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Evaluating and Prioritizing Management and Process Strategies for Integrating Sustainability in Construction Project Management: A Kano–Model Study in Iraq

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ABSTRACT

Integrating sustainability in construction project management requires practical, management-oriented approaches addressing environmental, economic and operational challenges. This study is a review and prioritization of management and process strategies involved in integrating the concept of sustainability into construction projects. The research methodology included a systematic literature review, followed by expert validation with an open-ended questionnaire, and a closed-ended questionnaire that was distributed among 83 professionals. The information obtained was examined by applying the Kano model and Timko indices to rank and prioritize strategies according to their impact on stakeholder satisfaction and dissatisfaction. The results show that strategies which are resource efficiency, construction waste reduction, environmental compliance and site safety management were found to be high impact Attractive attributes with good potential to improve feelings for stakeholders. In addition, three strategies that were originally considered Indifferent in the Kano model were identified as Attractive using Timko analysis which shows their increased importance in operational sustainability practices. This study presents an empirically-based prioritization framework that provides good information for construction decision-makers to give guidance on the most influential strategies for sustainable project delivery.

Keywords: Sustainability, Construction project management, Strategies, Management and process, Kano-Model.

1. INTRODUCTION

Sustainability emerged in the 1960s as a response to growing concerns about environmental degradation and resource depletion. It is commonly associated with the responsible use of natural resources to ensure that future generations can meet their own needs **(Sherratt and Farrell, 2022; Benton-Short, 2023)**. In the construction sector, sustainable construction is essential for mitigating the adverse effects of building activities while achieving sustainable

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development goals. It is based on three key principles: (1) Resource management aimed at minimizing, reusing, and recycling limited resources; (2) Life-cycle design that reconciles environmental considerations with traditional construction demands throughout all project stages; and (3) Human and environmental harmony, guaranteeing occupant contentment and ecological integrity **(Olanipekun, 2017)**.

Sustainable construction has gained increasing importance as construction projects have become more complex and resource-intensive. During construction and operational phases, factors such as energy and water consumption, material use, and land utilization significantly affect the environmental performance of buildings **(Ofori and Kien, 2004)**. Embedding sustainability principles into project planning and process management is therefore essential to balance economic, environmental, and social objectives. In large-scale projects with many stakeholders, the adoption of sustainable management practices can help reduce resource waste, align stakeholder expectations, and improve long-term project performance **(Yu et al., 2018)**. Project Sustainability Management (PSM) has emerged as a framework that encompasses both the project and product perspectives of sustainability. It involves the adoption of environmental technologies, design-for-surroundings concepts, green procurement, and social obligation practices. Empirical research shows that embedding sustainability practices into challenge control undoubtedly impacts assignment fulfillment and decreases environmental and social influences, despite the fact that many corporations still face challenges in fully implementing these practices **(Carvalho and Rabechini, 2017)**. Recent research also highlights the role of construction project managers in advancing sustainable practices by establishing clear policies, improving stakeholder communication, and including sustainability requirements in procurement and supply-chain decisions **(Arabpour and Silvius, 2023)**. Sustainability indicators are increasingly used to guide project teams, as they capture the economic, environmental, and social dimensions of the triple bottom line and help assess project sustainability performance **(Stanitsas et al., 2021; Stanitsas and Kirytopoulos, 2023)**.

The Kano model, introduced by Noriaki Kano in 1984, provides a structured framework for classifying product or service attributes based on their impact on user satisfaction **(Kano et al., 1984)**. In creation project control, it is widely used to evaluate and prioritize sustainability techniques, because it links management interventions to stakeholder pride and perceived value **(Chen and Chuang, 2008; Spool, 2011)**. According to **(Walden et al., 1993)**, the model classifies strategies into six categories:

1. **Must-Be (M):** Basic expectations that cause dissatisfaction if absent but do not increase satisfaction when present.
2. **One-Dimensional (O):** Features where higher fulfillment leads to proportionally higher satisfaction.
3. **Attractive (A):** Unexpected features that delight when present but do not cause dissatisfaction if absent.
4. **Indifferent (I):** Features with no significant impact on satisfaction.
5. **Reverse (R):** Features that decrease satisfaction when present and increase it when absent.
6. **Questionable (Q):** Inconsistent or illogical responses that cannot be clearly interpreted.

By identifying what type of strategy falls within categories such as Attractive, One-Dimensional, or Indifferent, practitioners can know what type of action will be most helpful, what to eliminate, and what resources to allocate in a more efficient way. This makes the Kano model especially suitable for prioritizing sustainability strategies in the management of construction projects, in which the choice between the most influential managerial and process interventions is of prime importance to enhance the outcome of the construction project. Despite a growing body of literature on sustainable construction and project sustainability management, several important gaps remain unaddressed. Many studies propose general frameworks or conceptual models for sustainable project management, yet only a limited number translate these frameworks into concrete management and process strategies that can be practically applied in construction project environments **(Zuo and Zhao, 2014; Gan et al., 2015).** In addition, previous research employing multi-criteria or satisfaction-based methods tends to focus on critical success factors or performance indicators rather than on the prioritization of managerial and operational strategies from the perspective of project stakeholders **(Stanitsas and Kirytopoulos, 2023)**. A further gap is the scarcity of applied empirical studies that integrate the Kano model with quantitative extensions such as Timko analysis to classify and rank sustainability-related strategies in real construction settings, particularly within developing construction sectors **(Khalifeh et al., 2020)**. To address these gaps, the present study specifically concentrates on the management and process dimension of sustainability integration in construction project management. By identifying relevant strategies via the literature, validating them via expert consultation, and using a closed-ended questionnaire to assess the strategies using the Kano and Timko models, the study gives an empirical prioritization based on stakeholder satisfaction and dissatisfaction judgment. The application of the Kano model is particularly useful in this context, because it makes it possible to distinguish between strategies that merely fulfill basic expectations and those that actually increase the satisfaction of stakeholders. Timko's indices further quantify these effects, creating a more precise ranking of strategies based on their overall impact.

