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Research Article

Development of a Performance Assessment Model for Contractors in Saudi Arabian Construction Projects

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Saudi Arabia leads the Gulf Cooperation Council countries in the construction industry, with 63% of the region's future projects and $1.4 trillion in building and transportation projects. Previous studies have shown that 60% of construction projects are behind the schedule. One of the reasons behind this delay is the inappropriate selection of contractors for construction projects; therefore, the development of a contractor performance assessment model is needed for construction projects in Saudi Arabia. The proposed model includes the major key performance indicators (KPIs) used to measure contractors' performance in construction projects. Afterward, a questionnaire is conducted with construction professionals to recommend the important KPIs to consider while developing the model. The analytic hierarchy process decision-making technique is applied for assessing relative priorities among the identified KPIs based on expert or decision-maker consensus. The results show that the time category is the most important in selecting the best contractor, emphasizing the significance of timely project completion.

1. Introduction

1.1. Background and Motivation. Nowadays, Saudi Arabia is witnessing a boom in the construction industry in light of 2030 Saudi vision and demand for building millions of housing projects. Construction firms encounter several challenges in the continuously evolving construction sector due to increased uncertainty in technology, budget, and development process. These hindrances are exacerbated by several factors such as the complexity of planning, design, and construction as well as the presence of different interest groups (i.e., contractors, owners, consultants, suppliers, etc.) [1, 2]. In Saudi Arabia, the construction sector is affected by several challenges. Payment delay is a common problem that jeopardizes the financial viability of businesses [3, 4]. In addition, the sector has a labor shortage, mostly because of its reliance on foreign labor, which causes delays in project completion and may result in penalties [5, 6]. The expense of incorporating technology developments might be prohibitive for many firms, even though they provide prospects for enhanced efficiency and safety [7–9]. Excessive costs for resources, such as raw materials, also lead to delays in projects and overspending. Furthermore, workers' safety and the success of projects are in danger when safety training is neglected [10, 11]. These challenges highlight the necessity for encompassing measures to raise the resilience and productivity of the Saudi Arabian building sector.

Spencer and Spencer [12] introduced the concept of "competencies," measurable activities and interactions within construction projects that distinguish between average and high-performance levels. These competencies indicate distinct performance levels and are crucial for assessing construction organizations and projects, facilitating improvements in organizational and project performance. Key performance indicators (KPIs), essential metrics for project and organizational success, are described as criteria used to evaluate tasks in construction projects. According to Zavvy [13], these criteria include accuracy, completeness, cost, and time, and they serve as predefined requirements for project performance assessment. KPIs enable the comparison of actual project performance against anticipated outcomes, encompassing effectiveness, craftsmanship, efficiency, and product quality [14, 15].

1.2. Problem Statement. Saudi Arabia, nowadays, is witnessing a boom in the construction industry in light of 2030 Saudi vision and demand for building millions of housing projects [16, 17]. Previous studies showed that 60% of the construction projects are behind schedule because of the inappropriate selection of contractors for construction projects [18]. Another reason might be the cost deviation of construction projects [19]. The contractors should be selected based on their performance in previous projects [20–23]. Previous studies showed that there is a lack of measurement tools for assessing the performance of contractors in construction projects. Hence, this study aims to bridge this gap by developing a performance assessment model for contractors in Saudi Arabian construction projects. The subobjectives are defined as follows: (1) review the contractor performance assessment methods in Saudi Arabia, (2) define, weigh, and measure the KPIs of contractors, and (3) develop the proposed contractor performance assessment model in Saudi Arabia.

2. Literature Review

2.1. Theoretical Background. KPIs serve as crucial metrics for gauging the success of endeavors, particularly in the organizational context [24, 25]. They offer insights into project achievement, aiding informed decisions for subsequent or related undertakings. Time often serves as a primary metric of effectiveness, with increased labor productivity being indicative of daily workload. Reduced workforce productivity can lead to prolonged project timelines, potentially escalating overall costs [26]. Construction KPIs, encompassing health, safety, and accident rates, significantly influence project outcomes. Favorable health and safety records signify successful construction projects. Moreover, low accident rates and high employee satisfaction enhance workforce quality, attracting new talented workers and employees [27]. Comprehensive project success involves factors such as material quality, proper handling, inventory management, management efficacy, and resource coordination along with external conditions like climate and geographical aspects [28, 29]. Leveraging gathered metrics, KPIs not only aid construction business enhancement but also serve as benchmarks for industry comparison. KPIs also aid in future project preparation by refining cost estimates and project plans based on past performance data. In conclusion, KPIs play a pivotal role in assessing project success, enabling meticulous future project planning, and positioning a business within the industry landscape.

