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How Public Owners Communicate the Sustainability Requirements of Green Design-Build Projects

Bo XIA¹, Martin Skitmore², Peng WU³, Qing CHEN⁴

Abstract: The design-build (DB) system is regarded as an effective means of delivering sustainable buildings. Specifying clear sustainability requirements to potential contractors is of great importance to project success. This research investigates the current state-of-the-practice for the definition of sustainability requirements within the public sectors of the U.S. construction market using a robust content analysis of 49 DB requests for proposals (RFPs). The results reveal that owners predominantly communicate their desired level of sustainability through the LEED certification system. The sustainability requirement has become an important dimension for the best-value evaluation of DB contractors with specific importance weightings of up to 25%. Additionally, owners of larger projects and who provide less design information in their RFPs generally allocate significantly higher importance weightings to sustainability requirements. The primary knowledge contribution of this study to the construction industry is the reveal of current trend in DB procurement for green projects. The findings also provide owners, architects, engineers, and constructors with an effective means of communicating sustainability objectives in solicitation documents.

Key words: Contractor Selection; Design-Build; Request for Proposals; Sustainability Requirements; Sustainable Buildings.

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22 **Introduction**

23 As one of the integrated delivery systems, design-build (DB) has been demonstrated to have a
24 number of advantages such as single-point responsibility, time saving, early cost certainty
25 and increased constructability, and has gained in popularity around the world in past decades
26 (Songer and Molenaar 1997; Konchar and Sanvido 1998; Hale et al. 2009; Shrestha et al.,
27 2012). Recent studies indicate that DB provides an effective means of delivering high
28 performance sustainable construction projects (e.g. Dahl et al., 2005; Ugwu and Haupt 2007;
29 Molenaar et al. 2010; Korkmaz et al. 2010a, 2010b). With single point responsibility, higher
30 levels of team integration and efficient communication in the DB process, DB contractors are
31 in a better position to address owner sustainability requirements with innovative project
32 solutions. Additionally, as DB contractors are normally selected on the basis of best-value
33 rather than lowest price, DB provides opportunities for contractors to pursue green objectives
34 in addition to those of time, cost and quality (Schaufelberger and Cloud, 2009; Molenaar et
35 al. 2010). As a result, it is found that 75 percent of current new construction projects seeking
36 sustainability certification in the U.S. are delivered by integrated project delivery methods,
37 including DB (Molenaar et al. 2009).

38 In order to obtain high-performance sustainable construction projects, owners need to
39 define sustainability requirements clearly in the early project stages (Bunz et al., 2006;
40 Schaufelberger and Cloud, 2009; Yates, 2014). In particular, as the success of projects
41 depends largely on the selection of appropriate contractors, as they take full responsibility for
42 coordination and project control (Xia et al. 2009; Xia and Chan 2012), owners should
43 communicate their sustainability requirements to potential contractors and include these
44 requirements in the contractor selection process. The inclusion of sustainability-related
45 clauses in the early project stages is an important driver toward achieving a sustainable
46 construction environment (Ugwu and Haupt 2007; Enache-Pommer and Horman, 2009).

47 However, to many DB owners, defining sustainability requirements, which is not generally
48 accounted for in traditional building projects, is a difficult task, as the majority of project
49 management plans in DB projects do not include sustainable objectives - overlooking an
50 opportunity to evaluate sustainable solutions from DB contractors (Molenaar et al. 2010).

51 In order to help owners better define sustainability requirements for DB contractor
52 selection, a content analysis was conducted of DB requests for proposals (RFPs) collected
53 from the U.S. public sector. As the primary solicitation instrument in DB, the RFP is a
54 document in which an owner develops his/her requirements and conveys the project scope to
55 DB contractors (Harris and McCaffer 1995; Molenaar et al. 2000; Migliaccio et al. 2009).
56 Owners need to ensure that the required information is sufficiently incorporated into their
57 RFPs, as it is their last opportunity to define project scope and requirements before the
58 selection of contractors (Puerto et al. 2008). Based on the requirements outlined in the RFPs,
59 interested contractors develop DB proposals accordingly. Therefore, a comprehensive
60 analysis of DB RFPs will not only provide a review of current practice in the DB industry but
61 also the practical implications involved in the delivery of sustainable construction projects.

