washable, and as time passes, its glossiness increase. In relation to conventional painting, it gives enhanced aesthetics (Patil & Patil, 2017). Walls painted with colour lime plaster normally give a surface with little or no maintenance.

[ix] Fly Ash: Fly ash is one of the by-products of coal combustion and it is also similar to volcanic ash. Fly ash can be used to produce various types of bricks; some of them are Clay fly ash bricks, Red mud-fly ash bricks, sand fly ash bricks and fly ash lime/gypsum bricks. According to Patil and Patil (2017), some of the social and environmental benefits of fly ash include; saving of topsoil, elimination of carbon emission, prevention of dumping of fly ash ponds, and provision of all-year-round employment.

The literature review and focus group discussion identified thirty-seven (37) green (sustainable) building materials. These materials are classified into three (3) major categories based on their sources and material makeup. These three classifications are (1) Composite Materials/ waste/by-product from building and industrials, (2) Natural occurring materials, and (3) Earth materials (see Table 1).

Table 1: Summary of Identified Green Building Materials

S/N	Green materials	Sources
A	Composite Materials/ waste/by-product from building and industrials	
1	Empty plastic bottles	Expert discussion
2	Worn out tyres	Expert discussion
3	Fly ash	Patil & Patil (2017).
4	Ferrock	Peckenham (2016); Cifani (2017)
5	Recycled steel	Cifani (2017)
6	Hempcrete	Peckenham, (2016)
7	Recycled Plastic	Peckenham (2016)
8	Ashcrete	Peckenham (2016)
9	Timbercrete	Peckenham (2016)
10	Insulated concrete forms	The Constructor (2019).
11	Earthbags	The Constructor (2019); Expert discussion
12	Polyurethane	The Constructor (2019).
13	Cellulose	The Constructor (2019).
14	Polystyrene and isocyanurate	The Constructor (2019).
15	Fibre Cement	The Constructor (2019).
16	Fibreglass	The Constructor (2019).
17	Steel	Kim & Rigdon (1998); The Constructor (2019).
18	Non-VOC paints	Fithian & Sheets (2009); The Constructor (2019).
19	Insulated Concrete Forms	The Constructor (2019).
20	Structural insulated panels (SIPs	The Constructor (2019).
21	GrassCrete	Peckenham (2016)
B	**Natural materials**	
22	Recycled wood	Peckenham (2016); Cifani (2017); The Constructor (2019)
23	Mycelium	Peckenham (2016); Cifani (2017)
24	Stray bales	Fithian & Sheets (2009); Peckenham (2016); Cifani (2017); The Constructor (2019).
25	Grasses	Focus group discussion
26	Bamboo	Fithian & Sheets (2009); Peckenham (2016); Cifani (2017); Patil and Patil (2017); The Constructor (2019).
27	Coconut fibre	Expert discussion
28	Wood Timber	Kim and Rigdon (1998); Peckenham (2016); The Constructor (2019).
29	Trees and Leaves	Expert discussion
30	Wool (Natural Fibre)	Cifani (2017); The Constructor (2019).
31	Cork	Fithian & Sheets (2009); Cifani (2017); The Constructor (2019).
32	Rice husk	Expert discussion
33	Cow dung	Expert discussion
C	**Earth materials**	
34	Stone	The Constructor (2019)
35	Bricks and tile	Kim & Rigdon (1998)
36	Limestone	Kim & Rigdon (1998); Patil & Patil (2017); The Constructor (2019).
37	Natural Clay and mud	Peckenham (2016); The Constructor (2019).

The adoption of these materials is helping to make modern construction to be environmentally friendly as they are recyclable, reusable which reduces waste and landfills arising from the huge construction wastes. Furthermore, these materials support occupants' health as they help improve air quality, reduce CO_2 emissions, and climate change.

Factors influencing sustainable building materials selection

There are many factors to be considered before the selection of materials for the construction of proposed projects. Wastiels and Wouters (2008) described materials selection as a complex process that is impacted and influenced by vast qualifications, judgments and thoughts. Even though there are a lot of variables to be considered in the quest for selecting materials at both the design and construction phases, efforts should be put at choosing strong, cheap and readily available materials (Wastiels & Wouters, 2008). One very vital strategy in the design and construction of green buildings is the selection of green (sustainable) building materials and products (The Constructor, 2013). The incorporation of green building materials and products (GBM&P) in building production assist in the preservation of non-renewable resources globally. Thus, the impact on the environment due to the extraction, transportation, processing, fabrication, installation, reuse, recycling, and disposal of these building industry source materials is reduced (The Constructor, 2013).

Akadiri (2018) investigated the perception of Architects regarding the factors affecting the selection of building materials and found that the client and climate are the most prominent. The climatic condition of a region should be given adequate consideration in the choice of building materials (Akadiri, 2015; Herda *et al.*, 2017; Marsono & Balasbaneh., 2015). The construction process will be improved when the climate of the proposed location of a project is given priority in the selection of materials. Thus, there would be financial, economic, social and environmental benefits (Marsono & Balasbaneh, 2015). The durability of the finished building, the safety of the project outcome, embodied energy, legislation and environmental impact; are the factors that influence the decision regarding materials selection in construction (Emmitt, 2011). According to The Constructor (2013), the resource efficiency criteria for selecting green materials include; recycle content, natural and renewable, resource-efficient manufacturing process, locally available, salvaged, refurbished or remanufactured, reusable or recyclable, and durable. The indoor air quality (IAQ) criteria include low or non-toxic, minimal chemical emissions, moisture resistance, healthfully maintained, and systems or equipment. Other criteria include affordability, water conservation, and energy efficiency.

The safety and health of the occupants have been posited to be important, as they sometimes exceed the cost durability of housing projects (Chan & Tong, 2007). It was further maintained that putting much emphasis on materials cost at the expenses of health and safety, could have a considerable implication on the overall wellbeing of the end-users. In the selection of composite sustainable materials, durability, functions and quality of the products should be the influencing factors. According to Ljungberg (2007), the choice of sustainable construction products is influenced by specific factors, including economic impacts, safe to use, low operating and maintenance, highly durable, very satisfying to end-users, customer requirements, and market demand environmental impacts. Glavic and Lukman (2007) suggest that for complex construction projects, the critical variables to be considered in selecting sustainable materials are: rapid renewable periods, low toxin emission, durable and low maintenance, easy to handle during building, safe to use and low energy and other resource consuming. Similarly, Zhou *et al.* (2009) identified factors crucial for materials selection to include: recyclable high content, harmless to use, emitting low contaminants, and free from harmful contaminants. However, harmless to use tops the most important factors that influence the building materials selection process.

Mora (2007) emphasised the need to use materials technical specification. This document could be a very useful input as it gives detailed technical and safety performance of materials. According to Mora (2007), the lack of use of the technical aspect of materials has resulted in a huge waste of materials and poor performance of construction projects. The quality of end-product and client's requirements is the client's major concern. Identifying factors related to the client's requirements lies in the designers and other professionals at the design stage to specify quality materials that could lead to the client's satisfaction. (Heijungs et al., 2010). Besides client satisfaction and materials quality, Heijungs *et al.* (2010) suggested that at the planning and design stages, factors such as the aesthetics of facades, occupants' satisfaction, and landscape quality are importantly considered too. Kim and Rigdon (1998) identified fifteen key qualities required to be possessed by a material (product) to be classified as green (sustainable) building materials. These qualities influence the choice of selection at the pre-building phase (manufacture), building phase (use) and post-building phase (disposal). These qualities include pollution prevention at manufacture, waste reduction during manufacture, contains recycled content, embodied energy reduction, use of naturally occurring materials, construction waste reduction, local materials, energy efficiency, water treatment and conservation, use of non-toxic or less-toxic materials, renewable energy systems, higher durability, reusability, recyclability and biodegradability. Certain performance criteria influence the choice of green building materials selection. These criteria as highlighted by (Patil & Patil, 2017) are locally sourced and produced, thermal efficiency, financial viability, occupants needs and health considerations, waste and pollution generated in the manufacturing process, recyclability of the building materials and the demolished building, maintenance costs, use of renewable resources, transport cost and environmental impact, toxic emissions generated by the products, and energy requirements in the manufacturing process.

