

APPLICATION OF A PROPOSED SUSTAINABILITY CHECKLIST FOR CONSTRUCTION PROJECTS

Thamir M. Ahmed¹, Bayan S. Al-Nu'man²

^{1&2}*Ishik University*

¹*thamir.ahmed@ishik.edu.iq*, ²*bayan.salim@ishik.edu.iq*

doi:10.23918/iec2018.25

ABSTRACT

In the current work, 22 construction projects were evaluated in the province of Erbil / Kurdistan region of Iraq through the inclusion of a set of sustainability criteria in the form of questions addressed to the engineers and project managers. The results were analyzed to determine the implementation approaches of the sustainability criteria. Economic, social and environmental factors were included and construction steps were weighed in the questions of the checklist, developed in a companion paper, according to these factors. The results confirm the effectiveness of the proposed checklist for estimating a sustainability score for construction projects. In average, the score of approximately 54% of applying the sustainability measures was obtained. The results show high variations in applying sustainability measures in the various construction steps in all of the construction projects. The reasons are due to the absence or weakness of binding laws, absence of sustainability requirements as a topic in civil engineering curricula, and the lack of adoption of comprehensive designs based on the pillars of sustainability.

Keywords: Engineering Sustainability, Checklist, Construction Projects.

1. INTRODUCTION

In all areas of civil engineering, engineers are encouraged to ensure that projects have the maximum lifespan for their intended use and employ the least amount of natural resources (e.g., raw materials and energy required for their production) while still meeting client, economic, social demands and code requirements. This subject is of vital importance in Erbil province; with the existence of many construction projects all over the city and the lack of proper knowledge on evaluation and measurement of sustainability of construction projects. The authors tried in previous works to develop a framework of sustainability performance checklist for construction projects. (Al-Nu'man et al,) in 2014, investigated 11 of the largest construction projects in Kurdistan of Iraq to find out to what degree the sustainability measures were implemented. They obtained 40.48% in average as a score of sustainability in construction projects. They found that “building and material reuse”, “recycling” and “waste prevention” requires great attention. (Al-Nu'man and Ahmed) 2016, put a detailed checklist useful for construction officials to measure the sustainability condition of construction projects. The same authors (Al-Nu'man and Ahmed) 2016, applied the developed guidelines on 16 large projects in Kurdistan. Approximately 50% was the score for the application of sustainability measures.

2. OBJECTIVES AND METHODOLOGY

The objectives are to examine sustainability assessment for different construction stages, and to evaluate the sustainability of the collected responses on construction process of projects in Erbil province, more thoroughly, through interviews with project engineers. A project sustainability performance checklist was developed in a companion paper (Al-Nu'man and Ahmed 2018), that can be used by all construction project participants to understand, assess and improve sustainability performance of construction projects. The data used for analysis are mainly from a comprehensive literature review. Interviews were invited and arranged with different project parties, including engineers and managers. These interview discussions provide valuable comments on the sustainability measures that were taken into consideration through the construction process.

3. RESULTS OF A WIDE SURVEY AND DISCUSSION

The checklist described in (Al-Nu'man and Ahmed) 2018 is used in a wide survey on 22 large projects in Kurdistan. Table 1 shows the list of these projects, the corresponding sustainability average scores and weighted average scores. The average score considers all the questions are of the same weight. The weighted average score considers a weighted average based on 3 points for class A questions, 2 points for class B questions and 1 point for class C questions. Figures 1 to 6 show the results of answers on the checklist on the specific main construction steps namely; site, wastes and recycling, roofs, exterior wall systems, interior wall systems, and finishing materials. Figure 7 summarizes the results according to construction category and questions class.