62

63 **Research Methods**

64

65 Similar to Xia et al. (2012a, 2012b, 2013), a content analysis of DB RFPs was employed to
66 understand how U.S. public sector owners define their sustainability requirements for green
67 buildings. Content analysis is an observational research methodology for studying the content
68 of communications and compressing many words of text into fewer content categories
69 (Stemler 2001). As a data reduction technique, it can help reveal emerging themes contained
70 in unstructured data.

71 A total of 49 DB RFPs for sustainable construction projects were collected online mainly
72 from local (County, Town, City, State) governments, public schools, colleges and universities,

73 U.S Army Corps of Engineers, Naval Facilities Engineering Command and Highway
74 Administrations (U.S. and State and Federal). These RFPs were posted publicly from 19
75 States between 2000 and 2013 with an aggregate contract value of over \$2 billion. As shown
76 in Table 1, the majority of these RFPs are for institutional and commercial buildings.

77
78 **Please insert Table <1> here**
79

80 For each proposal, the following information was recorded for further analysis:

- 81 1. project size (small, large)
- 82 2. project location
- 83 3. time of release
- 84 4. statements of sustainability requirements
- 85 5. LEED certification level (if any)
- 86 6. importance weighting of sustainability requirements and price proposal
- 87 7. contractor selection method (lowest price, best value, qualification based)
- 88 8. owner-provided design proportion (e.g. 0-10% conceptual planning, 10-30%
89 schematic design, 30-50% design development)
- 90 9. contract types (lump sum, GMP, others).

91
92 Once the data for these variables were collected, qualitative analysis was conducted to
93 investigate how DB owners define and communicate their sustainability requirements to
94 contractors, and quantitative analysis used to explore the relationships between different
95 variables.

96
97
98 **Data Analysis**

99 ***Sustainability Certification Levels***

100 Of all the RFPs, 92% used LEED™ rating systems with the desired level of LEED categories
101 to convey the sustainability requirements of the projects. The remaining RFPs (8%)
102 mentioned the LEED rating system as a sustainability benchmark but did not require
103 LEED™ certification.

104 **Please insert Fig <1> here**

105 As shown in Fig 1, owners used “LEED Certified or Equivalent”, “Minimum LEED
106 Certified”, “LEED Silver”, “Minimum LEED Silver”, “LEED Gold”, and “LEED Platinum”
107 categories to convey their sustainability requirements. The “Minimum Silver” (39%) is the
108 most frequently required, and more than 60% of the projects target silver or higher levels.
109 This is mainly due to the fact that, in recent years, a number of U.S. governments (e.g. US
110 General Services Administration, California government, etc.) have encouraged or mediated
111 LEEDs Silver or higher for public projects. The only LEED-Platinum required building (the
112 highest level of sustainability certification) is a residence hall for university students. To be
113 considered as qualified, all interested contractors need to demonstrate their design and
114 construction/construction management experience with LEED certified projects, with
115 preference given to experience with LEED Gold (or better) projects by team members.

116

117

118 ***Sustainability Requirements for Contractor Evaluation***

119 In DB RFPs, owners need to establish the selection criteria and their importance weightings
120 for the evaluation of qualified contractors. According to Xia et al. (2013), the most frequently
121 used selection criteria for contractors in the U.S. public sector are *price, experience, technical*
122 *approach, management approach, qualification, schedule, and past performance*, with *price*
123 being the most important criterion, accounting for 27% of the total weightings.

124

125 Of the 49 RFPs examined, 27% (13 RFPs) include sustainability requirements as a separate,
126 additional evaluation criterion, and 41% include sustainability requirements as a sub-factor in
127 other well-established selection criteria (see Fig 2). For the remaining 33% of RFPs, the
128 sustainability requirement is incorporated into the project requirements/objectives/ scope.