Accordingly, the aim of this study is to create an applied framework to identify, validate, classify, and prioritize management and process strategies to assist in the integration of sustainability in the management of construction projects. The ultimate goal is to provide decision-makers with evidence-based insight into how different managerial and operational interventions are perceived as most influential and improve sustainable project outcomes, and thus help the construction sector to allocate effort and resources to the most influential strategies.

2. APPLICATION OF THE KANO MODEL IN THIS STUDY

This study has used the Kano model as a diagnostic tool to assess and categorize the proposed management and process strategies in integrating sustainability in the construction project management practices. The application was designed to reflect the perceptions and emotional reactions of the stakeholders on each of the strategies, which would allow prioritizing interventions more closely.

First, each strategy was assessed using a pair of Kano-based questions: one functional and one dysfunctional.

A. The functional question was phrased as:

"How do you feel if this strategy is applied in a construction project you are involved in?"

B. The dysfunctional question was phrased as:

"How do you feel if this strategy is not applied in a construction project you are involved in?"

Participants responded to both questions using the following five-point scale:

1. Very Satisfied
2. Accept It

3. Neutral
4. Do Not Accept It
5. Completely Reject It

Second, each method was labeled into a selected Kano category primarily based on the aggregate of solutions to the purposeful and dysfunctional questions. The category manner turned into done using the Kano evaluation matrix, and carried out in IBM SPSS 27 by way of making use of conditional formulas and logical statements to automate the classification of responses.
The Kano evaluation matrix used for classification is illustrated in **Table 1**, while the conceptual model that explains the relationship between satisfaction and functionality, known as the 2D Kano Model is presented in **Fig. 1**.

Table 1. Kano Evaluation Matrix **(Cho and Kim, 2022)**.

Participant Response		**Response To dysfunctional Questions**				
		Very Satisfied	**Accept It**	**Neutral**	**Do Not Accept It**	**Completely Reject It**
Response To Functional Questions	Very Satisfied	Q	A	A	A	O
	Accept It	R	I	I	I	M
	Neutral	R	I	I	I	M
	Do Not Accept It	R	I	I	I	M
	Completely Reject It	R	R	R	R	Q

When A is an Attractive Quality, M is Must-be, O is One-dimensional, I is Indifferent, R is Reverse and Q is Questionable.

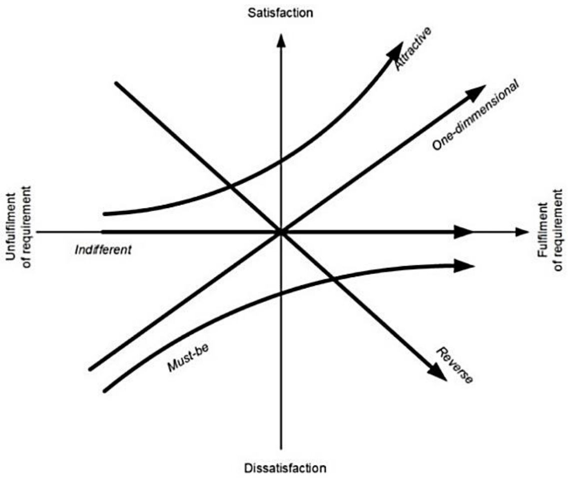

Figure 1. Two-Dimensional Kano Model **(Madzík et al., 2019)**.

3. QUANTITATIVE ASSESSMENT OF KANO STRATEGIES USING TIMKO MODEL

Although the Kano model is a widely accepted tool for understanding stakeholder perceptions, its categorical nature does not always reflect the relative strength of strategies within the same classification. For instance, multiple strategies may fall under the "Attractive" category, yet vary greatly in their actual influence on satisfaction and decision-making. As such, Kano classification alone is insufficient for effective prioritization **(Walden et al., 1993; Timko, 1993)**. In response to this limitation, this paper has used the Timko method, which is a quantitative improvement of the Kano model, to further determine the strength and significance of each sustainability strategy. The given method adds some analytical metrics, which give a numerical understanding of the stakeholder satisfaction and dissatisfaction reactions, allowing for the classification and rank the strategies more precisely.

3.1 Key Indicators in Timko Analysis

1. Kano Classification Strength (KCS):
Measures the level of dominance of assigned Kano category of each strategy. It is computed by as the difference in percentage between the highest category selected and the next most frequent category. KCS value is higher giving a stronger agreement among the respondents on the classification of the strategy **(Dash and Mahajan, 2024)**.

2. Satisfaction Index (SI):
Represents the positive emotional impact of a strategy to its implementation. It quantifies the magnitude of a plan in terms of customer delight. Customer satisfaction index varies between 0 and 1, whereby a high customer satisfaction index indicates near 1, hence high customer satisfaction and a low customer satisfaction index indicates a near value of 0. **(Palumbo et al., 2014)**.

3. Dissatisfaction Index (DI):
Measures the extent to which the strategy reduces unhappiness on implementation. It shows the negative emotional response that was alleviated due to the introduction of the technique. The customer dissatisfaction index has a value of -1 to 0. Values that are close to -1 represent a high level of dissatisfaction, and values close to 0 represent a low level of dissatisfaction **(Palumbo et al., 2014)**.

4. Overall Satisfaction Coefficient (OSC):
The Overall Satisfaction Coefficient (OSC) is a composite indicator that reflects the total emotional impact of a strategy by combining its ability to both increase satisfaction and reduce dissatisfaction **(Dash and Mahajan, 2024)**.

