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Key Performance Indicators of Sustainability to select contractors

Omar M. Abed, Maysoon A. Mansor
Department of Civil Engineering, University of Tikrit, Salah Al-Din, Iraq

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ABSTRACT

Given the significance about sustainability in the building sector, it is essential to establish a precise mechanism for evaluating the sustainability performance of contractors, who are a crucial component in project execution. Analyzing contractors' sustainability performance indicators is a crucial step in identifying the contractor most dedicated to sustainability standards. This study seeks to identify and comprehend the principal sustainability performance metrics of contractors in Iraq, considering the direct influence of their projects on community development and welfare. According to previous research, indicators of sustainability were gathered and categorized into three categories (environmental, social, and economic), resulting in a total of 127 indicators. A questionnaire was subsequently developed and disseminated to a selection of engineers and sustainability experts, yielding (104) responses for study. The statistical software (SPSS-V26) was employed to analyzed the results and establish priorities. The principle of the relative importance index was also applied, and indicators with an importance greater than or equal to 0.70 were selected in order To diminish and refine the indicators to 64 essential metrics that underpin the selection process for sustainable contractors.

Corresponding Author:
Omar M. Abed
Department of Civil Engineering, University of Tikrit
AlYarmouk Street, Baqubah, Iraq
Email: omar.a.mohammed43824@st.tu.edu.iq

1. Introduction

Before awarding any project to a contractor through a public or selective tender, the owner or consultant often sets a set of criteria to evaluate the applicants. However, these criteria vary in priority and importance across countries and local contexts. In light of contemporary environmental, social, and economic challenges, it has become imperative to adopt sustainability indicators as a pivotal tool in evaluating contractors. These indicators play a direct role in improving project efficiency, ensuring their compliance with sustainability principles, and reducing negative impacts on the environment and society. Selecting a sustainable contractor is not limited to the quality of implementation or adherence to schedules alone. It also includes their commitment to responsible environmental practices, their contribution to community development, and their ability to manage resources economically. This paper outlines the standard sustainability indicators for selecting contractors. This was accomplished following a review of earlier research, the collection of categories and indicators, their prioritization through surveys, and their analysis using SPSS.

2. Literature review

To efficiently pick contractors based on sustainability, key performance indicators (KPIs) must be established that include environmental, social, and economic elements. Integrating these KPIs throughout the contractor selection process not only improves project sustainability, but also fits with larger sustainability goals. The research conducted by Rajabi et al. addressed the use of renewable energy: it was ranked as the most important environmental KPI, emphasizing the importance of energy sources in construction projects [1]. Among Myers' topics are the initiatives promoting sustainable building in the UK and a survey of the generally unfavorable views held by major corporations regarding their social responsibility and sustainability.[2]. Along with the other workers,

Moawiah A set of sustainability evaluation indicators culled from surveys, expert opinions, and literature reviews to evaluate contractors' work during the building process.[3]Sarkis Examine application of the analytical hierarchy methodology contributes to providing an integrated framework that helps decision-makers select subcontractors, by highlighting the advantages of this model in enhancing the sustainability of the built environment and addressing the economic, social, and environmental dimensions associated with project implementation.[4] Wadi and A 'edh conducted an analytical study that identified critical A factor study of sustainability indicators in Iraq concluded that economic considerations and institutional frameworks are the foundations. elements necessary for achieving sustainable development[5] According to Jasim and Mahmoud's research, performance indicators were improved by implementing the social and economic stability parameters provided in the GRI framework. A better grasp of these signs leads to better policy implementation and decision-making. according to the results of the study [6].

3. Research methodology

indicators of sustainability for contractor selection were gathered relevant prior research. indicators then categorized and organized using a content analysis methodology. Sustainability performance measures were then developed, and a questionnaire was created using specialized references to scientifically frame and categorise the indicators.To prioritise these indicators, A group of specialists and engineers from different fields were given a questionnaire to fill out. The Relative Importance Index (RII) methodology was used to analyse the data and prioritise the indicators. Indicators with a value greater than or equal to 0.70 were the total number of indicators was then reduced and the focus was on the most important ones.. As a result, key sustainability performance indicators were identified, which can be used to select sustainable contractors. Figure 1 illustrates the research methodology used.

