

ASSESSING AREAS AND TRENDS OF BAMBOO USAGE IN BUILDING CONSTRUCTION IN GHANA

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Bamboo has gained popularity in its usage in many areas in building construction in some Asian and Latin American countries where it is grown as an alternative material to timber. However, in Ghana, bamboo usage in building construction has not been given much attention. This study focuses on identifying areas and trends of bamboo usage in building construction in Ghana and the prospect of being an alternative material to timber. The study employed structured questionnaire survey of 100 medium and small scale building contractors and 84 architects who responded to 14 areas of bamboo usage identified through a comprehensive literature review. Data was analysed by means of relative importance index to identify the possible areas in the construction industry where bamboo is mostly used. The findings showed that props, landscaping and hoarding among others are the three most significant areas in construction where bamboo is used. The findings further showed that though bamboo has received little attention in its usage in the areas of ladders, scaffolds, workers shed, roofing, ceiling, wall partitioning and flooring. Generally, the respondents agreed to the increase in the usage of bamboo as a construction material in the building industry. However, the increment is significant in the areas of props and landscaping. This study should create the required awareness of bamboo as an alternate material to timber which is dwindling in its supply to the building industry.

Keywords: bamboo, building construction, Ghana

INTRODUCTION

The increase in the population and human activities in Ghana has rapidly pulled up a high demand of buildings to house both the individuals and activities (i.e. the provision of residential, commercial, industrial or the combination of any of the building categories). However, the demand for building has beckoned the activeness of the building construction industry (BCI) to support in whinging the wheels of development especially in developing countries (Ofori, 2012; Lopes, 2012).

The BCI is characterised by three main resources; human, plant and equipment, and material resources. Notwithstanding the importance of the mentioned resources, arguably the impact of the material resource in building construction (BC) should not be undermined (Fapohunda and Stephenson, 2010). Deshwal (2011) asserts that building materials account for nearly 60% to 65% of the total cost of building construction. The demand for materials either locally obtained or imported has pulled an array of different industries to play roles in the construction industry and the list of these industries is not complete without mentioning the timber industry. To confirm the rapid demand for timber and timber products, a study by Food and Agriculture

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Organisation (1997) affirms that there is an outburst demand for building construction and this is coupled with the increased demand for timber in the industry. In a study to project into the stability of the supply of timber into the market for various uses, it was anticipated by the Food and Agriculture Organization (FAO) that the demand of order for wood and wood products would increase by thirty percent (30%) by 2013 (FAO, 1997). Notwithstanding the increased demand of timber and timber products, related study outlined that, Ghana's forest timber production area is declining in an increasing manner in both size and productivity due to unecological logging practices and over utilization of the traditional timber species. The extreme exploitation of the forest has beckon on authorities to put strict regulation which has eventually reduced the quantity of timber supplied to the furniture and construction industries. (Ayarkwa, 1998; Solomon-Ayeh, 2004).

The alleviation of the problem of insufficient and extinction of the timber species allowable to the market especially to the construction industry, has called on exploitation of other forest resources comparable to timber. Bamboo is identified as a constructional material which has constructional properties comparable to that of timber (Amanda et al. 1997). Bamboo has been identified and tested by many countries and proven to have the qualities which make it a very good material for the building and construction industry. According to Gutiérrez (2000), there has been an ancient exploration of bamboo for construction and this is due to the fact that it appears to be a tailor-made material for use as a building component. Bamboo appears round, straight, smooth, strong and beautiful.

Bamboo possesses constructional properties like high tensile strength, high strength to weight ratio and high specific load bearing capacity hence, confirming its potential as a material for building construction (Tada et al. 2010; Ghavami, 2005; Van der Lugt et al. 2005; Paudel, 2003; Yao and Li, 2003; Iyer, 2002; Amada and Untao, 2001). Bamboo has the ability to grow almost everywhere in various seasons and has short rotation (Liese, 1985 and Power, 2004). Like wood bamboo also possesses high residual strength to absorb shocks and impacts—this makes it a highly suitable material for construction of houses to resist seismic and high wind forces (Shyamasundar et al., 2008)

AREAS OF BAMBOO USAGE IN BUILDING CONSTRUCTION

The uses of bamboo for building construction have metamorphosized from simple pole construction to more sophisticated construction. Bamboo can serve as a material for the whole or part of a construction of a building (Tekperthey, 2006).

