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

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1 **Strategies to promote green building technologies adoption in developing**

2 **countries: The case of Ghana**

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6 **Abstract**

7 Because of its potential to deal with negative environmental impacts of construction activities

8 and contribute to sustainable development, the adoption of green building technologies

9 (GBTs) has received a high level of global attention in recent times. Accordingly, studies on

10 strategies to promote GBTs adoption have been done around the world, but they are scarce in

11 developing countries such as Ghana. The aim of this study is to identify the important

12 strategies to promote GBTs adoption with reference to the Ghanaian construction market. To

13 this end, this study commenced with a literature review and interviews with industry

14 professionals to identify 15 potential strategies. An empirical questionnaire survey was

15 carried out with 43 professionals with green building experience. The analysis results

16 revealed that "more publicity through media", "GBTs-related educational and training

17 programs for key stakeholders", "availability of institutional framework for effective GBTs

18 implementation", "a strengthened GBTs R&D", and "financial and further market-based

19 incentives" were the top five strategies to promote the GBTs adoption. Additionally, results

20 comparison indicated that the top strategies to promote GBTs adoption in the developing

21 country of Ghana mostly differ from those in the developed country of the US. Furthermore,

22 factor analysis showed that the underlying strategy groupings were government regulations

23 and standards; incentives and R&D support; awareness and publicity programs; education

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24 and information dissemination; and awards and recognition. Theoretically, from a developing

25 country's perspective, this research contributes to the literature on green building by

26 improving understanding of the key strategies to promote GBTs adoption. Practically, this

27 research helps policy makers, industry stakeholders, and advocates formulate and implement

28 proper strategies for GBTs adoption promotion. The directions for future research include to

29 model the interrelationships between the strategies, as well as their likely effects on the GBTs

30 adoption activity.

31 **Keywords:** Green building technologies; Promotion strategies; Environmental sustainability;

32 Construction market; Developing countries; Ghana.

33 **1. Introduction**

34   Through its consumption of large amounts of energy and natural resources, the

35 construction industry exerts significant impacts on the climate and environment. Consuming

36 various forms of energy plays a key role in greenhouse gas (GHG) emissions, which are also

37 the leading cause of global warming and climate change (Karunathilake et al., 2017). In line

38 with this, because the construction industry consumes more than 40% of the total global

39 energy, it also accounts for more than 40% of the total global GHG emissions (International

40 Energy Agency (IEA), 2013a, b). Besides, the construction industry has been tagged as a

41 "resource-intensive industry" (Shi et al., 2017, p. 615) responsible for consuming 40% of the

42 raw materials (stone, sand, and gravel), 16% of the water, and 25% of the timber in the world

43 annually (Arena and De Rosa, 2003). With regard to impact on human health, construction

44 activities produce considerable quantities of dust, noise, solid waste, smoke, and wastewater

45 (Shen et al., 2017a). In the current situation, it has been predicted that, unless cost-effective

46 technologies and best practices – in addition to radical lifestyle and behavioral changes – are

47 promoted and accepted worldwide, the global energy demand of the construction industry

48 and the associated emissions of GHGs will be more than double by 2050 (IEA, 2014;

49 Berardi, 2017).

50   As such, green building has been well received by many governments and promoted as a

51 strategy for reducing the negative effects of the construction industry on the environment

52 (Shen et al., 2017b). Green building is the practice of developing buildings in a resource-

53 efficient and environmentally friendly manner (US Environmental Protection Agency

54 (USEPA), 2016). According to the World Green Building Council (WorldGBC) (2017), "a

55 green building is a building that, in its design, construction or operation, reduces or

56 eliminates negative impacts, and can create positive impacts, on our climate and natural

57 environment". Moreover, not only do green buildings preserve precious natural resources, but

58 they also improve human quality of life (WorldGBC, 2017). Green building technologies

59 (GBTs) have an essential role in the development of green buildings. They are those

60 technologies, such as passive solar technology, green roof technology, and energy-efficient

61 HVAC systems, employed in building design and construction to improve overall

62 sustainability performance (Zhang et al., 2011a; Ahmad et al., 2016). Many researchers and

63 organizations have shown that GBTs adoption could significantly help the construction

64 industry achieve sustainable development. It was reported by the United Nations

65 Environment Programme (UNEP) (2009) that with the adoption of GBTs, a 30-80%

66 reduction in building energy consumption is realizable. The study by Roufechaei et al. (2014)

67 found that the use of GBTs had a strong positive correlation with the three dimensions of

68 sustainable development (environmental, economic, and social). Explicitly, the GBTs

69 adoption was helpful in achieving the goals of sustainable development, such as conserving

70 energy and non-renewable resources, reducing ecological footprint, and minimizing lifecycle

71 costs. At a company level, it is useful to adopt GBTs as that increases competitiveness while

3

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

73   et al., 2012).