2.2. Previous Work. Numerous research studies have been published on the performance assessment models in construction. For instance, Ali et al. [30] identified KPIs that Saudi Arabian construction executives might use to measure success at the corporate level. The literature research led to an identification of 47 performance indicators. A questionnaire survey was undertaken on a set of randomly selected Saudi construction companies. Ten important KPIs were provided as a result of the statistical analysis of the gathered replies. The results showed that traditional financial metrics cannot be the only factor determining a firm's performance. The significance of other performance measures such as external customer satisfaction, safety, company efficiency, and planning effectiveness was growing. The study's outcome was a list of KPIs that can be used as a starting point for developing a national benchmarking system to improve the performance of construction enterprises in the Kingdom.

Matoug et al. [31] developed the most typical KPIs for Libyan oil and gas projects. The most crucial KPIs were determined by evaluating the literature and validated through questionnaire surveys and semistructured interviews with project practitioners, including clients, consultants, and contractors. According to the findings, it was no longer possible to evaluate the performance and accomplishment of these projects using the conventional KPIs. Other essential key performance metrics, including those related to sustainability, maintainability, shareholder satisfaction, health, safety, environment, resource efficiency, profitability, and learning acquired from the project, were becoming more significant.

Enshassi et al. [32] identified and assessed the primary elements influencing the success of building projects in the Gaza Strip. Out of the 60 distributed surveys among contractors, only 46 were received with a 77% response rate. Ten categories were extracted from the 63 identified criteria. From the contractors' viewpoints, the relative significance of these criteria was rated using the relevance index. The average delay brought on by closures and material shortages, the availability of resources, the project manager's leadership abilities, the increase in material prices, the availability of highly skilled staff, and the quality of the machinery and raw materials were the most crucial factors.

El Touny et al. [33] identified the most crucial performance indicators for gauging the satisfaction of various project stakeholders. Eight primary perspectives namely, financial, operation, stakeholders, human capital, health, safety, environmental, social, innovation, learning, and growth were used to categorize indicators. First, 110 indicators were identified from the literature to be filtered using a questionnaire. Finally, the top 40 indicators influencing the development project's success were determined.

Enshassi et al. [34] identified the performance of building projects and elicited judgments of their relative values. An extensive research was adopted to generate a list of variables that impact project performance. The three main project participant groups (i.e., owners, consultants, and contractors) were each given a total of 120 questionnaires. The survey results showed that delays caused by closed borders or roads resulting in a shortage of materials, a lack of resources, poor project leadership abilities, an increase in material prices, a shortage of highly experienced and qualified workers, and inadequate equipment and raw materials were the most significant factors influencing project performance.

Alzahrani and Emsley [35] identified the contractors' most crucial success factors (CSFs) and linked these factors to project success goals. A literature research was first carried out to examine the CSFs of contractors in construction projects. The attitudes of construction professionals regarding the CSFs of contractors were then determined by a survey. A total of 164 questionnaires with a 32% response rate were gathered and analyzed using SPSS. Nine underlying clusters were revealed by factor analysis, including health, safety, and quality, historical performance, environment, management and technical elements, resource, organization, experience, size/type of prior projects, and cash. These clusters were found to exert a considerable influence on project success.

In each of the engineering, procurement, and construction (EPC) phases, Habibi et al. [36] evaluated the KPIs and best practices for the identified phase-based metrics. A survey was conducted after a review of the body of current literature to gather information from the completed building projects. The data were analyzed using some statistical techniques, such as the Kruskal–Wallis test and the two-sample t-test. The Epsilon-squared impact size approach was then used to prioritize the selected KPIs. It was determined that managerial actions had a significant impact on timetable performance since delayed decision-making and poor communication were found to be the main schedule performance indicators. Clients also had a significant impact since owner-driven change orders were found to be the most important cost performance indicator influencing how well the engineering and construction phases performed.

Monyane et al. [37] determined the KPIs for assessing the efficiency of applying lean construction principles in South Africa. Content analysis was used to extract pertinent KPIs from conference materials posted between 1996 and 2016 on the website of the International Group for Lean Construction. Then, a set of contractors were interviewed to name the KPIs used by their companies. The most notable KPIs were mostly the traditional ones, such as cost, time, quality, customer satisfaction, reduced environmental effect, and increased value. This insight confirmed the view that South Africa had not yet adopted lean construction approaches to a significant degree, and standard KPIs were insufficient to provide evidence to the contrary.