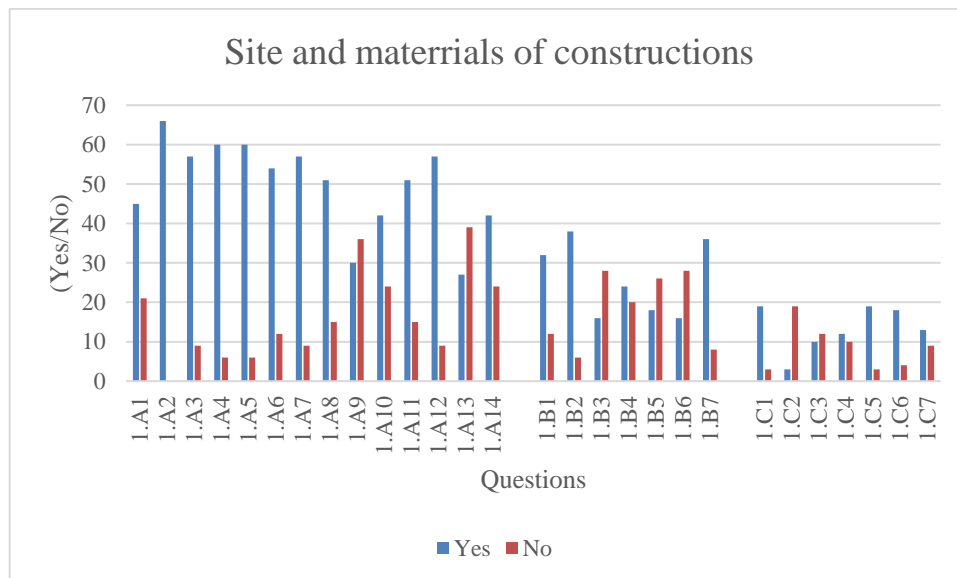


FIGURE 1. Answers for site and materials of constructions

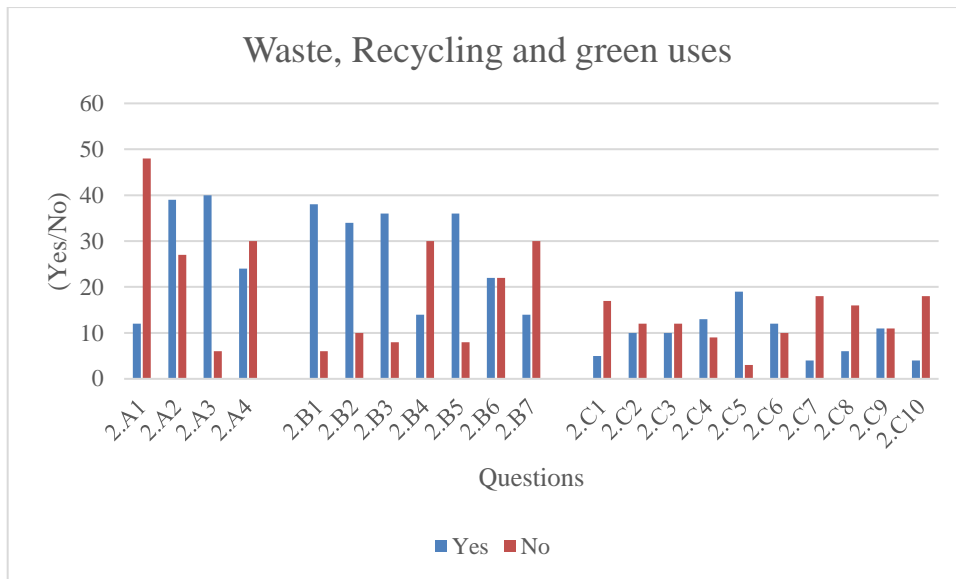


FIGURE 2. Answers for waste, recycling and green uses

