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Strategies to promote green building technologies adoption in developing countries: The case of Ghana

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Abstract

Because of its potential to deal with negative environmental impacts of construction activities and contribute to sustainable development, the adoption of green building technologies (GBTs) has received a high level of global attention in recent times. Accordingly, studies on strategies to promote GBTs adoption have been done around the world, but they are scarce in developing countries such as Ghana. The aim of this study is to identify the important strategies to promote GBTs adoption with reference to the Ghanaian construction market. To this end, this study commenced with a literature review and interviews with industry professionals to identify 15 potential strategies. An empirical questionnaire survey was carried out with 43 professionals with green building experience. The analysis results revealed that "more publicity through media", "GBTs-related educational and training programs for key stakeholders", "availability of institutional framework for effective GBTs implementation", "a strengthened GBTs R&D", and "financial and further market-based incentives" were the top five strategies to promote the GBTs adoption. Additionally, results comparison indicated that the top strategies to promote GBTs adoption in the developing country of Ghana mostly differ from those in the developed country of the US. Furthermore, factor analysis showed that the underlying strategy groupings were government regulations and standards; incentives and R&D support; awareness and publicity programs; education

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and information dissemination; and awards and recognition. Theoretically, from a developing country's perspective, this research contributes to the literature on green building by improving understanding of the key strategies to promote GBTs adoption. Practically, this research helps policy makers, industry stakeholders, and advocates formulate and implement proper strategies for GBTs adoption promotion. The directions for future research include to model the interrelationships between the strategies, as well as their likely effects on the GBTs adoption activity.

Keywords: Green building technologies; Promotion strategies; Environmental sustainability; Construction market; Developing countries; Ghana.

1. Introduction

Through its consumption of large amounts of energy and natural resources, the construction industry exerts significant impacts on the climate and environment. Consuming various forms of energy plays a key role in greenhouse gas (GHG) emissions, which are also the leading cause of global warming and climate change (Karunathilake et al., 2017). In line with this, because the construction industry consumes more than 40% of the total global energy, it also accounts for more than 40% of the total global GHG emissions (International Energy Agency (IEA), 2013a, b). Besides, the construction industry has been tagged as a "resource-intensive industry" (Shi et al., 2017, p. 615) responsible for consuming 40% of the raw materials (stone, sand, and gravel), 16% of the water, and 25% of the timber in the world annually (Arena and De Rosa, 2003). With regard to impact on human health, construction activities produce considerable quantities of dust, noise, solid waste, smoke, and wastewater (Shen et al., 2017a). In the current situation, it has been predicted that, unless cost-effective technologies and best practices – in addition to radical lifestyle and behavioral changes – are promoted and accepted worldwide, the global energy demand of the construction industry

and the associated emissions of GHGs will be more than double by 2050 (IEA, 2014; Berardi, 2017).

As such, green building has been well received by many governments and promoted as a strategy for reducing the negative effects of the construction industry on the environment (Shen et al., 2017b). Green building is the practice of developing buildings in a resource-efficient and environmentally friendly manner (US Environmental Protection Agency (USEPA), 2016). According to the World Green Building Council (WorldGBC) (2017), "a green building is a building that, in its design, construction or operation, reduces or eliminates negative impacts, and can create positive impacts, on our climate and natural environment". Moreover, not only do green buildings preserve precious natural resources, but they also improve human quality of life (WorldGBC, 2017). Green building technologies (GBTs) have an essential role in the development of green buildings. They are those technologies, such as passive solar technology, green roof technology, and energy-efficient HVAC systems, employed in building design and construction to improve overall sustainability performance (Zhang et al., 2011a; Ahmad et al., 2016). Many researchers and organizations have shown that GBTs adoption could significantly help the construction industry achieve sustainable development. It was reported by the United Nations Environment Programme (UNEP) (2009) that with the adoption of GBTs, a 30-80% reduction in building energy consumption is realizable. The study by Roufechaei et al. (2014) found that the use of GBTs had a strong positive correlation with the three dimensions of sustainable development (environmental, economic, and social). Explicitly, the GBTs adoption was helpful in achieving the goals of sustainable development, such as conserving energy and non-renewable resources, reducing ecological footprint, and minimizing lifecycle costs. At a company level, it is useful to adopt GBTs as that increases competitiveness while

also allowing the company to enjoy more business opportunities (Zhang et al., 2011b; Ageron et al., 2012).

With the global awareness of the multiple sustainability benefits brought about by GBTs adoption, how to promote the successful and widespread adoption of GBTs has been a priority issue in the construction industry recently. As a result, research on strategies to promote GBTs and practices adoption is already underway (Darko et al., 2017a; Hwang et al., 2017a; Chan et al., 2017). Despite the importance of such kind of studies to the industry and academia, they are scarce in developing countries. This paper is part of a large-scope research project aimed at promoting GBTs adoption within the developing country of Ghana. Whereas the relevant driving forces and barriers of the GBTs adoption are reported elsewhere (Darko et al., 2017b; Chan et al., 2018), the objective of this paper is to identify the important strategies to promote the GBTs adoption. Thus, this paper primarily addresses the following research question: what are the important strategies to promote GBTs adoption in Ghana? The first contribution of this paper is helping fill a gap in the green building body of knowledge, particularly for developing countries. Additionally, the findings of this paper help in better understanding the key strategies to promote GBTs adoption, which could guide policy makers, industry stakeholders, and advocates in formulating and implementing proper strategies for GBTs adoption promotion. Ultimately, this paper would benefit the sustainable development of the construction industry in general. The rest of this paper is structured as follows: section 2 reviews the relevant literature; section 3 describes the research methodology; section 4 presents and discusses the results; and the conclusions, limitations of this study, and future research directions are presented in section 5.

2. Literature review

This study adopts Mintzberg's (1987, p. 11) definition of strategy: "strategy is a plan, some sort of consciously intended course of action, a guideline (or set of guidelines) to deal

97 with a situation". GBTs adoption in developing countries such as Ghana is slow and still in
98 its infancy (Darko et al., 2017b; Nguyen et al., 2017). For an overview of the current situation
99 of GBTs adoption in Ghana, the reader is referred to Darko et al.'s (2017b) paper. The above
100 definition of strategy reflects that strategies have two key characteristics: they are developed
101 purposefully and consciously, and they are developed in advance of the actions to which they
102 apply (Mintzberg, 1987). Hence, at this preliminary stage of GBTs adoption in developing
103 countries, it is necessary to develop strategies to promote GBTs adoption. However, only
104 limited attempts have been made to better understand the strategies to promote GBTs
105 adoption in developing countries. Over the past few years, researchers have investigated
106 strategies to promote GBTs and practices adoption. Much of this research has been focused
107 on developed countries. Moreover, as Chan et al. (2017) indicated, most of the previous
108 studies recommend strategies to promote GBTs and practices adoption without empirical
109 evidence. Given the limitations of previous research, it is of interest to perform an empirical
110 investigation on the strategies to promote GBTs adoption within the context of a developing
111 country. In order to identify the strategies to promote GBTs adoption, a review of relevant
112 published literature was conducted.