Bamboo has greatly been given consideration by several countries in Asia and Latin America as an important building material not only for the construction of rural houses but also for urban private houses and public buildings (Shyamasundar and Vengala, 2008). According to Malin and Boehland (2006) the use of bamboo in building construction can be classified into temporary (Props, Scaffolding, Workers shed, Ladder, Formwork and Hoarding) and permanent uses (Bamboo Reinforcement, Trusses, Ceiling, Doors and windows, Roofing, Bamboo floor, Partition walls and Landscape).

To confirm the growing utilization of bamboo in building construction, literature outlines that bamboo tremendously has multiple uses in building construction (Table 1). Jansen (2000) asserts that the trend of bamboo usage in building construction is increasingly gaining attention and utilisation. Contractors and architects are

patronising the potential of bamboo by increasing its usage and specifying it respectively.

Table 1: Summary of the areas of bamboo in building construction

No.	Areas	Reference
1	Props	Jiang, (2008), Tekpetey (2006)
2	Scaffolding	Fu, (1993), Chung, et al., (2003), Chung and Sin, (2002), Janssen, (2000), Jayaneti and Follet, (1998)
3	Workers shed	Recht et al., (2001)
4	Ladder	Chung, et al., (2003)
5	Formwork	Recht et al., (2001)
6	Hoarding	Jiang, (2008), Tekpetey (2006)
7	Bamboo Reinforcement	Iyer (2002)
8	Trusses	Paudel and Solomon-Ayeh, (2004)
9	Ceiling	Bandara, 1990
10	Doors and windows	Gangopadhyay (2003)
11	Roofing	Shyamasundar, K. (2005)
12	Bamboo floor	Xiao et al, (2009), Haregewoin, (2007), Customs General Administration of China, (2004)
13	Partition walls	Punhani and Pruthi (1992)
14	Landscape	Sta. Ana, (2006)

Although the above mentioned areas expose extensive use of bamboo in building construction in some Asian and Latin American countries, little research has been done to popularise the potential of bamboo to make it attractive to architects and building contractors to specify and use it respectively. To confirm the areas of bamboo usage in building construction in Ghana, Tekpetey (2006) noted that the most popular areas are props and hoarding though his statement was not with any empirical evidence but by observation. This study therefore focuses on identifying other areas and trends of bamboo usage in building construction in Ghana.

RESEARCH METHODOLOGY

This study deployed a comprehensive review of related published works to identify the various areas of bamboo usage in building construction and the identified information modified to suit the situation in the Ghanaian building construction industry to help outdoor the pertaining situation of bamboo usage in Ghana. The survey instrument employed was a structured questionnaire and this was adhered to in order to reduce bias in the question and answer processes, closed-ended questions were mainly used in the survey (Roberts, 2007). However, respondents were asked to add to the areas of bamboo usage and suggest other values that will improve the use of bamboo in building construction in Ghana. The questionnaire was administered to 100 small and medium scale building contractors in the Kumasi metropolis and 72 Principal Architects of registered architectural firms in Accra and Kumasi. A face-to-face approach of questioning was used to administer the questionnaires to maximize the response rate. The questionnaire administration took place in the offices and active sites of the respondents.

The questionnaire was divided into three sections. Section one primarily focused on background information of the respondents and how often bamboo is used in building and design. The second section sought information on the possible areas and trends of

bamboo usage. On the possible areas of bamboo usage respondents were asked to rank on the Likert scale of 1 to 5, which areas bamboo is highly used, where 1= less used, 2= not used, 3= neither used nor highly used, 4= used and 5=highly used. Lastly, the third section focused on the trend of bamboo usage with regards to volumes and this was evaluated on the likert scale 1 to 5, where the score '1' = highly decreased, score '2' = decreased, score '3' = stable, score '4' = increased and score '5' = highly increased. A number of sampling techniques in research were considered and the purposive sampling was decided upon due to time limitation. Out of the total of 172 questionnaires administered to the building contractors (100 questionnaires) and Architects (72 questionnaires), 138 were retrieved (85 from contractors and 53 from Architects) and used in the analysis. This represented a response rate of 85% and 73% respectively and it is considered sufficient for the study (Oladapo, 2005; Newman and Idrus, 2002; Ellhag and Boussabaine, 1999).

