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Awareness and Application of Green Building Concepts by Construction Industry Stakeholders of Sub-Saharan African Countries

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Abstract: The notoriety of the construction industry regarding its impacts on the environment has brought to limelight the need for green buildings (GB). GB practices have become topical as the best vehicle for addressing these negative impacts by reducing CO_2 emissions, minimising water and energy consumption amongst other benefits. Ignorance of the implementation of green building concepts (GBCs) in developing countries like Ghana accounts for a very slow pace of uptake as opposed to the developed country counterparts. This paper investigates the awareness and application of GBCs among Ghana Construction Industry (GCI) stakeholders. The data for the study was elicited via questionnaire survey of 292 stakeholders. The results indicate 88.4% of the respondents have previous knowledge of GBC with 69.2% of them indicating GB is environmentally

friendly. The study revealed GCI stakeholders' awareness of GBC is high with energy efficiency and indoor environmental quality recording the highest awareness rates of 97.6% and 93.8% respectively. The extent of application of GBCs in Ghana is moderate with energy efficiency and indoor environmental quality highest with relative importance indices of 0.680 and 0.660 respectively. It found the One Airport Square building, Accra is the most popular GB in Ghana. The internet is the most effective medium of disseminating and creating awareness of GB. The findings of this study is useful for stakeholders desirous to improving the momentum of GB uptake in the GCI. This study adds to the body of knowledge as the first study on GB in Ghana context involving all major stakeholders.

Keywords: green building; awareness; adoption; Ghana construction industry; green building concepts; extent of application; dissemination.

1. Introduction

Over the last decade, the world has had bitter experiences of the effects of global warming, ozone and resources depletion, energy scarcity, ecological toxicity, human toxicity, acid rains among other unfriendly challenges to the environment [1-3. Despite the foregoing, human beings see the planning, design and development of buildings as a way to fulfill their own social demands in terms of housing, economic investment needs, and achieving corporate objectives. Nonetheless, the complete fulfillment of these criteria usually comes at a significantly high cost, a lasting harm to our environment. This has led to an increased global understanding to modifying our traditional way of building development into a much more responsible approach that can, in effect, fulfill our construction needs without harming the environment in which we live [4-5]. Green buildings have been touted as the surest way to address the challenges posed by buildings to our environment and way of life. According to Daniel & Odoala [6] and Zhang et al., [7], Green building is a technique that uses designs and materials to allow better use of natural resources, safeguard occupant health and safety, improve employee

efficiency and minimize waste materials, emissions and environmental degradation. Darko & Chan [8] also posit that the concept helps reduce the use of energy and water as well as recycled or even recyclable non-toxic materials with low toxic emissions.

Europe has taken the lead in this drive to build responsibly. For instance, the World Green Building Council recognizes 25 countries that have Green Building Councils in Europe. Europe is widely regarded as a global pioneer in reducing resource and energy use, with its clear emphasis on zero net resource usage and passive solutions. For instance, UK was the first country to establish a major green building certification system called the Building Research Establishment Environmental Assessment (BREEAM). Australia has Green Star and Singapore has Greenmark as their own green building rating systems whilst Leadership in Energy and Environmental Design (LEED) of the USA has gained avowed popularity in Europe [9].

Despite the merits surrounding GB activities, the knowledge and awareness of practitioners about GB appears to be limited. This is a serious concern since the awareness of green building technologies to practitioners is essential since it contributes to reducing the negative impacts of buildings on the environment [10-11]. While numerous approaches have been used to share green building technology, little work is available to demonstrate awareness achieved from green building sites in Ghana. There are very few GBs under construction and these buildings could be a source of awareness.

Scholarly studies on knowledge and awareness of the GBC has been narrowly researched in Ghana. Rather, extensive research conducted recently has largely focused on the barriers in implementing GBCs [4-5, 8, 11-13] and drivers of GBCs [12-13]. Other studies have also focused on exploring eco-aesthetics for urban green infrastructure development and building resilient cities [10, 14]. Meanwhile, understanding artisans, societies and professionals' level of awareness, opinions and attitudes about GB activities offers a strong starting point for communicating information on green building technology and implementing it. This paper therefore sought to investigate the level of

awareness and knowledge of green building practices amongst Ghanaian construction stakeholders.

2. Literature Review

2.1 Green building development in Ghana

The adoption of the concepts of green building in Ghana is both slow and at its infant phase [15]. It is primarily reflected through disjointed and piecemeal efforts in terms of policies and some actions which seek to promote aspects of the green building concept. These efforts have mostly been on energy efficiency as a result of the recurring energy crisis that the country experiences. Yet still, other aspects of green building such as indoor air quality, efficient consumption of water and other resources as well as sustainability of sites are not under any regulation. As an example from 1996, renewable energy policies were developed within the context of energy policy with the goal of developing indigenous and renewable energy sources from solar, small and medium sized hydro, wind, biomass and solid municipal waste [16]. Again in 2007, the Ghana Government embarked on a programme resulting in the direct replacement of six million traditional incandescent lamps with six million energy-efficient compact fluorescent lamps for free [17] as a one-off measure to mitigate the 2007 energy crisis in Ghana. This led to peak load reduction of 124 MW, reduction of 496,000 kWh/day leading to savings of US$107/day, or US$38,558 million/year; and a reduction of 116,000 tons of CO_2/year.

A number of national frameworks aimed at sustainability has been promulgated but without any clear green building mandates in them. For example, the Ghana Shared Growth and Development Agenda (GSGDA) 2010-2013, concentrated on affordable housing, slum upgrading/urban regeneration through urban infrastructure development, basic services provision, etc. with no clear mandates on GBCs in terms of material specification, design requirements, siting etc. Again the National Housing Policy of 2015 which sought to review and merge existing housing policy frameworks to make

them more relevant and focused on the housing needs of low-income people only concentrated on affordability and quantity without any GBC requirements addressed.