74   With the global awareness of the multiple sustainability benefits brought about by GBTs

75   adoption, how to promote the successful and widespread adoption of GBTs has been a

76   priority issue in the construction industry recently. As a result, research on strategies to

77   promote GBTs and practices adoption is already underway (Darko et al., 2017a; Hwang et al.,

78   2017a; Chan et al., 2017). Despite the importance of such kind of studies to the industry and

79   academia, they are scarce in developing countries. This paper is part of a large-scope research

80   project aimed at promoting GBTs adoption within the developing country of Ghana. Whereas

81   the relevant driving forces and barriers of the GBTs adoption are reported elsewhere (Darko

82   et al., 2017b; Chan et al., 2018), the objective of this paper is to identify the important

83   strategies to promote the GBTs adoption. Thus, this paper primarily addresses the following

84   research question: what are the important strategies to promote GBTs adoption in Ghana?

85   The first contribution of this paper is helping fill a gap in the green building body of

86   knowledge, particularly for developing countries. Additionally, the findings of this paper help

87   in better understanding the key strategies to promote GBTs adoption, which could guide

88   policy makers, industry stakeholders, and advocates in formulating and implementing proper

89   strategies for GBTs adoption promotion. Ultimately, this paper would benefit the sustainable

90   development of the construction industry in general. The rest of this paper is structured as

91   follows: section 2 reviews the relevant literature; section 3 describes the research

92   methodology; section 4 presents and discusses the results; and the conclusions, limitations of

93   this study, and future research directions are presented in section 5.

94   **2. Literature review**

95   This study adopts Mintzberg's (1987, p. 11) definition of strategy: "strategy is a plan,

96   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

122   development (R&D). In Hong Kong, Wong et al. (2016) studied a set of factors for

123   facilitating green procurement adoption in building projects. They identified the top three

124   factors from 35 factors: government's mandatory environmental regulations, requirements of

125   clients in tendering, and government's and NGOs' requirements. Moreover, they identified

126   10 underlying grouped facilitators. At least, they found government regulations and

127   standards, green technology and lifecycle considerations, and commitment from executive

128   management to be the most important facilitator groups. Darko et al. (2017a) discovered that

129   providing relevant incentives, making better information regarding the GBTs costs and

130   benefits available, and green labeling and rating were the most important promotion

131   strategies of GBTs adoption in the US. From a global perspective, Chan et al. (2017)

132   identified the important promotion strategies for GBTs adoption. Qian and Chan (2010)

133   carried out a comparative analysis of the building energy efficiency promotion measures

134   existing in the UK, US, Canada, and China, and developed a conceptual model on the

135   measures. Several promotion measures were present in their model, examples of which were

136   funding from government for building energy efficiency technologies R&D, financial and

137   nonfinancial incentives, granting low-cost loans for building energy efficiency

138   implementation, product labeling and rating, and better enforcement of existing standards. In

139   Utrecht of the Netherlands and Valencia of Spain, Van Doren et al. (2016) identified the local

140   strategies to accelerate the scaling up of energy conservation initiatives. They identified

141   strategies such as developing and enforcing regulatory structures, developing private and

142   public funding mechanisms, communicating the financial and co-benefits of energy

143   conservation initiatives, establishing offline and online information points for energy

144   conservation initiatives, and educating and training stakeholders on energy conservation

145   initiatives. Elsewhere, Potbhare et al. (2009) designed an implementation strategy to promote

146   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

222 collect responses from contractor, consultant, and developer companies. Finally, 43 sets of

223 questionnaires with valid responses were returned, corresponding to a 44.8% response rate.

224 Although the sample size was relatively small, statistical analyses could still be carried out

225 because according to the commonly accepted rule, with a sample size of 30 or above, the

226 central limit theorem holds true (Ott and Longnecker, 2010; Hwang et al., 2015).

227 Additionally, as GBTs have not been widely adopted in the Ghanaian construction market,

228 the number of experienced professionals is limited. Moreover, the sample size compares

229 favorably with those of many previous green building-related studies. For example, the

230 surveys by Shen et al. (2017a) and Hwang et al. (2017a) were based on 39 and 40

231 respondents, respectively. Hence, the sample size of this study is considered reasonable and

232 representative.

233 For full details of the respondents' profiles, the reader is referred to Darko et al. (2017b).

234 The profiles of the respondents revealed that 16 (37%) of the respondents were from

235 consultant companies, 14 (33%) were from contractor companies, and 13 (30%) were from

236 developer companies. With the respondents' professional backgrounds, those who identified

237 themselves as engineers (13, 30%) formed the majority and the rest had other professional

238 backgrounds, such as project managers, architects, and quantity surveyors. Furthermore, the

239 majority of the respondents (37, 86%) had more than 5 years' working experience in the

240 construction industry, whereas only 6 (14%) had 1-5 years' working experience. Also, all of

241 the respondents had experience in green building, with 24 (56%) having 1-3 years'

242 experience, 11 (25%) having 4-6 years' experience, and 8 (19%) having more than 6 years'

243 experience. Given the few green building projects launched in Ghana in recent years, this

244 result could be deemed reasonable. In light of the experience of the respondents in the

245 construction industry and green building, their views were representative for this study to

246 guarantee the reliability of the findings.