113 Hwang et al. (2017a) identified the three most feasible solutions to promote the adoption
114 of green business parks in Singapore, which were co-funding and incentives from
115 government, green development policies and regulations, and collaborating with research
116 institutions to study the green business parks benefits. Another Singapore-based study by
117 Hwang and Tan (2012) identified the strategies to encourage green building adoption,
118 including widening the coverage of governmental incentives to include GBTs adoption,
119 educating clients on the green building benefits, developing a green building project
120 management framework, organization of construction tours for educating the public on the
121 green building benefits, and government funding for green building research and

development (R&D). In Hong Kong, Wong et al. (2016) studied a set of factors for facilitating green procurement adoption in building projects. They identified the top three factors from 35 factors: government's mandatory environmental regulations, requirements of clients in tendering, and government's and NGOs' requirements. Moreover, they identified 10 underlying grouped facilitators. At least, they found government regulations and standards, green technology and lifecycle considerations, and commitment from executive management to be the most important facilitator groups. Darko et al. (2017a) discovered that providing relevant incentives, making better information regarding the GBTs costs and benefits available, and green labeling and rating were the most important promotion strategies of GBTs adoption in the US. From a global perspective, Chan et al. (2017) identified the important promotion strategies for GBTs adoption. Qian and Chan (2010) carried out a comparative analysis of the building energy efficiency promotion measures existing in the UK, US, Canada, and China, and developed a conceptual model on the measures. Several promotion measures were present in their model, examples of which were funding from government for building energy efficiency technologies R&D, financial and nonfinancial incentives, granting low-cost loans for building energy efficiency implementation, product labeling and rating, and better enforcement of existing standards. In Utrecht of the Netherlands and Valencia of Spain, Van Doren et al. (2016) identified the local strategies to accelerate the scaling up of energy conservation initiatives. They identified strategies such as developing and enforcing regulatory structures, developing private and public funding mechanisms, communicating the financial and co-benefits of energy conservation initiatives, establishing offline and online information points for energy conservation initiatives, and educating and training stakeholders on energy conservation initiatives. Elsewhere, Potbhare et al. (2009) designed an implementation strategy to promote green building guidelines adoption in India; availability of institutional framework,

147 availability of better costs and benefits information, enhancing the environmental awareness
148 of the public through seminars, conferences, and workshops, and educational programs for
149 contractors, policy makers, and developers were highlighted as crucial promotion strategies.
150 Li et al. (2014) addressed the problem of how to promote green building in China, arguing
151 that enhancing stakeholders' environmental awareness, strengthening green technology R&D
152 and communication, and formulating green building policies were the three fundamental
153 measures to promote green building. In Malaysia, Esa et al. (2017) identified the key
154 strategies for driving construction and demolition waste minimization practices adoption:
155 regulations enhancement, awareness and awards, and effective management procedures. As
156 for Li et al. (2017) and Doan et al. (2017), they studied the literature on green building
157 certification systems and concluded that developing green building certification systems
158 plays an important part in nurturing green building development internationally.

159 The literature documents several strategies to promote GBTs and practices adoption.
160 These strategies existing in various other countries may not be applicable to Ghana due to the
161 cultural, economic, and regulatory differences between countries. Thus, carrying out a study
162 specifically focused on the developing country of Ghana is worthwhile.

163 **3. Research methodology**

164 *3.1. Formulation of initial strategies*

165 Formulating the initial strategies involved the following two steps: (1) literature review
166 and (2) interviews with industrial professionals. In the first step, a provisional list of 12
167 strategies was identified from previous research. It should be noted that although several
168 studies were reviewed, in the preceding section, this provisional list was adapted from Darko
169 et al. (2017a). As Darko et al. (2017a) recently developed (based on the literature) and
170 analyzed (empirically) a list of strategies to promote GBTs adoption in the construction
171 market, it was reasonable to adapt their list. In the second step, before the questionnaire

172 survey, interviews were performed with four industrial professionals to assess the
173 comprehensiveness and relevance of the said provisional strategies. Each of the professionals
174 had over 10 years' working experience in the local construction industry and possessed
175 relevant experience in green building. They were asked to consider the characteristics of the
176 Ghanaian construction market and the background of GBTs adoption in the market and assess
177 whether all potential strategies were covered by the provisional list, and whether any
178 strategies could be added to, or removed from the list. The professionals provided valuable
179 feedbacks. For example, they advised that three potential strategies – "acknowledging and
180 rewarding GBTs adopters publicly", "support from executive management", and "more
181 GBTs adoption advocacy by the Ghana Environmental Protection Agency" – were omitted by
182 the provisional list and should be added. Thus, eventually, a list of 15 potential strategies to
183 promote GBTs adoption, as shown in Table 1, was used in designing the survey
184 questionnaire. Each strategy was assigned a code to facilitate the data analyses and allow
185 easy presentation of the results and discussion in later sections.

186 **<Insert Table 1 around here>**

187 *3.2. Data collection*

188 After formulating the initial strategies, an empirical questionnaire survey was conducted
189 to gather the professional views on their relative importance. Conducting questionnaire
190 survey affords the opportunity to achieve "quantifiability and objectiveness" (Ackroyd and
191 Hughes, 1981). Hence, the method of questionnaire survey has seen wide usage in the green
192 building research area (Chan et al., 2016; Olanipekun et al., 2017). Focusing on question
193 construction and wording, the survey questionnaire was reviewed by an international expert,
194 a professor who had over 10 years' experience in green building, ensuring that it was free of
195 ambiguous expressions and that it used appropriate technical terms. The survey questionnaire
196 comprised three sections. Section one presented the research objective and contact details.

197 Section two was designed to gather background information of the respondents. Section three
198 presented the aforementioned 15 initial strategies and requested the respondents to assess the
199 degree to which each strategy is important to promote GBTs adoption using a five-point
200 Likert scale (1 = not important, 2 = less important, 3 = neutral, 4 = important, and 5 = very
201 important). The five-point Likert scale was adopted in this study because of its advantage of
202 providing results that are unambiguous and hence can be interpreted without difficulty
203 (Ekanayake and Ofori, 2004).

204 The population comprised all industry practitioners with knowledge and understanding of
205 GBTs adoption in Ghana. Since there was no sampling frame for this study, the sample was a
206 nonprobability sample (Zhao et al., 2014). The nonprobability sampling technique can be
207 used to acquire a representative sample (Patton, 2001). It is appropriate when a random
208 sampling method cannot be used to select respondents from the population, but the
209 respondents can rather be selected based on their willingness to participate in the research
210 study (Wilkins, 2011). Thus, a snowball sampling method was used in this study to attain a
211 valid and effective overall sample size. This method was also used in previous construction
212 engineering and management studies (Zhang et al., 2011b; Mao et al., 2015), and it allows the
213 gathering and sharing of information and respondents through referral or social networks.
214 Local companies that have been directly involved in the development of green building
215 projects in Ghana were approached to identify the initial respondents. In the Ghanaian
216 context, this study defines green building projects as building projects that have either
217 obtained the Green Star of South Africa certification or the Leadership in Energy and
218 Environmental Design of the US (LEED) certification. Currently, these are the two main
219 green building certification systems applied in Ghana (Darko et al., 2017b). The initially
220 identified respondents were asked to share information regarding other knowledgeable
221 participants. Using this approach, a total of 96 survey questionnaires were administered to

collect responses from contractor, consultant, and developer companies. Finally, 43 sets of questionnaires with valid responses were returned, corresponding to a 44.8% response rate. Although the sample size was relatively small, statistical analyses could still be carried out because according to the commonly accepted rule, with a sample size of 30 or above, the central limit theorem holds true (Ott and Longnecker, 2010; Hwang et al., 2015). Additionally, as GBTs have not been widely adopted in the Ghanaian construction market, the number of experienced professionals is limited. Moreover, the sample size compares favorably with those of many previous green building-related studies. For example, the surveys by Shen et al. (2017a) and Hwang et al. (2017a) were based on 39 and 40 respondents, respectively. Hence, the sample size of this study is considered reasonable and representative.