5. Total Strength (TS)
TS is the overall percentage of responses in the three Kano ranges of positive strategic value, which are Must-Be (M), One-Dimensional (O), and Attractive (A). It is a measure of the general perceived value and importance of a strategy and is applied to justify its ranking and prioritization **(Dash and Mahajan, 2024)**.
The calculation formulas for each of the Timko-based indicators used in this study are summarized in **Table 2**.

Table 2. Calculation Formulas for Timko-Based Indicators

-	Indicator	Formula	References
1	KCS	Highest Category % – Second Highest One %	(Dash, 2021; Dash et al., 2022; Münster and Grabkowsky, 2023; Dash and Mahajan, 2024)
2	SI	$\frac{(A+O)}{(A+O+M+I)}$	(Madzík et al., 2019; Dash, 2021; Cho and Kim, 2022; Dash et al., 2022; Münster and Grabkowsky, 2023; Dash and Mahajan, 2024)
3	DI	$\frac{(M+O)}{(A+O+M+I)}$	(Madzík et al., 2019; Dash, 2021; Cho and Kim, 2022; Dash et al., 2022; Münster and Grabkowsky, 2023; Dash and Mahajan, 2024)

4	**OSC**	$SI + DI = \frac{(A - M)}{(A + O + M + I)}$	**(Bilgili and Ünal, 2008; Dash et al., 2022; Dash and Mahajan, 2024)**
5	**TS**	$\frac{(A + O + M)}{N} \times 100\%$	**(Dash, 2021; Dash et al., 2022; Münster and Grabkowsky, 2023; Dash and Mahajan, 2024)**

4. METHODOLOGY

4.1 Research Design

In this study, the research adopted sequential research methodology to identify, validate, and rank the management and process strategies to incorporate sustainability in construction project management. It was comprised of three key steps, as shown in **Fig. 2**.

4.2 Identification of Strategies Through Literature Review

The literature review has been conducted as the initial phase of the research over the period 2005-2025, on peer-reviewed articles, conference papers, and technical reports. This was to determine management and process strategies that facilitate the integration of sustainability in the management of construction projects, and also to ensure that every strategy is based on valid theoretical sources. The current step led to a list of confirmed strategies, which is illustrated in **Table 3**, with its description, major sources, and classification into management (M) and operational (O) strategies.

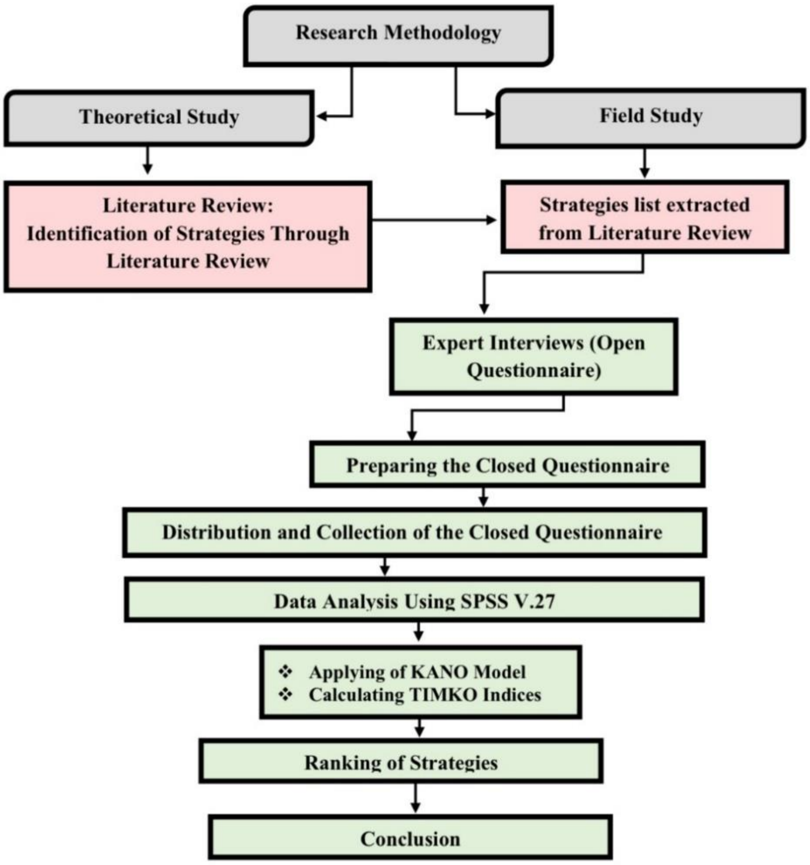

Figure 2. Research Methodology

Table 3. Identified Management and Process Strategies.