129

130 **Please insert Fig <2> here**

131

132 As shown in Table 2, “Approach to sustainability requirements” is the most frequently
133 used criterion for sustainability evaluation of DB contractors. Contractors are normally
134 required to submit a detailed narrative describing their approach to achieving the proposed
135 level of LEED™ certification. The narrative needs to be accompanied by a completed LEED
136 checklist identifying the specific LEED features that the contractor proposes to incorporate
137 into the design and construction of the project. Sometimes sustainability is required through a
138 lower life-cycle cost, reducing long-term maintenance and operational cost to achieve
139 sustainability goals, with the DB contractor’s LEED experience and capability playing a
140 lesser role.

141

142 **Please insert Table <2> here**

143

144 41% (20) of the RFPs include sustainability requirements as sub-factors of other
145 traditional selection criteria. As shown in Table 3, the most frequently mentioned of these
146 (70%) are related to technical approach, where DB contractors need to provide strategies,
147 approaches and measures to achieve sustainable performance of the project, normally defined
148 in design criteria and project performance specifications. Less frequently required is
149 information regarding the team’s certification, experience and past performance
150 implementing LEED methodologies in projects of similar size and scope.

151 **Please insert Table <3> here**

152 In the remaining 33% (16) of RFPs the sustainability requirements are not included as
153 evaluation criteria for contractor selection but instead are included in the overall project
154 requirements and objectives. Of these, 88% specify the level of LEED™ certification to be
155 achieved; 56% require contractors to implement sustainable design (and construction); and 31%
156 require contractors to incorporate sustainable facilities and features such as solar panels,
157 energy efficient systems and green roofs.

158 For the 67% of RFPs where sustainability requirements are included as an evaluation
159 factor or sub-factor, importance weightings were allocated to sustainability requirements.
160 These range from 1% to 25% of the contractor evaluation system, with an average
161 importance weighting of 6.7%. As shown in Fig 3, most of DB RFPs (84%) allocate less than
162 10% of importance weightings to sustainability requirements.

163 **Please insert Fig <3> here**

164 The average sustainability requirement weightings using sustainability as a separate
165 factor and sub-factor are 10.3% and 4.3% respectively. Using the conventional $p < 0.05$ as the
166 cut-off value (the likelihood of the difference occurring by chance alone being less 5 in 100),
167 these percentages are significantly different ($p < 0.001$) according to the Mann-Whitney
168 nonparametric U-test (Corder and Foreman, 2009).

169

170 ***Two-way Contingency Table Analysis***

171 A series of Chi-Square (χ^2) contingency table analyses were conducted with the numerical
172 values of the categorized data to investigate the relationship between the importance of
173 sustainability requirements and other coded variables. The chi-square test is widely used for
174 categorical data analysis as it determines the degree of statistical relationship existing

175 between two variables (McClave et al. 2010). However, it should be borne in mind that a
176 statistical association between variables does not infer a causal relationship.

177 Based on the importance weightings of *price* (using 27% as the threshold according to
178 Xia et al. 2013), the RFPs were divided into two groups, i.e. price focused (with the
179 weightings of price higher than 27%) and qualification focused. According to the results in
180 Table 4, the null hypothesis that price importance is independent of sustainability importance
181 is rejected ($p=0.033$). In other words, when the contractor evaluation is more price oriented,
182 the owners tend to accord less importance to sustainability requirements. As shown in Table
183 4, most of price-focused RFPs (87%) allocate less than 5% of importance weightings to
184 sustainability requirements while 42% of qualification-based RFPs allocate more than 5% to
185 sustainability requirements.

186 **Please insert Table <4> here**

187 As shown in Table 5, the relationship between project size (small or large) and
188 sustainability importance is statistically significant at $p=.003$, implying that sustainability
189 requirements tend to be more important for larger size projects. This may be due to a
190 tendency for larger projects to be more concerned with life cycle costs, and have a better
191 financial capacity than smaller projects to cover the green certification costs.