For full details of the respondents' profiles, the reader is referred to Darko et al. (2017b). The profiles of the respondents revealed that 16 (37%) of the respondents were from consultant companies, 14 (33%) were from contractor companies, and 13 (30%) were from developer companies. With the respondents' professional backgrounds, those who identified themselves as engineers (13, 30%) formed the majority and the rest had other professional backgrounds, such as project managers, architects, and quantity surveyors. Furthermore, the majority of the respondents (37, 86%) had more than 5 years' working experience in the construction industry, whereas only 6 (14%) had 1-5 years' working experience. Also, all of the respondents had experience in green building, with 24 (56%) having 1-3 years' experience, 11 (25%) having 4-6 years' experience, and 8 (19%) having more than 6 years' experience. Given the few green building projects launched in Ghana in recent years, this result could be deemed reasonable. In light of the experience of the respondents in the construction industry and green building, their views were representative for this study to guarantee the reliability of the findings.

Before analyzing the data collected, Cronbach's alpha coefficient was used to evaluate the reliability of the five-point rating scale used in capturing the survey responses. Cronbach's alpha evaluates the reliability of a rating scale through examining the average correlation or internal consistency between the variables that were assessed using the scale (Santos, 1999). The value of Cronbach's alpha coefficient ranges from 0 to 1, where the higher the value, the more reliable would be the adopted rating scale. Nevertheless, the standard rule is that the scale could be said to be reliable if the Cronbach's alpha coefficient value is higher than or equal to 0.70 (Nunnally, 1978). Therefore, in this study, the Cronbach's alpha coefficient value of 0.813 indicated that the assessment using the five-point scale and hence the data collected were reliable for further analyses in later sections.

3.3. Data analysis methods

In order to achieve the research objective, the survey respondents were requested to state the importance of the various strategies to promote GBTs adoption using a five-point rating scale, as described in the preceding section. With the aid of the SPSS 20.0 statistical package, the data collected from the survey were analyzed using various statistical analysis methods, which are described in this section.

3.3.1. Data normality test

As many statistical tests require a normal distribution of the data (Kim, 2015), the Shapiro-Wilk test, which is a widely used method for testing data normality (Hsu et al., 2000; Ferretti et al., 2017), was first used to test the data normality. The null hypothesis of the Shapiro-Wilk test is that 'the data were normally distributed'. The common alpha value for testing normality (i.e., 0.05) was used in conducting the Shapiro-Wilk test. If the *p*-value produced by the test is lower than the selected alpha value, then the null hypothesis should be rejected, and conclusion that the data are not normally distributed can be drawn. In this study, all the *p*-values produced by the Shapiro-Wilk test were 0.00 (Table 2), indicating that the

data collected are not normally distributed. This is an expected result since data collected from samples that are not very large are usually not normally distributed (Field, 2013; Shan et al., 2017; Hwang et al., 2017b). The non-normal distribution of the data influenced the selection of statistical tests for analyzing the data.

3.3.2. Descriptive statistics

The most commonly used descriptive statistics of mean and standard deviation (SD) were used to rank the strategies to promote GBTs adoption in descending order of importance, as perceived by the respondents. Following Mao et al.'s (2015) approach, where two or more strategies had the same mean score, the strategy with the smallest SD was given the highest rank. A smaller SD suggests that the differences in responses were not statistically large and thus the average is more likely to be valid for the majority (Staplehurst and Ragsdell, 2010).

3.3.3. Inter-group comparison

Because the respondents were from different companies (i.e., consultant, contractor, and developer companies), it was important to check whether there were any significant differences between them, through conducting an inter-group comparison (Shan et al., 2017). To conduct the inter-group comparison, two dissimilar statistical techniques were considered: analysis of variance (ANOVA) and Kruskal-Wallis H test. ANOVA is a commonly applied parametric test for checking differences between mean scores from three or more groups; it has an assumption that the population from which the sample was drawn is normally distributed (Pallant, 2013). As the non-parametric alternative to ANOVA, the Kruskal-Wallis H test, on the contrary, does not have any stringent requirements; it does not also make any assumption about the underlying distribution of the population (Pallant, 2013; Field, 2013). Therefore, owing to the non-normal distribution of the data, the Kruskal-Wallis H test was chosen over ANOVA for the inter-group comparison in this study. In addition to the inter-group comparison, the mean difference analysis was performed to determine the actual values

297 of the differences in the mean scores from different groups (Hwang et al., 2016; Chan et al.,
298 2017).

299 *3.3.4. Concordance test*

300 To analyze the agreement amongst the respondents regarding the rankings of the
301 strategies, Kendall's coefficient of concordance (Kendall's *W*) test was conducted. Kendall's
302 *W* test is a non-parametric test widely used to determine the overall agreement among sets of
303 rankings by different rankers (Chan et al., 2009; Darko et al., 2017c). Kendall's *W* tests the
304 null hypothesis that 'no agreement exists among the rankings given by the respondents in a
305 particular group'. It ranges in value from 0 to 1, where when there is no agreement amongst
306 the respondents, the value would be 0 and when there is a complete agreement, the value
307 would be 1 (Siegel and Castellan, 1988). The null hypothesis should be rejected if the
308 significance level of Kendall's *W* is low (p-value ≤ 0.001), otherwise the null hypothesis
309 should be retained.

310 *3.3.5. Variable comparison*

311 Similar to Shan et al. (2017) and Hwang et al. (2017b), this study conducted a detailed
312 variable comparison to identify the most important strategies to promote GBTs adoption.
313 This was done to complement the descriptive analysis. To perform the variable comparison,
314 two statistical techniques were taken into consideration: paired *t*-test and Wilcoxon's signed
315 rank test. Paired *t*-test is a widely applied method for testing statistical difference between
316 two matched variables (Shan et al., 2017). As a parametric test, this method has a
317 requirement that the tested data must be normally distributed (Lam et al., 2009). The non-
318 parametric alternative to paired *t*-test is Wilcoxon's signed rank test (Pallant, 2013).
319 Wilcoxon's signed rank test is suitable for comparing matched variables (Wu et al., 2014)
320 without assuming any specific nature of data distribution or requiring equal variance of data

(Field, 2013). Thus, Wilcoxon's signed rank test was used for the variable comparison in this study.

4. Results and discussion

Table 2 shows the results of the descriptive analysis as well as the results of other relevant statistical tests. The mean scores of the importance of the strategies range from 3.95 to 4.67. It is noteworthy that the mean scores of all the strategies were much higher than 3.00, which is the middle value of the rating scale, implying that all the strategies had significant importance. This could be attributed to the vision of Ghanaian professionals and stakeholders to "transform the built environment in Ghana towards sustainability" (Ghana Green Building Council (GHGBC), 2010). Because of this vision, strategies to promote GBTs adoption have become a necessity rather than an option for Ghana. Although all the strategies were important, ranking them would enable policy makers, stakeholders, and advocates to understand which strategies are worth focusing more attention on, thus prioritizing the strategies for GBTs adoption promotion activities. From the mean analysis results, the top five strategies (mean $\geq$ 4.58) were "more publicity through media (e.g., print media, radio, television, and internet)" (ST07), "GBTs-related educational and training programs for developers, contractors, and policy makers" (ST08), "availability of institutional framework for effective GBTs implementation" (ST11), "a strengthened GBTs R&D" (ST12), and "financial and further market-based incentives for GBTs adoption" (ST01). The results indicate that these strategies were considered the most important strategies to promote GBTs adoption and therefore should draw the policy makers', stakeholders', and advocates' attention. These five strategies are discussed below, along with the strategy "mandatory green building policies and regulations" (ST02) as the relatively low rank of this strategy (rank 12) seems surprising.