S.N.	C.	Strategy Description	References
STR.1	M	Encouraging suppliers to adopt sustainable practices in production and supply processes.	**(Shi et al., 2012; Eriksson et al., 2014;Aarseth et al., 2017)**
STR.2	M	Steering project practices toward sustainability by reducing waste and improving resource efficiency.	**(Aarseth et al., 2017; Rajab and Breesam, 2025; Tafesse et al., 2022)**
STR.3	O	Use of waste reduction technologies in design and construction.	**(Kibert, 2022; Vivian, 2011)**
STR.4	O	Integration of building service in the construction process.	**(Häkkinen and Belloni, 2011; Shen et al., 2010; Zuo and Zhao, 2014; Al-Rudainy and Mahjoob, 2024)**
STR.5	M	Coordinated supply chains in the construction process.	**(Malik et al., 2024; Arabpour and Silvius, 2023; Krainer et al., 2021)**
STR.6	M	Proper implementation of an Asset Management Plan in buildings.	**(Häkkinen and Belloni, 2011; Amadi-Echendu et al., 2010)**
STR.7	M	Efficient allocation of resources.	**(Shen et al., 2010; Krainer et al., 2021; Malik et al., 2024)**
STR.8	M	Enforcing existing green building policies and standards more effectively.	**(Gan et al., 2015; van Doren et al., 2016; Chan et al., 2017)**
STR.9	O	Implement comprehensive health and safety management systems to protect workers and improve site conditions.	**(Ayarkwa et al., 2022; Gunduz et al., 2017; Nnaji et al., 2018; Malik et al., 2024)**
STR.10	O	Develop and apply effective storage management systems to improve material handling and site organization.	**(Ayarkwa et al., 2022; Al-Shammari et al., 2024)**
STR.11	O	Utilize just-in-time scheduling to enhance workflow efficiency and reduce material waste.	**(Kabirifar et al., 2020; Ayarkwa et al., 2022; Alafeef, 2024)**
STR.12	O	Maintain Lighting systems regularly to ensure high energy efficiency.	**(Adelakun and Omolola, 2025; Nigel and Longe, 2021; Sapuan et al., 2022)**
STR.13	O	Recycling waste generated from construction activities into new building materials.	**(Nebrida and Gomba, 2023; Shooshtarian et al., 2020; Tafesse et al., 2022; Shooshtarian et al., 2020)**
STR.14	M	Repurposing existing projects to achieve sustainability goals.	**(Rajab and Breesam, 2025; Strumiłło, 2016; Aigwi et al., 2023)**
STR.15	O	Develop strategies to prevent pollution during construction.	**(Altuma et al., 2024; Al Harazi et al., 2022)**
STR.16	M	Plan the measurement and reporting of environmental and social impacts of the project.	**(Xiahou et al., 2018; Tafesse et al., 2022)**

4.3 Conducting Open-Ended Questionnaire

The second stage aimed to validate the relevance and practical applicability of the strategies identified in Stage 1 by consulting domain experts using an open-ended questionnaire.

4.3.1 Expert Selection

A total of 15 experts were selected to validate the relevance and applicability of the strategies identified in the literature review. The expert panel included professionals from academia, governmental construction agencies, and the consultancy sector, ensuring coverage of the main institutional perspectives involved in construction project management. Their academic and professional backgrounds represent key disciplines such as civil, architectural, electrical, mechanical, and environmental engineering, all of which influence sustainability-related managerial and operational decisions in construction projects. The selection of 15 experts is consistent with methodological recommendations for qualitative validation, which suggest that a panel of 10-15 experts is adequate to achieve content validity, ensure diversity of opinions and provide stability in expert judgement. Moreover, all the selected experts had more than 10 years of professional experience in construction project management, which fulfilled predetermined criteria on the reliability of expert-based evaluation. The involvement of experts representing different sectors and with a wide experience enhances the validity process and provides the best guarantee that the identified strategies are implemented in the industry. **Table 4** shows the background information of experts participating in the consultation, including their experience and professional role.

Table 4. General Information of Experts Participating in the Open-ended Questionnaire

Expert Number	Scientific Qualification	Specialization	Work Sector	Years of Experience
EXPERT (1)	M.Sc.	Civil Engineering / Construction Project Management	Ministry of Education	17
EXPERT (2)	M.Sc.	Civil Engineering / Construction Project Management	Ministry of Higher Education and Scientific Research / Scientific Research Authority	32
EXPERT (3)	Ph.D.	Environmental Engineering	Ministry of Higher Education and Scientific Research / Scientific Research Authority	35
EXPERT (4)	M.Sc.	Architectural Engineering	Ministry of Higher Education and Scientific Research / Scientific Research Authority	32
EXPERT (5)	B.Sc.	Electrical Engineering	Ministry of Higher Education and Scientific Research / Scientific Research Authority	25
EXPERT (6)	B.Sc.	Mechanical Engineering	Ministry of Higher Education and Scientific Research / Scientific Research Authority	35
EXPERT (7)	M.Sc.	Chemical Engineering	Ministry of Higher Education and Scientific Research / Scientific Research Authority	29
EXPERT (8)	Ph.D.	Civil Engineering / Construction Project Management	Ministry of Construction, Housing and Public Municipalities	15

Expert Number	Scientific Qualification	Specialization	Work Sector	Years of Experience
EXPERT (9)	B.Sc.	Architectural Engineering	Ministry of Construction, Housing and Public Municipalities	28
EXPERT (10)	M.Sc.	Electrical Engineering	Ministry of Higher Education and Scientific Research / Scientific Research Authority	35
EXPERT (11)	B.Sc.	Building and Construction Engineering	Private Sector	26
EXPERT (12)	B.Sc.	Building and Construction Engineering	Ministry of Higher Education and Scientific Research / Scientific Research Authority	30
EXPERT (13)	B.Sc.	Electrical Engineering	Ministry of Higher Education and Scientific Research / Scientific Research Authority	22
EXPERT (14)	B.Sc.	Architectural Engineering	Ministry of Construction, Housing and Public Municipalities	16
EXPERT (15)	Ph.D.	Civil Engineering / Structural Engineering	Ministry of Construction, Housing and Public Municipalities	28

4.3.2 Questionnaire Design

Experts were given the list of strategies and asked to either confirm or reject the relevance of each strategy in the form of a Yes/No answer. This way, the process was possible to validate clearly, but still left a space for comments or suggestions for refinement.