192 **Please insert Table <5> here**

193 With DB RFPs, owners normally carry out some design work (e.g. conceptual planning,
194 schematic design) prior to handing their project to contractors. Although the relationship
195 between design provision and sustainability importance is not statistically significant at the
196 $p>0.05$ level ($p=.062$, Table 6), owners who provide less design work in RFPs tend to accord
197 more importance to their sustainability requirements. In particular, as shown in Table 6, when

198 owners provide schematic design (around 30% of design proportion), the importance
199 weightings of sustainability requirements are no more than 5%.

200 **Please insert Table <6> here**

201 For contract type (lump sum or GMP), projects using GMP tend to have higher
202 importance weightings of sustainability requirements although not significantly so ($p=0.587$,
203 Table 7). Additionally, it should be pointed out that although only lump sum and GMP were
204 used in these 49 DB RFPs, they are not the only contract methods for DB projects. Other
205 methods such as cost plus fee are also used by DB owners. Nevertheless, lump sum and GMP
206 are the most frequently used ones for DB projects in the current industry. According to the
207 project database of Design-build Institute of American (DBIA, 2014), more than 85% of DB
208 projects adopted lump sum or GMP with only 4% (20 out of 462) using cost plus fee and 7.8%
209 (36 out of 462) using “other” ones.

210 **Please insert Table <7> here**

211 **Discussion**

212 The LEED level is the dominant means used by project owners to define their sustainability
213 objectives/requirements. The LEED rating system released by the United States Green
214 Building Council (USGBC) is the sustainability standard that provides owners with a
215 framework for identifying and implementing practical and measurable green building
216 solutions for planning, design, construction, operations and maintenance. The content
217 analysis demonstrates that owners prefer to use threshold statements such as “minimum
218 LEED Certified” and “minimum Silver” rather than specific LEED levels in order to provide
219 more opportunity for the DB contractors’ contribution.

220 The RFP selection criteria and importance weightings are known to be important
221 components in contractor evaluation (Xia et al., 2013) and the majority (67%) of the RFPs
222 analyzed here include sustainability requirements as a selection criterion or sub-criterion with
223 importance weightings of up to 25%. As is to be expected, the importance weightings for the
224 sustainability requirements as separate selection criteria (e.g. approach to the LEED
225 requirements) are significantly higher than those of sub-factors.

226 It is of interest to note that the highest weighting (25%) allocated to sustainability
227 requirements is for a university educational outreach building that aimed to be American's
228 Greenest College. Every new building in this university completed since 2006 earned a
229 LEED Gold certification from the U.S. Green Building Council. For this educational outreach
230 building, a total of 300 points (out of 1200) are available for the criterion of "Sustainability
231 and Energy Efficiency". All available points are awarded to the proposal with the most
232 supportable points in the LEED Rating System and lowest accumulative maintenance cost
233 with optional five-year extended warranty.

234 The chi-square tests indicate that owners generally allocate significantly higher
235 importance weightings for the sustainability requirements of larger DB projects. This is
236 understandable as larger DB construction projects normally involve a higher project cost,
237 longer project time span and higher environmental impact. These projects normally have
238 higher contractor competency requirements and best-value contractor selection incorporating
239 non-price criteria. Higher sustainability requirements help achieve greater durability, better
240 constructability and less maintenance and operation cost, leading to reduced life cycle cost
241 and environment impact. Additionally, due to the cost of the LEED certification, larger
242 projects with higher budgets are more likely to be able to afford the additional cost involved
243 as LEED-related costs per gross square foot (GSF) are significantly lower for larger projects
244 (U.S. General Services Administration, 2004)

245 Also of note is that, despite the impact of owner design provision and contract type on
246 the importance of sustainability requirements not being statistically significant, owners tend
247 to attribute more importance to sustainability requirements when they hand over projects to
248 DB contractors at an earlier stage. Owners carrying out less design work and adopting GMP
249 contracts at an early stage create more opportunities for contractors to develop innovative
250 solutions. According to Gransberg et al. (2010), DB projects using GMP contracts have a
251 higher chance of exceeding initial LEED levels and may improve project delivery success
252 rates. Sustainable buildings require a closer integration of innovative design, construction and
253 even post-construction in order to achieve a lower life cycle cost, and earlier handing over of
254 projects to DB contractors helps to facilitate this integration. In placing more importance on
255 sustainability requirements in the earlier project stage, owners not only emphasize the need
256 for sustainable solutions from contractors, but also provide contractors with more freedom to
257 do this.