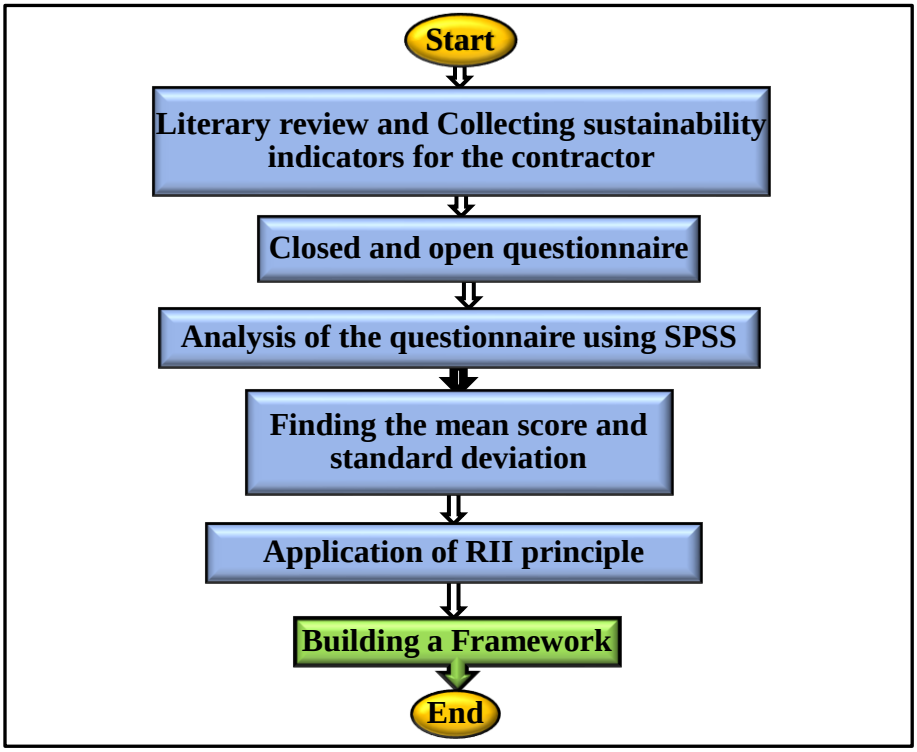

Figure (1) Flowchart showing the research methodology

3.1 Determining the indicators for selecting contractors

The goal to identify Sustainability indicators used in contractor selection and. Drawing on insights from previous research, academic studies, relevant literature, along with related theoretical frameworks a total of 127 indicators were identified and grouped into 21 categories and then developed an open-ended questionnaire to collect data, allowing participants to freely express their opinions. They are presented in Tables 1, 2, and 3.

3.2 Closed data questionnaire

The questionnaire used in this study consisted of five main axes. The first axis addressed the personal data of the respondents, while the second axis focused on the participants' level of knowledge of sustainability standards. The third axis addressed the economic indicators associated with choosing a sustainable contractor, while the fourth axis was devoted to social indicators, and the fifth axis to environmental indicators. A five-point Likert scale was adopted to measure the opinions of the respondents, with values ranging from (1) very low to (5) very high. To prioritize the indicators, a survey was organized that included a group of experts from various engineering disciplines. The questionnaire was distributed to (104) participants, including engineers, academics, and those with experience in the field of sustainability..

3.3 Closed questionnaire data analysis

The questionnaire's analysis has three primary sections:

Section One: Examination of participants' personal data to comprehend the demographic attributes and of the respondents. Section Two: Assessments of participants' sustainability knowledge to gauge their comprehension of sustainability concepts and standards. Section Three: Evaluation of sustainability indicators for contractor selection to ascertain the significance of each indicator.

3.3.1 Analysis of respondents' demographic information

This section aims to identify participants' characteristics in terms of their work sector, academic qualifications, nature of work, department in which they work, number of years of professional experience, and specialization. Frequency counts and percentages were used to summarize participants' basic information in the survey responses, as shown below.

Figure (2) represents the certificate for the respondent as 20% represent PhD, 40% for Master, 3% for Higher Diploma and 37% for Bachelor.

