

THE INTERNATIONAL JOURNAL OF SCIENCE & TECHNOLEDGE

Drivers and Barriers of Timber for Building Construction in Nigeria: A Case Study of Akure, Ondo State

Rhema Olajide Ajao

Graduate Researcher, Department of Architecture,
Federal University of Technology, Akure, Nigeria

Abstract:

Timber, as a building material, when effectively maximized, can be used to ensure sustainability and low-cost housing. Timber, with its great qualities and abundance of availability in Nigeria, has predominantly been confined in its usage in building construction in Nigeria to the unseen and peripheral components of a building. It is sparsely used for structural reasons, mostly limited to the roof structure, furniture fittings, doors, and decorative purposes in some cases. As such, this research responds to that call. This paper aims to explicitly examine the drivers and barriers of its usage and adoption for building construction in Nigeria using Akure South Local Government, Ondo State, as the case study. The research confronts the topic by conducting a literature analysis of the possible use of timber in building construction, as well as its qualities and challenges as a building material. Questionnaires were also designed to investigate the factors that could promote its use and the barriers that are hindering its adoption in the Nigerian construction industry. A random sampling method was used to collect the required data from a total population size of 60 building professionals. A statistical analysis was carried out using the statistical package for social science. Results indicated that timber is a recognized building material, but its utilization in the Nigerian construction industry is restricted. This limitation is attributed to perceived challenges, including concerns about susceptibility to water damage and fire and a lack of technical expertise in utilizing timber for various building components. The study recommends that the usage of timber should be advanced through collaboration and training about the use of timber among building construction experts and also that building codes that would guide the use of timber in building construction should be worked on and included in the Nigeria national building codes as this would help to improve its awareness and encourage its use in the building industry.

Keywords: Timber, drivers, barriers, building construction

1. Introduction

Buildings are a composition of various materials, components and styles. The selection of materials for construction is a very complex one that must be done carefully and take into consideration a number of varying factors. Timber has been utilized as a key building material for centuries (Abimaje & Baba, 2014). Timber can be utilized in nearly every part of a building, including the walls, floors, roofs, windows, and doors. According to Abimaje and Baba (2014), proponents of timber as a building material see it as an appealing building material. Structural Timber Engineering Bulletin (2019) states that timber is a hard, fibrous substance that is obtained from trees. In the construction sector, it is commonly known as timber and has been utilized since ancient times. Hardwood and softwood are the two general categories of timber. Although the two groups are typically utilized in the construction sector, their applications differ because of differences in their strength, resistance, workability, and durability. The density, weight, strength, flexibility, hardness, and durability of timber, which is derived from plants and trees, varies based on the species and the section of the plant or tree that is cut down. Timber as a material has been limited in its use in the construction industry in Nigeria. The usage of timber has been limited, mainly to the construction of roofs, ceilings, and formworks, and the usage of materials like steel, iron, and glass is more prominent. Timber, when used and modified properly, can meet the taste of any part of construction. According to Andreas (2005), no architectural material is without its own set of obstacles; nonetheless, the constraints of these materials exist only in connection to the existing degree of knowledge, creativity, and technology. According to Iwuagwu & Iwuagwu (2015), one of the issues for rising housing costs is the rising cost of imported building materials. The current situation of slums in Nigeria is out of control, owing to the high cost of building materials (cement, sand, iron, and sharp sand), which are frequently imported. Industrialized building materials are becoming increasingly rare, expensive, and non-renewable, with the concomitant problem of environmental deterioration in the areas where they are sourced. These industrialized building materials are one of the reasons contributing to the country's unsustainable housing costs. The majority of locally accessible resources, such as timber, are used for temporary constructions, such as shops and viewing centres. Therefore, there is a need to look into locally available materials such as Timber as an alternative option. Hence, there is a need to understand the factors influencing the adoption of timber for building construction in Nigeria.

The aim of this study is to assess the capability of timber with a view to determining the drivers and barriers to the usage of timber for building construction in Nigeria. The objectives were thus to investigate the qualities and general use of timber as a building material, examine the challenges associated with the use of timber as a building material, investigate the drivers and barriers of the use of timber for building construction in Nigeria and propose ways that could lead an increase in the use of timber for building construction.