The Relative Importance Index (RII) method of analysis was employed to help identify the significance of the factors which influence bamboo in building construction (BC). According to Adnan et al. (2007), to analyse data on an ordinal scale (e.g. Likert scale 1-5) as used in this research, the application of Importance Index (II) is suitable and this helped in coming out with various ranking in the research. Ranking as defined by Fowler et al. (1995) is a comparison among given options, within pairs of options, by cardinal of importance (first, second, third, etc). Additionally, he asserted that, ranking is scoring items one at a time using a common scale, and it also determines the importance of factors.

RESULTS AND DISCUSSION

Uses of bamboo in building construction

Figure 1 shows that, 100% of the building contractors have used bamboo or bamboo products at least in an area in building construction. Ninety-four (94%) of architects responded they have specified bamboo for use in a building project. However, six percent (6%) of the Architects sampled responded they have not specified bamboo for use in any project. This result suggests that bamboo has a potential of gaining popularity in building construction in Ghana as majority of the respondents they have used it at least for a specific purpose in a project.

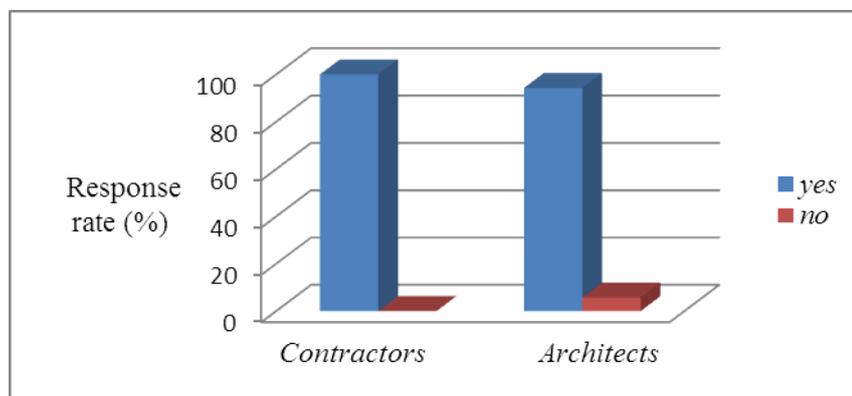


Figure 1: Response to the use of bamboo

How often bamboo is used

Respondent were asked to evaluate how often they use and specified bamboo in building construction. Figure 2 shows that thirty two percent (32%) and twenty percent (20%) of building contractors reiterated that they do not to use bamboo often and often respectively. However, eighteen percent (18%) of building contractors use bamboo very often and twelve percent (12%) using bamboo in areas in construction quiet often.

The response from the Architects as also reveal that, sixty percent (60%) of Architects do not often specify bamboo for use as a material in Building construction. twenty six percent (26%) and six percent (6%) of the Architect reiterated the specify bamboo quiet often and very often respectively. However, three percent (3%) of architects specify bamboo often.