<Insert Tables 2 and 3 around here>

"More publicity through media (e.g., print media, radio, television, and internet)" (ST07) was ranked first with the highest mean score (mean = 4.67). Moreover, the Wilcoxon's signed rank test results in Table 4 indicate that ST07 is the only strategy ranked among the top five strategies, whose assessment was statistically higher than the assessments for as many as eight of the other strategies not ranked among the top five strategies: ST09, ST06, ST14, ST04, ST02, ST03, ST13, and ST15. For the other four strategies ranked among the top five strategies, their assessments were statistically higher than the assessments for only a few of the other strategies not ranked among the top five strategies. For example, the assessment for ST08 was statistically higher than those of only four of the other strategies: ST02, ST03, ST13, and ST15. These results represent that ST07 was considered the most important strategy. The importance of this strategy was also supported by Chan et al. (2017) and Potbhare et al. (2009), where more publicity through media was an important promotion strategy for GBTs and green building guidelines adoptions. Publicity, also called public relations, is a promotion strategy that can help create a positive image for a product, encourage people to engage in the use of the product, convey the benefits of the product, enhance awareness, and increase demand for the product (Belch and Belch, 2007). Thus, more publicity through media is of great importance to the promotion of GBTs adoption. The research finding could essentially provide concrete evidence that advertising or marketing GBTs in the media – through various media channels: print (newspapers and magazines), radio, television, billboards, internet, etc. – can significantly help advance GBTs adoption in Ghana. Publicity through media could be an easy and effective way of promoting GBTs in the public domain. For instance, publicity through the electronic media of the internet and television takes advantage of innovative technologies to easily reach and communicate with the public (Thackeray et al., 2007) about GBTs. Such communication should introduce GBTs and educate the public about the GBTs benefits and the need to adopt GBTs. In addition, to

promote GBTs adoption, the government could sponsor media campaigns that draw attention and exposure to GBTs.

<Insert Table 4 around here>

The strategy "GBTs-related educational and training programs for developers, contractors, and policy makers" (ST08) was ranked second (mean = 4.65). The role the provision of GBTs-related educational and training programs for developers, contractors, and policy makers plays in promoting GBTs adoption cannot be underrated. Potbhare et al. (2009) also identified that educational programs for developers, contractors, and policy makers was one of the top five most important strategies to catalyze the green building guidelines adoption in the developing country of India. Educating and training developers, contractors, and policy makers about GBTs is of high importance in shaping and driving the GBTs adoption in the industry because they are key stakeholders in the adoption and promotion processes. Developers, for example, have significant and decisive roles in GBTs and practices adoption. According to Mao et al. (2015), developers are not only the key decision makers in the adoption of GBTs, but their usage of GBTs also influence the R&D done by scholars, contractors' construction approach, and the investments of manufacturers. Similarly, Hu et al. (2015) and Hu et al. (2017) agree that within the industry, developers are key decision makers in the adoption of green practices because they are the investors. In light of these reasons, developing and implementing effective GBTs-related education and training programs for increasing developers' knowledge and awareness of and expertise in GBTs would certainly have a substantial impact on promoting GBTs adoption. Likewise, as developers have a great capacity to influence firms and individual practitioners within the construction industry in a manner which fosters innovation (Blayse and Manley, 2004), providing them with GBTs-related education and training would not only help their own GBTs adoption, but it would also help them influence or guide other industry participants to

accept and embrace GBTs. In that way, GBTs adoption would gradually become an industry-wide accepted practice. The Ghana Real Estate Developers Association (GREDA) is one of the largest and most active construction industry associations in Ghana that makes recommendations to the government about ways to promote real estate development (GREDA, 2014). It is also active in seeking solutions to the problems, including sustainability problems, in the Ghanaian property market (GREDA, 2014). These may perhaps explain why "GBTs-related educational and training programs for developers, contractors, and policy makers" was ranked as the second important strategy to promote the GBTs adoption. Although the above discussion focuses more on developers for simplicity, the research result implies that to widely promote the use of GBTs, the GBTs education and training should go beyond only developers' education; it should include other relevant stakeholders, such as policy makers and contractors.

The strategy "availability of institutional framework for effective GBTs implementation" (ST11) occupied the third position (mean = 4.60). This result indicates that to promote the successful and effective implementation of GBTs, an institutional framework that explicitly outlines the roles and responsibilities of all stakeholders is needed, which is consistent with the findings of previous studies (Potbhare et al., 2009; Chan et al., 2017). According to the Global Water Partnership (GWP) (2008), frameworks are an essential prerequisite for implementing sustainable practices because they form the basis for successful implementation. Frameworks have two major components: legal framework and institutional framework. While the legal framework is determined by national, provincial and local policies and regulations, which constitutes the "rules of the game", the institutional framework comprises the institutions and organizations with forums and mechanisms, information and capacity building, founded to establish the "rules of the game" and to facilitate stakeholder involvement (GWP, 2008). Thus, an institutional framework can simply

421 be defined as a set of formal organizational structures, rules, and informal norms for
422 performing an activity (International Ecological Engineering Society (IEES), 2006). In GBTs
423 adoption, an institutional framework can provide an enabling environment for adoption
424 (Lloyd-Williams, 2012) by guiding the behavior of all stakeholders. Ghana needs to develop
425 an efficient institutional framework in order to move forward with the implementation of
426 GBTs. Such a framework must consist of different organizations that could actively promote
427 GBTs adoption at various levels of society. Organizations such as government bodies, NGOs,
428 professional institutes, industry associations, community-based organizations, and civil
429 society institutions could be considered in developing the institutional framework for GBTs
430 implementation, and the framework should clearly outline the roles and responsibilities of
431 each organization.

432 Similar to strategy ST11, the strategy "a strengthened GBTs R&D" (ST12) obtained a
433 mean score of 4.60, but because its SD (0.583) was higher than the SD of strategy ST11
434 (0.541), it was ranked fourth. Having a strong R&D base in green technology is a necessary
435 ingredient to foster the adoption of GBTs. This finding concurs with Li et al. (2014), who
436 stated that to promote green building adoption, it is important to strengthen technology
437 research and communication. In fact, the approach to green building varies between countries
438 and regions. Different countries and regions have a range of characteristics, such as
439 distinctive climatic conditions and unique traditions and cultures, that shape their approach to
440 green building (WorldGBC, 2017). In line with this, the GBTs available in the local market
441 also affect the approach to green building. For example, the architects of the Ridge Hospital
442 in Ghana, which is Africa's first LEED-certified hospital, observed that most of the GBTs in
443 the US and Canada, wherein LEED is most popular, do not exist in Ghana. But with an
444 understanding of the GBTs available locally, they were able to efficiently complete this green
445 project (Bubbs, 2017). In addition, they indicated that although they could have imported

several ‘high-tech’ solutions, such an action would be unwise in the long run, as many local professionals cannot operate or maintain them successfully. These show that GBTs adoption depends on a better understanding of the GBTs that are available and could be applied locally. It has been identified that GBTs R&D is crucial to promote GBTs adoption in Ghana. The R&D efforts could focus on studying the locally available GBTs, their application and applicability, and their (system) performance. Furthermore, the GBTs R&D should conduct proper analyses to highlight the lifecycle costs and environmental, economic, and social benefits of the GBTs. The study result suggests that to promote GBTs adoption, government supports for GBTs R&D are needed. The government could establish green technology research institutes and centers and/or support academic institutions, such as universities, to undertake GBTs R&D. In addition to the book and research allowance that the Ghanaian government currently provide for universities, the government has a plan to create a research fund to enable the universities to undertake “special research projects and innovation” (Daily Guide, 2017). It would be beneficial if the government and the universities treat GBTs R&D as a vital component of all of these research funding initiatives. Many developed countries have made good progress in GBTs R&D (Li et al., 2014). So, in the process of attempting to strengthen GBTs R&D, it would be useful for Ghana to communicate with developed countries and learn from their experiences. In the end, to stimulate interest and demand for the GBTs, all GBTs R&D outcomes should be communicated through means like development tours, the media, academic and industrial publications, seminars, and workshops to educate the industrial practitioners and the general public. It could be inferred from the above discussions that strategies ST07, ST08, and ST12 are closely connected. For instance, implementing strategy ST12 could provide valuable information and evidence for use in implementing strategies ST07 and ST08. This could further explain why all of these strategies were considered top strategies in this study.

