

Prospect of Bamboo Utilization in the Building Industry in Owerri, Imo State

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Abstract: The study examines the level of Professional prospective on the Factors Affecting the prospect of Bamboo Utilization in Building Industry in Owerri, Imo State. The research was pursued using a well-structured questionnaire. With a view to assess the registered professionals in the field of building in Owerri, 64 questionnaires were distributed with 54 of them properly filled and returned, giving a percentage response of 84.38%. The opinion of the respondents was analyzed using simple percentages, tables and charts. From the research, it was confirmed that although bamboo could be utilized in the building construction industry for purposes such as scaffolding, reinforcements for concrete, and flooring among others. Its utilization in Owerri is only frequently used for scaffolding, plantain lodging among others. This was perceived to have been influenced by some identified negative factors of which through the use of Relative Importance Index, they were ranked by the respondents in the order of, susceptibility to fungi and termite attack (1st), fire prone (2nd), poor knowledge of the diverse application (3rd), shape of bamboo (4th), poor thermal insulation (5th) and finally poor sound insulation (6th). Based on the findings, it was recommended that the application of engineering on bamboo will greatly influence its prospects for use in the building construction industry of Owerri.

Key Words: Bamboo Utilization, Owerri Construction industry

1.0 Introduction

Bamboo is one of the fastest growing plants in Africa, growing skyward as fast as 121cm in 24hours period and can also reach maximal growth rate exceeding one meter per hour for short period of time (Kigomo2007). A Culm can reach its full maturity in a matter of two to three months which makes it one of the forests growing, highest yielding renewable natural Resources. Bamboo reaches maturity in three to five years of growth compared with timber products that take a longer of period 30-50 years to mature. It is one of the most important non-timber forest resources because of its high socio economic benefits. It has a wide range of applications in the textile industry, the manufacturing industry, the transport industry, the construction industry and more precisely, the building industry.

According to Ogunwusi & Onwualu (2013) carried out an inventory of bamboo accessibility and exploitation in Nigeria. The authors used partial essential survey and field inventory visits. The results show that the act of bamboo farming and production is more concentrated in the middle belt region and the southern part of Nigeria.

Bamboo is widely distributed in South East, South-South and middle belt of Nigeria based on ecological disposition of these rain forest regions. Here in Nigeria, Bamboo is generally called Indian Bamboo and originated from South East Asia. From various research works, it has been found that bamboo have some various unique advantages that makes it suitable as a building material and is being explored in some countries around the world as well as in some locations in Nigeria. It serves as a raw material in the building process for

various applications, including flooring, walling, roofing, upholstery, utensils and even as reinforcements for structural elements. Bamboo houses are common in the country side of china, and most Asian countries.

Review of research works indicate that 40 trees are required to build a good size wood frame house which is much, and leads to increase in global deforestation and reduction in wood resource. Again trees take longer time to grow to maturity, it is costly, and the embargo placed on felling in natural forests necessitates the need for an excellent alternative. Bamboo which could serve as one of the excellent alternative has been found to have properties stronger and better than timber as well as compete favorably with some other building materials in Owerri. Bamboo is environmentally friendly, durable if treated properly, has high strength against heat, high specific load bearing capacity, high strength to weight ratio, has natural insulation and has wider application in building and civil construction such as in walling, flooring, roofing and as reinforcement in place of steel both in buildings and in bridges.

With the development of advanced processing technologies, the utilization of raw materials and natural resources, have had a broader application in modern times. Bamboo is one of such materials that have been considered and found to be suitable for use in various building and construction works. But a look at the building industry in Owerri, one would wonder whether the application of bamboo for various building construction purposes is feasible, considering the fact that the usage of the material in the city is majorly for scaffolds and formwork erection. Furthermore with the advancement in processing technologies, one is meant to suggest that the utilization should become even broader.

Hence this study was carried out to explore the properties of bamboo available in Owerri metropolis especially as a building material so as to ascertain its usefulness in the building industry and as well as seek the perception of professionals on the factors that influences its prospects in the metropolis.

This study will expose readers to the properties of bamboo and as well as the wide areas in which it can be utilized in the field of building construction so that it can be explored in the building construction industry of Owerri. This paper takes a closer look at this material in the building industry of Owerri with a view to ascertain its prospects.