2. Literature Review

2.1. Use of Timber in Building Construction

Timber is a great building construction material due to its strength, light-weight, environmental benefits, and ability to be prefabricated for building purposes. According to Falk (2010), few building materials are as environmentally friendly as timber. It is not only one of the most regularly used building materials, but it also has qualities that make it suitable for a wide range of construction applications. Timber is very efficient and durable, and usable timber products manufactured from trees can range from a barely treated log at a log-home construction site to a highly processed and highly engineered lumber composite developed in a large manufacturing facility. Timber is a gift from nature to humans, and there are countless uses for it. Thus, the importance of using timber in building construction cannot be stressed (Abimaje & Baba, 2014). Nwachukwu (2017) stated that timber is used in construction for many different purposes, such as constructing structural elements, including walls, beams, columns, slabs, and tubery or pneumatic formworks using timber as a formwork material. Major components of a roof structure, like wall plates, kingposts, and purlins, are constructed from timber. Timber is used in the design of drainages and lintels as struts and braces; timber is used in the production of furniture; in fact, the best furniture of today is mostly made of timber; timber is used in the construction of formworks of elements such as foundation footings in the preliminary stage of building construction.

Era	Application	Forms
Medieval	Wall framing	close studding to create loadbearing wall panels square panels with curved braces chevron bracing
	Floor structures	common joists between 'spine' beams 'jettied' floor construction
	Roofs	common rafter roofs purlin-supported roofs arched roofs collar-tied roofs scissor-braced roofs crown-post roofs
	Whole buildings	cruck frames box frames post and stud frames aisled construction
Post Medieval (17th-19th Century)	Wall framing	internal partitions trussed partitions
	Floor structures	common joists with primary 'girder' beams ceiling joists trussed girders
	Roofs	king post trusses with ironwork queen post trusses with ironwork mansard roofs mechanically laminated timber arches
Modern (20th Century onwards)	Roof and floor structures	use of mechanical connectors glued laminated timber beams lattice girders I-joists and open-web joists plywood box beams Belfast trusses 'Fink', 'Pratt' and 'Warren' trusses bowstring girder folded plate roofs
	Whole buildings	arches and rigid frames post and beam construction membrane shells platform-frame construction balloon-frame construction

Table 1: The Historic Use of Timber and Structural Forms in Buildings
Source: Structural Timber Engineering Bulletin (2019)

2.2. Qualities of Timber as a Building Material

With the shift from the Stone Age to the Computer Age, advancements in technology and the general way of life, man generally strives to build comfortable homes within these environments through the utilization of building materials of excellent qualities (Temitope, 2019). Timber is one of many materials utilized in building and construction. It is one of the oldest and most sustainable resources available in construction. Moreover, it is natural and renewable, making it one of the most predominantly used in construction (Apu, 2003; Douglas, 1995).

It is a flexible material with a variety of uses ranging from columns, girders, and beams. Timber has many intrinsic qualities that make it such an important building material, including a high strength-to-weight ratio, excellent performance, durability, superior heat and sound insulation. Additionally, the natural growing qualities of timber, such as its colors, patterns, and availability in a wide variety of species, sizes, and shapes, contribute to its remarkable versatility and aesthetic appeal (Kumar et al., 2020).

Timbers are anisotropic, meaning their properties vary based on the environment and can be altered. One of their most important qualities is their ready availability and processing. Timber is widely available in most countries of the world; besides, it requires little processing compared to other materials used in construction (Temitope, 2019).

Timber is easily workable and can be whipped into different shapes by simple hand tools or heavy machines. Since they are versatile materials, they can be attached to timbers or other materials using a variety of methods, such as bolts and nuts, screws, and nails (Temitope, 2019; Kumat et al., 2020). Unlike concrete, timber in construction is faster as it requires no curing period, and finishing can also be immediate, making the whole process achievable within a short period.

Overall, the most significant quality of timber is its environmental sustainability. Timber is renewable and biodegradable. From the harvesting of the raw materials to the manufacturing process, the energy and air emissions are minimal at best. Furthermore, timber is known to be a great insulator against cold or heat (Abimaje & Baba, 2014).