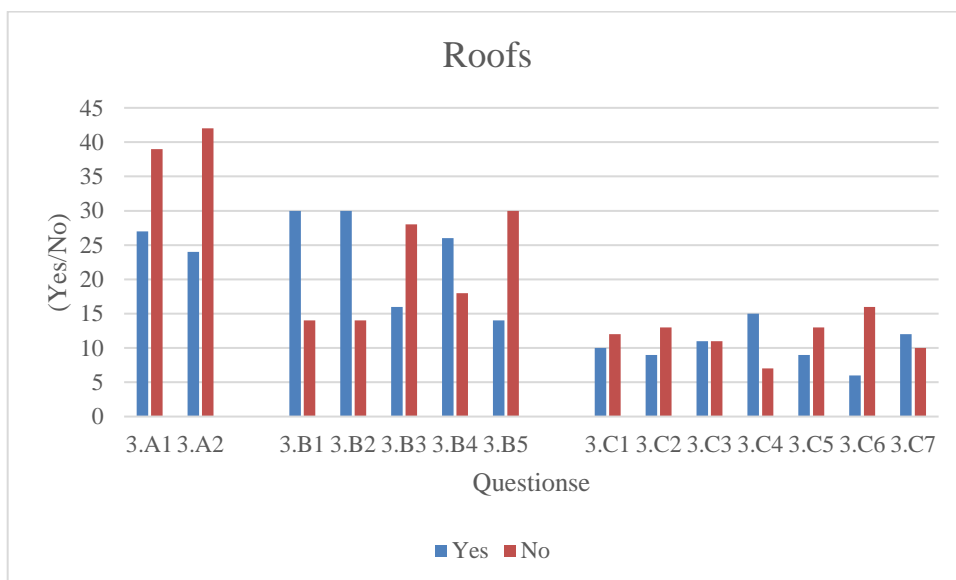


FIGURE 3. Answers for roofs

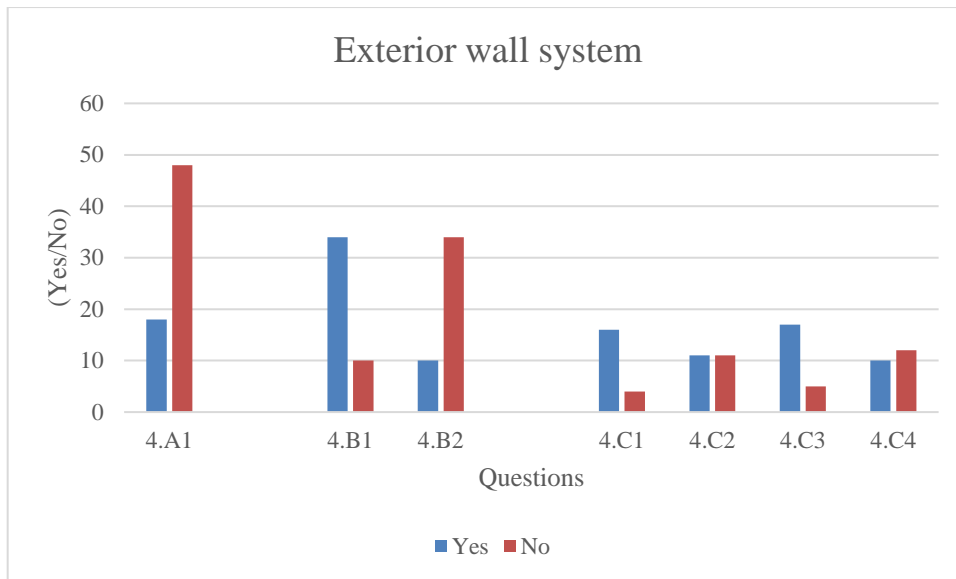


FIGURE 4. Answers exterior wall systems

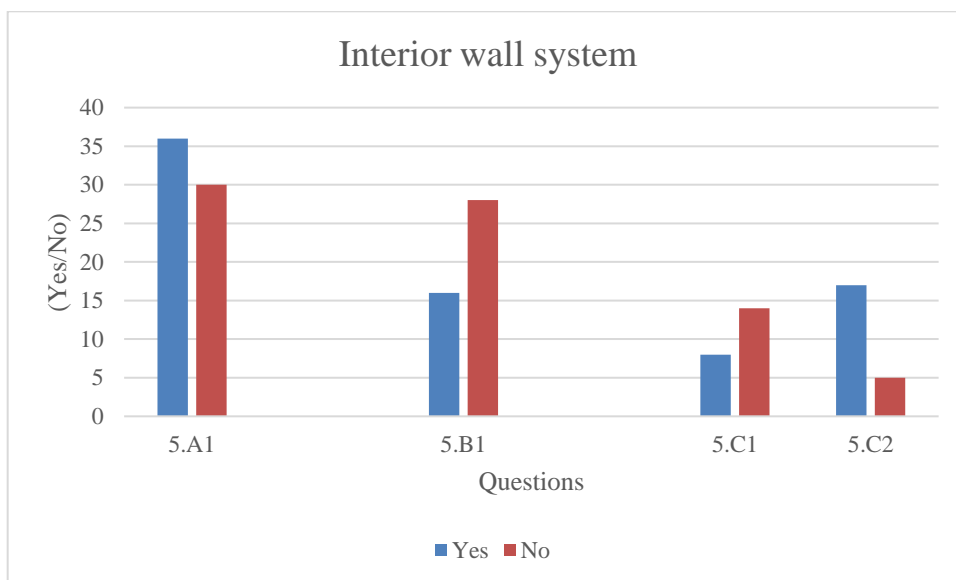


FIGURE 5. Answers interior wall systems