Nevertheless, in the midst of the seemingly lack of policy direction, Ghana is one of the developing countries making strides, taking initiatives and actions to promote the adoption of GB. In 2009, the torch bearer of the GB revolution in Ghana, the Ghana Green Building Council (GhGBC) was formed and launched in 2011 as a member-based Non-Governmental Organization [18]. As the local branch of the World Green Building Council (WorldGBC), its operations since establishment has been largely limited to education and publication of the GBC as a national framework that will create a combined enabling environment for the construction and execution of sustainable buildings. The Council acts as a voluntary network for all parties involved in the development of the built environment; from architects or materials manufacturers, to financial institutions, academics, national institutions and professional associations. The Council has adapted the Green Star SA certification system and has developed it to Green Star SA-GH for the certification of buildings in Ghana.

The first certified GB in Ghana – the One Airport Square building, was completed in 2012. This pioneer GB was a pilot project for the adaptation of an international "green" certification procedure in the Ghanaian context - Green Star SA [19]. It is touted as the first green commercial office building in West Africa. Other green certified buildings that followed are as detailed in Table 1 following below [20-21].

Table 1. Certified Green Buildings in Ghana

Sn	Certified Building	Year	Location	Certification Tool
1.	One Airport Square	2012	Airport city, Accra	GreenStar - SA
2.	IFC World Bank Group Office Building	2013	Ridge, Accra	EDGE
3.	New Ridge Hospital	2016	Ridge, Accra	LEED for Health Care, Silver
4.	Radisson Blu Hotel & Exchange Complex Residential Blocks A & B	2017	Accra	Preliminary EDGE Certification
5.	The Standard Chartered bank Headquarters building	2018	Accra	LEED, Gold category
6.	Mother and Baby Unit, Komfo Anokye Teaching Hospital *(1st certified GB outside Accra in Ghana)*	2018	Kumasi	EDGE, 1st EDGE Hospital category in Africa
7.	Atlantic Tower building, developed by Meridian Ghana Ltd	2019	Airport city, Accra	EDGE
8.	Workshop, Administration & Maintenance Building of Tema Port MPS	2019	Tema Port	EDGE
9.	Takoradi Mall	2019	Takoradi	EDGE
10.	CalBank Head Office	2019	Accra	EDGE
11.	PWC Towers	2020	Accra	EDGE
12.	*Ghana Infectious Disease Centre	2020	Accra	EDGE
13.	Consar Ltd New Head Office	2019	Accra	*Registered and awaiting LEED certification*
14.	GNPC Research and Technology Centre	2019	Accra	*Registered and awaiting LEED certification*

- At the final stage of consideration.

It is observed from the foregoing that some rating tools were used to measure the green performance of these buildings to enable certification hence they are considered effective instruments for leading the construction industry towards green building uptake. Currently, three of these rating tools have been used in Ghana. These include the US LEED, Green Star SA and EDGE. Currently, EDGE seems to be dominating as it has been used the most in Ghana. The GhGBC has adapted the Green Star SA to a localized GB rating system for Ghana called Green Star SA-Gh.

It is also observed that all the certified GBs in Ghana with the exception of the Ridge Hospital and the Mother and Baby unit at KATH, belong to private developers; revealing very little government involvement in GB adoption. The few number of certified GBs also affirms the assertion that GB adoption is at an infancy phase in Ghana and thus efforts to promote GB adoption must be scaled up in the GCI. Such efforts as increased awareness of GBs, the benefits, government policies and legislations, the provision of incentives among others have been recommended by many studies [12-13]. It is interesting to note that the new Ghana Building Code launched in 2018 has a section on green buildings.

2.2 Awareness of Green Buildings

Sichali and Banda [22] opine that with the goal of practitioners on the promotion of sustainability, it is of key essence that there is an increased awareness of GBs. In view of this, the use of GB demonstration projects has been utilized as a means of disseminating the idea to both practitioners and communities of delivery. Umar and Khamidi [23] define green building awareness as the suitable strategic and advocacy activities which are undertaken to help people comprehend the essentials and objectives of goals and the requisites in task accomplishment. In the view of Abolore [24], the awareness of GB practices depends on individual acts of the stakeholders, their appetite for knowledge, full immersion and serious commitment to GB principles.

Although the issue of how the general public perceives GBCs might be of utmost significance, plainly, a rational start line for trying to capture information about the kind of support for green building initiatives would be to survey people who may be more likely to have an opinion. Green building support depends on individual awareness of the subject matter. Since it is known that there has been a long association of public awareness with the creation of support for causes and policies, unambiguously, green building awareness should be positively linked with such support. For example, in health issues such as HIV/AIDS and Maternal mortality, the power of raising public awareness has been employed many a time by activists to improve support for these causes. Credit is often given to awareness and education for improved rates of support, even though insufficient evidence exist to the effect that awareness is solely liable for increased support. It is the proposition of Irwin [25] that public awareness is analogous to publicity; stating that "publicity is often used to develop an awareness of the public, which in turn determines the level of support in the community" [25]. According to [26], attitudes can change as people learn about the views of others, since understanding others' opinions, causes people to think about reasons that justify the positions of others. To illuminate, "opinions of others" are not limited to the verbal opinions of an individual, but may include other sources such as media coverage and educational information. It is important to incorporate the issue of momentum to support the hypothesis that GB awareness yields support. Mutz [27], with strategic voting as a case study, asserts that "movement in the direction of mass opinion is most likely to occur among primary voters when levels of information and involvement are low". Clearly, the momentum claim put forward by [27] is used to connect awareness to support and not to say that GB support will be universal. At this point, awareness is equated with [27] description of having information, but also having low levels of involvement.