247   Before analyzing the data collected, Cronbach's alpha coefficient was used to evaluate

248   the reliability of the five-point rating scale used in capturing the survey responses.

249   Cronbach's alpha evaluates the reliability of a rating scale through examining the average

250   correlation or internal consistency between the variables that were assessed using the scale

251   (Santos, 1999). The value of Cronbach's alpha coefficient ranges from 0 to 1, where the

252   higher the value, the more reliable would be the adopted rating scale. Nevertheless, the

253   standard rule is that the scale could be said to be reliable if the Cronbach's alpha coefficient

254   value is higher than or equal to 0.70 (Nunnally, 1978). Therefore, in this study, the

255   Cronbach's alpha coefficient value of 0.813 indicated that the assessment using the five-point

256   scale and hence the data collected were reliable for further analyses in later sections.

257   *3.3. Data analysis methods*

258   In order to achieve the research objective, the survey respondents were requested to state

259   the importance of the various strategies to promote GBTs adoption using a five-point rating

260   scale, as described in the preceding section. With the aid of the SPSS 20.0 statistical package,

261   the data collected from the survey were analyzed using various statistical analysis methods,

262   which are described in this section.

263   *3.3.1. Data normality test*

264   As many statistical tests require a normal distribution of the data (Kim, 2015), the

265   Shapiro-Wilk test, which is a widely used method for testing data normality (Hsu et al., 2000;

266   Ferretti et al., 2017), was first used to test the data normality. The null hypothesis of the

267   Shapiro-Wilk test is that 'the data were normally distributed'. The common alpha value for

268   testing normality (i.e., 0.05) was used in conducting the Shapiro-Wilk test. If the *p*-value

269   produced by the test is lower than the selected alpha value, then the null hypothesis should be

270   rejected, and conclusion that the data are not normally distributed can be drawn. In this study,

271   all the *p*-values produced by the Shapiro-Wilk test were 0.00 (Table 2), indicating that the

11

272 data collected are not normally distributed. This is an expected result since data collected

273 from samples that are not very large are usually not normally distributed (Field, 2013; Shan et

274 al., 2017; Hwang et al., 2017b). The non-normal distribution of the data influenced the

275 selection of statistical tests for analyzing the data.

276 *3.3.2. Descriptive statistics*

277   The most commonly used descriptive statistics of mean and standard deviation (SD) were

278 used to rank the strategies to promote GBTs adoption in descending order of importance, as

279 perceived by the respondents. Following Mao et al.'s (2015) approach, where two or more

280 strategies had the same mean score, the strategy with the smallest SD was given the highest

281 rank. A smaller SD suggests that the differences in responses were not statistically large and

282 thus the average is more likely to be valid for the majority (Staplehurst and Ragsdell, 2010).

283 *3.3.3. Inter-group comparison*

284   Because the respondents were from different companies (i.e., consultant, contractor, and

285 developer companies), it was important to check whether there were any significant

286 differences between them, through conducting an inter-group comparison (Shan et al., 2017).

287 To conduct the inter-group comparison, two dissimilar statistical techniques were considered:

288 analysis of variance (ANOVA) and Kruskal-Wallis H test. ANOVA is a commonly applied

289 parametric test for checking differences between mean scores from three or more groups; it

290 has an assumption that the population from which the sample was drawn is normally

291 distributed (Pallant, 2013). As the non-parametric alternative to ANOVA, the Kruskal-Wallis

292 H test, on the contrary, does not have any stringent requirements; it does not also make any

293 assumption about the underlying distribution of the population (Pallant, 2013; Field, 2013).

294 Therefore, owing to the non-normal distribution of the data, the Kruskal-Wallis H test was

295 chosen over ANOVA for the inter-group comparison in this study. In addition to the inter-

296 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).

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.

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

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

322 study.

4. Results and discussion

324 Table 2 shows the results of the descriptive analysis as well as the results of other relevant

325 statistical tests. The mean scores of the importance of the strategies range from 3.95 to 4.67.