2.0 Literature Review

Bamboo Industrial Properties

Bamboo high mechanical properties such as tensile and compressive strength, shrinkage, resistibility and elasticity make it a potential multi-functional material for structural applications. Fibres in bamboo run axially; hence the tensile strength of bamboo is on the outer edge of the culm which is a profoundly versatile vascular bundle. The strength of bamboo fibres varies along with culm height. The compressive strength of culms increases with height while bending strength has opposite pattern. Bamboo shrinks more than wood when it loses water. It shrinks in the cross sections between 10– 16%, and in the wall thickness is also about 15–17%. The property of high silicate acid by bamboo makes it have an abnormal flame resistibility. Bamboo has an enormous elasticity which makes it suitable building material and is environmentally friendly for areas with quakes. Furthermore, bamboo has a relatively low weight and can be transported easily and utilised at any given distance across the globe (Kiflu, 2006).

Bamboo Industrial Uses

According to research by Vogtländer, (2011), Waite (2009) and Wooldridge (2012), utilisation of bamboo range from foods, medicines, biomass, textiles, pulp and paper making. Also, it is used as a candidate material, seeing its application ranging from construction of buildings and bridges, construction of furniture, household items, application in the electronic and automobile industry, and other products like chopsticks and so on. (Xaing, 2010). Bamboo possesses a high amount of nutritional minerals including amino acids, vitamins, and steroids which are removed from bamboo culm, leaves and shoot. Some other products from bamboo include processed beverages, medicines, pesticides and household items, e.g., toothpaste, soap, and so on. (Vogtländer, 2011). The industrial processing of bamboo in recent years gives an indication that anything that can be made from the wood material can also be developed from industrial bamboo materials. The industrial processing of bamboo and in particular the laminate bamboo strips made into boards (Plybamboo), mostly finds applications in flooring, furniture board, veneer, and woven bamboo mats (van der Lugt and Lobovikov 2008)

Bamboo for construction use

In the construction industries, bamboo is used as a building material for decoration and as a structural member of a house. Bamboo utilisation for housing has since ages back, used as poles, trusses, rafter, flooring, ceiling, roof, window and door frames, footbridges, fence posts and, the wall as shown in figure 9. They are also used in modern-day as scaffolds to support slabs while constructing. Bamboo production is now familiar with

the world and has since been in China, India, Vietnam and Thailand where mat boards are produced. Sustainability of bamboo is attainable across the globe according to studies as it is in most Asian countries.

The use of bamboo in recent times as a raw material in structural works is due to its environmentally friendly attributes and readily availability (Yu et al. 2011). Bamboo-based panels are products made from raw bamboo through a series of mechanical and chemical procedures, such as spraying glue, laying up, and hot pressing. According to Naxium (2001), the bamboo-based panels have the advantages of considerable size, high strength, stabilisation in shape and size, and it is parallel and perpendicular strength and property that can be adjusted according to different demands. Bamboo-based panels are relatively typical engineering materials. The panels are manufactured under high temperature and pressure with the aid of adhesives. Ply bamboo is used in truck floors as the weight of steel materials is too high. Also, ply bamboo has a high friction coefficient, and it does not rust. The bamboo species in Ghana at present can be developed into bamboo-based panels which can be used in the structural application fields in the form of Mat Plybamboo, Curtain Plybamboo, Laminated Bamboo of Strips, Plybamboo, Bamboo Particleboard, and Bamboo Composite Board. The bamboo-based composite may also be the suitable alternative as the materials of prefabrication regarding the various advantages they contain. Development of panel products based on bamboo strips and fibre polymer is gaining importance as these panel products reassemble wood when used in a particular fashion as in parallel laminates and as reinforcement in other matrices. These products will have superior physical, mechanical properties and are suitable for the structural and specialised application. Moreover, the requirement of resin adhesives is expected to be lower compared to bamboo mat based composites and therefore making the products cost-effective which are considered to be ideal for alternatives to wood and plywood for several end-user applications. Bamboo laminates and fibre polymers could replace timber in many applications such as house building, doors, windows, ceiling, furniture, and several other structural applications.

Methodology

The study was carried out via an intensive appraisal of literatures in the area of interest as well as with the use of a well-structured questionnaire, in view to assess the perspective of building professionals on the factors affecting the prospect of bamboo in the building construction industry. The research is targeted to assess Building professionals registered with the Nigerian Institute of Building (NIOB) Imo chapter; to establish their perspective on the factors affecting the prospect of bamboo in the building construction industry.