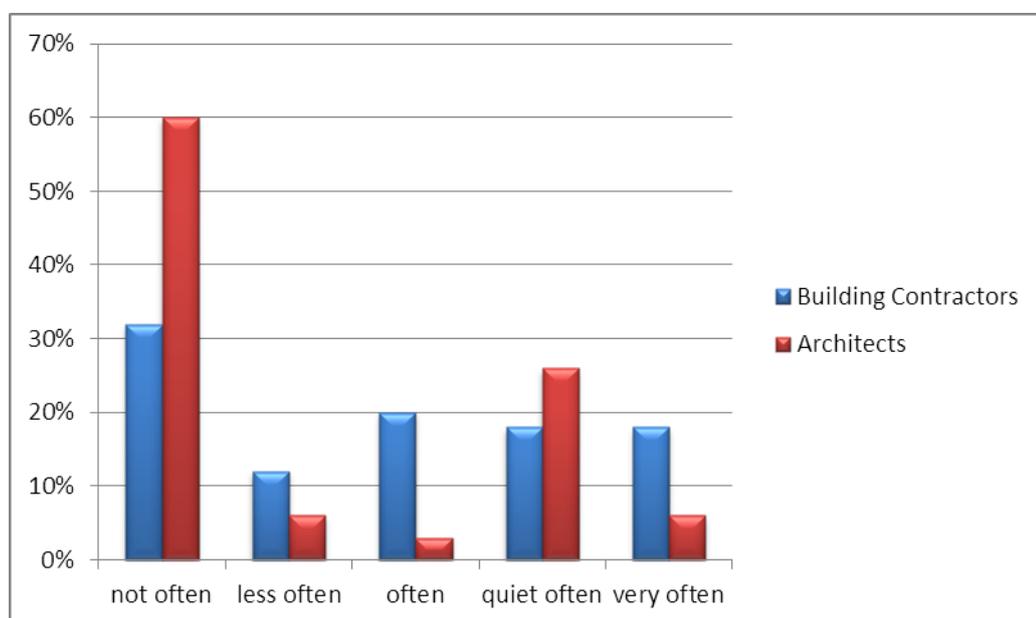


Figure 2: Response on how often bamboo is used in BC

Figure 2 above shows that majority of respondents do not often use bamboo in building construction in Ghana and this represent that, there is less attention to the frequency of it usage. This therefore calls for attention in ways of promotion of bamboo usage for it to gain popularity as in the case of other building materials especially the imported ones.

Building contractors response to the areas of bamboo usage in BC

With a Relative Importance Index (RII) score of 0.8582 which is very close to one (1) and being ranked as first means that contractors agreed that bamboo is highly used in the area of props than any other area. Building contractors emphasised that bamboo is less used in the other mentioned areas including scaffolding, workers shed, ladder, formwork, hoarding, landscaping, doors and windows, trusses and ceiling. Although building contractors agreed to have used bamboo in all the areas, its usage in all the

areas except props is not significant since their RII score is less than the neutral score (0.5). Thus, with the exception of props, the uses of bamboo in BC in Ghana have not been exploited by contractors. This result is perhaps bamboo as a material has not been industrialised extensively and given the needed promotion of its properties enough as in the case of other building materials hence, the contractors do not want to go in for a material they are not sure of. This is reflected in the RII value where the temporary uses are higher.

Table 2: Response to the areas of bamboo usage

Area of usage	Building contractors		Architects	
	RII = $\frac{\sum W}{(S * N)}$	Rank	RII = $\frac{\sum W}{(S * N)}$	Rank
Props	0.8582	1st	0.8343	1st
Workers shed	0.4182	2nd	0.3714	6th
Scaffolding	0.3891	3rd	0.3771	5th
Ladder	0.3856	4th	0.2971	12th
Hoarding	0.3782	5th	0.3829	4th
Formwork	0.3236	6th	0.3143	10th
Landscape	0.3055	7th	0.5257	2nd
Doors and Windows	0.2946	8th	0.3086	11th
Bamboo Reinforcement	0.2836	9th	0.2743	14th
Trusses	0.2800	10th	0.2913	13th
Bamboo floor	0.2691	11th	0.3657	7th
Ceiling	0.2582	12th	0.3257	8th
Partition Walls	0.2546	13th	0.3886	3rd
Roofing	0.2400	14th	0.3200	9th

Architects' responses to the areas of bamboo usage in BC

Architects were asked to evaluate their bamboo usage in the various identified areas in building construction and the result is as shown in the Table 2. The Relative Important Index (RII) scores of all the areas except props (0.8343) and landscaping (0.5257) were found to be less than the neutral score (0.5). Thus, Architects were of the view that bamboo is highly used in the areas of props and landscaping whereas in the areas of scaffolding, workers shed, ladder, formwork, hoarding, flooring, doors and windows, partition wall, trusses and bamboo reinforcement were less specified. Bamboo specified for props and landscaping were ranked t first and second respectively by the respondents. The results also buttress the fact that architects have

also contributed to the less exploitation of bamboo on construction site because the fail to specify them for use in the industry.