2.3. Challenges of Timber

Ubani (2021) stated that timber was widely utilized in building construction in the late nineteenth and early twentieth centuries until the introduction of concrete and steel, which decreased its use. However, advances in engineered timber products have revived the use of timber in building construction. Environmental concerns, along with contemporary manufacturing methods and prefabrication in timber, have enabled engineers to design and build larger and taller timber buildings than ever before (Voulpiotis et al., 2021). Voulpiotis et al. (2021) highlighted the important challenges of timber:

- **Susceptibility to Moisture:** Timber is a naturally occurring, hygroscopic substance that deteriorates greatly under moist conditions. Especially for heavily loaded components, it is crucial to design timber such that it is protected from high moisture in its structural lifetime. This can prevent everything from minor swelling to total loss of structural integrity due to fungal assault due to exposure to moisture.

- **Light-weight in nature:** The density of timber used in construction is around five times lower than that of reinforced concrete and fifteen times lower than that of structural steel. As a building gets taller, the immediate benefit of having a lighter structure with smaller foundations has the drawback of becoming significantly more vulnerable to crucial lateral loads.

- **Orthotropic:** Timber is a naturally grown material; hence, its qualities vary depending on which way it is grown. Timber is extremely weak across its strands yet robust along them.

- **Low stiffness:** The stiffness of timber used in buildings is about three times lower than that of reinforced concrete and twenty times lower than that of structural steel. This can seriously affect deflections, accelerations, and passenger comfort at higher elevations.

- **Brittleness:** Timber can break brittlely when it is under tension, bends, or shears; nevertheless, ductility can be accomplished with careful design, especially in connections with steel fasteners.

- **System effects:** System effects involve how loads are distributed within a structure, which is less straightforward for heterogeneous timber components. In large timber structures facing abnormal loads and potential damage, a deeper understanding of system behavior is crucial for effective analysis and design.

- **Effects of size:** Size effects, influencing a notable decrease in overall strength, are observed in various materials. While the impact of size effects on large timber elements is not fully understood, preliminary indications suggest their potential significance (Fryer et al., 2018).

- **Effects of time:** Timber creeps with time, which can be problematic in heavily loaded constructions such as tall timber buildings.

Dost and Botsai (1990) further discussed that the performance of timber in building construction is dependent on a wide range of characteristics, which is usually dependent on the intended use of such timber. He further discussed that deterioration has been one of the major problems of timber construction. The deterioration is usually a result of climatic and weather conditions. They further emphasized that deterioration refers to the loss of the initial ability of a timber product to serve its intended purpose in appearance, strength and any other required functions. He further expatiated that the deterioration of timber buildings can be discussed in the aspects of exposure hazards and their effects.

2.4. Timber Usage Techniques in Contemporary Building Construction

Adedeji and Ogunsoye (2005) highlighted contemporary techniques with which timber is used in four specific building elements, which include:

- **Walls:** Walls can be constructed in a modern approach where they are assembled horizontally on the sub-floor, then elevated in a "tilt-up" fashion and securely attached to the floor platform's perimeter. Following this, exterior coverings, doors, and windows are incorporated once the walls are properly aligned and braced. In the context of timber wall construction, the structure comprises a solid timber frame enveloped on both sides by solid timber boards, particle boards, or fibreboard. The intervening space between these coverings can be intentionally left void or filled with various materials possessing sound or thermal insulation properties, enhancing the overall functionality and efficiency of the wall system. This technique not only facilitates efficient construction but also allows for customization based on specific insulation and acoustic requirements.

- **Roof:** In contemporary timber roof construction techniques, alternative trusses and conventional joist-and-rafters are employed, often eliminating the need for a separate ceiling finish. The integration of decking or a combination of beams and decking serves a dual purpose: not only does it function as an interior finish, but it also provides a surface for applying roofing materials. The structural integrity of the construction is ensured through the use of epoxy steel dowels for major connections.

- **The Ceiling:** The ceiling construction method mirrors that of the wall, albeit with a reduced thickness. It involves the creation of a robust wooden framework, and the cladding may be limited to one side, opening towards the interior of the house. Typically, the cladding boards vary in thickness.