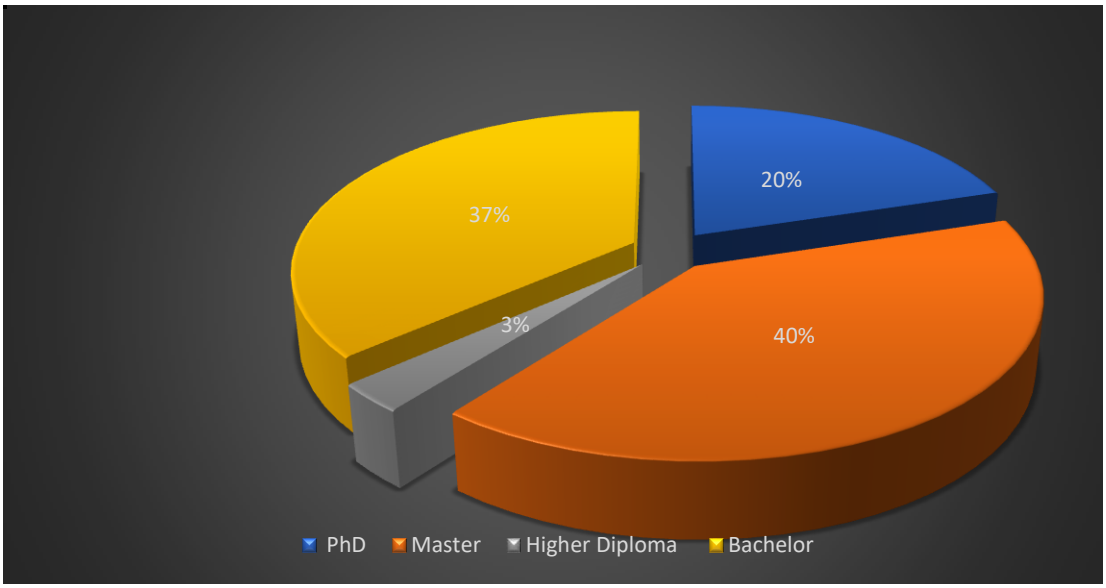

Figure (2) The distribution of responders' academic certificates as percentages

Figure (3) represents the working sector for the respondent as 88% represent public sector and 12% for private sector

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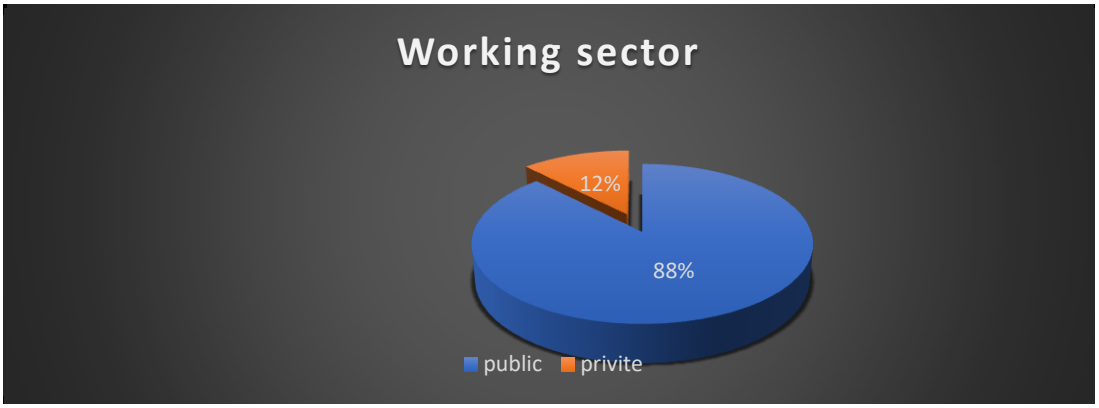


Figure(3). Distribution of respondents' work sector as percentages

Figure (4) represents the certificate for the respondent as 93% represent civil , 1% for architectural , 4% for electrical and 2% for others(**Mechanical, Environment).**