Sample Size and Sampling Techniques

The sampling technique adopted in the distribution of the questionnaire was random sampling technique owing to the fact that all the professionals have same chances to give the right answer. The sample size was determined based on the formula below, considering the fact that the targeted population was known;

$n =$

Where;

n = The desired sample size

N = Population size

e = Margin of error (level of confidence) considering that:
confidential level

i A 90 % level of confidence has $\alpha = 0.10$ and critical value of $Z_{\alpha/2} = 1.64$

ii A 95 % level of confidence has $\alpha = 0.05$ and critical value of $Z_{\alpha/2} = 1.96$

iii A 99 % level of confidence has $\alpha = 0.01$ and critical value of $Z_{\alpha/2} = 2.58$

iv A 99.5 % level of confidence has $\alpha = 0.005$ and critical value of $Z_{\alpha/2} = 2.81$ For the purpose of this research, a confidence level of 95% was adopted in an attempt to get a dependable data collection. Consequently, the sample size was determined as follows,

$$= 0.05$$

$$N = 76$$

Therefore from the formula $n =$

$$n =$$

$$n = 64$$

Hence a total number of 64 questionnaires were distributed.

The questionnaire was a combination of closed, ranked as well as an open ended type, which allows for either strongly agree (SA), Agree (A), Strongly Disagree (SD), Disagree (D), or Indecisive (ID) responses from the respondents.

The questionnaires were administered to the building professionals in Owerri, Imo state during the 2017/2018 academic session.

Some of the questionnaires were collected back from the professionals the same day they were administered to them whereas some others were collected some time later. The questionnaires were then scored and analyzed based on their individual and collective responses.

Data Analysis Procedure

Responses from the building professionals were collected and analyzed using statistical package for social sciences (SPSS). And the result of the analysis was presented in simple percentages and bar chart.

For the questions that entails ranking, the numerical scores for the completed questionnaires provided an indication of the varying degrees on the factors affecting the prospect of bamboo in the building construction industry.

To further analyze the data with a view to establish the significance of the variables considered, the Relative Importance Index (RII) was calculated for each prospect according to their frequency of use as suggested for use by Memon et al, (2006) and Othman et al, (2005). It was calculated using the formulae;

RII =

Where:

n1 = number of respondents for 'Strongly Disagree'

n2 = number of respondents for 'Disagree'

n3 = number of respondents for 'Indecisive'

n4 = number of respondents for 'Agree'

n5 = number of respondents for 'Strongly Agree'

N = total number of respondents

RII ranges between Zeros and One. The five point scale ranking was transformed to relative importance indices (RII) for each.

Results are classified into three categories (Othman et al, 2005) as follows:

When;

(RII < 0.60), it indicates a low frequency in use.

(0.60 ≤ RII < 0.80), it indicates a high frequency in use.

(RII ≥ 0.80), it indicates a very high frequency in use.

Data Presentation and Analysis

This section gives the outcome of the research on the building professional's perspective on the factors affecting the prospect of bamboo in the building construction industry of Owerri. The opinion of the respondents to the questions asked are analyzed and presented in simple percentages, bar charts and other statistical tools.

Percentage Response:

The table below presents a summary of the responses to the administered questionnaires.

Table 1: Percentage Response of respondents

Questionnaire	Frequency	Percentage (%)
Questionnaires returned	54	84.375
Questionnaires not returned	10	15.625
Total Questionnaires	64	100

Source: Survey, 2018

From the analysis, the total number of administered questionnaires was 64 corresponding were ministered with only 54 returned adequately filled giving a percentage response of 84.38%. This shows that a greater percentage of the questionnaires was retrieved, hence a greater percentage of the building professionals in Owerri, gave us their perspective as regards to the subject of research.

Gender Percentage of Respondents:

From the questionnaires distributed, the table below shows the percentage distribution by gender of the respondents.