- **Timber Floor System:** A contemporary approach to timber floor construction involves establishing a floor system supported by beams securely affixed to treated posts embedded in the soil or masonry piers, specifically designed to resist termite infestations. This method offers a notable advantage as it eliminates the necessity for extensive grading, enabling its application on relatively steep or uneven slopes.

3. Research Methodology

3.1. Study Area

The study was conducted in Akure, Nigeria. Ondo State's capital, Akure, is situated in Nigeria's southwest geopolitical zone. Having a land area of 15,500 square kilometres, Ondo State was established on February 3, 1976. It is located between latitudes 5°45' and 7°52'N and longitudes 4°20' and 6°5'E. It is divided into administrative divisions, which are further divided into 18 Local Government Areas.

3.2. Instrument

The research approach involves a cross-sectional survey through quantitative research targeted at examining the drivers and barriers to the use of timber in the Nigeria building construction industry. A total of 29 questions with options to be ticked were prepared in the questionnaire. Questions were asked in relation to the objectives of this research. The questionnaire was designed into five (5) sections; each section was designed to evaluate a specific aspect of the set objectives. The first section was structured to obtain the general information pertaining to the correspondents, such as gender, age group, educational background, occupation, working experience and type of building projects often executed. This is to check the effectiveness and the quality of the data acquired before proceeding to the statistical analysis. The second section of the questionnaire was designed to acquire information on the level of awareness of the use of timber as a building material. The third section was to gather data on the level of usage of timber for building construction in Akure South Local Government, Ondo State, Nigeria. The fourth section was to gather data on the benefits of the usage of timber as a building construction material. The fifth section was to gather data on the possible hindrances and barriers to the adoption and usage of timber in building construction. Data were obtained from self-administered questionnaires completed by 60 people (n=60). Some sets of data were intended to describe the demographic variables of the sample and to assess for any influence on the research findings. The demographic data consisted of sex, educational background, profession, relevant working experience and type of building often executed. The research data were collected between July and October 2019.

3.3. Data Analysis

The data extracted from the survey were analyzed through a Statistical package for social science.

4. Results and Discussions

4.1. Socio-economic Characteristics of Respondents

Socio-economic Characteristics	No. of Respondents	Percentage (%)
Age of Respondents		
Male	43	71.7
Female	17	28.3
Educational Background		
O'Level	0	0
OND	3	5
HND	19	31.7
B.Tech, B.Sc. or B.Eng.	15	25
M.Sc., M.Tech or M.Eng	16	6.7
Ph.D.	7	11.7
Profession		
Architect	27	45
Building Engineer	11	18.3
Quantity Surveyor	10	16.7
Others	12	20
Socio-economic Characteristics		
No. of Respondents		
Percentage (%)		
Relevant Working Experience		
1-5 years	15	25
6-10 years	34	56.7

11-15 years	5	8.3
Above 15 years	6	10
Types of Building Projects Often Executed		
Residential Projects	27	45
Commercial Projects	8	13.3
Religious Projects	5	8.3
All of the above	29	31.7
Others	1	1.7

Table 2: Analysis of Socio-economic Characteristics of Respondents
Source: Author's Field Work

The table below shows the educational background of the respondents and this would assist in ascertaining the level of knowledge of the respondents. The table revealed that the majority of the respondents were HND holders, followed by M.Sc., M.Tech. or M. Eng. followed by B. Tech, B.Sc. or B.Eng., then Ph.D. thereafter OND holders. Since a good number of the respondents have formal education, it was easier for them to understand the qualities of timber and its use in the building industry and respond to the questionnaires effectively. Hence, the result of this research is highly reliable. The table showed that the majority of the respondents were architects. The table also shows the relevant working experience of the respondents, and it can be inferred from the table that an average of the respondents have about 6-10 years of working experience. The table also shows the type of building projects often executed by the respondents, and it can be inferred that the majority of the respondents execute residential projects more than any other projects.

4.2. Level of Awareness of the Use of Timber as a Building Material

The table below shows the respondents' reactions to the questions about their awareness of using timber as a building material. A huge percentage of the respondents are interested in using timber as a building material. Other questions asked include their research on the extensive use of timber, their awareness about the various forms of timber used for building construction, and their level of awareness about the special qualities timber has as an advantage over other types of building material.