4.3.3 Data Collection and Analysis

Responses of all 15 experts were collated in **Table 5**, showing the results of validation for each strategy. The analysis has shown that there was agreement on all strategies between more than 50% of the experts, which is the threshold of agreement for practical relevance. The use of a 50% agreement threshold is supported by methodological standards in expert-based research. Studies such as **(Okoli and Pawlowski, 2004; Hallowell and Gambatese, 2010)** note that in the case of more than half of an expert panel agreeing on an item, it can be considered that a minimum acceptable level of consensus has been reached. Therefore, adopting the criterion of >50% agreement in this study is consistent with practices of expert judgment. Consequently, all identified strategies were kept and passed through to the closed questionnaire stage for Kano-based assessment, in order to ensure that the following quantitative evaluation was based on a comprehensive and expert-validated list of management and process strategies.

Table 5. Expert Responses and Validation Results

S.N.	EXPERT 1	EXPERT 2	EXPERT 3	EXPERT 4	EXPERT 5	EXPERT 6	EXPERT 7	EXPERT 8	EXPERT 9	EXPERT 10	EXPERT 11	EXPERT 12	EXPERT 13	EXPERT 14	EXPERT 15	Consensus %
STR.1	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	86.6%
STR.2		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	86.6%
STR.3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	100%
STR.4	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	93.3%
STR.5	✓	✓	✓		✓	✓			✓	✓	✓		✓	✓	✓	73.3%
STR.6	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	93.3%
STR.7	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	86.6%
STR.8	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	100%
STR.9	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓	✓	✓	86.6%
STR.10	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓		80%
STR.11	✓	✓	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓		80%
STR.12	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	93.3%
STR.13	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	93.3%
STR.14		✓	✓		✓	✓	✓		✓	✓	✓	✓	✓	✓		73.3%
STR.15	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	93.3%
STR.16	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	93.3%

4.4 Conducting Closed-Ended Questionnaire

The third stage involved a quantitative assessment to classify and prioritize the validated strategies using the Kano model. A closed questionnaire was developed.

4.4.1 Sample Size and Participants' Profile

A total of 95 closed-ended questionnaires were distributed to professionals working in the fields of sustainability and construction project management. Out of these, 83 questionnaires were fully completed and considered valid for analysis, yielding a high response rate of 87.4%. The final sample size is methodologically adequate for Kano model applications. Several methodological studies report that a minimum of 50 respondents is sufficient to obtain stable and reliable Kano category classifications **(Sauerwein et al., 1996; Bilgili and Ünal, 2008; Cho and Kim, 2022)**. Samples exceeding 70 participants are generally regarded as highly robust for quantitative Kano evaluation, providing strong representativeness and minimizing category fluctuation.

Accordingly, the sample size of 83 obtained is above the recommended methodological threshold, which ensures high reliability in the identification of satisfaction - dissatisfaction patterns and strong statistical validity for the computation of Timko indicators. The participants came from various engineering specializations and different job sectors such as public agency, private contractor, and consultancy agency which improve the generalizability of the results in the context of construction project management. **Fig. 3** presents the educational level, most of them with bachelor or master degree and a percentage with PhD, **Fig. 4** Field of Specialization, principally areas of Civil Engineering, Architectural and Mechanical, **Fig. 5** Employment Sectors, split between the public and private sector and **Fig. 6** years of experience, most of them with more than 10 years in construction projects.