The strategy "financial and further market-based incentives for GBTs adoption" (ST01) received the fifth position (mean = 4.58). Incentive schemes are a very important strategy to promote GBTs adoption. This result is in line with Qian et al. (2016), Olubunmi et al. (2016), and Shazmin et al. (2017), who have pointed out that the practice of providing financial and nonfinancial incentives is important to promoting GBTs and practices adoption within the construction market. Financial incentives, for instance, do not only increase the motivation of construction stakeholders to adopt GBTs, but they also help build a solid financial foundation for adopting GBTs. In a way, incentive schemes compel people to adopt GBTs, as they are normally awarded only when certain green requirements have been fulfilled. Owing to their importance, incentive schemes have been adopted by many developed countries as a strategy for promoting GBTs and practices adoption. For example, Singapore has launched numerous incentive and funding schemes, e.g., Grant for Energy Efficient Technologies (GREET), for accelerating energy-efficient technologies adoption (Green Future Solutions, 2015). The US has also introduced a lot of incentive schemes for motivating GBTs adoption (Gou et al., 2013; Mulligan et al., 2014). The tax incentive scheme, whereby stakeholders who adopt GBTs are offered tax discounts or fully exempted from the payment of tax, is one of the most popular green building incentives in the US (Gou et al., 2013). The gross floor area concession scheme has also been popular in Hong Kong and Singapore for encouraging GBTs adoption (Qian et al., 2016). This is a nonfinancial/regulatory incentive scheme whereby stakeholders who meet certain green requirements are granted an additional floor area by the government. The finding of this study infers that Ghanaian practitioners would like to see the government's intervention in the construction market in the form of incentive schemes to help them increase the pace of GBTs adoption. In order to do this efficiently and effectively, the government could learn from the developed countries' experiences of implementing green building incentives.

Perhaps, the most surprising feature of the results is the relatively low rank of the strategy "mandatory green building policies and regulations" (ST02) (rank 12). In fact, there is growing evidence supporting that mandatory government policies and regulations are of the utmost importance in promoting GBTs and practices adoption (Chan et al., 2009; Wong et al., 2016; Shen et al., 2017a). To a large extent, this has been because government policies and regulations create mandatory push for stakeholders to engage in GBTs adoption (Chan et al., 2009). As such, it is surprising that the Ghanaian professionals did not perceive this strategy as a highly important strategy to promote the GBTs adoption. It could be that the professionals were more optimistic about strategies that could help stakeholders adopt GBTs out of their own volition. Another possible reason could be because most government policies relating to the construction market in Ghana have been ineffective (Appiah, 2007). In spite of the relatively low rank of this strategy, the research results (Table 2) still suggest that formulating effective policies and regulations aimed at mandating the adoption of GBTs in construction projects would have a positive influence on promoting GBTs adoption in Ghana.

As Darko et al. (2017b) indicated, GBTs adoption in Ghana is still in its early stage. At this early stage, government practically has the most critical and leading role in promoting GBTs adoption (Hwang et al., 2017a); to formulate and implement appropriate strategies to drive the industrial practitioners and the public to implement GBTs. This research presents the important strategies to promote GBTs adoption. Because these strategies have been identified from the perspective of experienced practitioners, who would themselves be affected by the strategies when applied, in the Ghanaian construction market, the strategies could serve as an effective checklist for the government, stakeholders, and advocates and when used appropriately, would surely contribute to the success of promoting GBTs adoption in Ghana. As can be found from the discussions above, the identified strategies are not only typical for Ghana, but have also been relevant for many developed countries, such as the US,

Singapore, and Hong Kong. In the implementation of these strategies, it is very important to regularly monitor and assess their performance and influence on promoting the GBTs adoption in the industry. That will help in making necessary amendments to the strategies to optimize and maximize their effectiveness throughout the various stages of development of the GBTs adoption. Thus, when the GBTs adoption becomes more mature, future studies would be useful for refining the results of the present study, which could help the government, stakeholders, and advocates revise their strategies accordingly, in order to ensure the continuous promotion of GBTs adoption.

Moreover, although this study aims to provide a generic list of strategies to promote GBTs adoption in Ghana, it is equally important to note that the importance of these strategies could vary depending upon several factors, such as type and scale of projects (e.g., government- or private-funded projects), the sector under consideration (e.g., the residential or commercial sectors), and firm characteristics (e.g., firm size – large or small firms). For the promotion of GBTs adoption in private-funded projects, for example, the provision of financial incentives might be regarded as more important than other promotion strategies for at least two reasons. First, the GBTs adoption may require higher investment costs (Dwaikat and Ali, 2016). Second, most private developers act as "rational economic men" who pursue profit (Mao et al., 2015). To assess the effects of various contextual factors on the importance of the strategies to promote GBTs adoption, future studies should focus on specific contexts when analyzing the strategies.

As Table 2 shows, aside from the overall strategies ranking, this research also analyzed the respondents' agreement regarding the rankings, as well as the differences in views between the respondents from consultant, contractor, and developer companies. As mentioned in section 3.3.4, Kendall's *W* test was used for the agreement analysis. The Kendall's *W* value generated from the test was 0.089, and the associated significance level

546 was 0.000, implying that there exists a significant degree of agreement among the
547 respondents in a particular group. As for the results of mean difference analysis, it could be
548 noted that, generally, the contractors' and developers' views of the importance of the
549 strategies were higher than the consultants' views. This might imply that the contractors and
550 developers attached relatively more importance to the strategies. Moreover, the consultants
551 and contractors showed the largest difference in the view of the importance of "low-cost
552 loans and subsidies from government and financial institutions" (ST05, Diff. (CS–CT) =
553 0.73). The consultants and developers showed the largest difference in the view of the
554 importance of "more GBTs adoption advocacy by the Ghana Environmental Protection
555 Agency" (ST15, Diff. (CS–DP) = 0.69). Likewise, the contractors and developers showed the
556 largest difference in the view of the importance of ST15 (Diff. (CT–DP) = 0.52). After
557 investigating the differences in views by taking two groups at a time, Kruskal-Wallis H test
558 was implemented to check which of the strategies would have their differences in views to be
559 significant if all the three groups are combined and compared. According to the Kruskal-
560 Wallis H test results in Table 2, the *p*-values of all strategies, except "financial and further
561 market-based incentives for GBTs adoption" (ST01, *p*-value = 0.010) and "low-cost loans
562 and subsidies from government and financial institutions" (ST05, *p*-value = 0.008), were
563 greater than 0.05. The results indicate that the differences in views of the importance of these
564 strategies amongst the three groups of respondents were not statistically significant. For the
565 strategies ST01 and ST05, the differences in views of their importance were statistically
566 significant. It could be noted that these two strategies are more related to financial issues, and
567 as financial issues remain sensitive issues in the GBTs adoption arena (Mao et al., 2015;
568 Luthra et al., 2015), it is unsurprising that practitioners have different views about them. In
569 Kruskal-Wallis H test application, once a significant difference is observed, the mean ranks
570 for the respondent groups could be inspected to identify the group that is significantly

different from the others (Pallant, 2013). In this respect, Table 3 shows that the consultant group had the lowest overall rankings (ST01, mean rank = 15.94; and ST05, mean rank = 15.66) corresponding to the lowest scores on ST01 (mean = 4.25) and ST05 (mean = 4.13) (Table 2). These results suggest that the consultant group is the main contributor to the significant differences in the views of strategies ST01 and ST05, which could be attributed to the relatively low mean scores from the consultant group.