According to the report by Intel Corporate Responsibility (2008), the decision to build a green rated building is influenced by the need to have a building that can provide healthier occupants work environment, greenhouse gas emission reduction from the building, and inhibiting the overall impact of the building on the environment. While environmental issues play a major role in the decision to undertake sustainable construction, a vital consideration is also given to the extraction of raw materials and harvesting, manufacturing processes, construction methods, and waste disposal from demolition (Kim & Rigdon, 1998). Building appearance and aesthetic characteristics should be considered in the course of choosing building materials (Ashby & Johnson, 2002). Cagan and Vogel (2002) and Wastiels and Wouters (2008) highlighted that visible benefits, efficient safety, fitness for use, durability, and serviceability are the six critical factors identified as crucial for selecting sustainable products, especially for large public construction projects. Materials characteristics, function, use, personality, shape, and manufacturing processes were identified as the elements industrial designers should consider during materials selection (van Kesteren *et al.*, 2005). The consideration of users' needs and sustainable resources at the design phase of construction projects has been reported (Jimoh *et al.*, 2020).

The selection of materials, when limited to a range of variables, could hinder the discovery of the sustainability properties of some materials (Wastiels *et al.*, 2007). Building and infrastructure designers should be well informed about these materials as their benefits are integral and pivotal for achieving sustainability. Although, the factors considered during the selection of materials is hinged on both objective and subjective measures. Thus, the quality and level of performance that would be obtained in a product or material will be dependent upon taking into account the subjective and objective variables (Florez *et al.*, 2010). Ogunkah and Yang (2013) found that environmental impacts, site-related issues, cost-effectiveness, socio-cultural impacts, technical performance and sensorial effects are the major dimensions of assessment criteria for green building materials selection in the production of low-cost housing. Table 2 summarises the selected factors influencing the choice of sustainable building materials selection in construction projects.

Table 2 Factors influencing the choice of GBM adoption in construction

	Factors influencing the choice of GBM utilisation	Source(s)
1	Water treatment and conservation	The Constructor (2013); Kim & Rigdon (1998)
2	Naturally occurring materials	Kim & Rigdon (1998)
3	Locally sourced and produced	Patil & Patil (2017); The Constructor (2013); Kim & Rigdon (1998)
4	Thermal efficiency	Patil & Patil (2017)
5	Financial viability and economical	Patil & Patil (2017);Wastiels & Wouters (2008); Ljungberg (2007)
6	Occupants needs and health considerations	Patil & Patil (2017)
7	Pollution prevention at manufacture	Patil & Patil (2017); Kim & Rigdon (1998)
8	Waste reduction during manufacture	Patil & Patil (2017); Kim & Rigdon (1998)
9	Recyclability of the building materials	Patil & Patil (2017); Ogunkah & Yang (2013); The Constructor (2013); Zhou *et al.* (2009); Kim & Rigdon (1998)
10	Operating and maintenance costs	Patil & Patil (2017); Ogunkah & Yang (2013); Ljungberg (2007)
11	Renewable (reusable) properties	Patil & Patil (2017); Ogunkah & Yang (2013);The Constructor (2013)
12	Non-toxic or low toxic emissions generated by the products/materials	Patil & Patil (2017); Ogunkah & Yang (2013); Zhou *et al.* (2009) ; Glavic & Lukman (2007);Kim & Rigdon (1998);
13	Energy required in the manufacturing process	Patil & Patil (2017); The Constructor (2013)
14	Healthier occupants work environment	ICR (2008)
15	Reducing greenhouse gas emissions from building	Ogunkah & Yang (2013); ICR (2008)
16	Inhibiting the impact of buildings on the environment	ICR (2008)
17	Readily available and affordable	Ogunkah & Yang (2013); The Constructor (2013); Wastiels & Wouters (2008)
18	Appearance and aesthetic	Ogunkah & Yang (2013); Heijungs *et al.* (2010); Ashby & Johnson (2002)
19	Fitness for use and client satisfaction	Heijungs *et al.* (2010); Wastiels & Wouters (2008); Ljungberg (2007); Cagan & Vogel (2002)
20	Durability and serviceability	Wastiels & Wouters (2008); Glavic & Lukman (2007); Ljungberg (2007); Cagan & Vogel (2002);

21	Safety and health of the occupants	Ogunkah & Yang (2013); Zhou *et al.* (2009); Wastiels & Wouters (2008); Glavic & Lukman (2007); Ljungberg (2007); Chan & Tong (2007); Cagan & Vogel (2002)
22	Occupants comfort and satisfaction	Ljungberg (2007); Heijungs *et al.* (2010)
23	Rapid renewable periods	Glavic & Lukman (2007); Kim & Rigdon (1998)
24	Easy to handle during building	Ogunkah & Yang (2013); Glavic & Lukman (2007)
25	Low energy and other resource-consuming	Wastiels & Wouters (2008); Glavic & Lukman (2007); Cagan & Vogel (2002)
26	Construction waste reduction	Kim & Rigdon (1998)
27	Geographic Location of Building Site	Ogunkah & Yang (2013)
28	Building Regulation and Certification for Use	Ogunkah & Yang (2013); Emmitt, 2011
29	Environmental Statutory Compliance	Ogunkah & Yang (2013); Emmitt, 2011
30	Capital Cost (Economic Status of the Client)	Ogunkah & Yang (2013)
31	Material Embodied Energy Cost	Ogunkah & Yang (2013); Emmitt (2011); Kim & Rigdon (1998)
32	Material Compatibility with Traditions	Ogunkah & Yang (2013)
33	Compatibility with Client's requirement & Preference	Akadiri (2018); Ogunkah & Yang (2013)
34	The climatic condition of the place/region	Akadiri (2018)
35	Availability of the Technical Skills	Ogunkah & Yang (2013)

RESEARCH METHODOLOGY

This study aims to assess the critical factor influencing the choice of sustainable building materials selection in the construction industry of Nigeria, with the view to identifying some of the commonly used materials and determines their level of awareness and adoption in building construction projects in the South-East geopolitical zone of the country. The zone houses five states and they are Abia state, Anambra state, Ebonyi state, Enugu state, and Imo state. With a view to leveraging the number of participants across these states, the study gathered data from the state capitals as they are mostly urban (Adedeji & Fa, 2012). According to Nwankwo *et al. (*2012), these state capitals contain a lot of housing estates with conventional buildings that are undergoing modifications to make the buildings sustainable. Thus, this implies that efforts are targeted towards making buildings and other infrastructures sustainability compliant in the region. Furthermore, most government developmental and beautification and upgrading projects are usually concentrated in the state capital.

The study used a focus group and questionnaires in the collection of data. The Focus group method was developed in medical and marketing studies but has since found use in social science studies (Parker & Tritter 2006). One focus group of 10 members who are experienced/ knowledgeable in the subject of this study met virtually via the MS Teams and the researchers moderated the discussion session. The ten members of the focus group are within the range proposed by (Krueger & Casey, 2000). The experts that made up the focus group were (2 Consultants, 1 Contractor, 2 Architects, 2 Engineers, 1 Project manager, 1 Builder and 1 Quantity Surveyor). They were purposively selected based on their experience in the subject of this study. Literature review aided in the list of questions regarding green building materials identification. The use of a focus group helped improve the quality of data collected and gave insight into the direction of the research method. Two sampling techniques were adopted to administer the well-structured questionnaire used as the research instrument. The use of the questionnaire was premised on the need to reach the participants who are scattered across the five states in the zone. According to Tan (2011), the questionnaire is easy to use and it's suitable that would cover a large audience in a shorter time. Thus, the questionnaire is common for social research techniques (Blaxter *et al.*, 2001). This study used a mixed research method involving the qualitative data from the focus group and quantitative data from the use of the questionnaire.

A purposive sampling technique was initially used in the administration of the questionnaire to clients, consultants, contractors/subcontractors and construction professionals within the states of the zone. Sustainability attainment in the construction industry begins with the incorporation of SBM at both the design and construction phases (Jimoh et al., 2020), hence, the sampling of both design and construction stakeholders. Purposive sampling was used in other to leverage the qualities possessed by the participants (Etikan *et al.,* 2016). This was achieved by first identifying and selecting participants who met the set condition and willing to participate in the survey (Cresswell & Plano, 2018). To obtain rich, quality, and unbiased data, only participants who have worked for at least five years in construction were sampled who are aware of green (sustainability) construction concepts and are still engaged in the construction industry. The questionnaire stated these criteria to ensure that only qualified participants took part in the survey. Also, to ensure that only participants within the study area took part in the study, the region and the states from which responses were expected were stated. The researchers self-delivered the questionnaire with the help of trained research assistants.