258

259 **Conclusions**

260 DB is an effective delivery system for both traditional and sustainable construction projects.
261 With an increasing number of public owners using DB to deliver their green buildings, it is
262 important to understand how they define their sustainability requirements in RFPs. This paper
263 investigates the current state-of-practice for the definition of public sector sustainability
264 requirements in the U.S. construction market. The results of the content analysis indicate that
265 owners predominantly specify LEED certification levels (e.g. LEED Certified, Silver, Gold,
266 and Platinum) to do this. As an important dimension for the best-value evaluation of DB
267 contractors, sustainability requirements are usually used as selection factors/sub-factors with
268 specific importance weightings. Additionally, owners of larger and qualification-based
269 projects tend to allocate significantly higher importance weightings to sustainability

270 requirements. In addition, owners encourage more contractor-initiated sustainable solutions
271 by providing less design information in RFPs and hand over projects to contractors at an
272 earlier stage.

273 The major knowledge contribution of this study is the reveal of owners' current practice
274 of defining sustainability requirements in DB projects and their underlying philosophy
275 concerning sustainability development. Factors that may affect owners' determination of
276 sustainability importance have also been identified. The findings will provide owners,
277 architects, engineers and constructors with an effective means of communicating
278 sustainability incentives and objectives in solicitation documents. These findings also have a
279 number of practical implications for different project stakeholders. First, experienced DB
280 owners are recommended to incorporate their sustainability requirements (with specified
281 importance weightings) in the contractor selection criteria of technical (design) approach,
282 contractor's past performance, experience and qualifications. Second, for those with limited
283 experience in delivering sustainable projects, LEED certification levels and LEED checklists
284 can be used to serve as an effective means to convey sustainability requirements. Finally,
285 contractors need to acquire LEED experience and capability and would be best advised to
286 have internal LEED certified design professionals in order to identify sustainable design
287 solutions.

288 A limitation of the study is that the number of RFPs analyzed is comparatively small and
289 therefore the findings may not present a complete picture of current practice. In addition, it is
290 noted that subjectivity and possible bias cannot be avoided in content analysis, which was
291 particularly true in a few RFPs, where it was difficult to obtain precise importance weightings
292 of the sustainability requirements. Future research is needed to cover a larger number of
293 RFPs in order to obtain more generalizable findings, and validate the findings from this study
294 with hard data input from owners and industry practitioners in the U.S. DB market.

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367

Table 1. Summary of the Data Sample

Project type	Number of RFPs
Institutional buildings	28
Commercial buildings	12
Renovation projects	5
Residential buildings	4
Total	49

368

369

Table 2. Sustainability Requirements as a Separate Evaluation Criterion

Sustainability requirement criteria	Frequency	Percentage
Approach to sustainability (LEED) requirements (narrative and/or LEED checklist)	7	54%
Sustainability with lower life-cycle cost	4	31%
Evidence of LEED experience/capability	2	15%

370

371

Table 3. Sustainability as a sub-factor of evaluation criterion

No.	Sustainability requirements	Frequency	Percentage
1.	Sustainability as sub-factor of technical (design) approach	14	70%
2.	Sustainability as sub-factor of past performance, experience	8	40%
3.	Sustainability as sub-factor of qualification of contractors (key personnel, certifications)	5	25%

372

373

Table 4. Cross tabulation analysis of price importance and sustainability weightings

Price importance in contractor evaluation	Sustainability importance		Total
	No more than 5%	More than 5%	
Qualification focused	11 58%	8 42%	19 100%
Price focused	20 87%	3 13%	23 100%
Total	31 73.8%	11 26.2 %	42 100%

374 Note: $\chi^2 = 4.546$ ($p=.033$, d.f.=1). Of 49 RFPs, only 42 contain the information of price importance and
375 sustainability importance for statistical analysis.