326 It is noteworthy that the mean scores of all the strategies were much higher than 3.00, which

327 is the middle value of the rating scale, implying that all the strategies had significant

328 importance. This could be attributed to the vision of Ghanaian professionals and stakeholders

329 to "transform the built environment in Ghana towards sustainability" (Ghana Green Building

330 Council (GHGBC), 2010). Because of this vision, strategies to promote GBTs adoption have

331 become a necessity rather than an option for Ghana. Although all the strategies were

332 important, ranking them would enable policy makers, stakeholders, and advocates to

333 understand which strategies are worth focusing more attention on, thus prioritizing the

334 strategies for GBTs adoption promotion activities. From the mean analysis results, the top

335 five strategies (mean ≥ 4.58) were "more publicity through media (e.g., print media, radio,

336 television, and internet)" (ST07), "GBTs-related educational and training programs for

337 developers, contractors, and policy makers" (ST08), "availability of institutional framework

338 for effective GBTs implementation" (ST11), "a strengthened GBTs R&D" (ST12), and

339 "financial and further market-based incentives for GBTs adoption" (ST01). The results

340 indicate that these strategies were considered the most important strategies to promote GBTs

341 adoption and therefore should draw the policy makers', stakeholders', and advocates'

342 attention. These five strategies are discussed below, along with the strategy "mandatory green

343 building policies and regulations" (ST02) as the relatively low rank of this strategy (rank 12)

344 seems surprising.

345 **<Insert Tables 2 and 3 around here>**

14

346   "More publicity through media (e.g., print media, radio, television, and internet)" (ST07)

347   was ranked first with the highest mean score (mean = 4.67). Moreover, the Wilcoxon's

348   signed rank test results in Table 4 indicate that ST07 is the only strategy ranked among the

349   top five strategies, whose assessment was statistically higher than the assessments for as

350   many as eight of the other strategies not ranked among the top five strategies: ST09, ST06,

351   ST14, ST04, ST02, ST03, ST13, and ST15. For the other four strategies ranked among the

352   top five strategies, their assessments were statistically higher than the assessments for only a

353   few of the other strategies not ranked among the top five strategies. For example, the

354   assessment for ST08 was statistically higher than those of only four of the other strategies:

355   ST02, ST03, ST13, and ST15. These results represent that ST07 was considered the most

356   important strategy. The importance of this strategy was also supported by Chan et al. (2017)

357   and Potbhare et al. (2009), where more publicity through media was an important promotion

358   strategy for GBTs and green building guidelines adoptions. Publicity, also called public

359   relations, is a promotion strategy that can help create a positive image for a product,

360   encourage people to engage in the use of the product, convey the benefits of the product,

361   enhance awareness, and increase demand for the product (Belch and Belch, 2007). Thus,

362   more publicity through media is of great importance to the promotion of GBTs adoption. The

363   research finding could essentially provide concrete evidence that advertising or marketing

364   GBTs in the media – through various media channels: print (newspapers and magazines),

365   radio, television, billboards, internet, etc. – can significantly help advance GBTs adoption in

366   Ghana. Publicity through media could be an easy and effective way of promoting GBTs in

367   the public domain. For instance, publicity through the electronic media of the internet and

368   television takes advantage of innovative technologies to easily reach and communicate with

369   the public (Thackeray et al., 2007) about GBTs. Such communication should introduce GBTs

370   and educate the public about the GBTs benefits and the need to adopt GBTs. In addition, to

371 promote GBTs adoption, the government could sponsor media campaigns that draw attention

372 and exposure to GBTs.

373   **<Insert Table 4 around here>**

374   The strategy "GBTs-related educational and training programs for developers,

375 contractors, and policy makers" (ST08) was ranked second (mean = 4.65). The role the

376 provision of GBTs-related educational and training programs for developers, contractors, and

377 policy makers plays in promoting GBTs adoption cannot be underrated. Potbhare et al.

378 (2009) also identified that educational programs for developers, contractors, and policy

379 makers was one of the top five most important strategies to catalyze the green building

380 guidelines adoption in the developing country of India. Educating and training developers,

381 contractors, and policy makers about GBTs is of high importance in shaping and driving the

382 GBTs adoption in the industry because they are key stakeholders in the adoption and

383 promotion processes. Developers, for example, have significant and decisive roles in GBTs

384 and practices adoption. According to Mao et al. (2015), developers are not only the key

385 decision makers in the adoption of GBTs, but their usage of GBTs also influence the R&D

386 done by scholars, contractors' construction approach, and the investments of manufacturers.

387 Similarly, Hu et al. (2015) and Hu et al. (2017) agree that within the industry, developers are

388 key decision makers in the adoption of green practices because they are the investors. In light

389 of these reasons, developing and implementing effective GBTs-related education and training

390 programs for increasing developers' knowledge and awareness of and expertise in GBTs

391 would certainly have a substantial impact on promoting GBTs adoption. Likewise, as

392 developers have a great capacity to influence firms and individual practitioners within the

393 construction industry in a manner which fosters innovation (Blayse and Manley, 2004),

394 providing them with GBTs-related education and training would not only help their own

395 GBTs adoption, but it would also help them influence or guide other industry participants to

396 accept and embrace GBTs. In that way, GBTs adoption would gradually become an industry-

397 wide accepted practice. The Ghana Real Estate Developers Association (GREDA) is one of

398 the largest and most active construction industry associations in Ghana that makes

399 recommendations to the government about ways to promote real estate development

400 (GREDA, 2014). It is also active in seeking solutions to the problems, including

401 sustainability problems, in the Ghanaian property market (GREDA, 2014). These may

402 perhaps explain why "GBTs-related educational and training programs for developers,

403 contractors, and policy makers" was ranked as the second important strategy to promote the

404 GBTs adoption. Although the above discussion focuses more on developers for simplicity,

405 the research result implies that to widely promote the use of GBTs, the GBTs education and

406 training should go beyond only developers' education; it should include other relevant

407 stakeholders, such as policy makers and contractors.