Snowball sampling techniques were further used to increase the number of participants and coverage. The Snowball sampling technique potentially increases the sample size significantly (Atkinson & Flint, 2001), the technique is dependent on referrals (Ahmadzadehasl & Ariasepehr, 2010; Heckathorn, 2011). Furthermore, the set characteristic expected to be possessed by the participants also informed the use of this sampling method. Snow sampling techniques are the most efficient and economical and time-saving method of reaching specific groups that might be difficult to access (Naderifar *et al*., 2017; Hejazi, 2006). This sampling technique was used successfully through an internet-mediated survey. Internet-mediated research, according to Padayachee (2016) involves the use of online platforms such as social media platforms. The online platforms save cost and time and allow for prompt access to a large audience with common interests (Wright, 2005), and who can be impracticable to reach. Google form was used to re-create the questionnaire, and the link was sent to the selected professionals and contractors/subcontractors social media groups such as LinkedIn, WhatsApp, and email addresses of some of the earlier identified participants across the zone.

Besides, the study could not ascertain the population and sample size because there was no database where construction-based professionals, contractors/sub-contractors, consultants and clients with the set characteristics could be obtained. The questionnaire used was designed in three parts. The first part harnessed data on the respondents' general background information. The second part was concerned with the rating of the 22 selected SBM from the 37 identified from literature; in terms of levels of knowledge and utilisation. The participants were required to rate the level of awareness and adoption of the SBM on a 5-point Likert scale; where 1 = very low, 2 = low, 3 = moderate, 4 = high, and 5 = very high. In the last part of the questionnaire, the respondents were presented with the 35 selected factors influencing the selection of SBM in construction and were required to rate them using a scale of 1 to 5; where, 1 = least important, 2 = fairly important, 3 = important, 4 = very important and 5 = extremely important. The study devised a decision scale for the level of awareness and adoption and importance/significance of the assessed variables as follows; using the mean item score value range; 4.5-5.0 ‘Very high’, 3.5 – 4.49 ‘High’, 2.5-3.49 ‘Moderate’, 1.5-2.49 ‘Low’, 0.0 – 1.49 ‘Very low’. The decision scale adopted was modified from the study of (Saidu & Shakantu, 2016). The data gathering process took about two months and three weeks, and 130 responses were received (79 hardcopy questionnaires and 51 Google Form responses). Since the emphasis of the study is on richness and quality of data and not on quantity thus, 130 responses received were deemed adequate for analysis. It was impracticable to determine the response rate as there was no established population or sample size to relate the number of responses to.

Percentage, frequencies, mean item score (MIS), paired sample t-test, Kruskal-Walis test, and factor analysis were used to analyse the gathered data. Percentage and frequency were used to analyse data collected on the background information of the respondents. Data collected on the level of awareness and adoption of SBM were analysed using MIS and paired sample t-test. Mean item score was used to rank the variables and the pair sample t-test was use to compare the level of awareness and level of adoption of the assessed materials. Paired sample test was used to determine the relationship between the perceived level of awareness and the extent of adoption of SBM. The paired sample t-test, sometimes called the dependent sample t-test, is a statistical procedure used to determine whether the mean difference between two sets of observation is zero. Also, the mean item score (MIS) was used to analyse and rank the data collected on the factors influencing SBM selection. The ranking of the factors was done by considering the standard deviation (SD) alongside the mean item scores. The most frequently adopted descriptive analysis effectively identifies critical factors amongst numerous discrete factors, and has found use among construction management researchers is the MIS (Chan *et al.*, 2017). In addition, where two variables or more have the same values of MIS, the one with the lower value of SD is ranked higher. This is in adherence to the submission of Field (2005) who posits that where the mean score of more than one variable is the same, the variable with the smallest SD is ranked first. Kruskal-Walis test was used to determine whether there is a significant statistical difference in the pattern of the ranking of the assessed factors influencing the selection of SBM. The sampling of different construction-related stakeholders with a diverse profession would normally result in a disproportional ranking of variables (Oke *et al.,* 2020), based on their subjective perceptions. Hypothesis (H_{01}) was tested using Kruskal-Walis test.

Exploratory Factor analysis (EFA) was also conducted to reduce the number of variables, group them into manageable proportions. The EFA helps in the identification of variables with the best fit and cluster them for valuable and better insight and interpretations (Brown, 2015; Field, 2000). Factor analysis was applied on the assessed variables using principal component analysis (PCA) with a varimax rotation. PCA was found to be appropriate since, the object is to summarise the variable into a minimum number of factors for interpretation, prediction purposes (Edison and Singla, 2020; Hair *et al.*, 2010). The suitability of the assessed variable to factor analysis was determined by consideration of the sample size, the number of variables, Kaiser–Meyer–Olkin (KMO), Bartlett test of sphericity and commonalities. While there is no acceptable threshold for the number of variables and sample size, once the criteria for KMO, Bartlett test of sphericity, and communalities are reached, EFA can be run. The values of KMO and Bartlett test of sphericity (see values of the factors Influencing SBM selection in row 5 of Table 3). The communalities for the Factors influencing the choice of SBM adoption in construction ranges from 0.501 – 0.835. Based on these and the data reliability index value, EFA was adjudged as suitable for the study.

Before the analysis of the data collected on the level of awareness and adoption of SBM and factors influencing SBM selection, the reliability, construct validity and normality tests were carried out. The reliability test returned a Cronbach's alpha value of 0.805, 0.811 and 0.922 for the level of awareness, level of adoption, and factors influencing SBM selection respectively. The research instrument was deemed highly reliable as these values are far above the least value of Cronbach's of 0.60 suggested by (Hair *et al.*, 2010). The parametric assumptions were not met as the normality test carried out using the Shapiro-Wilk test returned a significant value of 0.000 (below 0.05 for all assessed variables on the factors influencing the choice of SBM selection). Shapiro-Wilk test was used since the sample size is less than in 2000 as suggested by (Ghasemi & Zahediasi, 2012). This, therefore, justify the use of a non-parametric test such as the Kruskal-Walis test; this test is suitable where the respondents' groups whose views are to be compared are at least three.

The structural validity test of the adopted measurement scale shows that the scale and EFA are valid. This is evident in the values of Kaiser–Meyer–Olkin (KMO) and Bartlett's test obtained. The acceptable range according to Tabachnick and Fidell (2007) is KMO of greater or equal to 0.60 and p-value of less than 0.05 for Bartlett's test (see Table 3). These analyses were performed using (SPSS 20, IBM).

Table 3. KMO and Bartlett's Test

	Bartlett's Test			KMO
Variables tested	**Approx. Chi-Square**	**df**	**Sig.**	
Level of awareness of SBM	1645.05	231	0	0.69
Level of adoption of SBM	2679.76	231	0	0.856
Factors Influencing SBM selection	4513.82	666	0	0.774

RESULTS AND DISCUSSIONS

Respondents background information

The analysis of the respondents' background Information of the samples in Table 4 reveals that Enugu and Imo states have the highest respondents with 40 (30.77%) each. Anambra state has the second-highest participants with (14.62%), then, followed by Abia state (13.08%) and finally Ebonyi state with (10.77%). Furthermore, the contractors/subcontractors' group is more with 35.38%, followed by construction professionals (28.46%), then clients (20.0%), and lastly, the clients with (16.15%). Also, the average working experience of the respondents in the construction industry is 14.20 years. The breakdown shows that a good number of them have spent about 11-15years with (34.62%), followed by 16-20years (24.62%), then 5-10years with (23.08%) and lastly those with 20years and above with (17.69%). In terms of highest educational level, those with

Bachelor of Science/Technology degree (37.69%) are more, followed by Master degree holders with (28.46%), and followed by Postgraduate Diploma (PGD) holders with (16.15%), then high national Diploma (HND) with (14.62%) and lastly, those with Doctorate (3.08%). With these results, the respondents can be said to have the requisite credentials and working experiences to give a reasonable insight into achieving the aim of this study