Table 2: Respondent Profile

S/N	Profile	Option	Frequency (No)	Percentage (%)
1	Gender of Respondents:	a) Male	51	94.44
		b) Female	3	5.56
		Total	54	100
2	Membership Category	a) Fellow	2	3.70
		b) Corporate Member	16	29.63
		c) Graduate	20	37.04
		d) Associate	26	48.15
		e) Others	0	0
		Total	54	100
3	Years of Experience	a) More than 15 years	16	29.63
		b) 11-15 years	12	22.22
		c) 6-10 years	17	31.48
		d) Less than 6 years	9	16.67
		Total	54	100

Source: Field Survey, (2018)

From the data presentation on the table above, it can be stated that the majority of the building professionals in Owerri are males, corresponding to 94.44% of the total retrieved questionnaires (54). Thus the percentage response of the females corresponds to 5.56%.

The section of NIOB (Nigerian Institute Of Building) membership of the respondents for the 2017/2018 session, was collected through the questionnaire. The table below gives the membership category of the respondents: From the table above, it is clear that the most of the respondents are Associates (48%) followed directly by Graduates (37.04), followed by Member (29.63), and finally by Fellow (3.70).

From the questionnaires distributed, the years of experience of the respondents were collected. The Essence is to ascertain their level of exposure in the field of building construction. The table below gives the summary of the respondent's years of experience in the field of building construction:

From the data in the table above, it is clear that the highest number of respondents have years of experience within the range of 6 to 10 years.

It can also be deduced from the cumulative frequency distribution that more than half of our respondents (51.85%), has as years of experience within the range of 11 to More than 15 years. This shows that a larger number of our respondents has practiced in the field of building construction for a very long time (11 years and above) thus possess a great deal of knowledge about various construction works in the field of building.

General Applications of Bamboo in Building Construction

The perspective of the respondents as regards the various applications of bamboo in the building construction industry globally was ascertained in the administered questionnaire. The various ways bamboo is being applied in the building construction industry was gathered from the review of several literatures and then itemized on a Linkert scale. They were required to show their level of agreement by ranking according to their perception. The table below shows their ranking on the various applications of bamboo in the building construction industry.

Table 3: Professionals perspective on the general applications of bamboo in building construction

S/N	Bamboo application	Number Of Respondents	Mean	RII	Ranking
1	Doors	54	3.481	0.696	4 th
2	Windows	54	3.444	0.689	5 th
3	Trusses	54	3.370	0.673	7 th
4	Roofs	54	3.648	0.730	2 nd
5	Framing and Scaffolding	54	5	1	1 st
6	Reinforcements for concrete	54	2.778	0.556	8 th

Flooring	54	3.370	0.674	6 th
Walling	54	3.574	0.715	3 rd

Source: Field Survey, (2018)

From the table above, it can be established that majority of our respondents agreed (average of the mean distribution greater than 3) that bamboo can be applied in building construction. However, bamboo for Framing and Scaffolding ranked 1st with a Relative Importance Index (RII) of 1. This was followed directly with Roofing (R.I.I. = 0.730). The last ranked was the application of bamboo as reinforcements in concrete (8th), followed by its application in roof trusses (7th).

Bamboo Application in the Building Industry of Owerri

The same previously itemized applications of bamboo in the building construction industry was itemized and respondents were required to rank based on their level of experience and exposure, the level of application of bamboo in the building construction industry of Owerri. This was required from then so as to draw a comparison between the global applications to that of Owerri. Their response was analyzed and presented on a table as shown below.

Table 4: Bamboo application in the building construction industry of Owerri.

S/N	Application In Building Construction	Number Of Respondents	Mean	RII	Ranking
1	doors	54	1.611	0.403	7 th
2	windows	54	1.667	0.417	6 th
3	Trusses	54	1.852	0.463	5 th
4	Roofs	54	2.259	0.565	2 nd
5	Framing and Scaffolding	54	3.926	0.981	1 st
6	Reinforcement for Concrete	54	2.074	0.516	4 th
7	Flooring	54	1.389	0.347	8 th
8	Walling	54	2.111	0.528	3 rd

Source: Field Survey, 2018

From the table above it can be established that majority of the respondents believe that bamboo is rarely used for most of the building construction application of bamboo (since the average of the mean is closer to the scale 2=Rarely Used). However, Majority of them believes that bamboo is frequently used for Framing and Scaffolding with a Mean value of 3.926, closer to the Linkert scale of 4=Frequently Used. However, the Relative Importance Index reveals that amongst those applications of bamboo in the building construction industry of Owerri that are rarely used, bamboo as reinforcement for concrete ranks the last (8th) with a R.I.I. of 0.347. This was followed directly by bamboo as door (7th), with a R.I.I. of 0.403.