3. Research Methodology

A quantitative approach was adopted by this study using empirical survey to collect responses from stakeholders of the Ghana construction industry on their level of awareness and knowledge of GBCs and Technologies. The questionnaire survey approach is adopted because it has the advantage to achieve objectivity and quantifiability [28]. It has also been employed widely and successfully in both construction management and green building research [29-30]. The questionnaire, developed following a comprehensive review of literature, was reviewed by two experts with over 15 years of professional experience to assess the structure, rationality and appropriateness of the questionnaire. The finalized questionnaire comprised three sections; the objectives of the study and feedback details of the researcher, the questions on GBCs awareness (both open and close ended questions and Likert scale questions), and the respondents' background information. In the case of the Likert scales, the 5-point Likert scale was adopted to achieve unambiguous results which are easily interpretable according to Zhang et al. [31].

Stakeholders of the GCI (see Table 2.0) formed the population of the study. GB is an emerging phenomenon in Ghana and as such, there is limited information on it and the number of individual and organizational stakeholders involved is gradually rising but not in a manner that the entirety of them can be determined easily. Therefore relying on Kumar [32] viewpoint that purposive sampling is particularly useful to describe a phenomenon, construct a historical reality, or develop something about which only a little is known, the study adopted purposive sampling of the population. This approach was complemented with the snowball sampling approach to enable the researchers access the client stakeholder group which does not have an umbrella group of members. Identifiable stakeholders such as architects, contractors, and other professionals were asked to recommend some clients they have worked with or are working with, to respond to the questionnaire. Both methods have been employed in past studies on construction

management [15, 33; etc] to sample respondents and have proved to be effective. Applying the two sampling methods ensured availability of the built environment professionals and stakeholders targeted for the survey, eased accessibility to data, and also facilitated identification of participating stakeholders that met 100% of the selection criteria set.

Using the combined approach, 564 questionnaires were distributed via email and personal deliveries. 292 questionnaires with valid responses were returned accounting for a response rate of 52%. This response rate is relatively high as compared to similar studies by [29] (44.8%); [5] (44%); and [34] (44%) and thus validates the representativeness of the sample of study. The relatively high response rate is possibly attributable to the fact that the topic has become topical only recently and many of the respondents are becoming interested in it.

The data was screened using categorical variables by employing frequency analysis to identify the missing cases and the minimum and maximum values. All data were entered into the SPSS V20.0. Descriptive statistics such as percentages, tables and frequencies, mean scores and relative importance indices were used to analyse the data on respondent's background information and responses on level of awareness of GBCs in Ghana. The mean score ranking technique has been applied in similar past green building studies such as [5] to rank the relative importance of specific factors. In this study, the mean score ranking technique is complemented with the relative importance index to determine the relative ranking of the level of awareness of GBCs, meaning of GB, sources of GB information, among others. Additionally, analysis of variance technique was applied to check if differences in means among the various stakeholder groups were statistically significant or not [35]. This was necessary since the respondents were of different professional backgrounds.

4. Results

4.1 Background of Respondents

The analysis of the demographic information of the respondents was done using descriptive statistics in the form of frequency distribution and percentages. This was with the purpose of understanding the profile of the respondents, and ensuring that their level of experience and expertise was suitable to give credence to the validity of their responses and the overall research findings. According to Field [36], this enhances the credibility and reliability of the responses and results in a survey. Table 2 below presents the summary of the background information of the respondents of the survey.

Table 2. Background Information of Respondents

Socio-demographic	Frequency	Percentage
Gender		
Male	231	79
Female	61	21
Total	292	100
Age		
Between 20-29 years	**32**	**11**
Between 30-40 years	143	49
Between 41-50 years	**93**	**32**
Between 51-60 years	18	6
61 years and above	6	2
Total	292	100
Level of Education		
Post-Graduate/Masters/PhD	186	63.70
Bachelor degree	78	26.71
Higher/Advanced diploma	22	7.53
Technician (CTC I/II/III)	3	1.03
Other	3	1.03
Total	292	100
Professional background		
Architect	138	47.26
Quantity Surveyor	69	23.63
Engineer (all categories)	53	18.15

Other	19	6.51
Project/Construction manager	13	4.45
Total	292	100
Type of Company/Organization		
Contractor	33	11.3
Consultant	129	44.2
Developer	25	8.6
Government department/Ministry/Regulator	29	9.9
Academic/research institution	60	20.5
Industry Association	6	2.1
Other	10	3.4
Total	292	100
Location within the country Ghana		
Coastal Belt	118	40.4
Middle Belt	106	36.3
Savanna Belt	68	23.3
Total	292	100.0
Green Building expert/specialist/accredited professional		
Yes	59	20.2
No	233	79.8
Total	292	100
Years of Green Building working/research experience		
1 – 3 years	28	47
4 – 6 years	14	24
Over 6 years	17	29
Total	59	100

There were a total of two hundred and ninety-two (292) responses of which, 79% were males and 21% were females. This result is representative as the percentage of female in the construction industry globally is generally low and put at 9% by the WEF [37]. It is perceived that the construction industry is difficult, dangerous and dirty and this perception can discourage women from joining this industry [38]. In addition,

Owusuaa [39] concluded that few women in GCI is due to Ghana's cultural norms coupled with the belief that women are unable to work up to expectation considering the physical nature of construction work.