Table 4: Respondents background information

Category	Classification	Freq.	Per cent	Cumm. Per cent
Respondents States	Abia state	17	13.08	13.08
	Anambra state	19	14.62	27.69
	Ebonyi state	14	10.77	38.46
	Enugu state	40	30.77	69.23
	Imo state	40	30.77	100.00
	TOTAL	**130**	**100**	
Group of respondents	construction professional	37	28.46	28.46
	consultants	21	16.15	44.62
	clients	26	20.00	64.62
	contractors/subcontractors	46	35.38	100.00
	TOTAL	**130**	**100**	
Working experience (in years)	5-10 years	30	23.08	23.08
	11-15 years	45	34.62	57.69
	16 - 20 years	32	24.62	82.31
	20 years and above	23	17.69	100.00
	TOTAL	**130**	**100**	
Highest Educational level	HND	19	14.62	14.62
	PGD	21	16.15	30.77
	BSc/Btech	49	37.69	68.46
	Master degree	37	28.46	96.92
	Doctorate	4	3.08	100.00
	TOTAL	**130**	**100**	

Stakeholders levels of Awareness and adoption of SBM

Table 5 shows the results of construction stakeholders' perception of the level of awareness and adoption of identified sustainable building materials. In terms of awareness level, the top ten SBM with a high level of awareness about their existence are: Recycled Plastic (MIS=4.38), natural Clay and mud (MIS=4.37), Stone (MIS=4.34), Bricks and tile (MIS=4.23), Cellulose (MIS=4.22), Stray bales (MIS=4.17), Grasses (MIS=4.09), Limestone (MIS=3.94), Wood Timber (MIS=3.88) and Earthbags (MIS=3.84). While the level of adoption of these materials shows that the most adopted are: Stone (MIS=3.9), natural Clay and mud (MIS=3.96), Bricks and tile (MIS=3.92), Recycled Plastic (MIS=3.89), Cellulose (MIS=3.89), Stray bales (MIS=3.80), Grasses (MIS=3.60), Limestone (MIS= 3.56), Wood Timber (MIS=3.46), Recycled wood (MIS=3.42) and Coconut fibre (MIS=3.42).

Table 5 Stakeholders Awareness Level and Adoption of SBM

		Awareness Level			Adoption level		
S/No	**Green materials**	**MIS**	**S.D**	**Rank**	**MIS**	**S.D**	**Rank**
1	Worn out tyres	3.21	1.3792	20th	3.21	1.3792	15th
2	Fly ash	3.41	1.418	16th	3.41	1.418	12th
3	Ferrock	3.38	1.2406	17th	3.02	1.3495	18th
4	Recycled Plastic	4.38	0.9432	1st	3.89	1.421	4th
5	Earthbags	3.84	1.2686	10th	3.39	1.5122	13th
6	Polyurethane	3.37	1.3704	18th	2.92	1.4362	21st
7	Cellulose	4.22	1.2199	5th	3.89	1.5262	4th
8	Non-VOC paints	3.25	1.3472	19th	2.94	1.3683	20th
9	Recycled wood	3.81	1.5804	11th	3.42	1.7735	10th
10	Mycelium	3.49	1.1697	15th	3.21	1.3848	15th
11	Stray bales	4.17	1.2767	6th	3.8	1.5819	6th
12	Grasses	4.09	1.3494	7th	3.6	1.6311	7th
13	Bamboo	3.57	1.4464	14th	3.38	1.5065	14th
14	Coconut fibre	3.81	1.5804	11th	3.42	1.7735	10th
15	Wood Timber	3.88	1.5026	9th	3.46	1.708	9th
16	Wool (Natural Fibre)	2.58	1.1266	22nd	2.28	1.163	22nd
17	Cork	3.68	1.5504	13th	3.19	1.6848	17th
18	Rice husk	3.21	1.3792	20th	2.95	1.5038	19th
19	Stone	4.34	0.9609	3rd	3.97	1.441	1st
20	Bricks and tile	4.23	1.0458	4th	3.92	1.4308	3rd
21	Limestone	3.94	1.2248	8th	3.56	1.5097	8th
22	Natural Clay and mud	4.37	0.8904	2nd	3.96	1.3776	2nd

It is obvious from the result that there is a level of relationship between the level of awareness of these materials and their extent of adoption. Even though these materials have a different ranking from one another, the top nine materials under the level of awareness are also the top nine under the level of adoption. However, the awareness level of 14 (63.64%) of the materials is 'high' and 8 (36.36%) of them is moderate. The average MIS under the level of awareness is 3.74, thus, the level of awareness of the assessed SBM is high. With regards to the level of adoption, 13(50.09%) of these materials have a 'moderate' level of adoption, 8 (36.36%) have a 'high' adoption level and 1(4.55%) have a low level of adoption. and adoption ranges from 'average to very high. The average MIS under the level of adoption is 3.40, thus, the level of adoption of the assessed SBM is 'moderate'. It can be concluded that the level of awareness is high and the level of adoption of green building materials is growing in Nigeria. These results obtained in this section corroborate the findings of (Aghimien *et al.*, 2019a; Anzagira *et al.*, 2019; Aghimien *et al.*, 2018a; Aje, 2015; Jimoh *et al.*, 2020). The high level of awareness is attributed to the work experience of professionals in the construction industry (Aghimien *et al.*, 2019a). While the level of usage of sustainable materials might be high, there are still appreciable levels of non-integration (adoption) of these materials in construction. There is evidence of the incorporation of sustainable construction materials in the construction phase of construction projects (Jimoh *et al.*, 2020). However, this result is not in line with the finding of Susilawati and Al-Surf (2011) who reported that a good percentage of the masses lack the knowledge and the awareness of the existence of green construction. Effective knowledge management has also helped in the integration of sustainable concepts in new projects. This was pointed out by Jimoh *et al*. (2020), who submitted that drawing from lessons learnt from previous projects, subsequent construction projects of a university in North-East Nigeria adopted sustainable components at the design and construction phases. This assessment means that while the level of awareness is high, the level of adoption is low compared to the knowledge of the existence of green building materials. This further means that a lot still a has to be done to ensure that every stakeholder is doing their part in contributing to the sustainability agenda.

Critical Factors influencing the choice of SBM selection in construction

The Kruskal– Wallis test result in column 6 and 7 of Table 6 shows that seven (20.0%) of the assessed factors has a p-value < 0.05. This implies that a divergence of perception in the rating of these variables the respondents from the different states within the same zone. These variables are healthier occupants' work environment, inhibiting the impact of buildings on the environment, Appearance and aesthetics, Fitness for use and client satisfaction, Building Regulation and Certification for Use, Capital Cost (Economic Status of the Client) and Climatic condition of the place/region. Hypothesis (H_{01}) is rejected on these variables owing to the significant p-value. However, 28 (80.0%) of the assessed factors had a p-value greater than 0.05, implying that there a no significant statistical difference in the rating by the respondents. Thus, respondents' opinions on these variables converged. The construction industry stakeholders agree on the factors assessed in this study. Thus, based on the significant p-value (Sig. ≥ 0.05) obtained, the hypothesis (H_{01}) is accepted.

Regarding the factors influencing SBM selection in construction is displayed in Table 6, it can be seen from the result that the top ten critical factors influencing the selection of sustainable building materials are Reducing greenhouse gas emissions from building (MIS=4.207, SD=0.8136), Material Embodied Energy Cost (MIS=4.162, SD=0.9133), Operating and maintenance costs (MIS=4.146, SD=0.8546), Non-toxic or low toxic emissions generated by the products/materials (MIS=4.131, 0.8926), Recyclability of the building materials (MIS=4.131, SD=0.9835), Availability of the Technical Skills (MIS=4.078, SD=1.0195), Renewable (reusable) properties (MIS=4.078, SD=1.0202), Inhibiting the impact of buildings on the environment (MIS=4.077, SD=0.8946), Safety and health of the occupants (MIS=4.077, SD=0.9369), and Appearance and aesthetic (MIS=4.054, SD=0.8919). While, the least five factors are Geographic Location of Building Site (MIS=3.269, SD=1.3106), Environmental Statutory Compliance (MIS=3.262, SD=1.2108), Capital Cost (Economic Status of the Client) (MIS=3.231, SD=1.0531), Easy to handle during building (MIS=3.162, SD=1.0841), Construction waste reduction (MIS=2.977, SD= 1.2102). The mean item score ranges from 4.207 to 2.977 and the average for the thirty-five assessed factors is (MIS =3.801, SD =1.0615). This implies that regardless of the relative ranking of these factors, they are all highly important and are considered in selecting the type of sustainable materials to use on construction projects in Nigeria, and by extension other developing countries that have not to gain wide-scale adoption and attainment of sustainability.