376

377

Table 5. Cross tabulation analysis of project size and sustainability importance

Project size	Sustainability importance		Total
	No more than 5%	More than 5%	
Small (less than 33.5*million)	26 84%	5 16 %	31 100%
Large(33.5 million and over)	5 39%	8 61%	13 100%
Total	31 70%	13 30%	44 100%

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Note: $\chi^2 = 9.073$ (p=.003, d.f.=1), *33.5 million USD is the size standard for small construction business in the North American Industry Classification System (NAICS, 2007). Of 49 RFPs, only 44 contain information of project size and sustainability importance for statically analysis.

382

Table 6. Cross tabulation analysis of design provision by owners and sustainability importance

Design provision	Sustainability importance		Total
	No more than 5%	More than 5%	
Conceptual planning	24 65%	13 35%	37 100%
Schematic design	7 100%	0 0%	7 100%
Total	31 70%	13 30%	44 100%

383

Note: $\chi^2 = 3.491$ ($p=.062$, d.f.=1). Of 49 RFPs, only 44 contain the information of design proportions and sustainability importance for statistical analysis.

384

385

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Table 7. Cross tabulation analysis of contract type and sustainability importance

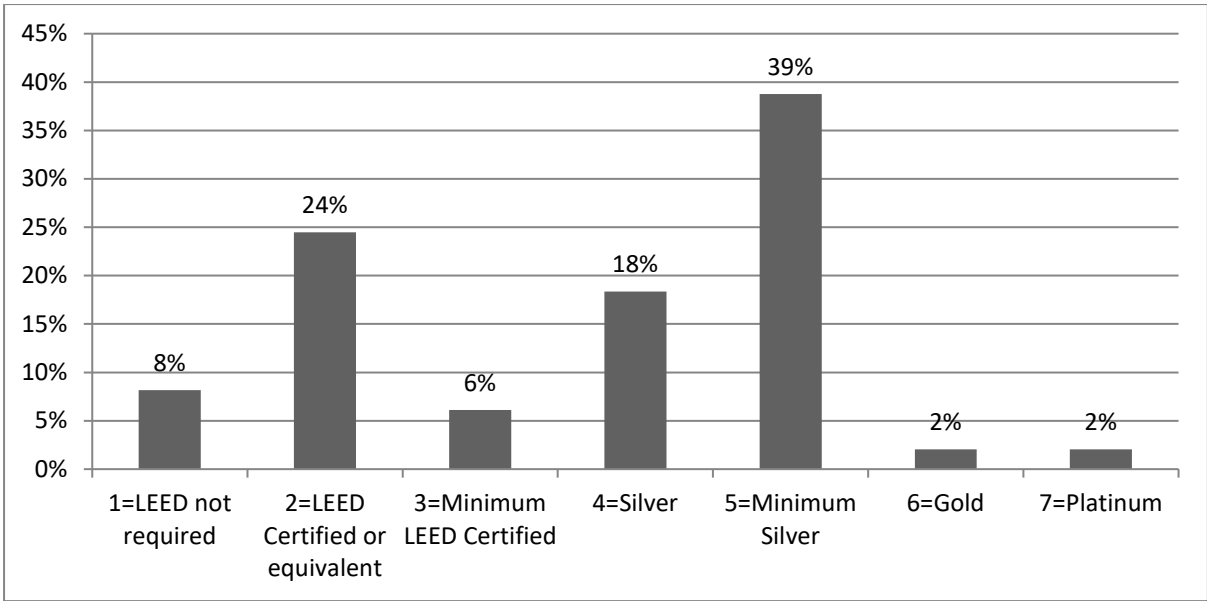
Contract type	Sustainability importance		Total
	No more than 5%	More than 5%	
Lump sum	21 72%	8 28%	29 100%
GMP	9 64%	5 36%	14 100%
Total	30 70%	13 30%	43 100%

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Note: $\chi^2 = 0.296$ ($p=.587$, d.f.=1). Of 49 RFPs, only 43 contain the information of contract type and sustainability importance for statistical analysis.