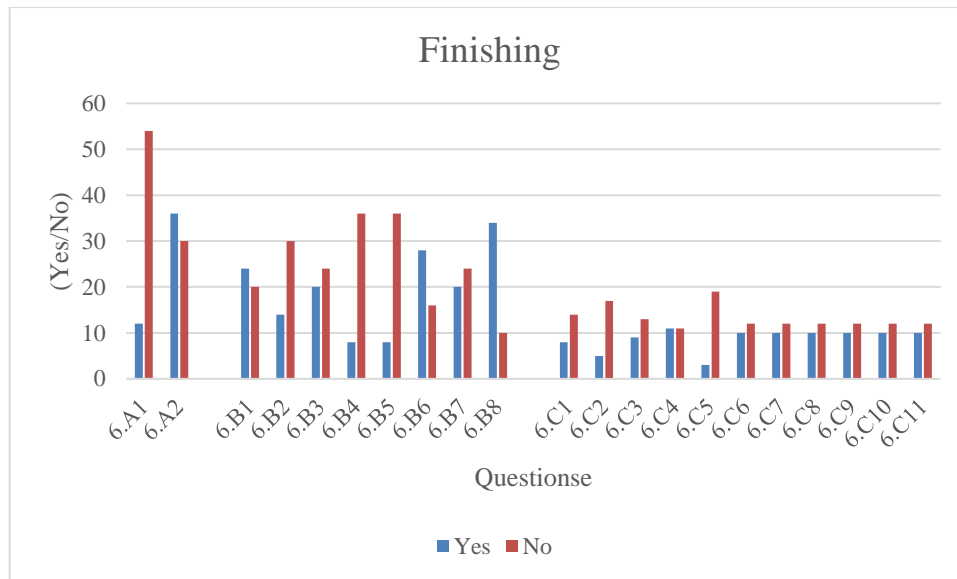


FIGURE 6. Answers for finishing

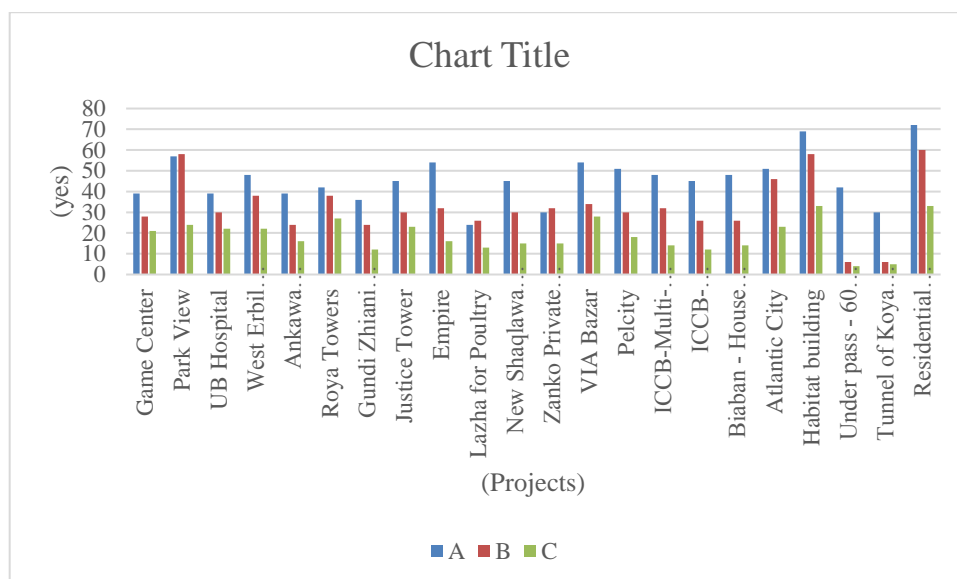


FIGURE 7. Answers for scores of considered projects

From the results it can be concluded as follows:

Most of the projects took into consideration the site selection for various reasons; main reason being the transportation system and how far the project is from main streets. However most of the projects were not making use of recycled materials. from the results it was found that most of the firms or companies did not have specific policies for minimizing wastes and recycling them. The survey results indicated that the five most significant sources of construction waste were design changes, leftover material

scraps, wastes from packaging, design/detailing errors, and poor weather. The result indicated that most of the projects used the traditional design and materials for the roof systems. However, some projects employed insulation layers for minimizing daily heat flow and therefore minimizing daily energy demand. As for water management, it is confirmed that green roofs significantly mitigate storm water runoff generation, most of the projects below did not include this aspect into their roof construction phase. Some aspects of sustainability were not witnessed in designing the exterior walls of most of the buildings. Companies stated that the cost of applying sustainable measures like green walls, for example, outweigh or compensate the benefits of such techniques. It is important to state that most of the projects did not consider the problems associated with using volatile organic compounds while furnishing the interior or during painting. Some stated that sustainability measures were not even discussed during the project feasibility studies. Most of the projects were not compatible with the sustainability requirements for finishing materials. Materials with VOCs has been used in furnishing also no materials of recycled content has been used or what is specified as green materials. The cost of sustainable material use is a factor, as stated before the sustainability standards were not included during the feasibility study nor implemented during the construction stage. Lack of policy within the companies also acts as a major factor.

4. SUMMARY OF QUESTIONNAIRE OUTPUT

Overall, the case studies show that the sustainability assessment checklist succeeds in assessing sustainability in civil engineering projects if the data is available and reliable. Sustainability data is therefore the key requirement to successfully apply the sustainability assessment checklist. Without specific indicator data, the framework can still be applied, but it is expected that the indicator is given insignificant points since the assessor cannot substantiate a certain indicator score. Table 1 shows the sustainability scores of the projects.

TABLE 1.

Sustainability Scores of the projects

Project's name	A score %	B score %	C score %	Av.Score	Av.Wt.Score
Game Center	162.50	93.33	51.22	50.68	51.18
Park View	237.50	193.33	58.54	78.12	81.56
UB Hospital	162.50	100.00	53.66	52.61	52.69
West Erbil Emerg. Hospital	200.00	126.67	53.66	61.22	63.39
Ankawa Private hospital	162.50	80.00	39.02	44.40	46.92
Roya Towers	175.00	126.67	65.85	62.51	61.25
Gundi Zhiani Hawcharekh	150.00	80.00	29.27	39.76	43.21
Justice Tower	187.50	100.00	56.10	56.20	57.27
Empire	225.00	106.67	39.02	55.79	61.78
Lazha for Poultry	100.00	86.67	31.71	36.12	36.40
New Shaqlawa City	187.50	100.00	36.59	49.70	54.01
Zanko Private Hospital	125.00	106.67	36.59	43.86	44.71
VIA Bazar	225.00	113.33	68.29	66.65	67.77
Pelcity	212.50	100.00	43.90	54.91	59.40
ICCB-Multi-Story -building	200.00	106.67	34.15	51.38	56.80
ICCB-Company- Warehouse	187.50	86.67	29.27	45.03	50.57
Biaban - House buildings	200.00	86.67	34.15	48.05	53.47
Atlantic City	212.50	153.33	56.10	67.87	70.32
Habitat building	287.50	193.33	80.49	91.00	93.55
Under pass - 60 m, Erbil	175.00	20.00	9.76	26.03	34.13
Tunnel of Koya Road	125.00	20.00	12.20	21.29	26.20
Residential building , Basra	300.00	200.00	80.49	93.50	96.75
Average %	190.91	108.18	45.45	57.42	54.39

The average of sustainability score was (57.42 %) and the weighted average score was (54.39 %). The classification into 'strong', 'normal and 'weak' sustainability questions in the checklist do influence the results and therefore it may be recommended to follow.

8 .CONCLUSIONS AND RECOMMENDATIONS

In this regard, the present study concluded some of the results as follows:

1. Most of the projects took into consideration the site selection for various reasons; main reason being the transportation system and how far the project is from main streets.
2. Most of the projects were not making use of recycled materials.
3. Most of the firms or companies did not have specific policies for minimizing wastes and recycling them.
4. Most of the projects used the traditional design and materials for the roof systems.
5. Materials with VOCs, which are not sustainable materials, have been used in furnishing.
6. The average sustainability score (57.42%) and the weighted one (54.39) are approximately similar to what was scored in previous works (4,5,6) which confirms that this checklist questionnaire is effective in estimating .

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