Table 6. Factors influencing the choice of SBM adoption in construction

		MIS	S.D	Rank	Kruskal Wallis Test		
S/N	**Factors influencing the choice of GBM a**				**Chi-Square**	**Sig.**	**Decision**
1	Water treatment and conservation	3.90	1.225	17	4.683	0.274	Accept
2	Naturally occurring materials	4.05	1.077	12	7.166	0.111	Accept
3	Locally sourced and produced	4.05	0.999	10	0.869	0.929	Accept
4	Thermal efficiency	4.01	0.944	14	0.314	0.989	Accept
5	Financial viability and economical	3.99	0.984	15	1.479	0.830	Accept
6	Occupants needs and health considerations	3.75	1.214	25	4.713	0.318	Accept
7	Pollution prevention at manufacture	3.89	1.097	19	1.374	0.849	Accept
8	Waste reduction during manufacture	3.29	1.156	30	7.599	0.107	Accept
9	Recyclability of the building materials	4.13	0.983	5	4.051	0.399	Accept
10	Operating and maintenance costs	4.15	0.855	3	6.857	0.128	Accept
11	Renewable (reusable) properties	4.08	1.02	7	6.149	0.180	Accept
12	Non-toxic or low toxic emissions generated by the products/materials	4.13	0.893	4	8.065	0.088	Accept
13	Energy requires in the manufacturing process	3.79	1.374	23	8.054	0.090	Accept
14	Healthier occupants work environment	3.79	1.322	24	52.15	0.000**	Reject
15	Reducing greenhouse gas emissions from building	4.21	0.814	1	7.334	0.119	Accept
16	Inhibiting the impact of buildings on the environment	4.08	0.895	8	21.19	0.000**	Reject
17	Readily available and affordable	3.96	1.067	16	3.47	0.482	Accept
18	Appearance and aesthetic	4.05	0.892	10	25.03	0.000**	Reject
19	Fitness for use and client satisfaction	3.82	1.055	22	13.81	0.008**	Reject
20	Durability and serviceability	3.66	1.198	26	2.356	0.642	Accept
21	Material Compatibility with Traditions	3.86	1.032	20	7.635	0.091	Accept
22	Occupant's comfort and satisfaction	3.89	1.006	18	8.519	0.074	Accept
23	Rapid renewable periods	3.84	0.995	21	4.481	0.334	Accept
24	Easy to handle during building	3.16	1.084	34	8.002	0.091	Accept
25	Low energy and other resource-consuming	3.55	1.05	27	7.037	0.134	Accept
26	Construction waste reduction	2.98	1.21	35	1.975	0.740	Accept
27	Geographic Location of Building Site	3.27	1.311	31	7.109	0.130	Accept
28	Building Regulation and Certification for Use	3.54	1.058	28	13.12	0.011**	Reject
29	Environmental Statutory Compliance	3.26	1.211	32	9.378	0.052	Accept
30	Capital Cost (Economic Status of the Client)	3.23	1.053	33	10.56	0.032**	Reject
31	Material Embodied Energy Cost	4.16	0.913	2	8.712	0.064	Accept
32	Safety and health of the occupants	4.08	0.937	9	7.217	0.125	Accept
33	Compatibility with Client's requirement & Preference	4.02	1.034	13	7.083	0.132	Accept
34	The climatic condition of the place/region	3.44	1.175	29	25.08	0.000**	Reject
35	Availability of the Technical Skills	4.09	1.019	6	3.331	0.504	Accept

****Sig. < 0.05**

The result obtained in this study is in line with the findings of (Chan & Tong, 2007; Emmitt, 2011; Patil & Patil, 2017; The Constructor, 2013). Among the factors that influence the decision of materials selection is the safety of the environment and embodied energy (Emmitt, 2011). Among the resource-efficient and indoor air quality criteria submitted by TheConstructor (2013) that are considered during the selection of green building materials include; recycle content, natural and renewable, reusable or recyclable, non-toxic and minimal chemical emissions, and energy efficiency. Chan and Tong (2007) posit that the safety and health of the occupants are sometimes given priority over the cost and durability of sustainable housing projects. It follows that where the emphasis is placed on cost, the health and wellbeing of the end-users will be affected. Similarly, high recyclable content, harmless to use, low emission of contaminants were highlighted by (Zhou *et al.*, 2009), as the crucial factor that impacts materials selection of SBM.

Patil and Patil (2017) highlighted certain performance criteria that influence SBM selection. These criteria are occupants' needs and health considerations, recyclability, recyclability of materials, a renewable resource, low maintenance costs, reduced environmental impact through pollution, and toxic emissions reduction. The availability of technical skills for incorporating SBM in construction activities is another critical factor required to be considered in selecting materials. Green buildings are attractive and appealing to the eye, as such, this quality also influences the choice of materials to achieve a good appearance and aesthetic (Ashby and Johnson, 2002). Ogunkah and Yang (2013) maintained that sensorial effects, which have to do with aesthetics as one of the critical factors considered in the choice of selection of sustainable building materials.

PCA and factor extraction and discussion

Factor analysis was conducted using principal component analysis (PCA), and the method of extraction is varimax rotation. Five (5) factors with eigenvalues of 1.0 and above were retained, and these factors accounted for more than 50% of the total cumulative variance. This supports the submissions of (Pallant, 2007; Stern, 2010). The factor loading of factors retained are 0.50 and above, and the number of variables loaded in each component range from 5 and above. This supports the submissions of Pallant (2007) and Spector (1992) (see Table 7).

The 1st component has 11 variables loaded under it, and they account for 27.60% of the total variance explained (TVE). This component is regarded as '*Emissions minimisation'*. This was based on the latent characteristics of the variables that loaded under it. These variables are; reducing greenhouse gas emissions from building, non-toxic or low toxic emissions generated by the products/materials, appearance and aesthetic ,inhibiting the impact of buildings on the environment, durability and serviceability, occupants needs and health considerations, healthier occupants work environment, compatibility with client's requirement & preference, occupants comfort and satisfaction, environmental statutory compliance, and climatic condition of the place/region.

The 2nd component accounts for about 12.68% of the TVE, with seven items loaded under it. A cursory look at these factors: operating and maintenance costs, recyclability of the building materials, rapid renewable periods, renewable (reusable) properties, availability of the technical skills, fitness for use and client satisfaction, and capital cost (economic status of the client), showed that they are closely related to the low cost of running and materials recyclability and reusability. Based on this, the component was named '*Low running cost and reusability'*.