Availability of Bamboo in Owerri

From the questionnaire distributed, respondents were required to assess the availability of bamboo in Owerri from a scale of 1-100 with an interval of 20. The table below shows their response:

Table 5: Availability of bamboo in Owerri

Availability of bamboo	Frequency	Percentage (%)	Cumulative frequency
81-100	12	22.22	12
61-80	27	50	39
41-60	15	27.78	54
21-40	0	0	
0-20	0	0	

Source: Field Survey, 2018

From the table above, it can be established that the majority of the respondents (27) believe that the availability of bamboo is between the ranges of 61-80 on a scale of 1100. From the cumulative frequency distribution, it can also be established that all the respondents (54) believe that the availability of bamboo is within the range of 41-100, on a scale of 1-100. This shows that bamboo is highly available in Owerri.

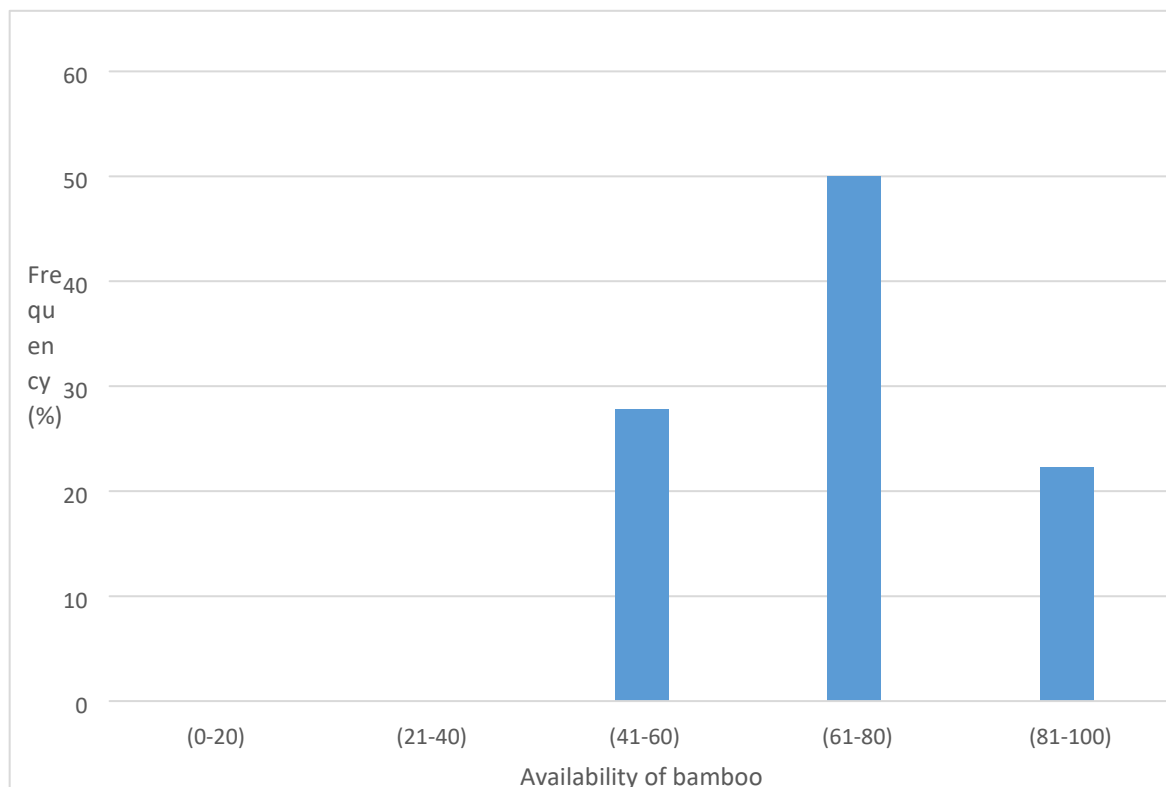


Figure 1: A Bar Chart showing the availability of bamboo in Owerri

Source: Field Survey, (2018)

As regarding the various application of bamboo in the building construction industry, majority of the respondents believe that bamboo is rarely used for most of the building construction purpose in Owerri, (since the average of the mean is closer to the scale 2=Rarely Used). Thus concurred that the application of engineering on bamboo as well as enlightenment on the varieties of its application in the building industry, will greatly promote its prospect in the building construction industry of Owerri.