Questions	Yes	No
Do you have any interest in the use of timber?	49	11
Have you ever done any research on the extensive use of timber for building construction?	33	27
Have you ever heard of the various forms of timber used for construction, such as Cross-Laminated Timber (CLT), Laminated timber	40	20
Do you know timber can be used extensively for the construction of all building components?	50	10
Do you know that Timber is a more environmentally friendly option than most modern and traditional building materials?	51	9
Do you know that the cost of construction with the use of timber is cheaper than many other building materials?	50	10
Do you know timber has a quicker construction time than other building materials?	54	6
Do you know that timber has more strength-to-weight ratio than steel	31	9

Table 3: Level of Awareness of the Use of Timber as a Building Material
Source: Author's Field Work

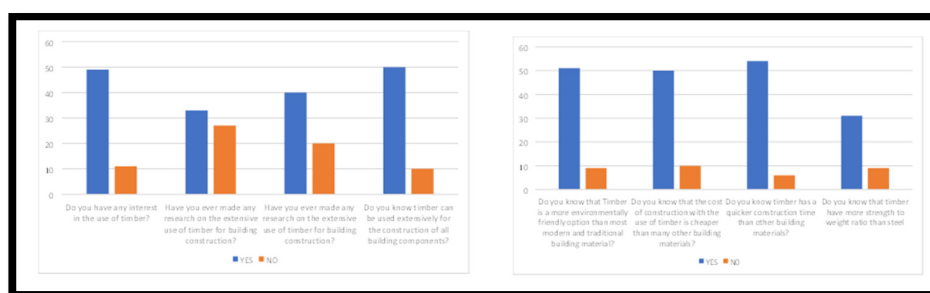


Figure 1: Bar Chart Showing the Respondent's Reaction on the Level of Awareness of the Use of Timber as a Building Material
Source: Author's Field Work

4.3. Level of the Usage of Timber for Construction

The table below shows the respondents' reaction to the questions asked regarding the level of timber usage for building construction in Akure South Local Government, Ondo State. A huge percentage of the respondents have not applied timber purely in any construction exercise in the local government. A huge percentage are also willing to attempt the usage of timber purely for building construction. Other questions asked include an idea about the construction method of timber. However, the majority do not have that idea. They also do not have an idea of any building constructed purely with timber in Akure.

Questions	Yes	No
Have you ever applied timber purely in any construction exercise in Akure South?	7	53
Do you know any building in Akure South constructed purely with timber?	9	51
Do you have any idea about its construction method?	25	35
Would you be willing to attempt to use timber purely for building construction in Akure South?	45	15

Table 4: Level of the Usage of Timber
Source: Author's Field Work

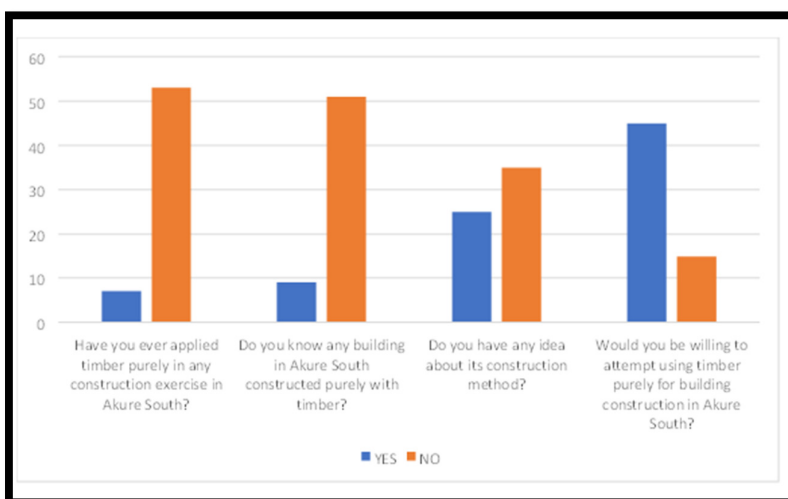


Figure 2: Bar Chart Showing the Respondent's Reaction on the Level of the Usage of Timber as a Building Material
Source: Author's Field Work

4.4. Benefits of Timber as a Building Material

The table below shows the respondent's reaction to the questions asked regarding the benefit of timber as a building material. A huge percentage of the respondents have a general knowledge about its benefits as a building material.