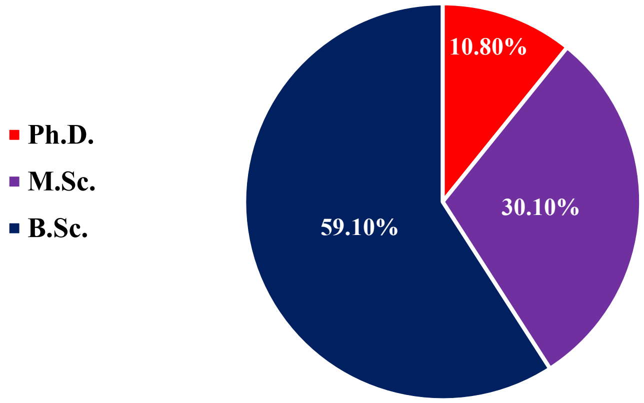

Figure 3. Respondents' Educational Attainment

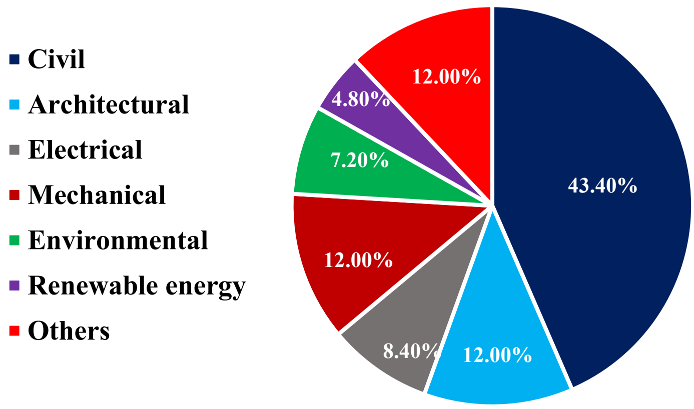

Figure 4. Respondents' Field of Specialization

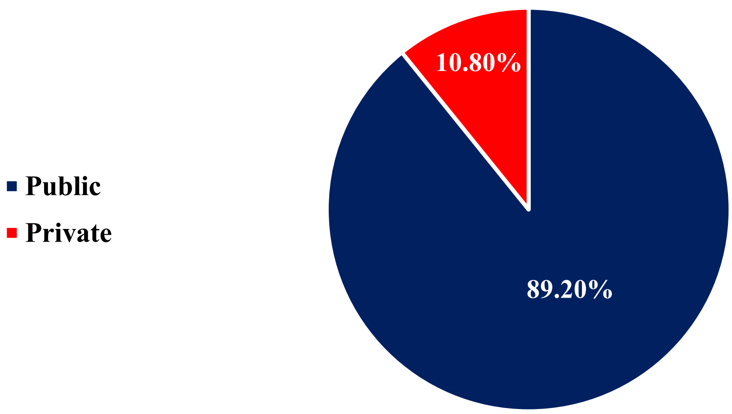

Figure 5. Respondents' Field of Specialization

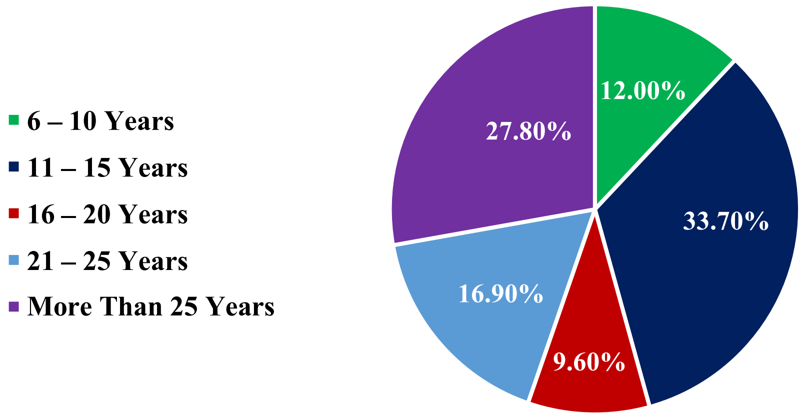

Figure 6. Respondents' Years of Experience

4.4.2 Kano Classification Results

The analysis of the Kano model for the management and process-related strategies showed that all were placed in the category of Attractive or Indifferent strategies. This suggests that respondents saw these strategies as either being value enhancing interventions that create satisfaction when applied (Attractive) or as having little effect on satisfaction (Indifferent). The lack of the Must-Be, One-Dimensional, Reverse or Questionable classifications implies that from the participant's view, managerial and operational strategies are viewed as generally desirable but not essential to their expectations and not their core expectations. The results of the detailed classification are given in **Table 6.**

Table 6. Kano Classification Results for Management and Process-Related Strategies

Strategy	N	KANO Categories						Result
		Reverse	Questionable	Indifferent	Attractive	Must-be	One Dimensional	
STR.1	83	0	1	41	29	1	11	Indifferent
STR.2	83	0	0	20	35	2	26	Attractive
STR.3	83	1	1	21	35	3	22	Attractive
STR.4	83	0	0	47	26	0	10	Indifferent
STR.5	83	0	0	52	19	2	10	Indifferent
STR.6	83	0	0	30	31	3	19	Attractive
STR.7	83	0	0	32	25	2	24	Indifferent
STR.8	83	1	0	12	35	2	33	Attractive
STR.9	83	0	0	17	33	2	31	Attractive
STR.10	83	0	0	35	33	0	15	Indifferent
STR.11	83	1	0	28	35	1	18	Attractive
STR.12	83	0	0	23	34	2	24	Attractive
STR.13	83	0	0	27	39	0	17	Attractive
STR.14	83	2	0	39	32	1	9	Indifferent
STR.15	83	0	0	20	35	3	25	Attractive
STR.16	83	0	0	40	26	2	15	Indifferent

4.4.3 Timko Analysis Procedure

The Timko analysis was carried out in order to quantitatively assess the sustainability strategies in terms of calculation of the Kano Classification Strength (KCS), Satisfaction Index (Si) and the Dissatisfaction Index (Di). Each strategy was represented as a coordinate (Si, Di) on the satisfaction - dissatisfaction diagram given in **Fig. 7** to identify its actual Timko classification. Finally, the Overall Satisfaction Coefficient (OSC) and Total Strength (Ts) were calculated to prioritize strategies based on the whole of their capacity to improve satisfaction and decrease dissatisfaction, yielding an evidence-based prioritization framework that combines stakeholder perceptions with quantitative metrics.

Example of Calculation for (KCS, SI, DI, OSC, and TS) Values for STR.1:

1. Applying Eq. (1) in **Table 2**: **KCS =** (41/83)% - (29/83)% = 14.45%
2. Applying Eq. (2) in **Table 2**: **SI =** (29+11)/(29+11++1+41) = 0.49
3. Applying Eq. (3) in **Table 2**: **DI =** (1+11)/(29+11++1+41) = 0.15
4. Applying Eq. (4) in **Table 2**: **OSC =** (29-1)/(29+11++1+41) = 0.49 – 0.15 = 0.34
5. Applying Eq. (5) in **Table 2**: **TS =** [(29+11+1)/(83)]×100% = 49.40%

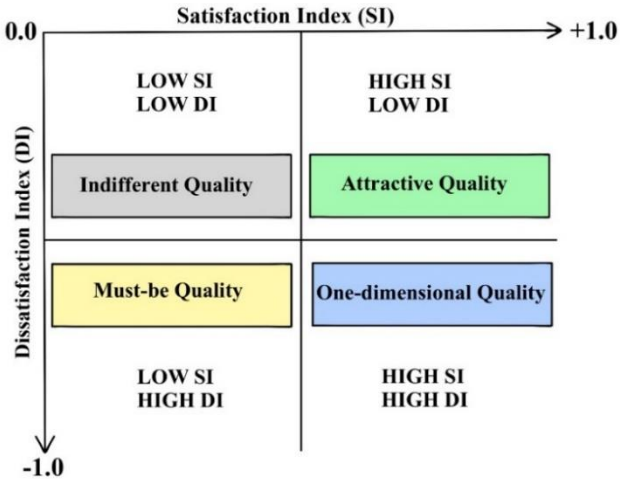

Figure 7. Application of Kano Model **(Timko, 1993; Cho and Kim, 2022)**.