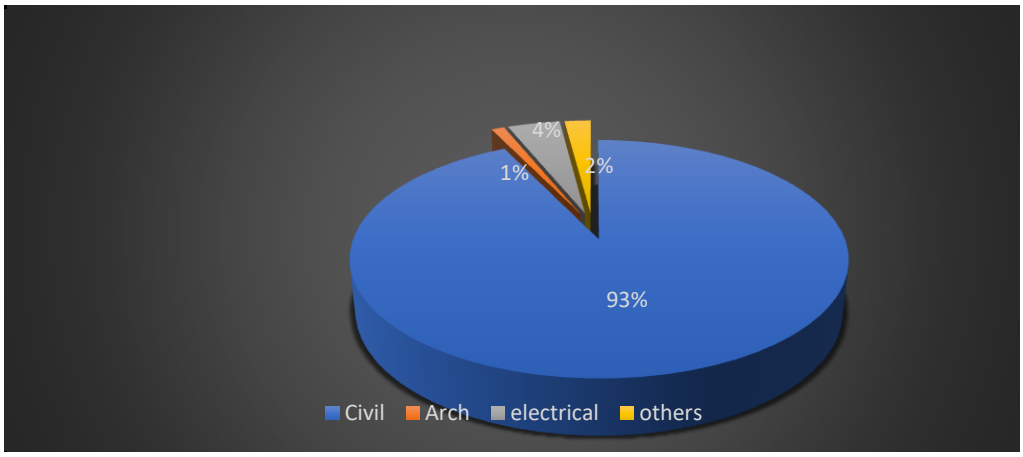
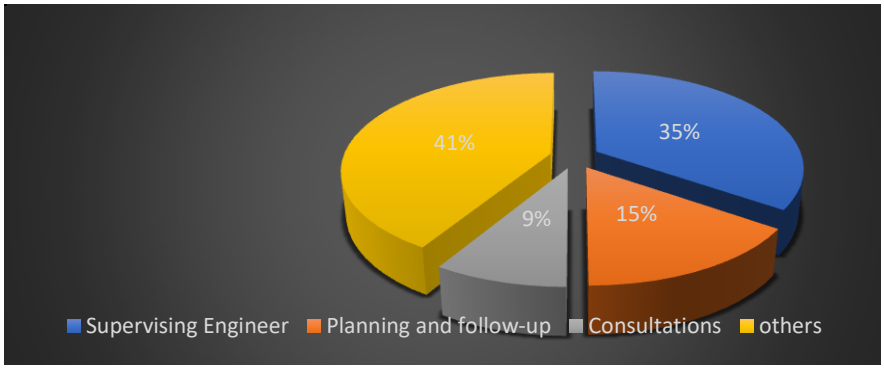


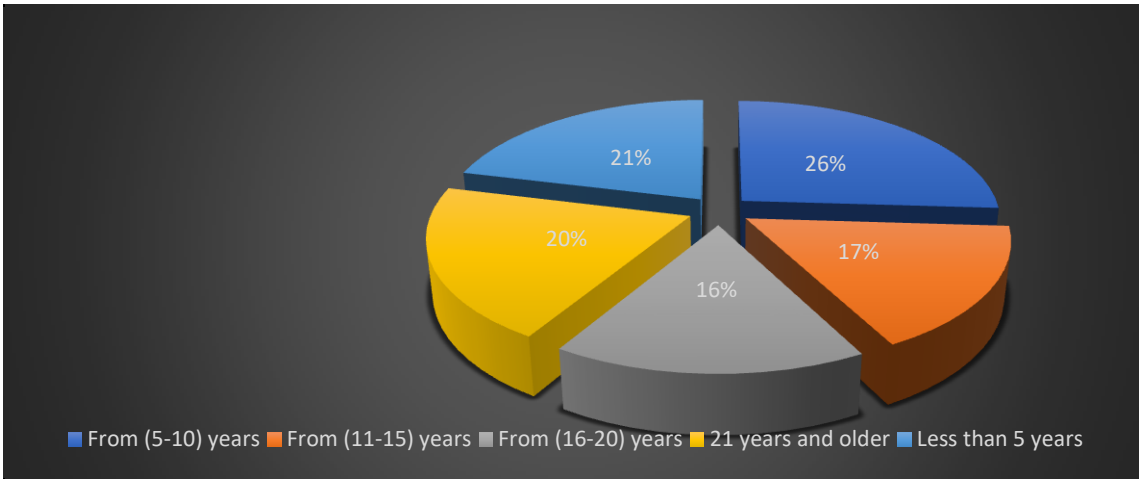
Figure (4) Distribution of specializations of respondents as percentages