Table 2 further shows that of the total number of respondents, 11% were between 21-29 years, 49% are between 31-40 years, 32% and 6% are respectively between 41-50 years and 51-60 years whilst 2% were 61 years and above. The results show a majority of the respondents were between 31-40 years followed by 41-50 years where respondents are in their prime lifetime; a situation that is consistent in Ghana as most people complete tertiary education and get employed in their mid to late twenties. Regarding respondents' level of education, all were educated with 63.7% holding Post-Graduate/Masters/PhD degrees and 26.71% holding Bachelor degrees. This result is reflective of the practical situation of the training courses and programmes in the GCI and thus is indicative that respondents have a good educational background with sufficient knowledge to more likely understand and accurately interpret the questionnaire items leading to the quality and reliability of the study through correct and consistent responses. Additionally, the results showed that the respondents comprised different professional backgrounds; with 47.3% Architects, 23.6% Quantity Surveyors, 18.2% all categories of Engineers, 4.5% Project/Construction Managers and 6.5% other Professionals (Planners, Lecturers, students etc.). The heterogeneous and diverse background of the respondents as witnessed ensures the reliability and quality of the responses collected. A large proportion (59.9%) of the respondents have at least six years of experience in the GCI. From a practical perspective of the GCI, this result is indicative that survey respondents have adequate experience hence plausibly concluding that they have sufficient knowledge based experience to offer valid and reliable responses in the survey. In terms of location of the respondents in Ghana, the results indicate that they were spread across the country with 40.4% in the coastal belt, 36.3% in the Middle belt and 23.3% in the Savanna belt. This is largely reflective of the real situation in Ghana as most of the

construction activity takes place in the urbanized cities of Accra (coastal belt) and Kumasi (middle belt) [40].

Additionally, the results showed that not all the respondents were GB expert/specialist/accredited professionals. Of the 292 respondents, it was realized that 20.2% are GB experts whilst 79.8% were not. The level of experience of the GB experts in the survey, ranged from 1-3 years with 47% respondents, 4-6 years with 24% and over 6 years with 29%. This results is reflective of the situation in Ghana given that green building is a new phenomenon which is gathering momentum evidenced by the few certified GBs in Ghana as reported by [41].

4.2 Awareness level and Knowledge of Ghanaian construction stakeholders of the Green building concept and technologies in Ghana.

Stakeholders' response to the question on what GB meant to them or what they perceived GB to mean are presented in Table 3 below. The question on what Green Building mean to respondents was allowed for multiple selections and the result showed 69.2% indicated Green Building is environmentally friendly and 61.6% indicated GB is energy efficient. It was also observed that 51% said Green Building mean environmental friendly, energy efficient, healthy indoor, less costly in terms of maintenance and water efficient (all).

Table 3. Descriptive Statistics of meaning of GB, relationship between meaning of GB and Professional Background and Independent Chi-square test results

Descriptive Statistics for the Meaning of Green Building				Relationship Between Meaning of GB and Professional Background							Chi-Square Test for the Distribution of Meaning of GB and Professional Background			
Meaning of GB	Sum	Percent	Rank	Response	Professional background					Total	Pearson Chi-Square			Sig. Level
					Arc	QS	Eng.	PM/CM	Other		Value	df	Sig. Value	
Environmentally friendly	202	69.2	1	No	29.7	43.5	35.8	0	0	90(31.8)	15.741	4	0.003	Significant
				Yes	70.3	56.5	64.2	100	100	193(68.2)				
Energy efficient	180	61.6	2	No	29.7	59.4	41.5	30.8	20.0	110(38.9)	19.15	4	0.001	Significant
				Yes	70.3	40.6	58.5	69.2	80.0	173(61.1)				
All the above	149	51.0	3	No	44.9	**53.6**	45.3	30.8	70.0	134(47.3)	4.996	4	0.288	Insignificant
				Yes	**55.1**	46.4	54.7	69.2	30.0	52.7				
Healthy indoor	139	47.6	4	No	42.0	72.5	64.2	46.2	30.0	151(53.4)	22.181	4	0.000	Significant
				Yes	58.0	27.5	35.8	53.8	70.0	132(46.6)				
Water efficient	127	43.5	5	No	42.0	81.2	66.0	61.5	20	159(56.2)	36.276	4	0.000	Significant
				Yes	58.0	18.8	34.0	38.5	80.0	124(43.8)				
Less costly in terms of maintenance	113	38.7	6	No	55.1	72.5	71.7	30.8	30.0	171(60.4)	17.304	4	0.002	Significant
				Yes	44.9	27.5	28.3	69.2	70.0	112(39.6)				
No idea	8	2.7	7	-	-	-	-	-	-	-				
				-	-	-	-	-	-	-				
None of the above	7	2.4	8	-	-	-	-	-	-	-				
				-	-	-	-	-	-	-				

The frequency distribution and independent chi-square test results in table 3 indicates, there is significant association between the professional background of the respondents and their understanding of what GB meant with architects and project/construction managers exhibiting more significant association for all the attributes.

On the question relating to the respondents' familiarity or whether they had any previous knowledge of GBCs, the result showed that majority (88.4%) of the respondents attest to being familiar with GBC and have previous knowledge of it, whereas 11.6% confirmed that, they were not familiar and had no previous knowledge of GBC.

The association between professional background of the participants and their familiarity/any previous knowledge of GBC was assessed. The distribution of professionals (5-category) familiarity of GB was assessed using independence chi-square test. The chi-square test result showed there was significant association between professional background of respondents and their familiarity or any previous of green building concept. The independent chi-square value recorded was 33.243 with degree of freedom of 4 and p-value < 0.05 level. The result indicate that project/construction managers and architects have a significantly high level of familiarity or any previous knowledge of GBC than the other professionals like quantity surveyors and other professionals (academic researchers, facility managers and planners).

Furthermore, Stakeholders' awareness of GBCs was assessed and results presented in Table 4. The various attributes of GB applied in construction industry with examples of each concept were listed and respondents asked to indicate whether they were aware or not aware.