4.4.4 Timko Classification Results

The Timko analysis done to the management and process strategies group proved that the majority of the strategies remained in their corresponding Kano categories. But three strategies (STR.7, STR.10, STR.14) are reclassified as Attractive rather than Indifferent, which shows that the participants understood that there is more potential in these strategies than in the Kano model to raise the degree of satisfaction. The last prioritization of the strategies of this group was determined on the basis of the application of the OSC and TS values, and the entire analysis findings are presented in **Table 7.**

To further visualize these results, radar charts were created in order to show the variation of values for the Satisfaction Index (SI) and Dissatisfaction Index (DI) across the strategies. For the clarity of presentation, the strategies were split into two groups, as **Fig. 8** shows the SI and DI values for the first eight strategies and **Fig. 9** show the corresponding values for the other eight strategies. These visualizations enable an intuitive comparison of different perceptions of stakeholders, indicating the relative positioning of strategies that have higher SI values (which means higher potential for satisfaction) as compared to strategies that have higher DI values (which means higher potential for causing dissatisfaction). Together, the radar charts complement the tabulated results as they provide a comprehensive graphical representation of Timko analysis results.

Table 7. TIMKO Results Classification for Management and Process Strategies

Strategy	KANO Quality Classification	Category Strength (KCS)	Better Index (SI)	Worse Index (DI)	(SI, DI)	TIMKO Quality Classification	Overall Satisfaction Coefficient (OSC)	Total Strength (TS)	Rank
STR.1	**Indifferent**	**14.46 %**	0.49	-0.15	(0.49, -0.15)	**Indifferent**	**0.34**	**49.40 %**	**14**
STR.2	**Attractive**	**10.84 %**	0.73	-0.34	(0.73, -0.34)	**Attractive**	**0.39**	**75.90 %**	**3**
STR.3	**Attractive**	**15.66 %**	0.70	-0.31	(0.70, -0.31)	**Attractive**	**0.39**	**72.29 %**	**5**
STR.4	**Indifferent**	**25.30 %**	0.43	-0.12	(0.43, -0.12)	**Indifferent**	**0.31**	**43.37 %**	**15**
STR.5	**Indifferent**	**39.76 %**	0.35	-0.14	(0.35, -0.14)	**Indifferent**	**0.21**	**37.35 %**	**16**
STR.6	**Attractive**	**1.20 %**	0.60	-0.27	(0.60, -0.27)	**Attractive**	**0.33**	**63.86 %**	**9**
STR.7	**Indifferent**	**8.43 %**	0.59	-0.31	(0.59, -0.31)	**Attractive**	**0.28**	**61.45 %**	**10**
STR.8	**Attractive**	**2.41 %**	0.83	-0.43	(0.83, -0.43)	**Attractive**	**0.4**	**84.34 %**	**1**
STR.9	**Attractive**	**2.41 %**	0.77	-0.40	(0.77, -0.40)	**Attractive**	**0.37**	**79.52 %**	**2**
STR.10	**Indifferent**	**2.41 %**	0.58	-0.18	(0,58, -0.18)	**Attractive**	**0.4**	**57.83 %**	**11**
STR.11	**Attractive**	**8.43 %**	0.65	-0.23	(0.65, -0.23)	**Attractive**	**0.42**	**65.06 %**	**8**
STR.12	**Attractive**	**12.05 %**	0.68	-0.31	(0.68, -0.31)	**Attractive**	**0.37**	**72.29 %**	**6**
STR.13	**Attractive**	**26.51 %**	0.67	-0.20	(0.67, -0.20)	**Attractive**	**0.47**	**67.47 %**	**7**
STR.14	**Indifferent**	**8.43 %**	0.51	-0.12	(0.51, -0.12)	**Attractive**	**0.39**	**50.60 %**	**12**
STR.15	**Attractive**	**12.05 %**	0.72	-0.34	(0.72, -0.34)	**Attractive**	**0.38**	**75.90 %**	**4**
STR.16	**Indifferent**	**16.87 %**	0.49	-0.20	(0.49, -0.20)	**Indifferent**	**0.29**	**51.81 %**	**13**

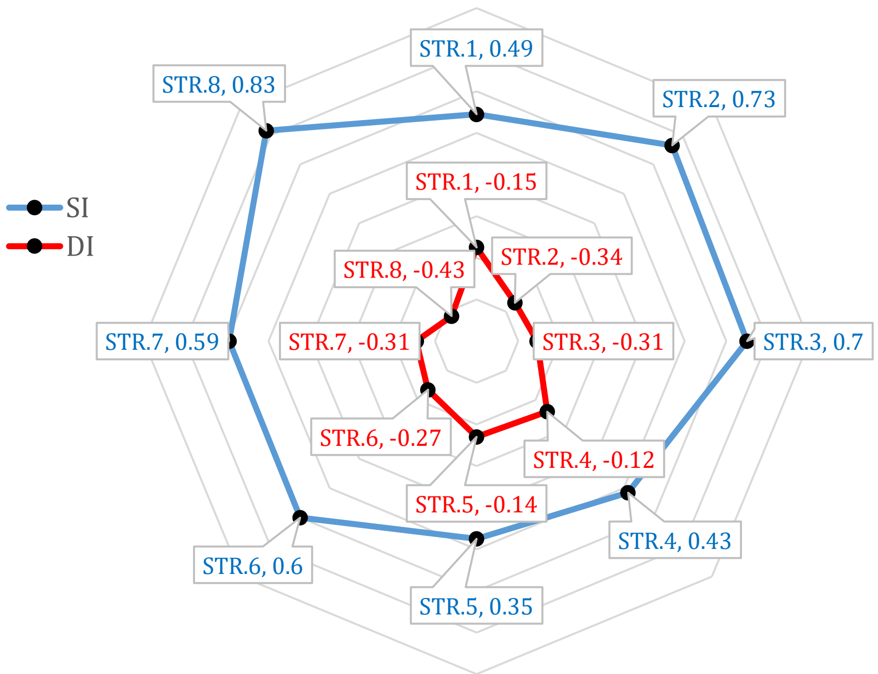

Figure 8. Radar chart of SI and DI for strategies (Group 1)