Figure (5) represents the working nature for the respondent as 35% represent supervising engineering, 15% for planning, 9% for consultant and 41% for others(Designer**,** Department Manager, Project Manager, Bidding Specialist, Contractor)



Figure(5) Distribution of respondents' work nature as percentages

Figure (6) represents the years of experience for the respondent as 21% represent less than 5 years, 26% for 5-10 years, 17% for 11-15 years, 16% for 16-20years and 20% for 21 years and older



Figure(6) Distribution of years of experience of respondents as percentages

3.3.2The extent of the respondent's knowledge of sustainability standards

The questionnaire results showed that the honourable respondent has an acceptable degree of knowledge of sustainability concepts, as his answers demonstrated a general understanding of its basic principles, especially with regard to the economic, environmental, and social dimensions**.**

1.Understanding the concept of sustainability for the construction sector.
The questionnaire results showed that most participants had a strong understanding of sustainability concepts, with 40 respondents indicating good knowledge, and 33 respondents indicating a very clear understanding of the concept. In contrast, 20 respondents demonstrated an average level of knowledge, while 8 respondents had only superficial knowledge, and 3 respondents reported no knowledge of the concept. These results indicate as most of them represent the option of good knowledge in sustainability، Shown in Figure (**7**)

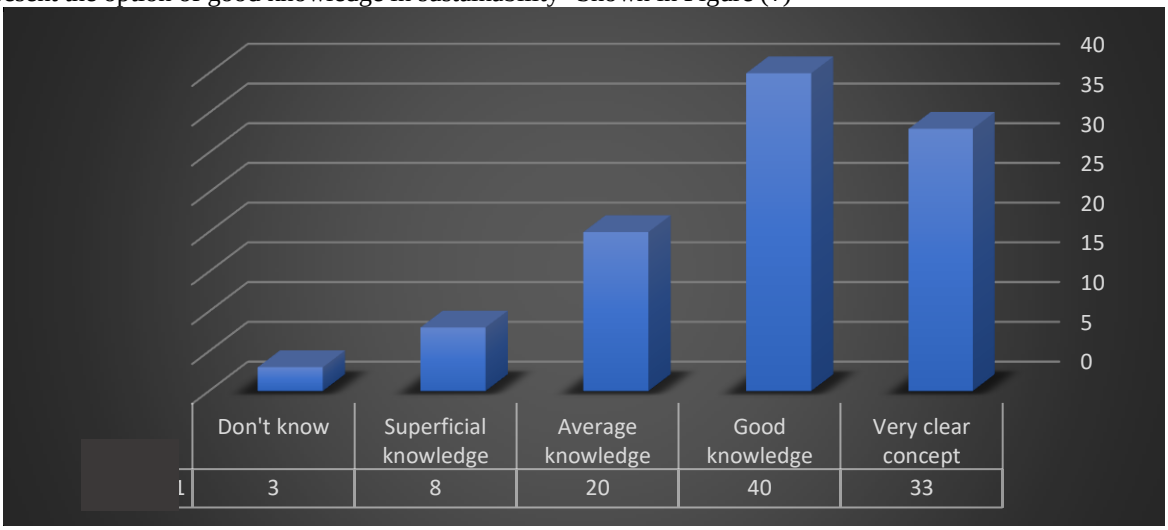


Figure (**7)** Understanding of the concept of sustainability

2. challenges facing the implementation of sustainability standards in construction projects in Iraq.
The questionnaire results revealed that the most prominent challenges to implementing sustainability practices is the lack of knowledge about sustainable technologies, as indicated by 65 respondents.29 respondents indicated weak government support as a major obstacle, while only 10 respondents considered high costs to be a significant challenge. These results indicate the need to focus on educational initiatives and disseminating knowledge of sustainable technologies as a priority to effectively promote sustainability practices, Shown in Figure (8)