408   The strategy "availability of institutional framework for effective GBTs implementation"

409 (ST11) occupied the third position (mean = 4.60). This result indicates that to promote the

410 successful and effective implementation of GBTs, an institutional framework that explicitly

411 outlines the roles and responsibilities of all stakeholders is needed, which is consistent with

412 the findings of previous studies (Potbhare et al., 2009; Chan et al., 2017). According to the

413 Global Water Partnership (GWP) (2008), frameworks are an essential prerequisite for

414 implementing sustainable practices because they form the basis for successful

415 implementation. Frameworks have two major components: legal framework and institutional

416 framework. While the legal framework is determined by national, provincial and local

417 policies and regulations, which constitutes the "rules of the game", the institutional

418 framework comprises the institutions and organizations with forums and mechanisms,

419 information and capacity building, founded to establish the "rules of the game" and to

420 facilitate stakeholder involvement (GWP, 2008). Thus, an institutional framework can simply

17

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

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

446 several 'high-tech' solutions, such an action would be unwise in the long run, as many local

447 professionals cannot operate or maintain them successfully. These show that GBTs adoption

448 depends on a better understanding of the GBTs that are available and could be applied

449 locally. It has been identified that GBTs R&D is crucial to promote GBTs adoption in Ghana.

450 The R&D efforts could focus on studying the locally available GBTs, their application and

451 applicability, and their (system) performance. Furthermore, the GBTs R&D should conduct

452 proper analyses to highlight the lifecycle costs and environmental, economic, and social

453 benefits of the GBTs. The study result suggests that to promote GBTs adoption, government

454 supports for GBTs R&D are needed. The government could establish green technology

455 research institutes and centers and/or support academic institutions, such as universities, to

456 undertake GBTs R&D. In addition to the book and research allowance that the Ghanaian

457 government currently provide for universities, the government has a plan to create a research

458 fund to enable the universities to undertake "special research projects and innovation" (Daily

459 Guide, 2017). It would be beneficial if the government and the universities treat GBTs R&D

460 as a vital component of all of these research funding initiatives. Many developed countries

461 have made good progress in GBTs R&D (Li et al., 2014). So, in the process of attempting to

462 strengthen GBTs R&D, it would be useful for Ghana to communicate with developed

463 countries and learn from their experiences. In the end, to stimulate interest and demand for

464 the GBTs, all GBTs R&D outcomes should be communicated through means like

465 development tours, the media, academic and industrial publications, seminars, and workshops

466 to educate the industrial practitioners and the general public. It could be inferred from the

467 above discussions that strategies ST07, ST08, and ST12 are closely connected. For instance,

468 implementing strategy ST12 could provide valuable information and evidence for use in

469 implementing strategies ST07 and ST08. This could further explain why all of these

470 strategies were considered top strategies in this study.

471   The strategy "financial and further market-based incentives for GBTs adoption" (ST01)

472   received the fifth position (mean = 4.58). Incentive schemes are a very important strategy to

473   promote GBTs adoption. This result is in line with Qian et al. (2016), Olubunmi et al. (2016),

474   and Shazmin et al. (2017), who have pointed out that the practice of providing financial and

475   nonfinancial incentives is important to promoting GBTs and practices adoption within the

476   construction market. Financial incentives, for instance, do not only increase the motivation of

477   construction stakeholders to adopt GBTs, but they also help build a solid financial foundation

478   for adopting GBTs. In a way, incentive schemes compel people to adopt GBTs, as they are

479   normally awarded only when certain green requirements have been fulfilled. Owing to their

480   importance, incentive schemes have been adopted by many developed countries as a strategy

481   for promoting GBTs and practices adoption. For example, Singapore has launched numerous

482   incentive and funding schemes, e.g., Grant for Energy Efficient Technologies (GREET), for

483   accelerating energy-efficient technologies adoption (Green Future Solutions, 2015). The US

484   has also introduced a lot of incentive schemes for motivating GBTs adoption (Gou et al.,

485   2013; Mulligan et al., 2014). The tax incentive scheme, whereby stakeholders who adopt

486   GBTs are offered tax discounts or fully exempted from the payment of tax, is one of the most

487   popular green building incentives in the US (Gou et al., 2013). The gross floor area

488   concession scheme has also been popular in Hong Kong and Singapore for encouraging

489   GBTs adoption (Qian et al., 2016). This is a nonfinancial/regulatory incentive scheme

490   whereby stakeholders who meet certain green requirements are granted an additional floor

491   area by the government. The finding of this study infers that Ghanaian practitioners would

492   like to see the government's intervention in the construction market in the form of incentive

493   schemes to help them increase the pace of GBTs adoption. In order to do this efficiently and

494   effectively, the government could learn from the developed countries' experiences of

495   implementing green building incentives.