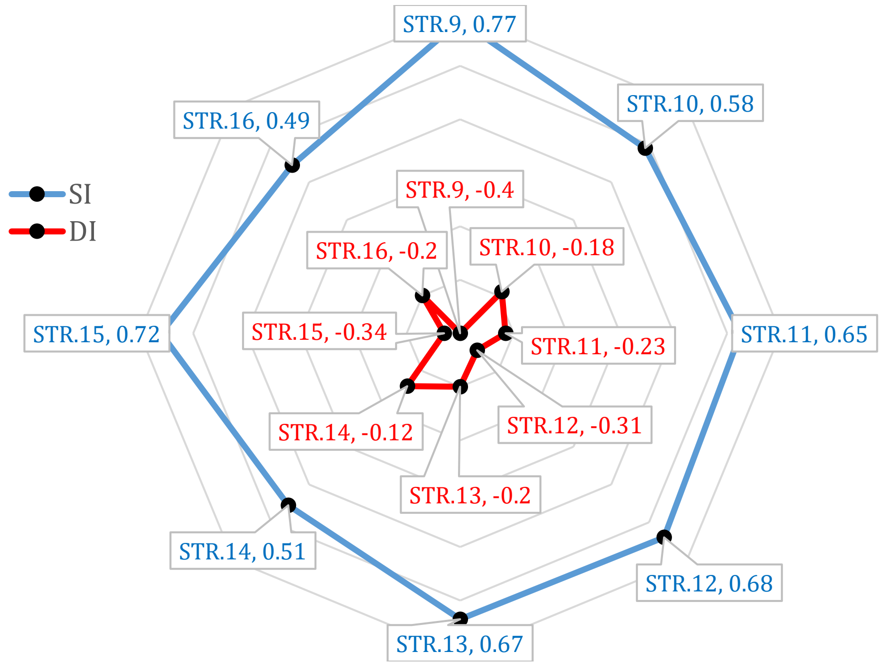

Figure 9. Radar chart of SI and DI for strategies (Group 2)

5. CONCLUSIONS

This study presents empirical insights into integrating sustainability into construction project management through management- and process-based strategies. Using a combined Kano - Timko evaluation, the research creates a prioritized set of strategies based on stakeholder satisfaction and dissatisfaction. The results show that resource efficiency-related, construction waste reduction-related, environmental compliance-related, and site safety management-related strategies are high-impact Attractive attributes, which indicates that these strategies exert a strong influence on stakeholder satisfaction and the sustainable delivery of the project. The findings also confirm that integration of sustainability is not so much about advanced technologies or green design per se, but about efficient managerial and operational practices associated with day-to-day project operations. Accordingly, the study emphasizes on the significance of considering sustainability as a fundamental management function and offers practical information for the decision-makers to concentrate on the most powerful strategies for improving sustainability performance in construction projects.

Credit Authorship Contribution Statement

Ahmed Basim Nasaif: Writing – original draft, review & editing, Research, Validation, Software, Methodology, Data collection, Data Analysis. Ahmed Mohammed Raoof Mahjoob: Supervision, Review & Editing, Validation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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تقييم وترتيب أولويات الاستراتيجيات الإدارية والعملية لدمج الاستدامة في إدارة المشاريع الإنشائية: دراسة باستخدام نموذج كانو في العراق

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الخلاصة

يتطلب دمج الاستدامة في إدارة المشاريع الإنشائية اعتماد ممارسات عملية تركز على الجوانب الإدارية وتعالج التحديات البيئية والاقتصادية والتشغيلية. تهدف هذه الدراسة إلى مراجعة وترتيب أولويات استراتيجيات الإدارة والعمليات المرتبطة بدمج مفهوم الاستدامة في المشاريع الإنشائية. وقد شملت منهجية البحث إجراء مراجعة منهجية للأدبيات، تلتها مرحلة التحقق من قبل الخبراء باستخدام استبيان مفتوح، ثم استبيان مغلق وُزّع على 83 مختصًا. جرى تحليل البيانات باستخدام نموذج كانو (Kano) ومؤشرات تيمكو (Timko) لترتيب الاستراتيجيات وتحديد أولوياتها وفقًا لتأثيرها في رضا وعدم رضا أصحاب المصلحة. أظهرت النتائج أن الاستراتيجيات المتعلقة بكفاءة استخدام الموارد، وتقليل نفايات البناء، والالتزام البيئي، وإدارة السلامة في الموقع صُنِّفت كسمات جذابة ذات تأثير عالٍ، لما لها من قدرة كبيرة على تعزيز رضا أصحاب المصلحة. بالإضافة إلى ذلك، تم تحديد ثلاث استراتيجيات كانت مصنفة في البداية كسمات غير مؤثرة (Indifferent) وفق نموذج كانو، على أنها سمات جذابة عند تطبيق تحليل تيمكو، مما يعكس تزايد أهميتها في ممارسات الاستدامة التشغيلية. وتقدم هذه الدراسة إطارًا تجريبيًا لترتيب الأولويات، يوفّر إرشادات قيّمة لصناع القرار في قطاع الإنشاءات للتركيز على أكثر الاستراتيجيات تأثيرًا في تحقيق تسليم مستدام للمشاريع.

الكلمات المفتاحية: الاستدامة، إدارة المشاريع الإنشائية، الاستراتيجيات، الإدارة والعمليات، نموذج كانو.