Quantity of bamboo culms per building project

With the result in table 2 showing that bamboo is mainly used for props with less attention to its usage in other areas, a further survey was conducted to identify the average bamboo culms used by contractors per building project. Figure 3 shows that thirty eight percent (38%) contractors use average bamboo culms of about 100 - 200. Twenty five percent (25%) contractors also responded that they use an average of 201-300 bamboo culms per project. However, contractors responded that, even though bamboo culms are used regularly on building sites for temporary activities, there was no contractor who had used more that 500 bamboo culms per project regardless of the size of the project. According to Tekperthey (2006), bamboo culms below 100 pieces are mainly used for activities which do not require a lot of time to complete. In relation to BC, the use of bamboo culms below 100 are for small building projects which require a very short time of execution. This result indicates that contractors embrace the temporary use of bamboo and with much insight to its advantage over other building materials will lead to high patronage; hence, bamboo will be among the common listed materials as in the case of timber.

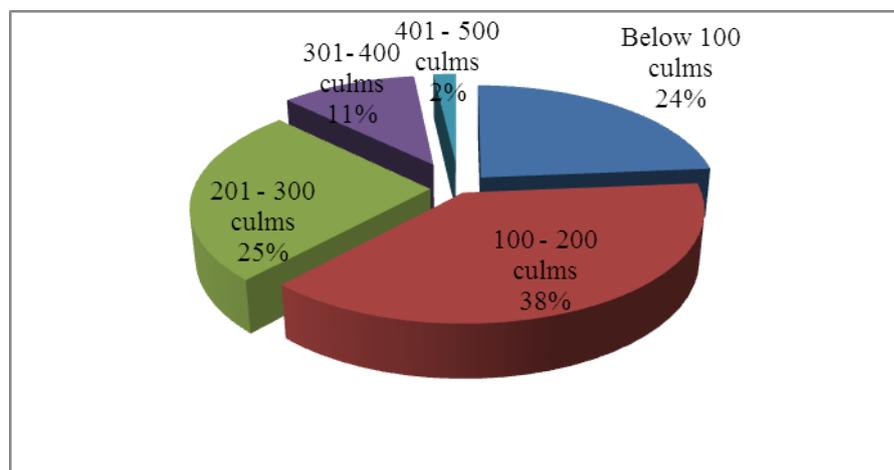


Figure 4: Contractors response on the average quantity of bamboo culms used per project

Perception of respondent on the trend of bamboo usage over the past 10year

This section was intended to ascertain the trend of bamboo usage by respondent over the last 10years for both temporary and permanent uses. From the evaluation of the perception of respondents on the trend of bamboo usage as shown in Table 3, averagely, about 62% of contractors reiterated that, their usage of bamboo generally in BC has neither seen increment nor reduction in the volumes. About 22% of contractors responded there is an increase in the use of bamboo for BC and 16% also

responded there is a significant decrease in the various temporary uses of bamboo. Averagely, majority (40%) of Architects responded that the trend of bamboo usage in building construction has been stable as shown in table 3. About 31% and 29% of Architects also indicated the used of bamboo in building construction had increased and decreased respectively. The result of this section of the study is thus, in line with the fact that less attention has been given to bamboo usage over the period of the past ten (10) years hence, the need to promote the bamboo usage through diverse platform as discussed in the recommendations.