496   Perhaps, the most surprising feature of the results is the relatively low rank of the strategy

497   "mandatory green building policies and regulations" (ST02) (rank 12). In fact, there is

498   growing evidence supporting that mandatory government policies and regulations are of the

499   utmost importance in promoting GBTs and practices adoption (Chan et al., 2009; Wong et al.,

500   2016; Shen et al., 2017a). To a large extent, this has been because government policies and

501   regulations create mandatory push for stakeholders to engage in GBTs adoption (Chan et al.,

502   2009). As such, it is surprising that the Ghanaian professionals did not perceive this strategy

503   as a highly important strategy to promote the GBTs adoption. It could be that the

504   professionals were more optimistic about strategies that could help stakeholders adopt GBTs

505   out of their own volition. Another possible reason could be because most government policies

506   relating to the construction market in Ghana have been ineffective (Appiah, 2007). In spite of

507   the relatively low rank of this strategy, the research results (Table 2) still suggest that

508   formulating effective policies and regulations aimed at mandating the adoption of GBTs in

509   construction projects would have a positive influence on promoting GBTs adoption in Ghana.

510   As Darko et al. (2017b) indicated, GBTs adoption in Ghana is still in its early stage. At

511   this early stage, government practically has the most critical and leading role in promoting

512   GBTs adoption (Hwang et al., 2017a); to formulate and implement appropriate strategies to

513   drive the industrial practitioners and the public to implement GBTs. This research presents

514   the important strategies to promote GBTs adoption. Because these strategies have been

515   identified from the perspective of experienced practitioners, who would themselves be

516   affected by the strategies when applied, in the Ghanaian construction market, the strategies

517   could serve as an effective checklist for the government, stakeholders, and advocates and

518   when used appropriately, would surely contribute to the success of promoting GBTs adoption

519   in Ghana. As can be found from the discussions above, the identified strategies are not only

520   typical for Ghana, but have also been relevant for many developed countries, such as the US,

521 Singapore, and Hong Kong. In the implementation of these strategies, it is very important to

522 regularly monitor and assess their performance and influence on promoting the GBTs

523 adoption in the industry. That will help in making necessary amendments to the strategies to

524 optimize and maximize their effectiveness throughout the various stages of development of

525 the GBTs adoption. Thus, when the GBTs adoption becomes more mature, future studies

526 would be useful for refining the results of the present study, which could help the

527 government, stakeholders, and advocates revise their strategies accordingly, in order to

528 ensure the continuous promotion of GBTs adoption.

529 Moreover, although this study aims to provide a generic list of strategies to promote

530 GBTs adoption in Ghana, it is equally important to note that the importance of these

531 strategies could vary depending upon several factors, such as type and scale of projects (e.g.,

532 government- or private-funded projects), the sector under consideration (e.g., the residential

533 or commercial sectors), and firm characteristics (e.g., firm size – large or small firms). For

534 the promotion of GBTs adoption in private-funded projects, for example, the provision of

535 financial incentives might be regarded as more important than other promotion strategies for

536 at least two reasons. First, the GBTs adoption may require higher investment costs (Dwaikat

537 and Ali, 2016). Second, most private developers act as "rational economic men" who pursue

538 profit (Mao et al., 2015). To assess the effects of various contextual factors on the importance

539 of the strategies to promote GBTs adoption, future studies should focus on specific contexts

540 when analyzing the strategies.

541 As Table 2 shows, aside from the overall strategies ranking, this research also analyzed

542 the respondents' agreement regarding the rankings, as well as the differences in views

543 between the respondents from consultant, contractor, and developer companies. As

544 mentioned in section 3.3.4, Kendall's W test was used for the agreement analysis. The

545 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

571 different from the others (Pallant, 2013). In this respect, Table 3 shows that the consultant

572 group had the lowest overall rankings (ST01, mean rank = 15.94; and ST05, mean rank =

573 15.66) corresponding to the lowest scores on ST01 (mean = 4.25) and ST05 (mean = 4.13)

574 (Table 2). These results suggest that the consultant group is the main contributor to the

575 significant differences in the views of strategies ST01 and ST05, which could be attributed to

576 the relatively low mean scores from the consultant group.