The results indicate that majority (92.7%) were aware of GBCs. Energy efficiency and indoor environmental quality emerged as the most popular GBCs with the highest awareness rates of 97.6% and 93.8% respectively. In general the respondents were aware

of the concepts except use of sustainable site practices where about 11.6% were not aware (Table 4).

Table 4: Stakeholders' Awareness and Extent of Application of Green Building Attributes

Awareness of Green Building Attributes			**Extent of Application of Green Building Concepts**			
Green Building Attributes	**Yes (%)**	**No (%)**	**Mean**	**Std. Dev.**	**RII**	**Mean Ranking**
Water Efficiency	266(91.1)	26(8.9)	3.04	1.091	0.608	3
Energy Efficiency	**285(97.6)**	**7(2.4)**	3.4	1.137	0.680	**1**
Use of Sustainable Material	270(92.5)	22(7.5)	2.84	1.181	0.568	5
Use of Sustainable Site Practices	258(88.4)	34(11.6)	2.99	1.203	0.598	4
Indoor Environmental Quality	**274(93.8)**	**18(6.2)**	3.3	1.127	0.660	**2**

4.3 Extent of application of Green Building Concepts among GCI stakeholders

The study further examined the extent to which stakeholders apply these green building concepts in the GCI based on their experience. A five-point Likert scale was used. The results showed the respondents moderately apply these GBCs in the construction industry with mean scores ranging from 2.84 to 3.4 which fall in the scale category of 3 (moderate extent). Amongst these GBCs, energy efficiency is widely applied in the GCI with a RII of 0.680 while Use of Sustainable material is the least applied in the GCI with a RII of 0.568 (Table 4).

4.4 Sources of Green building awareness among GCI stakeholders

Respondents who indicated they were aware of GBCs were further asked to indicate their source of information about GBC (where they acquired the knowledge of GBC from). The sources of knowledge about GB (Table 5) were identified to be through internet and school curriculum indicated by 60.3% and 45.7% of the respondents respectively.

Table 5. Source of GB Awareness, Association with Professional Background and Test of Association of Source of Awareness and Professional Background

Source of Green Building Awareness			Association between Source of Green Building Awareness and Professional Background							Chi-Square Test for the Distribution of Source of GB awareness and Professional Background			
	N	Percent within (N=282)	Response	Professional background					Total	Pearson Chi-Square			Sig. Level
				Arch	QS	Eng.r	PM/CM	Other		Value	df	Sig. value	
Internet	170	60.3	No	44(32.8)	29(44.6)	20(39.2)	12(92.3)	5(50.0)	110(40.3)	18.638	4	0.001	Significant
			Yes	90(67.2)	36(55.4)	31(60.8)	1(7.7)	5(50.0)	163(59.7)				
School curriculum	129	45.7	No	53(39.6)	41(63.1)	34(66.7)	6(46.2)	10(100)	144(52.7)	25.293	4	0.000	Significant
			Yes	81(60.4)	24(36.9)	17(33.3)	7(53.8)	0(0)	129(47.3)				
Seminar/conference	104	36.9	No	74(55.2)	39(60.0)	41(80.4)	9(69.2)	10(100)	173(63.4)	16.488	4	0.002	Significant
			Yes	60(44.8)	26(40.0)	10(19.6)	4(30.8)	0(0)	100(36.6)				
Colleagues in other workplaces	83	29.4	No	99(73.9)	55(84.6)	31(60.8)	12(92.3)	4(40.0)	201(73.6)	16.538	4	0.002	Significant
			Yes	35(26.1)	10(15.4)	20(39.2)	1(7.7)	6(60.0)	72(26.4)				
Magazine/newspaper	60	21.3	No	103(76.9)	49(75.4)	46(90.2)	11(84.6)	8(80.0)	217(79.5)	5.034	4	0.284	Insignificant
			Yes	31(23.1)	16(24.6)	5(9.8)	2(15.4)	2(20.0)	56(20.5)				
Professional/trade association brochures	58	20.6	No	106(79.1)	49(75.4)	41(80.4)	13(100)	8(80.0)	217(79.5)	4.065	4	0.397	Insignificant
			Yes	28(20.9)	16(24.6)	10(19.6)	0(0)	2(20.0)	56(20.5)				
Exhibition	48	17.0								12.102	4	0.017	Significant
Television/radio	44	15.6								2.239	4	0.692	Insignificant
Contractors/Suppliers	28	9.9								5.302	4	0.258	Insignificant
Estate agent/developer	13	4.6								10.072	4	0.039	Significant
Billboards/banners	3	1.1								3.316	4	0.506	Insignificant
This is the 1st time I have heard of this topic	2	0.7								12.762	4	0.012	Significant
Hiring consultants	1	0.4								3.212	4	0.523	Insignificant

Association between the Sources of knowledge about green building and the professional background of respondents were examined (Table 5). The chi-square test results (Table 5) showed that there was significant association between professional background and their source of knowledge about GB through internet, school curriculum, seminar/conference and colleague in other workplace. Architects, quantity surveyors and engineers said they got to know about GB first through the internet.

4.5 Green building information dissemination in GCI

Figure 1 showed the most effective medium of sharing/dissemination of information on green building to the public. Interestingly, majority (66.4%) of the respondents said internet should be used for sharing information on GB related to majority of the respondents first knowing green building through internet. This was followed by school curriculum, television/radio and seminar.