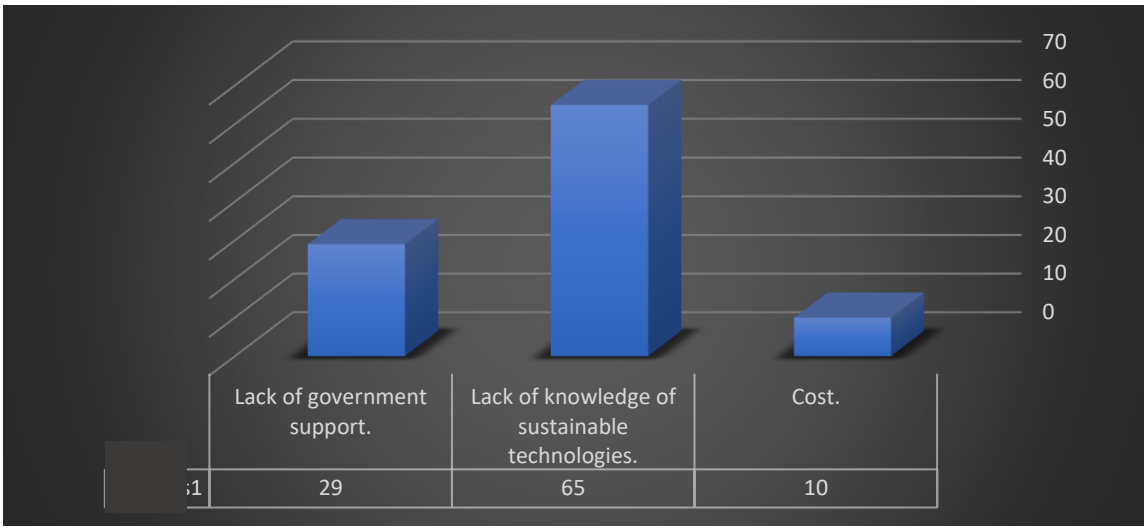


Figure (8) challenges facing the implementation of sustainability standards

3. Working on a construction project that applies sustainability standards.

The questionnaire results showed that practical experience in applying sustainability standards in construction projects remains limited. 72 participants had not worked on projects that applied these standards, while only 32 participants reported having such experience. This finding indicates the weak practical application of sustainability
.

4. Use Environmentally Friendly Building Materials in Projects.

The questionnaire results showed that the adoption of environmentally friendly building materials in projects remains limited, with only 32 respondents indicating their use of such materials, while 72 respondents reported not using them. These results indicate the weak prevalence of sustainable environmental practices in the construction sector, reflecting the need to raise awareness and encourage the adoption of materials more compatible with sustainability principles.

5. Respondent's knowledge global sustainability standards such as LEED or BREEAM.

The questionnaire results showed that most participants have moderate theoretical awareness global standards of sustainability such as BREEAM and LEED, with 45 respondents reporting a good understanding of these standards but not practical application. In contrast, 2**8** respondents reported being unfamiliar with them, while 25 respondents indicated they had only heard of them without knowing the details. In terms of actual application, only **6** respondents reported regularly applying these standards in their projects. These results demonstrate a clear gap between theoretical knowledge and practical application of sustainability standards in the workplace, Shown in Figure (**9**)