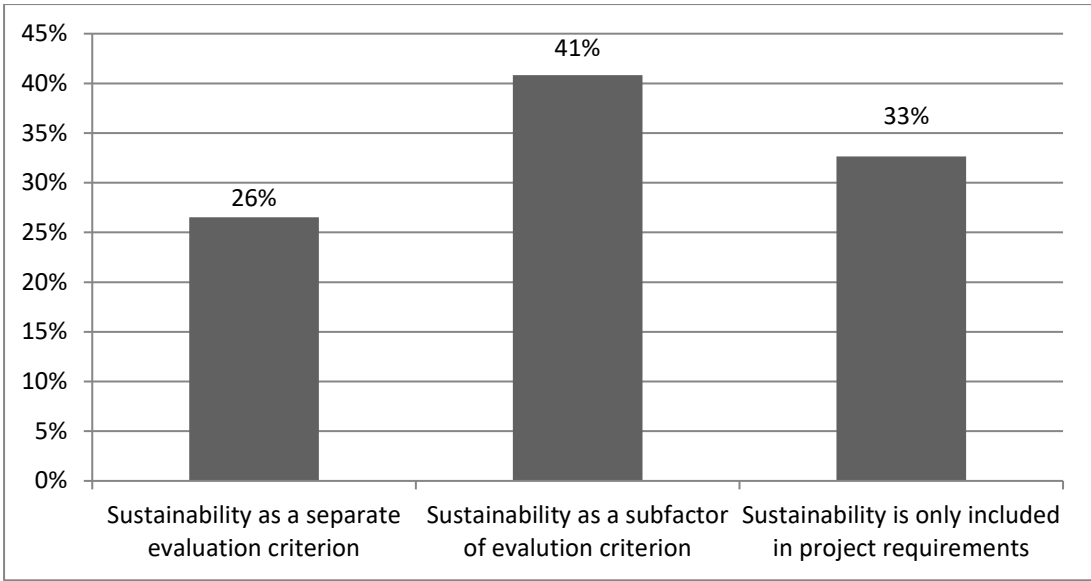
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Fig 1. Sustainability requirement levels in RFPs



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Fig. 2 Sustainability requirements for contractor evaluation

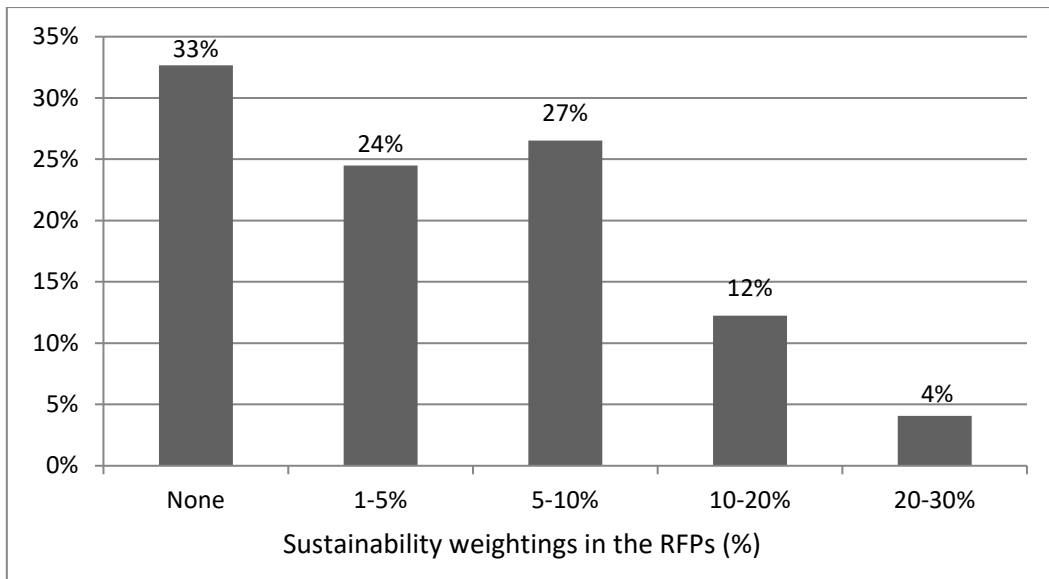


Fig 3. Sustainability weightings for contactor evaluation

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