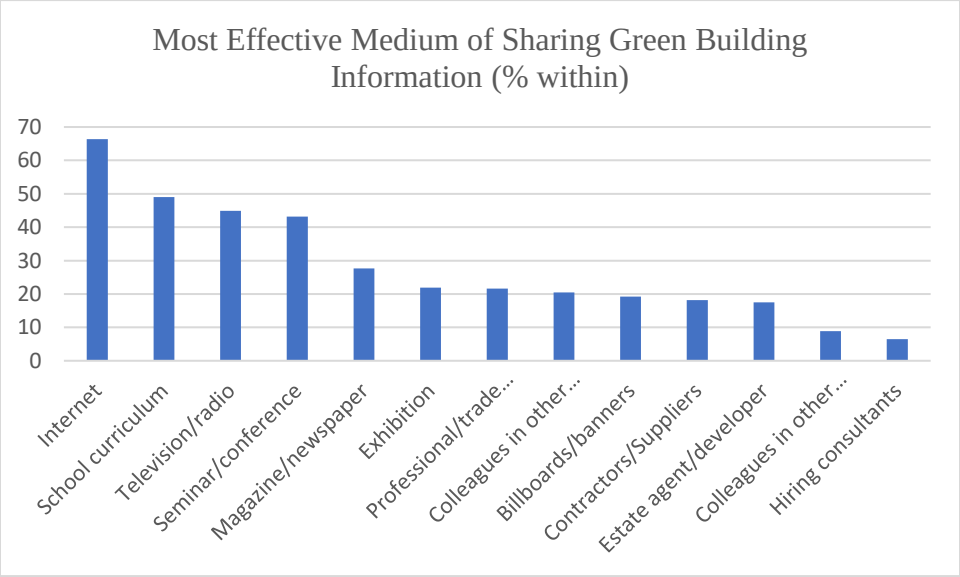

Figure 1: Most Effective medium for creating Green Building Awareness

4.6 Prioritization of GB and Examples of GBs in Ghana

The results also reveals that 89.4% of the respondents felt the government and the GCI do not place a high priority on green building. Reflecting on results in Tables 4 and

5, almost all the respondents have knowledge about GBCs in construction industry but in terms of application, the result showed moderate (with high deviation values). The government and the Ghana construction industry placed little priority on green building.

The respondents also confirmed that they knew about cases/examples of green building in Ghana albeit few in number, indicated by 64.1%. 7.7% of the respondents said they know cases of GBs in Ghana while 28.2% did not know of any cases in Ghana at all. Among the examples of specific GBs respondents know in Ghana, the One Airport Square building was the most popular cited with a frequency of 35, followed by the IFC World bank building, Ridge Accra with 27 and the Mother and Baby Unit at KATH, Kumasi with 12.

4.7 Awareness of the existence of the Ghana Green Building Council.

As far as the Ghana Green Building Council is concerned, the study asked respondents whether they had heard about it before. It was found that 39.4% had heard about the council while 34.2% had not heard it and 26.4% indicated they had just heard it for the first time. The results suggested majority of the respondents (60.60%) had no idea about the existence of the GhGBC.

4.8 Responsibility for ensuring buildings in Ghana are built to green standards

Participants in the study were asked to show their views on who has to be responsible for making buildings green in Ghana. A scale of 1-5 was provided with 1 being strongly disagree and 5 being strongly agree to measure their level of agreement to a list of seven stakeholders comprising; government of Ghana, developers, consultants, contractors, GhGBC, researchers/academics and all citizens. The study observed that respondents placed the greatest responsibility for ensuring buildings in Ghana are built to green standards on the GhGBC, with a mean score of 4.57 and a very low standard deviation of 0.770 (Figure 2).

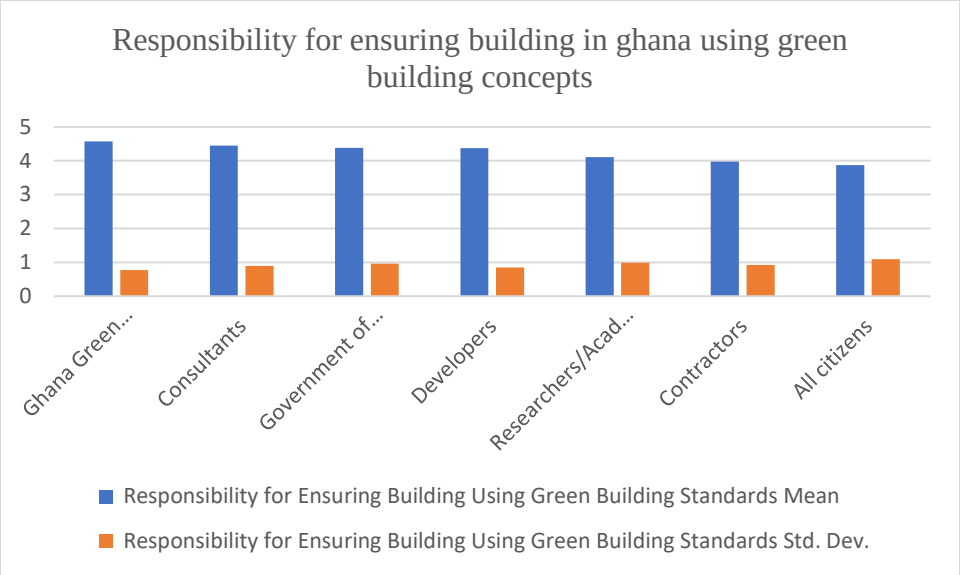

Figure 2: Responsibility for ensuring buildings in Ghana are Green

5. Discussion of the findings

In Rogers [42] innovation adoption process, the first stage is to become aware and acquire knowledge of an innovation in order to know how it functions and then later decide to adopt it or not. This presupposes that to be able to make a congenial atmosphere for the improved and increased uptake of GBCs in Ghana construction industry, awareness and knowledge of GBC are the first ingredients that must be nursed. Awareness, thus, serves the primary task of achieving enlightenment for the stakeholders. Zainul-Abidin [43] affirms awareness as the kickoff point of the path to increased adoption of GBCs and knowledge as being the main ingredient to move from awareness to implementation of GB practices. This section of the study joins the attempts being made by several bodies including the GhGBC, Government and professional bodies to increase the awareness and knowledge on GBCs among stakeholders in the GCI.