Table 7: Rotated Component Matrix (RCM) of the Assessed Factors

Variables	Component				
	1	2	3	4	5
Reducing greenhouse gas emissions from building	0.894				
Non-toxic or low toxic emissions generated by the products/materials	0.873				
Appearance and aesthetic	0.860				
Inhibiting the impact of buildings on the environment	0.853				
Durability and serviceability	0.833				
Occupants needs and health considerations	0.833				
Healthier occupants work environment	0.824				
Compatibility with Client's requirement & Preference	0.789				
Occupants comfort and satisfaction	0.781				
Environmental Statutory Compliance	0.764				
The climatic condition of the place/region	0.701				
Operating and maintenance costs		0.905			
Recyclability of the building materials		0.903			
Rapid renewable periods		0.889			
Renewable (reusable) properties		0.887			
Availability of the Technical Skills		0.883			
Fitness for use and client satisfaction		0.881			
Capital Cost (Economic Status of the Client)		0.743			
Thermal efficiency			0.883		
Low energy and other resource-consuming			0.844		
Material Embodied Energy Cost			0.837		
Material Compatibility with Traditions			0.836		
Financial viability and economical			0.832		
Building Regulation and Certification for Use			0.796		
Water treatment and conservation			0.711		
Readily available and affordable				0.889	
Locally sourced and produced				0.808	
Naturally occurring materials				0.707	
Safety and health of the occupants				0.676	
Geographic Location of Building Site				0.607	
Waste reduction during manufacture					0.712
Construction waste reduction					0.667
Easy to handle during building					0.587
Pollution prevention at manufacture					0.580
Energy require in the manufacturing process					0.509
Initial Eigenvalues	9.66	4.44	3.00	2.36	1.74
% of Variance	27.60	12.68	8.57	7.03	4.96
Cumulative %	27.60	40.28	48.85	55.89	60.85

Seven items are loaded under the 3rd component, and these account for about 8.57% of the TVE. These items that are loaded under this component are; thermal efficiency, low energy and other resource-consuming, material embodied energy cost, material compatibility with traditions, financial viability and economical, building regulation and certification for use, and water treatment and conservation. A careful examination of these items led to the naming of this component as '*Low thermal and energy consumption efficiency'*.

'*Low cost and high health and safety consideration'* is the name of the 4th component, and it contains five items accounting for about 7.03% of the TVE. These items are readily available and affordable, safety and health of the occupants, locally sourced and produced, naturally occurring materials, and geographic location of the building site.

The 5th component has five items loaded under it and accounts for 4.96% of the TVE. These items loading under this component are; waste reduction during manufacture, construction waste reduction, ease to handle during building, pollution prevention at manufacture, and energy required in the manufacturing process. '*Waste minimisation'* is the name given to this component and this is based on the examination of the attributes of the items that are loaded under it.

CONCLUSION

This study set out to assess the critical factors influencing the choice of sustainable building materials selection in the construction industry of Nigeria, with the view to identifying some of the commonly used materials and determining their level of awareness and adoption in building construction projects in the South-East geopolitical zone of the country. Utilising questionnaire and non-probability (purposive and snowball) sampling techniques and internet-mediated surveys, the study has answered the key objectives.

The study concludes that recycled plastic, natural clay and mud, stone, bricks and tile, cellulose, stray bales, grasses, limestone, and wood timber, are the commonly used materials. Furthermore, the level of awareness of these materials is high while their adoption is moderate. The level of adoption of these materials is 0.34 less than the knowledge of them. However, a statistically significant difference was observed between the level of awareness and adoption of sustainable building materials. The major clusters of determinants of green building materials' choice are emissions minimisation, low running cost and reusability, low thermal and energy consumption efficiency, low cost and high health and safety consideration and waste minimisation. The chief among the factor influencing the choice of sustainable building materials selection in the construction are: reducing greenhouse gas emissions from the building, materially embodied energy cost, operating and maintenance costs, non-toxic or low toxic emissions generated by the products/materials, recyclability of the building materials, availability of the technical skills, renewable (reusable) properties, inhibiting the impact of buildings on the environment, safety and health of the occupants, and appearance and aesthetic. These factors are embedded in the quality and functional requirements of the materials and their products (which are green/sustainable buildings). The factors considered cuts across sustainability's environmental, socio-cultural, and economic dimensions. Importantly, there is convergence in participants' perception regarding the factors assessed.

It is recommended that consideration be given to these factors in selecting sustainable /green building materials in designs and specifications of construction projects. This is so, as they covered the economic (financial issues both at initial outlay, operating cost in use), environmental (safety, health, and comfort of end-users and the environment), and socio-cultural (aesthetics, employment-skilled person) dimensions of sustainability. The use of reusable and recyclable materials should be encouraged so that landfills of demolished materials and other construction waste could be reduced or avoided. The government should enact appropriate legislation targeted at meeting the concern of sustainable development goals. This must be followed by strict monitoring to ensure total compliance in using sustainable materials for construction projects. The study implies that architects, design engineers, and other stakeholders in the built environment will gain from this study is when writing specifications regarding the choice of materials to be used in buildings and other components engineering structures. A careful selection of sustainable building materials at the early stages of the project will help improve supply chain performance as materials procurement and delivery time will be reduced, thus, saving construction tasks execution and delivery cost and time. It will also enhance the quality of work and reduce claims and disputes.

This study improves the sustainable construction discourse in the country as it will be useful to built environment consultants and other development experts in making the appropriate decision regarding materials selection for achieving sustainable construction projects. Corporate client organisations would also benefit from the findings regarding the materials that would benefit the health and comfort needs of the office environment for improved employees performance and productivity. Also, this reinforces the knowledge of the contribution of construction to greenhouse gas emission, climate change and environmental degradation, and how the suitable choice of materials can help minimise these.

The uniqueness of this study is the sampling of the clients, consultants, contractors, and construction experts in the South-East geopolitical zone of Nigeria. This has given this study a wider perspective on the sustainability discourse when compared to previous studies in the area. This study, however, is limited in the number of samples collected and it’s only in five states of Nigeria, which would not be adequate for the generalisation of its findings. Therefore, a similar study is advocated in other states or zones in the country. Also, this study could be replicated in other developing countries so that the findings could be compared.

REFERENCES

Adedeji, Y. M. D. & Fa, G. (2012). Sustainable housing provision: Preference for the use of interlocking masonry in housing delivery in Nigeria. *Journal of Environmental Research and Management, 3*(1), 009-016.

Aghimien, D. O, Awodele, O. A. & Aghimien, E. I. (2016). Providing sustainability in educational buildings through the use of compressed stabilized interlocking earth blocks. *Journal of Construction Engineering, Technology and Management*, *6*(2), 130-140.

Aghimien, D.O., Adegbembo, T.F., Aghimien, E.I. & Awodele, O.A. (2018). Challenges of sustainable construction: A study of educational buildings in Nigeria. *International Journal of Built Environment and Sustainability, 5*(1), 33-46. https://doi.org/10.11113/ijbes.v5.n1.244

Aghimien, D.O., Aigbavboa, C.O. & Thwala, W.D. (2019). Microscoping the challenges of sustainable construction in developing countries. *Journal of Engineering, Design and Technology, 17*(6), 1110-1128. https://doi.org/10.1108/JEDT-01-2019-0002

Ahmadzadehasl, M. & Ariasepehr, S. (2010). Sampling and sample size calculation: Basic Principles of Research in Medical Sciences. Tehran: Nour Danesh. https://doi.org/00.0000

Ahn, C., Lee, S., Peña-Mora, F., & AbouRizk, S. (2010). Toward environmentally sustainable construction processes: The US and Canada's perspective on energy consumption and GHG/CAP emissions. *Sustainability, 2*(1), 354-370 https://doi.org/10.3390/su2010354

Ahn, Y.H., Pearce, A.R., Wang, Y. & Wang, G. (2013). Drivers and barriers of sustainable design and construction: The perception of green building experience. *International Journal of Sustainable Building Technology, 4*(1), 35-45. https://doi.org/10.1080/2093761X.2012.759887

Aje, I. O. (2015). Effective financing options for sustainable construction in a developing economy. A Paper Delivered at National Seminar on Sustainable Construction in a Developing Economy: Factors and Prospects. Organized by The Nigerian Institute of Quantity Surveyors, Ondo State Chapter, at Theodore Idibiye Francis Auditorium, Federal University of Technology, Akure - Nigeria, 8-9 October.

Akadiri, P.O. (2015). Understanding barriers affecting the selection of sustainable materials in building projects. *Journal of Building Engineering*, *4*, 86-93. https://doi.org/10.1016/j.jobe.2015.08.006

Akadiri, P.O. (2018). Investigating factors affecting building materials selection in Nigerian construction industry. *American Journal of Civil Engineering and Architecture*, *6*(4), 154-157. https://doi.org/10.12691/ajcea-6-4-4

Alabi, A. A. (2012). Comparative study of environmental sustainability in building construction in Nigeria and Malaysia. *Journal of Emerging Trends in Economics and Management Sciences*, *3*(6), 951-961.