577 *4.1 Comparison of results with the United States*

578   Darko et al.'s (2017a) study, from which most of the strategies used in this study were

579 adapted (Table 1), is a study that investigated the strategies to promote GBTs adoption in the

580 developed country of the US. Therefore, as this study focused on Ghana, comparing the

581 results with that of Darko et al. (2017a) would assist in understanding and highlighting the

582 differences between the strategies for a developing country and a developed country, which

583 might be of benefit to policy makers, stakeholders, and advocates worldwide. To this end,

584 this study compares the top five identified strategies for Ghana and the US. Such kind of

585 results comparison has gained scholarly attention in the construction management field. For

586 example, Chan et al., (2010) compared their results on the critical success factors for public-

587 private partnership projects in China with that of a previous study in the UK; while Bagaya

588 and Song (2016) compared their results on the causes of schedule delays in construction

589 projects in Burkina Faso with that of previous studies in other countries (e.g., Hong Kong).

590 The present study however is one of the first to compare the strategies to promote GBTs

591 adoption in a developing country (Ghana) and a developed country (the US). Future research

592 could expand and improve this comparison by including many other specific countries.

593 Moreover, in future studies wherein cross-country empirical data on the strategies would be

594 collected and used, the Spearman rank correlation test could be used to measure the

595 correlation between the ranks of the strategies between every two countries.

596   Table 5 shows the summary of the comparison of the top five most important strategies to

597   promote GBTs adoption between Ghana and the US. As shown in Table 5, strategies that

598   were ranked among the top five strategies for both Ghana and the US are marked with this

599   symbol: √; whereas those that were not ranked among the top five strategies for the US are

600   marked with this symbol: –. Table 5 also shows the individual ranks (in bracket) of the

601   strategies across the two countries. It is interesting to find that the top three strategies for

602   Ghana – "more publicity through media (e.g., print media, radio, television, and internet)",

603   "GBTs-related educational and training programs for developers, contractors, and policy

604   makers", and "availability of institutional framework for effective GBTs implementation" –

605   did not appear in the top five strategies for the US; they were ranked ninth, sixth, and tenth in

606   the US, respectively. In addition, it is worth noting that "a strengthened GBTs R&D" and

607   "financial and further market-based incentives for GBTs adoption" were the only two

608   strategies that appeared in the top five strategies for both Ghana and the US. In this respect, it

609   could be seen that while the rank of the strategy "a strengthened GBTs R&D" for Ghana

610   (rank 4) is very close to the US rank (rank 5), the rank of the strategy "financial and further

611   market-based incentives for GBTs adoption" for Ghana (rank 5) appears to be slightly

612   different from the US rank (rank 1). This finding reveals that while the provision of relevant

613   incentives is considered the most important strategy to promote GBTs adoption in the US, in

614   the Ghanaian context, it is only considered one of the most important strategies. This

615   outcome may be because in the current economic conditions in developing countries, it is not

616   very likely that governments would provide financial incentives for green building adoption

617   (Nguyen et al., 2017).

618   **<Insert Table 5 around here>**

619   The results comparison between Ghana and the US has revealed that among the top five

620   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

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646   structure of strategies specific to the promotion of GBTs adoption. Therefore, supplementing

647   the analysis carried out in this paper to identify the important strategies to promote GBTs

648   adoption, this paper also briefly applied EFA to uncover the underlying structure of the

649   strategies. This could benefit scholars interested in analyzing and modeling the GBTs

650   adoption process.

651   Since all the 15 strategies (variables) had significant importance (Table 2), none of them

652   was excluded from the EFA; however, further analysis will determine whether some

653   strategies ought to be excluded. Prior to the EFA application, two tests were performed to

654   evaluate the appropriateness of factor analysis for the factor extraction, which are the Kaiser-

655   Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity. The

656   KMO value (0.612) was above the acceptable threshold of 0.5 (Kaiser, 1974), indicating that

657   the sample is adequate for factor analysis. The significance level of chi-square in Bartlett's

658   sphericity test was 0.000, suggesting that the population correlation matrix is not an identity

659   matrix (Pallant, 2013). The results of these two tests indicate that factor analysis is

660   appropriate for the factor extraction. To further verify the appropriateness of using factor

661   analysis, the communalities of the variables were examined. MacCallum et al. (1999)

662   indicated that sample size becomes increasingly important only when communalities are low.

663   In line with this, Field (2013, p. 684) argued that "with all communalities above 0.60,

664   relatively small samples (less than 100) could be deemed perfectly adequate." Table 6

665   indicates that all communalities were above 0.60, suggesting that the sample is acceptable for

666   factor analysis (Field, 2013). Furthermore, despite criticisms of factor analysis with small

667   samples, Lingard and Rowlinson (2006) identified that the majority (70%) of the factor

668   analysis-based studies in the construction management domain still used samples below 100,

669   with some using samples ranging from 20 to 42 (Dainty et al., 2003; Ng, 2004; Ramírez et

670   al., 2004). Hence, it is considered appropriate to use factor analysis to process the data

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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**

696   GBTs adoption has recently received increased global attention because of its numerous

697   sustainability benefits. However, GBTs adoption has been slower in developing countries

698   such as Ghana than in developed countries. This requires strategies that can assist in

699   promoting and accelerating the adoption of GBTs in developing countries. As such, this

700   paper attempted to identify the important strategies to promote GBTs adoption within Ghana.