i.) The level of awareness and knowledge on GB and GBCs among stakeholders in the GCI

The results of this study suggests that there is a relatively high level of awareness or previous knowledge of GBCs among stakeholders in the GCI as 88.4% indicated they

were aware. This result agrees to a large extent with similar studies from other countries (e.g. Son et al., [44]) which reported a high (above 50%) level of awareness of sustainable construction in their survey of US and Korea Constructors on their level of awareness of sustainable construction measures; Ametepey et al. [45] study in Ghana reported 83% of practitioners' awareness of sustainable construction; Zainul-Abidin [43] reported a high level of awareness of sustainable construction in Malaysia albeit a low extent of application; AlSanad et al., [46] reported a moderate level of awareness of GB among construction stakeholders in their study in Kuwait's construction industry; and Kibwami and Tutesigensi [47] reported a moderately high awareness rate of 53% in Uganda. It is however realized that the high level of awareness do not necessarily result in a high level of implementation of GBCs in the construction industry in Ghana. Many of the respondents in a follow up question requesting examples of GBs in Ghana cited wrong examples. This implies that stakeholders only heard about the concept but did not understand it. Stakeholders in the GCI seem to be comfortable with the status quo (traditional way of construction) and are not willing to adapt to the technology savvy era of construction that characterizes GB for reasons including the high upfront costs and are complex etc. They only act to fulfill the minimum requirements as stipulated in the national building regulations (which does not emphasise GBCs) and thus will not take the initiative to explore new and challenging horizons such as GB. In concurrence with the recommendations of [48] in China, this study recommends that, proactive measures be taken to improve upon awareness of stakeholders by launching national education and training programmes in green building concepts and methods. Curricula in the country's tertiary institutions should be revised to emphasize GBCs whilst public campaigns are mounted to educate stakeholders in non-construction related business who are potential clients about the benefits of adopting GBCs. The presence of the few GBs in Ghana should serve as a stimulant in this endeavor. With an increased level of

awareness, the demand for GBs is set to increase as the benefits would be known to many stakeholders in Ghana.

The study further requested respondents to select statements that best fit with what GB meant to them. The results indicate that majority (69.2%) of the respondents stated that GB meant Environmentally friendly buildings whilst 61.6% indicated that GB meant energy efficient buildings and 51.0% indicated that GBs encompassed all the six attributes of a GB. This result implies that many stakeholders understand GB to be about environmental protection. This result is not surprising at all as far as the GCI is concerned. The focus of the government and some professional bodies has largely been on environmental awareness and protection. Consequently the Environmental Protection Agency (EPA) was set up in Ghana. This finding agrees with the findings of [43] and [44] who both reported that respondents in Malaysia and US respectively, to a large extent stated environmental concern as their interpretation of green building. It is also consistent with the findings of [49] who reported a high level of awareness of environmental factors in China. The findings herein however disagrees with the Cambodian study results of [50] who reported corresponding low levels of awareness and application of GBCs. This study recommends an awareness campaign that would blend all the attributes of green building to ensure that, the benefits of green building are realized and enjoyed by all. This is with the view that, a good green design building would have a good orientation that can maximize the use of natural lighting and ventilation as well as landscaping whilst at same time improving accessibility and allowing open spaces for inhabitants to utilize. This would improve the value of the building and make it attractive to investors thereby yield returns to the developers.

A green building is hinged on five attributes/concepts; use of sustainable site practices, water efficiency, energy efficiency, use of sustainable materials and indoor environmental quality. The survey results indicate that most stakeholders are aware of energy efficiency as a GB concept. This was followed by indoor environmental quality

and use of sustainable materials. Energy efficiency as the most popular GBC in Ghana is not surprising as the country has been facing power supply problems for over a decade now. As such, many stakeholders view energy efficiency of buildings as one of the solutions to this problem the country is facing. It has thus made it a topical issue. This finding is consistent with the views of [48] who noted that, increasing residents' knowledge and awareness of energy saving and sustainability issues is essential to achieve improve GB adoption in China. A GB as earlier stated that applies the use of energy efficient principles such as the use of day lighting, renewable energy sources like solar, LED bulbs and devices as well as sensor controlled lighting devices would save energy, the environment and accrue economic savings to the developer and the tenant.

ii.) The extent of application of GBCs and responsibilities therein.

The foregoing discussion indicated, a high rate of awareness and knowledge of GBCs, however, this does not correlate with the extent of application of these GBCs. The study revealed that, many stakeholders believed that they moderately applied these GBCs over the last ten projects they have executed. This finding is consistent with [49] who reported a high level of awareness and low level of implementation attributable to the lack of punishment or specific requirements in their study in China. Many respondents further indicated that energy efficiency was the concepts they applied most; perhaps because that is the concept they are most aware of. This result could be attributed to the ignorance of the benefits of GB that exists in the GCI coupled with the lack of legislations and clear government directives on green building implementation. The government of Ghana could stimulate increased uptake of GBCs by making it mandatory that all government sponsored projects are built to green specifications and also offering incentives to stakeholders who want to implement GBCs in their projects. The responsibility of making building in Ghana green according to many stakeholders rest with the GhGBC, however, it's just an NGO and do not have the power to enforce regulations. This study urges the GhGBC steps up its educational campaigns through the vociferous mass media,

seminars, and community outreach programmes. This way, awareness of the benefits and practicality of the GBCs would increase and thus improve the uptake of GBCs. Respondents also indicated Consultants and the government as the 2nd and 3rd respectively as being responsible for making buildings in Ghana green. It's the view of stakeholders that, building design and construction supervision emanate and lie in the bosom of the consultants, hence, if they bring up green designs, naturally buildings in Ghana will become green. This is however not the case at present as there is limited publicity and interest of green building in Ghana [8].