Questions	Yes	No
Do you know that timber has good mechanical properties and can be used as structural elements?	46	14
Do you know that timber requires less construction time?	42	18
Do you know that the use of timber can be as cost-effective as possible?	47	13
Do you know timber enhances the sustainability of the environment?	47	13

Table 5: Benefits of Timber as a Building Material
Source: Author's Field Work

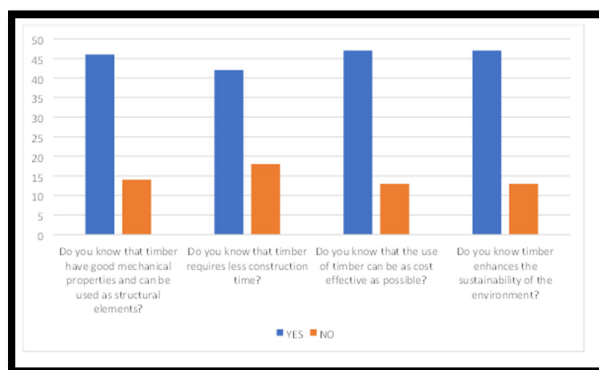


Figure 3: Bar Chart Showing the Respondent's Reaction on the Benefits of Timber as a Building Material
Source: Author's Field Work

4.5. Possible Barriers to the Usage of Timber

The table below shows the respondent's reaction to the possible barriers and hindrances to the adoption and usage of timber in building construction.

Barriers	Strongly Agree	Agree	Not Sure	Strongly Disagree	Disagree
Timber can be damaged by moisture or water	35	12	8	4	1
Timber can be damaged by fire	34	20	4	0	2
Timber is not structurally stable	19	17	13	6	5
Lack of special expertise and technical know-how about its use for building construction	18	32	8	2	0
Lack of building code to guide the use of timber	23	20	17	0	0
Lack of available local production and processing	14	20	13	9	4
Low level of awareness of the sustainable qualities of timber	19	19	15	4	3
The myth that makes some certain cultures not accept the usage	15	14	24	4	3

Table 6: Possible Barriers to the Usage of Timber
Source: Author's Field Work

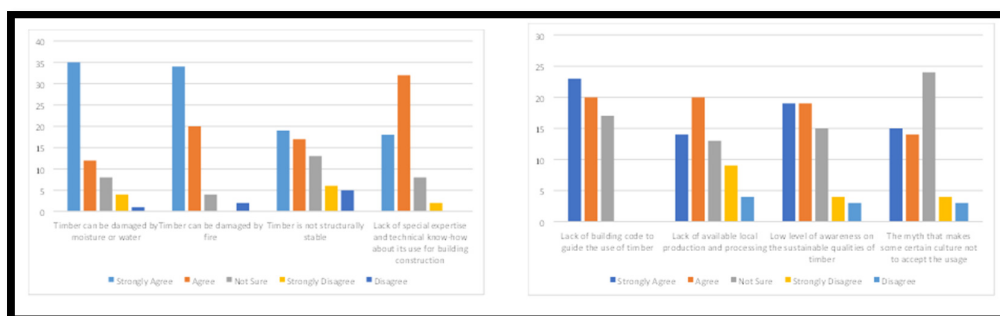


Figure 4: Bar Chart Showing the Respondent's Reaction on the Possible Barriers to the Usage of Timber
Source: Author's Field Work

In order to further investigate the use of timber, the questionnaires were made to address the level of its usage in Akure South Local Government Area of Ondo State, in which timber was discovered to be in very low use compared to other building materials and a very few professionals have an idea about its construction methods but quite a number are willing to attempt using timber purely for building construction. Also, a few numbers of the benefits of timber were ascertained, ranging from good mechanical properties to its sustainability in the building industry. In a bid to examine the drivers and barriers to the use and adoption of timber for building construction, after a series of questions answered by building professionals, the drivers and barriers were highlighted to be low-moisture and fire resistant, low fire resistance, structural instability, lack of expertise and technical know-how of its construction methods, no building code to guide its use, lack of local production and processing, low level of awareness, cultural myths, the wrong perception of its construction been expensive. Recommendations to fully tackle this have been made subsequently.