701   A literature review and interviews with industry professionals were conducted to identify 15

702   potential strategies that were presented in a questionnaire. After that, an empirical

703   questionnaire survey was carried out with 43 professionals with green building experience to

704   examine the relative importance of the strategies. This study is novel in three ways. First, to

705   the authors' knowledge, this study is one of the first in developing countries and the first in

706   Ghana to investigate the important strategies to promote GBTs adoption. Second, this study is

707   one of the first to compare the strategies to promote GBTs adoption between a developing

708   country and a developed country. Finally, this study is also the first to establish the

709   underlying factor structure of the strategies to promote GBTs adoption.

710   The results of this study first showed that "more publicity through media (e.g., print

711   media, radio, television, and internet)", "GBTs-related educational and training programs for

712   developers, contractors, and policy makers", "availability of institutional framework for

713   effective GBTs implementation", "a strengthened GBTs R&D", and "financial and further

714   market-based incentives for GBTs adoption" were the top five strategies to promote the

715   GBTs adoption. In addition, the importance of all the strategies were statistically significant,

716   and generally the differences in the perceptions of the importance of the strategies were

717   statistically insignificant. Furthermore, the comparison of the top five strategies between

718   Ghana and the US revealed that the most important strategies to promote GBTs adoption in

719   Ghana mostly differ from those in the US. However, the findings suggested that irrespective

720   of geographical locations, "a strengthened GBTs R&D" and "financial and further market-

721 based incentives for GBTs adoption" are two strategies that could greatly help in promoting

722 GBTs adoption. The implication of this finding is that these strategies need more attention in

723 order to promote GBTs adoption internationally. Further investigation with factor analysis

724 showed that the underlying strategy groupings were government regulations and standards;

725 incentives and R&D support; awareness and publicity programs; education and information

726 dissemination; and awards and recognition. This study contributes to the body of knowledge

727 relating to green building by analyzing the important strategies to promote GBTs adoption in

728 the construction market within the context of a developing country. Moreover, the findings of

729 this study could improve the understanding of policy makers, industry stakeholders, and

730 advocates on the key strategies to promote GBTs adoption and guide them in designing and

731 implementing appropriate strategies for GBTs adoption promotion.

732   Despite the achievement of the objective, this study was not conducted without

733 limitations. The first limitation is that the importance assessment made in this study could be

734 influenced by the respondents' experiences and attitudes, as it was subjective. Besides, since

735 the sample size was not very large, one must be cautious when interpreting and generalizing

736 the results. This study analyzed only the views of consultants, contractors, and developers on

737 the strategies, thus future research could increase the sample size by including the views of

738 the policy makers or government agencies. Moreover, as the first attempt to present the

739 important strategies to promote GBTs adoption in Ghana, this paper only briefly explored the

740 underlying factor structure of the strategies. Based on that, this study provided valuable

741 directions for future research, including modeling the interrelationships between the

742 strategies, as well as their possible effects on the GBTs adoption process. Additionally, the

743 comparative analysis carried out in this study was limited to only Ghana and the US, hence

744 future research could include many other specific countries, and by so doing, the comparison

745 will be expanded and improved.

746 Because this study was carried out in the developing country of Ghana, the findings and

747 implications could also be beneficial to policy makers, industry stakeholders, and advocates

748 in other developing countries around the world. Nonetheless, data collected and analyzed

749 from different countries may produce different results.   Therefore, using the proposed

750 strategies and following this study's methodology, similar studies could be conducted in

751 different developing countries, and the results could be used in observing the market-specific

752 differences. Promoting GBTs adoption requires an informed approach in the form of an

753 implementation strategy (Potbhare et al., 2009). As such, lastly, the future research paper will

754 combine all the findings from the previously mentioned large-scope research study on the

755 promotion of GBTs adoption in Ghana to develop a green implementation strategy that will

756 help Ghanaian policy makers, practitioners, stakeholders, and advocates to promote GBTs

757 adoption.

758 **Acknowledgements**

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1002 **Tables**

1003

1004 **Table 1**

1005 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]

1006 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.

38

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.

1024 **Table 6**

1025 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

Highlights

- The important strategies to promote GBTs adoption in Ghana were identified.

- Comparison was made between the GBTs adoption promotion strategies for Ghana and the US.

- The underlying structure of the GBTs adoption promotion strategies was established.