AlSanad, S. (2015). Awareness, drivers, actions, and barriers of sustainable construction in Kuwait. International Conference on Sustainable Design, Engineering and Construction, Procedia Engineering, 118, 969-983. https://doi.org/10.1016/j.proeng.2015.08.538

Anzagira, L.F, Badu, E. & Duah, D. (2019). Towards an uptake framework for the green building concept in Ghana: A theoretical review. *International Journal on Proceedings of Science and Technology*, 2(1),57-76. https://doi.org/10.21625/resourceedings.v2i1.452

Ashby, M. F. & Johnson K. (2002). Materials and design: The art and science of material selection in product design. Oxford; Boston: Butterworth-Heinemann. https://doi.org/10.1016/S0261-3069(01)00049-8

Atkinson, R. & Flint, J. (2001). Accessing hidden and hard-to-reach populations: Snowball research strategies. Social Research Update, Vol. 33. Available at: https://www.researchgate.net/publication/46214232_Accessing_Hidden_and_Hard-to-Reach_Populations_Snowball_Research_Strategies

Badam, P. (2017). Green materials and their advantages. Available at: http://www.greenbuildproducts.com/blog/green-materials-advantages/

Baloi, D. (2003). Sustainable construction: challenges and opportunities. In: Greenwood, D J (Ed.), *19th Annual ARCOM Conference*, 3-5 September 2003, University of Brighton. Association of Researchers in Construction Management, Vol. 1, 289-297.

Baron, N. & Donath, D. (2016). Learning from Ethiopia - A discussion on sustainable building. In Proceeding of SBE16 Hamburg International Conference on Sustainable Built Environment Strategies - Stakeholders - Success factors, Hamburg, Germany. 7-11 March.

Bennett, J. & Crudgington, A. (2003). Sustainable development: Recent thinking and practice in the UK. *The Institution of Civil Engineers, 156*, 27-32. https://doi.org/10.1680/ensu.156.1.27.37066

Blaxter, L., Huges, C. & Tight, M. (2001). How to Research, (2nd ed.). Open University Press, London

Brown, T.A., 2015. Confirmatory Factor Analysis for Applied Research. 2nd ed. New York: The Guilford Press.

Cagan, J. & Vogel C.M. (2002). Creating breakthrough products. Upper Saddle River: Prentice Hall.

Castro-Lacouture, D., Sefair, J.A., Florez, L., & Medaglia, A.L. (2009). Optimization Model for the Selection of Materials Using the LEED Green Building Rating System. Proceedings of the 2009 ASCE Construction Research Congress, Seattle, Washington, USA, 5-7 April, 608-617. https://doi.org/10.1061/41020(339)62

Chan, J.W.K. & Tong, T.K.L. (2007). Multi-criteria material selections and end-of-life product strategy: Grey relational analysis approach. *Materials and Design, 28*, 1539-1546 https://doi.org/10.1016/j.matdes.2006.02.016

Cifani, S. (2017). Eight Sustainable Building Materials to Green Your Next Construction Project. Available at: https://www.dumpsters.com/blog/green-building-materials

Cresswell, J. W. & Plano C. V. L. (2011). Designing and Conducting mixed method research (2nd ed.). Thousand Oaks, CA: Sage

Davies O.O.A, & Davies I.O.E. (2017). Barriers to Implementation of Sustainable Construction Techniques. *Journal of Environmental Science, 2*, 1-9.

Ding, G.K.C. (2008). Sustainable construction - The role of environmental assessment tools. *Journal of Environmental Management*, *86*(3), 451-64. https://doi.org/10.1016/j.jenvman.2006.12.025

Ding, L., Roberto, G. Q., Wei, Li., & Janneke, R. (2010, May 17). Risky borrowers or risky mortgages: Disaggregating effects using propensity score models. Working Paper. Durham, NC: Department of Urban Studies and Planning and the UNC Center for Community Capital.

Edison, J.C., and Singla, H.K. (2020). Development of a scale for factors causing delays in infrastructure projects in India. *Construction Economics and Building*, *20*(1), 36-55. https://doi.org/10.5130/AJCEB.v20i1.6750

Emmitt, S. (2011). Selection and specification of building products: Implications for design managers. *Architectural Engineering and Design Management*, *2*, 176-186. https://doi.org/10.1080/17452007.2006.9684614

Enshassi, A., Kochendoerfer, B. & Al Ghoul, H. (2016). Factors affecting sustainable performance of construction projects during project life cycle phases. International *Journal of Sustainable Construction Engineering & Technology*, *7*(1), 50-68

Etikan, I., Musa, S. A. & Alkassim, R.S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics*, *5*(1), 1-4. https://doi.org/10.11648/j.ajtas.20160501.11

Field, A. (2005). Discovering Statistics using SPSS for Windows. London: Sage publications.

Field, A. (2000). Discovering Statistics using SPSS for Windows. London: Sage publications.

Fithian, C., & Sheets, A. (2009). Green Building Materials: Determining the True Definition of Green. UTSoA - Seminar in Sustainable Architecture

Florez, L., Castro, D. & Irizarry, J. (2010). Impact of sustainability perceptions on optimal material selection in construction projects. Proceedings of the Second International Conference on Sustainable Construction Materials and Technologies, Università Politecnica delle Marche, Ancona, Italy, Coventry University and The University of Wisconsin Milwaukee Centre for By-products Utilization, 28-30 June. pp. 719-727. http://www.claisse.info/Proceedings.htm.

Ghasemi, A. & Zahediasl, S. (2012). Normality test for statistical analysis: A guide for non-statisticians. *International Journal of Endocrinol Metab*, *10*(2), 486-489. https://doi.org/10.5812/ijem.3505

Glavic, P. & Lukman, R. (2007). Review of sustainability terms and their definitions. *Journal of Cleaner Production, 15*(18), 1875-1885. https://doi.org/10.1016/j.jclepro.2006.12.006

Gluch, P. & Baumann, H. (2004). The life cycle costing (LCC) approach: a conceptual discussion of its usefulness for environmental decision making. Building and Environment, 39, 571-580. https://doi.org/10.1016/j.buildenv.2003.10.008

Gomes, V., & Da Silva., M.G. (2005). Exploring sustainable construction: Implication from Latin America, *Building Research and Information, 33*(5), 428-440. https://doi.org/10.1080/09613210500218891

Hair, J., Black, W., Babin, B.Y.A., Anderson, R., & Tatham, R. (2010). Multivariate Data Analysis, A Global Perspective. New Jersey, NJ: Pearson Prentice Hall. https://doi.org/10.1016/j.jmva.2009.12.014

Heckathorn, D.D. (2011). Comments: Snowballing versus respondent-driven sampling. *Sociological Methodology, 41*(1), 355-366. https://doi.org/10.1111/j.1467-9531.2011.01244.x

Heijungs, R., Huppes, G. & Guinee, J.B. (2010). Life cycle analysis and sustainability analysis of products, materials and technologies. Toward a scientific framework for sustainability life cycle analysis. *Polymer degradation and stability*, *95*(3), 422-428 https://doi.org/10.1016/j.polymdegradstab.2009.11.010

Hejazi, S. (2006). Sampling and its variants: Introduction to research methodology in medical sciences. Tehran: Islamic Azad University.

Herda, G., Sangori, R., & Bock, M. (2017). Low cost, low carbon, but no data: Kenya's struggle to develop the availability of performance data for building products. *Procedia Environmental Sciences, 38*, 452-460. https://doi.org/10.1016/j.proenv.2017.03.136

Hwang, B. G. & Tan, J. S. (2012). Green building project management: Obstacles and solutions for sustainable development. *Sustainable Development, 20*(5), 335-349. https://doi.org/10.1002/sd.492

Intel Corporate Responsibility Report (2008). Available at: http://www.intel.com/

Jahan, A., & Edwards, K. (2013). Multi-Criteria Decision Analysis for Supporting the Selection of Engineering Materials in Product Design. Elsevier science.

Jimoh, R., Lelle, H., Oyewobi, L., Bilau, A., & Sani, M, (2020). Improving sustainability in university environment: the stakeholders' viewpoints. *International Journal of Real Estate Studies, 14*(1), 9-16

John, T. A., Alumbugu, P.O. & Micheal, A. I. (2019). Contract awards disparity among multinational and indigenous construction companies. *Journal of Engineering, Project, and Production Management*, *9*(2), 126-131. https://doi.org/10.2478/jeppm-2019-0014

Kim, J., and Rigdon, B. (1998). Sustainable Architecture Module: Qualities, Use, and Examples of Sustainable Building Materials. Published by National Pollution Prevention Center for Higher Education, 430E. University Avenue, Ann Arbor.