Table 3: General perception of the level of increment of bamboo usage by respondent

Perception	Building Contractors		Architects	
	Frequency	Percentage (%)	Frequency	Percentage
Decreased	14	16	15	29
Stable	52	62	21	40
Increased	19	22	17	31

Table 4: Contractors' response to the trend of volume of bamboo usage

AREA OF USAGE	Building Contractors		Architects	
	RII = $\frac{\sum W}{(S * N)}$	Rank	RII = $\frac{\sum W}{\sum W / (S * N)}$	Rank
Props	0.8909	1st	0.8686	1st
Scaffolding	0.5636	6th	0.5486	8th
Workers shed	0.5600	7th	0.5886	3rd
Ladder	0.5673	5th	0.5543	7th
Formwork	0.5309	14th	0.4257	13th
Hoarding	0.5891	4th	0.5829	5th
Bamboo Reinforcement	0.4564	9th	0.4743	14th
Trusses	0.5927	3rd	0.5486	8th
Ceiling	0.5527	11th	0.5429	10th
Doors and Windows	0.5527	11th	0.5600	6th
Roofing	0.5455	13th	0.5429	10th
Bamboo floor	0.5600	7th	0.5314	12th
Partition Walls	0.5564	9th	0.5886	3rd
Landscape	0.6146	2nd	0.6514	2nd

The results as shown in tables 4 show that the use of bamboo in the area of props in building construction has seen significant increase (it was ranked first by both architects and building contractors) and this relate to the finding of Tekpertey (2006) which acknowledge the fact that bamboo is largely used in the area of props in building construction in Ghana. The use of bamboo in the area of landscape has also seen an appreciable increase as it is ranked second by both respondents. Averagely, respondents were indifferent (neutral) about the use of bamboo in areas such as scaffolding, workers shed, ladder, formwork, hoarding, trusses, ceiling, doors and windows, roofing, bamboo floor and partition walls. The result also shows that, the

use of bamboo in the areas of reinforcement and formwork has seen a decrease in its usage over the last ten (10) year as suggested by the architects. The building contractors suggested that bamboo usage in the area of reinforcement has seen no significant increase and this decrease is as a result of the shift to urban modernity since bamboo as a reinforced material was is the thing of the traditional construction in the rural areas of Ghana. There is therefore the need to put the use of bamboo in an innovative way to make it acceptable in the peri-urban and urban areas of Ghana.

CONCLUSION AND RECOMMENDATION

The architects and building contractors -respondents agreed they have used and specified bamboo for used respectively in at least an area in building construction. Basically, bamboo is mostly used for temporary works than permanent works in building construction in Ghana, with the most popular area of usage being props. Bamboo has not gained popularity in the areas of use for permanent purposes in building construction except in the area of landscape. Nonetheless not many respondents use bamboo in that area, even though it was ranked used than any other area of usage. It can further be deduced that, bamboo has a potential to thrive in the building construction industry in Ghana but the various areas of usage have not been exploited with the exception of the area of props which even need further attention to be able to modern trend of building construction material.

The result of the research shows that, generally, over the past ten (10) years, the different areas of bamboo usage in building construction has not seen any increase with respect to the volumes of usage except in the areas of props for temporary use and landscape for permanent use. Respondents agreed that the above mentioned areas are the only two gaining popularity.

At the end of the study, the researcher found out that, indeed, bamboo as a material in the building construction has a lot of potential but has not been exploited. Hence, it needs the involvement of the various stakeholder related to bamboo in construction to spearhead the potential into feasible uses. As a matter of urgency this paper recommends that: the government should give the needed support to the bamboo sector in Ghana to promote the extension of it areas of attention further to the construction industry. Industries which will treat and produce bamboo products for use in building construction should be established. Established institutions in the building construction industry such as Department of Building Technology, KNUST, Department of Architecture, KNUST, The building and road Research Institute (BRRI) and some Non-Governmental Organisations (NGOs) could be funded to organise training programmes and workshops towards the promotion of the use of bamboo and its potential in building construction. Architects should consider bamboo as a primary material in their specification for building designs and during construction. Promotion of bamboo usage in less used areas in building construction should be giving the needed hype to create the awareness of its potential as a building material. Research into bamboo in construction should be encouraged in building construction institutions to enhance basic promotion of the potential of bamboo.

Additionally, this paper suggests that further study in the following listed bullet points could be looked at to enhance the promotion of bamboo in building construction in Ghana.

- Extend the research to identify cost benefit analysis of bamboo and other building materials in specific areas of application in Ghana.
- Factors influencing the use of bamboo in building construction.
- Studies into specific details in bamboo construction.

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