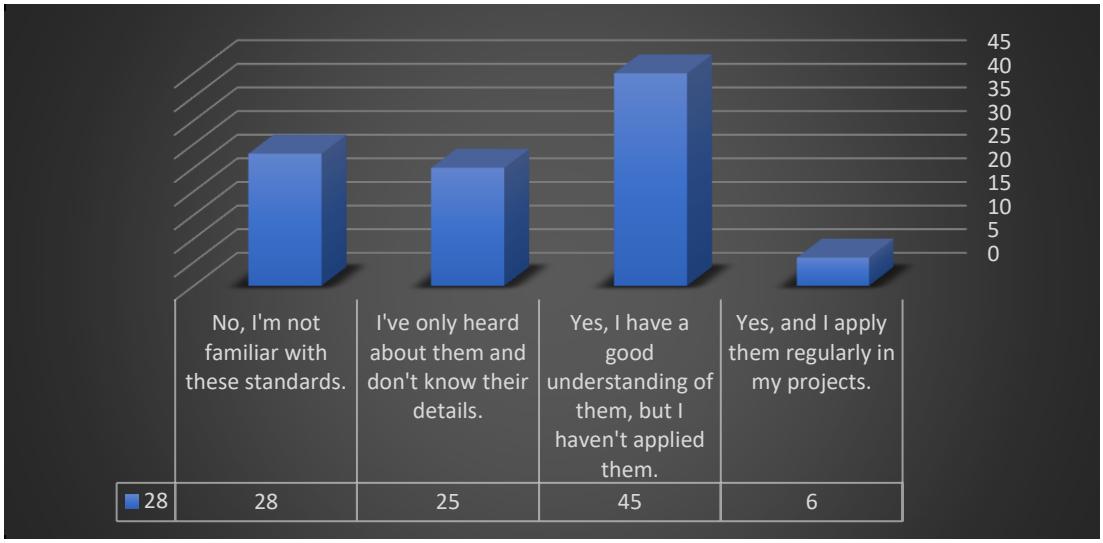


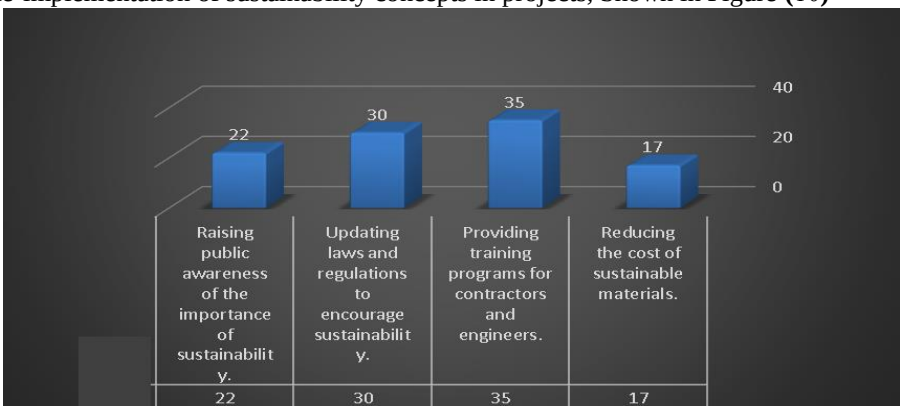
Figure (9) Respondent's knowledge global sustainability standards such as LEED or BREEAM

6. government support to encourage the implementation of sustainability in the construction sector

The questionnaire results showed revealed near-complete consensus among participants regarding the need for government support to encourage the implementation of sustainability practices. A total of 103 respondents indicated a genuine need for such support, while only one responded negatively. This finding indicates a widespread awareness among sample members of the importance of the government's role in stimulating the shift toward more sustainable practices within projects

7. More government support is needed to encourage the Application of sustainability in the construction sector.

The questionnaire results showed that a relative majority of participants indicated the need to provide training programs for contractors and engineers 35 respondents, while 30 respondents indicated the importance of updating laws and regulations to encourage sustainability, and 17 respondents indicated the importance of reducing the cost of sustainable materials. Only 22 respondents indicated the importance of increasing public awareness of the importance of sustainability. These results indicate that providing technical training is a top priority for participants to support the implementation of sustainability concepts in projects, Shown in Figure **(**10**)**



igure (10) Application of sustainability in the construction sector

3.2 Relative Importance Index (RII)

The relative its importance index(RII) serves as a crucial tool for prioritizing and evaluating the value of indicators. It functions as a standard for questionnaires utilizing a scale with five points. The relative importance index ranges from 0 to 1. The relative importance index might be determined with Formula No. (1).and the relative importance index values dictate the amount of relevance, as shown in Table No. (5) [59]. When evaluating variables using questionnaires, this approach is among the most popular and reliable options [60]. Consequently, relative importance index computation is crucial for this research in determining the environmental and socioeconomic dimensions' in proportion importance relative to sustainability indicators.

$$RII = \frac{\sum W}{(A*N)} \quad (1)$$

Where:
RII: Relative Important Index
W: (Weight of each indicator.) Respondents assigned numerical values to the relative importance of eachindicator 1, 2, 3, 4, and 5, respectively.
A: The highest weight in this study is 5.
N: Total number of responses

The first part of this research calculates the relative importance index (RII) for sustainability indicators in the environmental, social, and economic dimensions to determine the most influential and priority ones. The second part builds a framework that clarifies the mechanism for using these indicators in contractor evaluation and selection to improve sustainability.