5. Conclusion and Recommendation

Timber, as a building material, has been proven to have a lot of great qualities, ranging from strength and durability to light-weight, easy maintenance, affordability, flexibility, and sustainability. Its usage would help to enhance the environment as a whole, as it would reduce degradation environmentally and also help in significantly reducing the cost of housing in Nigeria. If the barriers to the usage and adoption in the Nigerian building industry are worked on effectively, it will help unlock the full potential of this material and also pave the way for a more sustainable, cost-efficient, and environmentally conscious construction sector in the country.

The following are recommendations to aid the use of timber in Nigeria's building construction industry:

- A technical knowledge of timber is necessary for its application and this can be advanced through collaboration and training among building construction experts because they are the essential players in the planning and execution of construction projects. Also, more innovative methods of its application can be introduced in the cause of the collaborations.
- In order to encourage the use of timber for building construction by professionals in the building industry, adequate consideration of the use of timber in building construction should be given in the Nigeria National building codes. This would also help to improve its awareness and guide its use.
- The quality of timber and its various components that are available in the Nigerian market can be improved significantly through their mass production. Timber and its various components are largely produced in small workshops using hand tools as of the present. Larger factories should be established that would make use of automated machines, which would make their production economical. This would help in improving the quality of building construction.
- Clients should be enlightened about the potentials, qualities and advantages of timber as a building construction material, as this would generally enhance its usage and adoption for various forms of building projects.

6. References

- i. Abimaje, J. and Baba, A. N. (2014). An Assessment of Timber as a Sustainable Building Material in Nigeria. *International Journal of Civil Engineering, Construction and Estate Management*, 1(2), 39–46.
- ii. Adedeji, Y.M.D. and Ogunsote O.O. (2005). Modern Techniques of Using Timber in Building Structures and Components in Nigeria. Retrieved from: https://www.academia.edu/73782644/Modern_Techniques_of_Using_Timber_in_Building_Structures_and_Components_in_Nigeria.
- iii. Andreas, F. (2005). Architectural forms of massive timber, 'structural forms and system. Doctoral thesis presented at the Lulca University of Technology Sweden. (page v) (27). Sp External Scientific Publication.
- iv. Apu, S.S. (2003). Wood Structure and Construction Method for Low-cost Housing. *International Seminar/ Workshop on Building Materials for Low-Cost Housing, September 7–28, Indonesia*.
- v. Douglas, W.M. (1995). America's Forest: A history of resiliency and recovery. *Forest Products Journal* 45(10), 18–28.
- vi. Falk, R.H. (2010). Wood as a Sustainable Building Material. *General Technical Report FPL-GTR-190*.
- vii. Fryer, B. K., Foster, R. M., and Ramage, M. H. (2018, January). Size effect of large-scale timber columns. In *WCTE 2018-World Conference on Timber Engineering* (Vol. 2018, pp. YSA-03). World Conference on Timber Engineering (WCTE).
- viii. Iwuagwu, B. U. & Iwuagwu, B. M. (2015). Local building materials: an affordable strategy for housing the Urban poor in Nigeria. *Procedia Engineering*, 118, 42–49, <https://doi.org/10.1016/j.proeng.2015.08.402>
- ix. Kumar, A. & Dhiman, B. and Sharma, D. (2022). Sustainability and Applications of a Timber as Structural Material: A Review. *International Research Journal of Engineering and Technology (IRJET)*, 07(10), 1868–1872.
- x. Structural Engineering Bulletin (2019). Timber as a structural material. *Structural Timber Engineering Association Bulletin*.
- xi. Temitope, O. O. (2019). Green Building and Energy Conserving Designs: Significance of Timber as a Sustainable Building Material in Nigeria. *World Journal of Innovative Research WJIR*, 6(5), 56–60.
- xii. Ubani O. (2021, January 15). The problems of using timber in building construction. Structville. Retrieved from: <https://structville.com/2021/01/the-problems-of-using-timber-in-building-construction.html>