Factors That Affect the Prospect of Bamboo in Owerri

The factors that could impact on the prospect of bamboo in Owerri, was identified through literature review and itemized on the administered questionnaire. Respondents were required to show their level of agreement on the itemized factors.

Positive Factors That Can Affect The Prospect Of Bamboo

The table below shows the respondents opinion on the positive factors that could impact the prospects of bamboo.

Table 6: Some positive factors that could affect the prospects of bamboo in Owerri.

S/N	Properties of Bamboo	Number of Respondents	Mean	RII	Ranking
1	Strong in Tension	54	3.778	0.756	7 th

2	Strong in compression	54	3.889	0.778	5 th
3	Light weight	54	3.963	0.793	4 th
4	Flexibility	54	3.648	0.730	8 th
5	Durability	54	3.815	0.763	6 th
6	Aesthetics	54	2.981	0.596	9 th
7	Easy and Safe to work with	54	4.037	0.807	3 rd
8	Availability	54	4.667	0.933	1 st
9	Cost effective	54	4.630	0.926	2 nd

Source: Field Survey, (2018)

From the table above, respondents believe that the availability of bamboo in Owerri is the 1st factor that could impact on the positive prospect of bamboo, with a R.I.I. of 0.933. This was followed closely by The Cost effectiveness of bamboo, ranking 2nd with a R.I.I. of 0.926. However, the Aesthetics of bamboo, was ranked last (9th) with a R.I.I. of 0.596. This was followed by the flexibility of bamboo (8th) with a R.I.I. of 0.730.

As regarding the Environmental Sustainability of bamboo, the table below shows the respondent's perspective of bamboo as follows:

Table 7: Respondents perspective on the environmental sustainability of bamboo.

S/N	Environmental Sustainability	Number of Respondents	Mean	RII	Ranking
1	Construction Waste	54	3.093	0.619	3 rd
2	Reusable	54	4.259	0.852	1 st
3	Recyclable	54	4.111	0.822	2 nd

Source: Field Survey, (2018)

From the table above, the mean value of the respondents tends towards the Linkert scale of 4 (Agree) which implies that the majority of the respondents believes that bamboo is environmentally sustainable both in terms of its reduction of construction wastes, as well as the fact that it can be reusable and recyclable.

Furthermore, from the R.I.I. values, it was deduced that the most decisive environmental factor that presents a more positive prospect for bamboo is that of its reusable property which ranks 1st, with a R.I.I. of 0.852. Its Recyclable property ranks 2nd with a R.I.I. value of 0.822.

Negative Factors That Affects the Prospect of Bamboo in Owerri

The table below shows the respondents opinion on the negative factors that affects the prospects of bamboo in Owerri:

Table 8: Negative factors that affects the prospects of bamboo in Owerri

S/N	Negative Factors Affecting the prospect of bamboo in Owerri	Number of Respondents	Mean	RII	Ranking
1	Availability	54	1.648	0.330	9 th
2	Expensive	54	1.778	0.356	8 th
3	Poor Knowledge about the diverse applications of bamboo	54	3.722	0.744	3 rd
4	Poor Aesthetics	54	3.222	0.644	7 th
5	Shape of bamboo	54	3.648	0.730	4 th
6	Fire prone	54	4.019	0.804	2 nd
7	Susceptible to Fungi and Termite attack	54	4.130	0.826	1 st
8	Lack of Expertise To use Bamboo In construction	54	3.333	0.667	6 th
9	Inadequate Bamboo Processing Companies	54	3.407	0.681	5 th

Source: Field Survey, (2018)

From the table above, it can be established that the respondents believe that the availability of bamboo in Owerri is the last factor that affects the prospects of bamboo in Owerri, (9th) with a R.I.I. of 0.330. This was followed closely with the expensive (high cost) factor of bamboo, ranking (8th) with a R.I.I. of 0.356. However, the fact that bamboo is susceptible to fungi and termite attack is the major factor respondents believe does affect the prospects of bamboo in Owerri. It ranks 1st, with a R.I.I. of 0.826. This was followed closely by the fact that

bamboo is fire prone (2nd), with a R.I.I. value of 0.804. Poor knowledge about the diverse applications of bamboo in the building construction industry of Owerri, ranks 3rd, with a R.I.I. of 0.744.