iii.) The sources of GB information and dissemination GB information

Increased awareness of GBCs by the public yields the market-driven power for GBs and thus efforts to increase publicity and awareness of GBCs need to be up scaled. The study requested stakeholders to indicate where they attained the awareness of GBCs from and the results indicates that, the highest source of GBC information is the internet. This implies that the internet can be a good source of knowledge on GBs. Similarly, majority of the stakeholders indicated the internet as the most effective media for sharing information on GB to the public. This finding is unsurprising as the express growth of the Internet with its accompanying advantages over traditional communication formats in terms of flexibility, speed and reach make it an obvious route for research dissemination [51]. It is clear that, the internet has a greater potential to get digestible information to the right people at the right time. This presupposes that an effective public awareness campaign of the GBCs can be carried using the internet mainly as the medium and complemented by school curricula, television and radio advertisement and programmes as well as professional seminars and conferences. This can be done by packaging information on the benefits of GBCs, the sources of GB material and the requirements of GBs and placing them in the web portals of all MMDAs, related agencies and professional bodies' websites (e.g. MWHWR, EPA, GIA, GhIE, GhIS, AESL, GHGBC, GREDA, etc). Liu et al. [48] in corroboration advocates the involvement of Local governments in the

investment of certain specific information dissemination efforts such as GB's social benefits via various information sources (e.g., print media, radio programs etc.) and building dedicated websites for providing concrete and tangible information of GB. They also advocate green construction tours and workshops to educate the lay people the social benefits and importance of GB so as to develop their awareness and interests in relation to GBs. The curricula of training institutions in Ghana should be upgraded ensure they include current knowledge of GBCs across the training levels in order to breed a generation that is conscious of GBs. Ghana is noted for a prolific media landscape in recent times. As such, these efforts would further be complemented by taking advantages of the proliferation of FM radio stations and Television station to propagate the awareness of GB. Empowered with the knowledge of the benefits, costs and methods of GB, it's obvious, many stakeholders would willingly implement GBCs in their construction projects leading to an increased uptake in the GCI.

6. Conclusions and implications

As a way of contributing to achieving the UN SDGs (goals 3, 7, 8, 9, 11, 12, 13, 15, and 17), as well as sustainability in the construction industry, the adoption of GBCs has become topical with increased attention and research interest worldwide. This global attention is noticed to be replete in developed but very scanty in developing countries such as Ghana. More so, awareness and knowledge of GB which are key ingredients to increased uptake of GBCs is reportedly higher in developed countries with several study reports. However, most developing country studies on GB adoption have focused on individual contextual issues such as drivers, barriers etc. with none on awareness and knowledge levels of stakeholders in Ghana. This study therefore aimed to investigate the level of awareness and knowledge of the uptake and adoption of GBCs among stakeholders of the GCI. This study drew extensively on literature studied which culminated in an empirical questionnaire survey involving 292 stakeholders of the GCI. This study to the best of the authors' knowledge is the first on GB awareness in the context of Ghana. It is

also a novel study as the first empirical study that involves the views of all categories of stakeholders in the GCI relating to GBC.

The results of this study showed that the level of awareness and knowledge of GCI stakeholders about the uptake of GBCs is high without a corresponding extent of application of the concepts. The extent of application of GBCs was found to be low with energy efficiency as the most applied GBC in the GCI. The results further indicated that many stakeholders only view GB to mean environmentally friendly buildings with the One Airport Square Building (first LEED certified GB in Ghana) located at Airport city, Accra as the most popular GB among the 8 certified GBs in Ghana. It is was also found that majority of the stakeholders do not know about the existence of the GhGBC. The results further indicated the internet is source of GB information for most stakeholders. Internet is also recommended as the most effective media for disseminating GB information by respondents. This implied that a lot more awareness of GBCs can be attained by channeling information on GB uptake through the internet which is why this study recommended the development and maintenance of a GB directory on the web portals of all MMDAs, and built environment related departments in Ghana. The significance test conducted generally showed statistically significant association between the professional backgrounds of the stakeholders and their level of awareness, knowledge and extent of application of GBCS.

This study has through its findings contributed to the GB body of knowledge by highlighting the level of awareness of stakeholders from developing country context with Ghana as the case. The study also serves as a useful guide to industry practitioners, policy makers, academia, and GB advocates desirous of promoting GB uptake to enable them design appropriate GB awareness messages, select appropriate GBCs, and disseminate same through the appropriate channels for increased uptake. It has also provided very useful feedback to the Ghana Green Building Council; as most stakeholders are of the view that they have a major responsibility to make buildings green in Ghana, even

though many of the stakeholders are not aware of their existence. They would need to upscale their efforts to become more visible and re-strategise their campaigns. The findings of this study could be useful to industry practitioners, academia, and policy makers in other developing countries with similar characteristics as Ghana.

A limitation of the study was that the responses on the awareness and application of GBCs could be influenced by the respondents' experiences and attitudes as it was subjective. This study analyzed the views of all category of stakeholders (policy makers, research and training institutions, regulators, and implementers. A future study could be limited to specific stakeholder categories to analyse their views and compare the awareness levels across the stakeholder categories. Future research could also be extended to investigate the extent of adoption of GBTs as well as the drivers and barriers empirically embracing all stakeholders of the GCI.

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