Krueger, R.A., and M.A. Casey. (2000). Focus Groups: A Practical Guide for Applied Research. Thousand Oaks, CA: Sage.

Ljungberg, L.Y. (2007). Materials selection and design for development of sustainable products. *Materials and Design*, *28*(2), 466-479. https://doi.org/10.1016/j.matdes.2005.09.006

Majdalani, Z., Ajam, M., & Mezher, T. (2006). Sustainability in the construction industry: A Lebanese case study. *Construction Innovation: Information, Process, Management, 6(*1), 33-46. https://doi.org/10.1108/14714170610710613

Marsono, A., & Balasbaneh, A. (2015). Combinations of building construction material for residential building for the global warming mitigation for Malaysia. *Construction and Building Materials, 85*, 100-108. https://doi.org/10.1016/j.conbuildmat.2015.03.083

Mora, E. P. (2007). Life cycle, sustainability and the transcendent quality of building materials. *Building and Environment*, *42*(3), 1329-1334. https://doi.org/10.1016/j.buildenv.2005.11.004

Naderifar,M., Goli, H. & Ghaljaie, F. (2017). Snowball sampling: A purposeful method of sampling in qualitative research. *Strides in Development of Medical Education, 14*(3), 1-6. https://doi.org/10.5812/sdme.67670

Nwankwo, S. I., Okonkwo M. M. & Nwankwo C. V. (2012). Towards advancing methodology of public residential building diagnosis in south-east Nigeria through mathematical model development and applications. *Journal of The Association of Architectural Educators in Nigeria (AARCHES J), 11*(1), 121-137

Ogunkah, I. & Yang, J. (2012). investigating factors affecting material selection: the impacts on green vernacular building materials in the design-decision making process. *Buildings*, *2*, 1-32. https://doi.org/10.3390/buildings2010001

Ogunkah, I.C., & Yang, J. (2013). Analysis of factors affecting the selection of low-cost green building materials in housing construction. *International Journal of Sciences, 2*(9), 41-75

Oke, A., Aghimien, D., Aigbavbooa, C. & Musenga, C. (2019). Drivers of sustainable construction practices in the Zambian Construction industry. *Energy Procedia*, *158,* 3246-3252. https://doi.org/10.1016/j.egypro.2019.01.995

Oke, A.E., Aghimien, D.O., Aigbavboa, C.O. & Akinradewo, O.I. (2020). Appraisal of the drivers of smart city development in South Africa. *Construction Economics and Building, 20*(2), 109-126. https://doi.org/10.5130/AJCEB.v20i2.6632

Oni, O.J. (2015). Accelerating sustainable construction in Nigeria: The Professionals' perspective. *Civil and Environmental Research, 7*(10), 61-67

Onyeagam, O. P., Eze, E. C., & Adegboyega, A. A. (2019). Assessment of quantity surveying firms' process and product innovation drive in Nigeria. *SEISENSE Journal of Management*, *2*(2), 22-38. https://doi.org/10.33215/sjom.v2i2.111

Onyegiri, I. & Ugochukwu, I.B, (2016). Traditional building materials as a sustainable resource and material for low cost housing in Nigeria: Advantages, challenges and the way forward. *International Journal of Research in Chemical, Metallurgical and Civil Engineering*, *3*(2), 247-252 https://doi.org/10.15242/IJRCMCE.U0716311

Padayachee, K. (2016). Internet-mediated research: Challenges and issues. South African Computer Journal, 28(2), 25-45. https://doi.org/10.18489/sacj.v28i2.376

Pallant, J. (2007). SPSS survival manual, 3rd Edition. McGrath Hill

Parker, A., and J. Tritter, J. (2006). Focus group method and methodology: Current practice and recent debate. *International Journal of Research & Method in Education*, *29*(1), 23-37. https://doi.org/10.1080/01406720500537304

Patil, K.M., & Patil, M. S. (2017). Sustainable Construction Materials and Technology in Context with Sustainable Development. *International Journal of Engineering Research and Technology*, *10*(1), 112-117.

Peckenham, E. (2016). Eleven green building materials that are way better than concrete. Available at: https://inhabitat.com/11-green-building-materials-that-are-way-better-than-concrete/

Saidu, I., and Shakantu, W.M. (2016). Effects of material-waste causes on project-cost overrun in Abuja, Nigeria: A site management perspective. Proceedings of the 9th Annual Quantity Surveying Research Conference, Port Elizabeth, 19-21 October, pp. 246-257.

Sheth, K. N. (2016). Sustainable building materials used in green buildings. 9th International Conference on Engineering and Business Education (ICEBE) & 6th International Conference on Innovation and Entrepreneurship (ICIE).

Shiva, J. (2011). Green Building Materials and their Common Use in Everyday Life. Student assignment submitted to Center for Continuing Education, Indian Institute of Technology Hyderabad, as a requirement for the courses; Environment and Sustainable Development.05.11

Spector, P. E. (1992). Summated rating scale construction: An Introduction: Quantitative Applications in the Social Sciences. In Sage university papers (Vol. 07, Issue 082). https://doi.org/10.4135/9781412986038

Stern, L. (2010). A Visual Approach to SPSS for Windows: A Guide to SPSS 17.0 (2nd Ed.).

Susilawati, C., & Al-Surf, M. (2011). Challenges facing sustainable housing in Saudi Arabia: A current study showing the level of public awareness. Paper presented at the 17th Pacific Rim Real Estate Society Conference Gold Coast, Australia.

Tabachnick, B. G. & Fidell, L. S. (2007).Using Multivariate Statistics. (5th Ed.). Pearson Education Inc, Boston, MA.

Tan, W.C.K. (2011). Practical Research Methods. Pearson Custom, Singapore.

The Constructor (2013). Selection of green building materials. https://theconstructor.org/building/selection-of-green-building-materials/7010/

The Constructor (2019). 23 Different Green Building Materials. Available at: https://theconstructor.org/building/green-building-materials/7028/

Trusty, W.B. (2003). Understanding the Green Building Toolkit: Picking the Right Tool for the Job. In Proceedings of the USGBC Greenbuild Conference & Expo, Pittsburgh, PA, USA, 12-14 November. Available at: http://www.athenasmi.ca/publications/publications.html (accessed 29 October 2010).

Van Kesteren, I. E. H., Stappers, P. J. & Kandachar, P. V. (2005). Representing product personality in relation to materials in a product design problem, 1st Nordic Design Research Conference, Copenhagen, Denmark, 2005

Wastiels L., Wouters I. & Lindekens J. (2007). Material knowledge for design: The architect's vocabulary, emerging trends in design research. International Association of Societies of Design Research (IASDR) Conference, Hong Kong, Hong Kong.

Wastiels, L., & Wouters, I., (2008). Material considerations in architectural design: A study of the aspects identified by architects for selecting materials. In: Undisciplined! Design Research Society Conference 2008, Sheffield Hallam University, Sheffield, UK, 16-19 July.

Wright, K. B. (2005). Researching internet-based populations: Advantages and disadvantages of online survey research, online questionnaire authoring software packages, and web survey services. *Journal of Computer-Mediated Communication, 10*(3), .00-00. https://doi.org/10.1111/j.1083-6101.2005.tb00259.x

Zhang, X., Platten, A. & Shen, L. (2011). Green property development practice in China: Costs and barriers. *Building and Environment, 46*(11), 2153-2160 https://doi.org/10.1016/j.buildenv.2011.04.031

Zhou, C. C., Yin, G.F. & Hu, X.B. (2009). Multi-objective optimization of material selection for sustainable products: Artificial neural networks and genetic algorithm approach. *Materials and Design, 30*(4), 1209-1215. https://doi.org/10.1016/j.matdes.2008.06.006

Zhou, P., Ang, B.W. & Zhou, D.Q. (2010). Weighting and aggregation in composite indicator construction: A multiplicative optimization approach. *Social Indicator Research, 96*(1), 169-181. https://doi.org/10.1007/s11205-009-9472-3