4.1 Comparison of results with the United States

Darko et al.'s (2017a) study, from which most of the strategies used in this study were adapted (Table 1), is a study that investigated the strategies to promote GBTs adoption in the developed country of the US. Therefore, as this study focused on Ghana, comparing the results with that of Darko et al. (2017a) would assist in understanding and highlighting the differences between the strategies for a developing country and a developed country, which might be of benefit to policy makers, stakeholders, and advocates worldwide. To this end, this study compares the top five identified strategies for Ghana and the US. Such kind of results comparison has gained scholarly attention in the construction management field. For example, Chan et al., (2010) compared their results on the critical success factors for public-private partnership projects in China with that of a previous study in the UK; while Bagaya and Song (2016) compared their results on the causes of schedule delays in construction projects in Burkina Faso with that of previous studies in other countries (e.g., Hong Kong). The present study however is one of the first to compare the strategies to promote GBTs adoption in a developing country (Ghana) and a developed country (the US). Future research could expand and improve this comparison by including many other specific countries. Moreover, in future studies wherein cross-country empirical data on the strategies would be collected and used, the Spearman rank correlation test could be used to measure the correlation between the ranks of the strategies between every two countries.

Table 5 shows the summary of the comparison of the top five most important strategies to promote GBTs adoption between Ghana and the US. As shown in Table 5, strategies that were ranked among the top five strategies for both Ghana and the US are marked with this symbol: √; whereas those that were not ranked among the top five strategies for the US are marked with this symbol: –. Table 5 also shows the individual ranks (in bracket) of the strategies across the two countries. It is interesting to find that the top three strategies for Ghana – "more publicity through media (e.g., print media, radio, television, and internet)", "GBTs-related educational and training programs for developers, contractors, and policy makers", and "availability of institutional framework for effective GBTs implementation" – did not appear in the top five strategies for the US; they were ranked ninth, sixth, and tenth in the US, respectively. In addition, it is worth noting that "a strengthened GBTs R&D" and "financial and further market-based incentives for GBTs adoption" were the only two strategies that appeared in the top five strategies for both Ghana and the US. In this respect, it could be seen that while the rank of the strategy "a strengthened GBTs R&D" for Ghana (rank 4) is very close to the US rank (rank 5), the rank of the strategy "financial and further market-based incentives for GBTs adoption" for Ghana (rank 5) appears to be slightly different from the US rank (rank 1). This finding reveals that while the provision of relevant incentives is considered the most important strategy to promote GBTs adoption in the US, in the Ghanaian context, it is only considered one of the most important strategies. This outcome may be because in the current economic conditions in developing countries, it is not very likely that governments would provide financial incentives for green building adoption (Nguyen et al., 2017).

<Insert Table 5 around here>

The results comparison between Ghana and the US has revealed that among the top five strategies to promote GBTs adoption in Ghana, there are three strategies that do not appear in

621 the top five strategies for the US. Based on this finding, it can be stated that the most
622 important strategies to promote GBTs adoption in the developing country of Ghana generally
623 differ from those in the developed country of the US. The different conditions and
624 regulations, as well as the different maturity levels of the GBTs adoption activity, in different
625 countries could explain the reason for the differences. However, the findings of this study
626 suggest that irrespective of geographical locations, these two strategies – "a strengthened
627 GBTs R&D" and "financial and further market-based incentives for GBTs adoption" – could
628 greatly help in the promotion of the adoption of GBTs. It is therefore suggested that
629 international policy makers and advocates should direct more attention towards these
630 strategies in their efforts to promote the successful and wider adoption of GBTs.

631 *4.2. Factor analysis*

632 Exploratory factor analysis (EFA) is a statistical technique for uncovering the underlying
633 factor structure of a set of variables (Field, 2013; McNeish, 2017). It is helpful for gaining an
634 understanding of the number of factors underlying the variables, which variables are more
635 closely correlated with each other, and the strength of the relationships between the
636 observable variables and the extracted latent factors. EFA can be applied when the underlying
637 structure of the variables (1) is unknown or not well-known, (2) has not been established in
638 previous research, and/or (3) has yet to be established with a particular subpopulation
639 (McNeish, 2017). Establishing the underlying structure is essential for hypotheses testing and
640 theory building. As a result, EFA has increasingly been used in construction management
641 studies (Zhao et al., 2013; Zhao et al., 2014). In the area of interest in this paper, albeit some
642 previous studies have used EFA to establish the underlying structure of strategies specific to
643 the promotion of certain green building practices adoption, such as the promotion of green
644 procurement adoption (Wong et al., 2016) and the promotion of waste minimization practices
645 adoption (Esa et al., 2017), no previous research has established the underlying factor

structure of strategies specific to the promotion of GBTs adoption. Therefore, supplementing the analysis carried out in this paper to identify the important strategies to promote GBTs adoption, this paper also briefly applied EFA to uncover the underlying structure of the strategies. This could benefit scholars interested in analyzing and modeling the GBTs adoption process.

Since all the 15 strategies (variables) had significant importance (Table 2), none of them was excluded from the EFA; however, further analysis will determine whether some strategies ought to be excluded. Prior to the EFA application, two tests were performed to evaluate the appropriateness of factor analysis for the factor extraction, which are the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity. The KMO value (0.612) was above the acceptable threshold of 0.5 (Kaiser, 1974), indicating that the sample is adequate for factor analysis. The significance level of chi-square in Bartlett's sphericity test was 0.000, suggesting that the population correlation matrix is not an identity matrix (Pallant, 2013). The results of these two tests indicate that factor analysis is appropriate for the factor extraction. To further verify the appropriateness of using factor analysis, the communalities of the variables were examined. MacCallum et al. (1999) indicated that sample size becomes increasingly important only when communalities are low. In line with this, Field (2013, p. 684) argued that "with all communalities above 0.60, relatively small samples (less than 100) could be deemed perfectly adequate." Table 6 indicates that all communalities were above 0.60, suggesting that the sample is acceptable for factor analysis (Field, 2013). Furthermore, despite criticisms of factor analysis with small samples, Lingard and Rowlinson (2006) identified that the majority (70%) of the factor analysis-based studies in the construction management domain still used samples below 100, with some using samples ranging from 20 to 42 (Dainty et al., 2003; Ng, 2004; Ramírez et al., 2004). Hence, it is considered appropriate to use factor analysis to process the data

671 collected from the sample of 43 respondents in the present study. The factor analyses
672 reported by Darko et al. (2017b) and Chan et al. (2018) were both also based on samples of
673 43 respondents. Moreover, because all factor loadings exceeded or were equal to 0.50 (Table
674 7), each variable is significant in contributing to the interpretation of its factor (Chan et al.,
675 2010), thus all the variables were retained.