4.1Finding the indicators' its relative importance index

The relative importance index (RI) was calculated for the three dimensions: environmental, social, and economic, to determine the level of importance of each indicator compared to the other indicators. Based on the derived RRI

values, in addition to the standard deviation, the indicators were ranked according to their degree of relative importance, as shown in Tables (6), (7), and (8)

3.3 Framework components for sustainability Indicators Used in Contractor Selection

After identifying and arranging the indicators, based on the relative importance index to determine the most important indicators, the number of indicators reached 42 indicators within the economic dimension, The social dimension had 42 indicators, whereas the environmental dimension included 43 indicators. The total amount of criteria in each dimension was then decreased using the approach of picking which were most important indicators to ensure that the study focused on the aspects that were most significant in determining sustainability. of relative importance index(RII). , a framework was created for selecting contractors based on important or critical sustainability indicators.The framework was built based on indicators of greater than or equal to importance (0.70), as in in [61]did. This framework consists of 64 indicators within 21 categories Distributed across the three dimensions: economic, social and environmental, as shown in the following table (9).

The results showed that economic indicators such as " green building project management team qualifications " and "Time for implementation" topped participants' priorities, reflecting a growing awareness of the importance of administrative efficiency and adherence to schedules in enhancing project sustainability. Regarding the social dimension, indicators such as "Employee skills" and "Experience in similar projects" emerged as pivotal elements contributing to ensuring quality performance and the continuity of sustainable practices. Regarding the environmental dimension, indicators such as "Renewable energy" and "Correct disposal of backfills without throwing it onto private property" were at the forefront of participants' concerns, confirming the growing awareness of the importance of reducing the direct environmental impact of projects. These findings provide credence to the idea that expanding the use of sustainability in the process of selecting sustainable contractors in Iraq requires the formulation of an integrated framework that combines economic efficiency, professional and social qualifications, and strict environmental commitment. Incorporating these dimensions into contractor prequalification systems would contribute to raising the level of project quality and expanding the scope of sustainable practices in the Iraqi construction sector.

Recommendations :

1. Government agencies and relevant institutions should adopt sustainability indicators within their contractor prequalification systems, given their pivotal role in evaluating and selecting the contractor most committed to sustainability.
2. Organizing training courses and workshops to enhance understanding of sustainability indicators.
3. Providing financial incentives or benefits to contractors committed to sustainability.
4. Developing clear and standardized evaluation guidelines and criteria.
5. Including sustainability clauses in project contracts.
6. Establishing a system for monitoring and periodically evaluating contractors' performance.

Conclusions

1- The study identified127 key performance indicators across three dimensions of sustainability. These indicators were ranked based on their relative importance through a questionnaire survey and interviews with engineers and sustainable

2- To choose the indicators within each of the three sustainability dimensions, we applied the relative importance principle to the aggregated indicators in order to reduce their number and select the most critical those with a relative importance index of 0.70 or higher. The result was 64 key performance indicators.

3- This research built a framework for the selection and qualification of contractors based on the most relevant sustainability parameters. This framework aids sustainable contractors by offering a just and transparent assessment system, improving their chances for meaningful involvement in projects and assuring compliance with sustainable development standards in the construction industry.

4- Prioritising sustainability indicators in contractor selection enables owners and decision-makers to identify the contractor most compatible with sustainability standards, thereby ensuring favourable long-term project outcomes.

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BIOGRAPHIES OF AUTHORS

	**Omar M. Abed** A master's student in the Department of Civil Engineering, Construction Project Management specialization, College of Engineering, Tikrit University (Salah alDin, Iraq), and currently a master's student .They can be contacted by email: omar.a.mohammed43824@st.tu.edu.iq
	**Assis.Prof.Dr.Maysoon Abdullah Mansor** (PhD Construction Project Management): She is an Assistant Professor in the Department of Civil Engineering, College of Engineering, University of Tikrit (Salah al-Din, Iraq). A lecturer of undergraduate and postgraduate courses (MSc) and a research supervisor for higher studies. They can be contacted on e-mail:dr.maysoonabdullah@tu.edu.iq