Promotion of the Utilization of Bamboo in Building Construction in Owerri

From the questionnaire distributed, respondents were required to show their level of agreement on the itemized measures that can be taken to promote the utilization of bamboo in the building construction industry of Owerri. The itemized measures were gotten from the numerous reviewed literatures. The table below shows their response:

Table 9: Measures to promote the utilization of bamboo in the building construction industry.

S/N	Measures To Promote Bamboo Utilization	Number Of Respondents	Mean	RII	Ranking
1	Enlightenment	54	3.907	0.781	2 nd
2	Code establishment	54	3.889	0.778	3 rd
3	Improve durability by preservative	54	3.796	0.760	4 th
4	Engineering	54	4.111	0.822	1 st
5	Manipulating the shape	54	2.870	0.574	6 th
6	Encourage bamboo plantation	54	3.463	0.693	5 th

Source: Field Survey, (2018)

From the table above, the respondents believe that the application of engineering on bamboo will greatly promote its prospect in the building construction industry. They ranked it 1st (R.I.I. of 0.822) followed by an enlightenment on the various applications of bamboo in the building construction industry (R.I.I = 0.693). The other measures in the decreasing order of their ranking are; Code establishment (3rd); Improving durability by preservative (4th); Encouraging bamboo plantation (5th) and finally Manipulating the shape of bamboo (6th).

Summary of Findings

From the total number of Building professional respondents assessed, only 54 questionnaires were filled and retrieved, corresponding to 71.05% of the entire sample size N, 76. This shows that a greater percentage of the Building professional questionnaires were retrieved. This follows that a greater percentage of the building professionals in Owerri, gave us their perspective as regards to the subject of research.

It was also deduced from the cumulative frequency distribution that more than half of our respondents (51.85%), have as years of experience within the range of 11 to More than 15 years. This follows that a larger number of our respondents have practiced in the field of building construction for a very long time (11 years and above) thus possess a great deal of knowledge about various construction works in the field of building.

It was also deduced from the respondents that the availability of bamboo is not a hitch that could affect the negative prospects of bamboo in the building construction industry of Owerri as majority of them attested to the fact that bamboo is relatively available in Owerri. From table 4.7, the availability of bamboo in Owerri can be represented on a bar chart as shown below:

Conclusion

The material bamboo has had a long and rich history. It is a fast growing natural resource and no doubt one of the most important non-wood forestry products and one of the most important agricultural plants in the world. However, it was not until the twentieth century before various research work began to reveal its economic value. Unlike most timber, bamboo is a self-regenerating natural resource with numerous rural and industrial uses. As a plant that provides considerable environmental benefits, it is also used for ecological purposes.

Bamboo has also been used to build houses for a long time. An estimated statistics shows that hundreds of millions of people (bamboo network) live in bamboo houses.

Even now, bamboo houses are common in the country side of South China, Eastern South Asia, and Latin America.

Bamboo presents advantages for building construction in Owerri, in the following areas; cheap cost, availability, easy and safe to work with, durability, strong in tension and compression, etc. However with the negative properties such as its susceptibility to termite and fungi attacks, poor thermal insulation, poor sound insulation, shape factor, etc, the prospects for use in the building construction industry of Owerri could be affected. But with improvements in manipulating shapes, bamboo laminated sheets, treatment of bamboo to

improve durability, water in timber to improve fire resistance, etc, these negative effects can be reduced to the barest minimum.

If the research findings on the ways to promote the utilization of bamboo in the building construction industry stated above are accepted and implemented, then it will be used for years to come in everything from building to other various construction works in Owerri to be precise.

Recommendations

Although various properties of bamboo which does presents a favourable prospect for use in the building construction industry in Owerri have been presented in our study, we recommend that to further improve on the positive prospects of bamboo, the following should be considered;

- i. An awareness platform to expose construction professionals on the diverse utilization of bamboo should be incorporated into the program of the professional bodies.
- ii. The government as well as private individuals should invest in bamboo cultivation so as to increase its availability.
- iii. Further studies should be carried out to seek for better ways of improving the fire resistance of bamboo as well as the shrinkage limits.
- iv. Entrepreneurs should be encouraged to consider the business of bamboo processing and finishing. Example, bamboo laminated sheets processing etc. so as to promote its utilization in Owerri.

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