676 **<Insert Tables 6 and 7 around here>**

677 The extraction method of principal component analysis, with varimax rotation, was used
678 to identify underlying grouped strategies. Five underlying grouped strategies with
679 eigenvalues greater than 1 were extracted in this research (Table 7). Table 8 shows that these
680 five underlying groupings explain 72.63% of the variance, which is higher than the guideline
681 of 60% (Malhotra, 2006; Zhao et al., 2013). As shown in Table 7, all the variables are split
682 into five meaningful groupings, and considering the variables with high loadings in each
683 grouping and their common features, the five underlying groupings could be named as
684 follows: government regulations and standards; incentives and R&D support; awareness and
685 publicity programs; education and information dissemination; and awards and recognition.
686 The primary purpose of applying EFA in this paper was not to identify and comprehensively
687 discuss an unconfirmed factor structure or model, but was to establish a factor model that
688 would be useful for future research to build upon this study and consequently expand the
689 knowledge base. Thus, having used EFA to identify the underlying factor model of the
690 strategies to promote GBTs adoption, the future research directions are to: (1) test this model
691 using confirmatory factor analysis (CFA); (2) analyze the interrelationships between the
692 strategies by using modeling methods, for example, structural equation modeling (SEM); and
693 (3) analyze the possible effects of the strategies on the GBTs adoption process.

694 **<Insert Table 8 around here>**

695 **5. Conclusions, limitations, and future research**

GBTs adoption has recently received increased global attention because of its numerous sustainability benefits. However, GBTs adoption has been slower in developing countries such as Ghana than in developed countries. This requires strategies that can assist in promoting and accelerating the adoption of GBTs in developing countries. As such, this paper attempted to identify the important strategies to promote GBTs adoption within Ghana. A literature review and interviews with industry professionals were conducted to identify 15 potential strategies that were presented in a questionnaire. After that, an empirical questionnaire survey was carried out with 43 professionals with green building experience to examine the relative importance of the strategies. This study is novel in three ways. First, to the authors' knowledge, this study is one of the first in developing countries and the first in Ghana to investigate the important strategies to promote GBTs adoption. Second, this study is one of the first to compare the strategies to promote GBTs adoption between a developing country and a developed country. Finally, this study is also the first to establish the underlying factor structure of the strategies to promote GBTs adoption.

The results of this study first showed that "more publicity through media (e.g., print media, radio, television, and internet)", "GBTs-related educational and training programs for developers, contractors, and policy makers", "availability of institutional framework for effective GBTs implementation", "a strengthened GBTs R&D", and "financial and further market-based incentives for GBTs adoption" were the top five strategies to promote the GBTs adoption. In addition, the importance of all the strategies were statistically significant, and generally the differences in the perceptions of the importance of the strategies were statistically insignificant. Furthermore, the comparison of the top five strategies between Ghana and the US revealed that the most important strategies to promote GBTs adoption in Ghana mostly differ from those in the US. However, the findings suggested that irrespective of geographical locations, "a strengthened GBTs R&D" and "financial and further market-

based incentives for GBTs adoption" are two strategies that could greatly help in promoting GBTs adoption. The implication of this finding is that these strategies need more attention in order to promote GBTs adoption internationally. Further investigation with factor analysis showed that the underlying strategy groupings were government regulations and standards; incentives and R&D support; awareness and publicity programs; education and information dissemination; and awards and recognition. This study contributes to the body of knowledge relating to green building by analyzing the important strategies to promote GBTs adoption in the construction market within the context of a developing country. Moreover, the findings of this study could improve the understanding of policy makers, industry stakeholders, and advocates on the key strategies to promote GBTs adoption and guide them in designing and implementing appropriate strategies for GBTs adoption promotion.

Despite the achievement of the objective, this study was not conducted without limitations. The first limitation is that the importance assessment made in this study could be influenced by the respondents' experiences and attitudes, as it was subjective. Besides, since the sample size was not very large, one must be cautious when interpreting and generalizing the results. This study analyzed only the views of consultants, contractors, and developers on the strategies, thus future research could increase the sample size by including the views of the policy makers or government agencies. Moreover, as the first attempt to present the important strategies to promote GBTs adoption in Ghana, this paper only briefly explored the underlying factor structure of the strategies. Based on that, this study provided valuable directions for future research, including modeling the interrelationships between the strategies, as well as their possible effects on the GBTs adoption process. Additionally, the comparative analysis carried out in this study was limited to only Ghana and the US, hence future research could include many other specific countries, and by so doing, the comparison will be expanded and improved.

Because this study was carried out in the developing country of Ghana, the findings and implications could also be beneficial to policy makers, industry stakeholders, and advocates in other developing countries around the world. Nonetheless, data collected and analyzed from different countries may produce different results. Therefore, using the proposed strategies and following this study's methodology, similar studies could be conducted in different developing countries, and the results could be used in observing the market-specific differences. Promoting GBTs adoption requires an informed approach in the form of an implementation strategy (Potbhare et al., 2009). As such, lastly, the future research paper will combine all the findings from the previously mentioned large-scope research study on the promotion of GBTs adoption in Ghana to develop a green implementation strategy that will help Ghanaian policy makers, practitioners, stakeholders, and advocates to promote GBTs adoption.

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Tables

Table 1

List of initial strategies to promote GBTs adoption.

Code	Strategies
ST01	Financial and further market-based incentives for GBTs adoption[a]
ST02	Mandatory green building policies and regulations[a]
ST03	Green rating and labeling programs[a]
ST04	Better enforcement of green building policies after they have been developed[a]
ST05	Low-cost loans and subsidies from government and financial institutions[a]
ST06	Public environmental awareness creation through workshops, seminars, and conferences[a]
ST07	More publicity through media (e.g., print media, radio, television, and internet)[a]
ST08	GBTs-related educational and training programs for developers, contractors, and policy makers[a]
ST09	Availability of better information on cost and benefits of GBTs[a]
ST10	Availability of competent and proactive GBTs promotion teams and local authorities[a]
ST11	Availability of institutional framework for effective GBTs implementation[a]
ST12	A strengthened GBTs R&D[a]
ST13	Acknowledging and rewarding GBTs adopters publicly[b]
ST14	Support from executive management[b]
ST15	More GBTs adoption advocacy by the Ghana Environmental Protection Agency[b]

Note: [a] The strategy was adapted from Darko et al. (2017a); [b] The strategy was added after interviews.

Table 2

Strategies to promote GBTs adoption.

Code	All respondents				Consultant			Contractor			Developer			Diff. (CS–CT)	Diff. (CS–DP)	Diff. (CT–DP)	*p*-value
	Mean	SD	Rank	*p*-value	Mean	SD	Rank	Mean	SD	Rank	Mean	SD	Rank				
ST07	4.67	0.522	1	0.000[a]	4.56	0.512	1	4.86	0.363	1	4.62	0.650	5	–0.30	–0.06	0.24	0.237
ST08	4.65	0.613	2	0.000[a]	4.56	0.512	1	4.79	0.579	4	4.62	0.768	8	–0.23	–0.06	0.17	0.311
ST11	4.60	0.541	3	0.000[a]	4.44	0.512	3	4.79	0.579	4	4.62	0.506	2	–0.35	–0.18	0.17	0.104
ST12	4.60	0.583	4	0.000[a]	4.44	0.727	4	4.79	0.426	3	4.62	0.506	2	–0.35	–0.18	0.17	0.351
ST01	4.58	0.663	5	0.000[a]	4.25	0.683	8	4.71	0.611	6	4.85	0.555	1	–0.46	–0.60	–0.14	0.010[b]
ST05	4.51	0.703	6	0.000[a]	4.13	0.806	12	4.86	0.363	1	4.62	0.650	5	*–0.73*	–0.49	0.24	0.008[b]
ST10	4.51	0.736	7	0.000[a]	4.25	0.931	10	4.71	0.611	6	4.62	0.506	2	–0.46	–0.37	0.09	0.242
ST09	4.47	0.702	8	0.000[a]	4.31	0.704	7	4.64	0.745	9	4.46	0.660	9	–0.33	–0.15	0.18	0.275
ST06	4.42	0.763	9	0.000[a]	4.19	0.655	11	4.71	0.611	6	4.38	0.961	13	–0.52	–0.19	0.33	0.066
ST14	4.42	0.763	10	0.000[a]	4.25	0.856	9	4.57	0.756	10	4.46	0.660	9	–0.32	–0.21	0.11	0.495
ST04	4.37	0.874	11	0.000[a]	4.13	1.204	13	4.43	0.514	11	4.62	0.650	5	–0.30	–0.49	–0.19	0.440
ST02	4.35	0.783	12	0.000[a]	4.44	0.814	5	4.21	0.893	12	4.38	0.650	11	0.23	0.06	–0.17	0.714
ST03	4.19	0.906	13	0.000[a]	4.44	0.892	6	4.00	1.038	14	4.08	0.760	15	0.44	0.36	–0.08	0.243
ST13	4.14	1.014	14	0.000[a]	4.06	1.063	14	4.14	0.770	13	4.23	1.235	14	–0.08	–0.17	–0.09	0.634
ST15	3.95	0.815	15	0.000[a]	3.69	0.873	15	3.86	0.770	15	4.38	0.650	11	–0.17	*–0.69*	*–0.52*	0.065

Note: SD = Standard deviation; [a] The Shapiro-Wilk test result is significant at the significance level of 0.05 (*p*-value < 0.05); [b] The Kruskal-Wallis H test result is significant at the significance level of 0.05 (*p*-value < 0.05); Diff. (CS–CT) = Difference in mean scores from consultant and contractor; Diff. (CS–DP) = Difference in mean scores from consultant and developer; Diff. (CT–DP) = Difference in mean scores from contractor and developer. The Kendall's *W* for ranking the 15 strategies was 0.089 with a significance level of 0.000.

Table 3

Mean ranks from the Kruskal-Wallis H test for the variables with significant differences in the respondents' views.

Code	M(CS)	M(CT)	M(DP)
ST01	15.94	24.32	26.96
ST05	15.66	27.64	23.73

Note: M(CS) = Mean rank for consultant group; M(CT) = Mean rank for contractor group; M(DP) = Mean rank for developer group.

Table 4

P-values comparing the assessments for the strategies.

Code	ST07	ST08	ST11	ST12	ST01	ST05	ST10	ST09	ST06	ST14	ST04	ST02	ST03	ST13	ST15
ST07	–	0.822	0.405	0.439	0.415	0.216	0.176	0.039[a]	0.008[a]	0.016[a]	0.048[a]	0.029[a]	0.005[a]	0.003[a]	0.000[a]
ST08		–	0.527	0.674	0.557	0.268	0.268	0.092	0.079	0.087	0.135	0.040[a]	0.002[a]	0.007[a]	0.000[a]
ST11			–	1.000	0.817	0.415	0.317	0.109	0.127	0.114	0.317	0.049[a]	0.002[a]	0.012[a]	0.000[a]
ST12				–	0.819	0.346	0.439	0.134	0.175	0.148	0.135	0.075	0.012[a]	0.005[a]	0.000[a]
ST01					–	0.439	0.683	0.381	0.276	0.257	0.164	0.135	0.036[a]	0.007[a]	0.001[a]
ST05						–	0.890	0.678	0.441	0.451	0.496	0.301	0.073	0.035[a]	0.002[a]
ST10							–	0.507	0.519	0.423	0.425	0.197	0.013[a]	0.031[a]	0.002[a]
ST09								–	0.825	0.678	0.819	0.458	0.058	0.059	0.003[a]
ST06									–	0.980	0.845	0.644	0.128	0.135	0.006[a]
ST14										–	0.937	0.616	0.133	0.160	0.006[a]
ST04											–	0.698	0.151	0.129	0.031[a]
ST02												–	0.071	0.319	0.036[a]
ST03													–	0.950	0.207
ST13														–	0.125
ST15															–

Note: [a] Wilcoxon's signed rank test result is significant at the significance level of 0.05 (p-value < 0.05), suggesting that the two compared variables are statistically different.

Table 5

Occurrence of Ghana's top five GBTs adoption promotion strategies in the United States.

Top five strategies to promote GBTs adoption in Ghana	Ghana[a] (this study)	US[b] (Darko et al., 2017a)
More publicity through media (e.g., print media, radio, television, and internet)	√ (rank 1)	– (rank 9)
GBTs-related educational and training programs for developers, contractors, and policy makers	√ (rank 2)	– (rank 6)
Availability of institutional framework for effective GBTs implementation	√ (rank 3)	– (rank 10)
A strengthened GBTs R&D	√ (rank 4)	√ (rank 5)
Financial and further market-based incentives for GBTs adoption	√ (rank 5)	√ (rank 1)

Note: [a] Developing country; [b] Developed country.

Table 6

Communalities.

Code	Initial	Extraction
ST01	1.000	0.716
ST02	1.000	0.762
ST03	1.000	0.895
ST04	1.000	0.719
ST05	1.000	0.661
ST06	1.000	0.776
ST14	1.000	0.664
ST07	1.000	0.790
ST08	1.000	0.656
ST09	1.000	0.691
ST10	1.000	0.647
ST11	1.000	0.778
ST12	1.000	0.662
ST13	1.000	0.691
ST15	1.000	0.787

Table 7

Results of EFA on strategies to promote GBTs adoption (rotated component matrix).

Code	Strategies to promote GBTs adoption	Strategy grouping				
		1	2	3	4	5
Grouping 1: Government regulations and standards						
ST03	Green rating and labeling programs	0.890	–	–	–	–
ST02	Mandatory green building policies and regulations	0.862	–	–	–	–
ST10	Availability of competent and proactive GBTs promotion teams and local authorities	0.543	–	–	–	–
ST04	Better enforcement of green building policies after they have been developed	0.500	–	–	–	–
Grouping 2: Incentives and R&D support						
ST01	Financial and further market-based incentives for GBTs adoption	–	0.832	–	–	–
ST05	Low-cost loans and subsidies from government and financial institutions	–	0.780	–	–	–
ST12	A strengthened GBTs R&D	–	0.712	–	–	–
Grouping 3: Awareness and publicity programs						
ST06	Public environmental awareness creation through workshops, seminars, and conferences	–	–	0.862	–	–
ST07	More publicity through media (e.g., print media, radio, television, and internet)	–	–	0.794	–	–
ST14	Support from executive management	–	–	0.699	–	–
Grouping 4: Education and information dissemination						
ST08	GBTs-related educational and training programs for developers, contractors, and policy makers	–	–	–	0.778	–
ST11	Availability of institutional framework for effective GBTs implementation	–	–	–	0.721	–
ST09	Availability of better information on cost and benefits of GBTs	–	–	–	0.606	–
Grouping 5: Awards and recognition						
ST15	More GBTs adoption advocacy by the Ghana Environmental Protection Agency	–	–	–	–	0.854
ST13	Acknowledging and rewarding GBTs adopters publicly	–	–	–	–	0.593

Note: Extraction method = principal component analysis; Rotation method = varimax with Kaiser normalization; Rotation converged in 7 iterations.

Table 8

Total variance explained.

Grouping	Initial eigenvalues			Rotation sums of squared loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.807	32.048	32.048	2.546	16.970	16.970
2	1.869	12.462	44.510	2.451	16.342	33.312
3	1.620	10.799	55.309	2.387	15.912	49.224
4	1.523	10.153	65.462	2.276	15.172	64.396
5	1.075	7.170	72.631	1.235	8.235	72.631