According to the features of small construction firms, Kim et al. [38] developed management performance evaluation indicators (MAPEIs) for assessing the management performance of small companies with 10 or less employees. A balanced scorecard, performance, and the ranking and weighting of KPIs made up MAPEIs. Following an expert interview, a final hierarchy of small construction businesses was developed based on the management performance indicators of major construction firms. The analytic hierarchy process (AHP) approach was used to examine the KPIs of the hierarchy and finalize MAPEIs for small construction enterprises in Korea. Finally, these indicators underwent a feasibility assessment to be put into practice.

A methodology for evaluating the performance of building contractors in Saudi Arabia was proposed by Tuffaha et al. [39]. A contractor's evaluation was primarily centered on financial factors while overlooking other nonfinancial factors. Therefore, a more thorough structure was required for the contractor's assessment in the Saudi Arabian construction sector. To guarantee that the most popular KPIs are properly aligned with Saudi Arabian construction business, the literature was first studied, and the most popular KPIs were recognized and assessed through contractors' inputs. Based on the views of the surveyed contractors, the selected set of KPIs was further prioritized using the relative importance index technique. Furthermore, using principle component analysis, the significant set of KPIs was divided into several categories, and the results were then verified by professional judgment. With the exception of the environmental category, all KPIs were demonstrated to be relevant. Performance, contentment, actual metrics, estimated metrics, and compliance were established as the five generic dimensions.

According to Naik et al. [40], many construction firms use the ISO 9000 series, an integrated system that promotes uniformity and improved project performance. The basic data for this research were gathered using questionnaire surveys with various contractors, clients, and consultants in India. In order to determine the variables influencing contractor performance in building projects, a few specialists were questioned and their comments were gathered. The study's findings resulted in the identification of 91 variables that might influence a contractor's performance throughout a building project. The factors were then divided into 12 broad categories, including cost, time, quality, management, material, worker, health and safety, client satisfaction, environmental, execution, design and documentation, and productivity. The relative relevance index technique was finally used to rank the contractor performance indicators.

Radujković et al. [41] examined the definition, purpose, and forms of KPIs in the construction sector from various managerial perspectives. A literature research was conducted to compile a list of KPIs in academia and business. The following step comprised gathering information from more than 30 construction firms in Southeast Europe using questionnaires and semistructured interviews. A list of KPIs was developed after detecting considerable discrepancies in interpreting KPIs by investors, consultants, and contractors. Quality, cost, investor interventions, project support modifications, time increase, customer and staff satisfaction, innovation and training, time, and customer interest were among the top 10 KPIs.

According to Takim and Akintoye [42], the UK working group defined 10 KPI factors for benchmarking projects in order to achieve good performance. Additionally, the study provided an overview of the metrics created to assess the performance of project and stakeholders. The proposed model comprised seven project performance metrics, namely construction cost, construction time, cost predictability, time predictability, defects, and customer satisfaction with product and service. Indicators of business success included productivity, profitability, and safety. Besides, three factors namely procurement direction, procedure, and outcome can be separated out to determine the successful implementation of a building project.

2.3. Summary. While previous studies collectively emphasized the effectiveness of using KPIs for evaluating construction projects, there remains a noticeable research gap that necessitates further investigation. The existing literature predominantly focused on KPIs tailored for large construction companies with major stakeholders, leaving a void in specific KPIs designed to evaluate contractors and ensure the seamless execution of projects. This gap underscores the critical need for this research article, which aims to address this gap by establishing a strong set of KPIs that are especially designed to evaluate contractor performance in building projects.

This research addresses an essential gap in the literature by recognizing the limitations of previous studies and pinpointing the specific area where research is required. This research attempts to offer useful insights and practical tools for enhancing the evaluation of contractors in construction projects through a methodical approach and thorough analysis. This advances scientific understanding while also providing tangible benefits to stakeholders and industry practitioners seeking to enhance project outcomes and overall performance.

Furthermore, the relevance and application of KPIs are prone to change as the construction sector continues to evolve in response to social, technical, and economic developments. In order to meet this dynamic landscape, the study provides contextually relevant KPIs that are in line with the evolving goals of the construction industry. This study is an invaluable resource for academics, practitioners, and policymakers attempting to manage the intricacies of contractor assessment in construction projects since it bridges the research gap and provides pertinent insights.

3. Methodology

3.1. Overview. The overall methodology of the present study is summarized in Figure 1, which illustrates the various inputs, analysis, and expected output. The inputs include reviewing the contractors' performance assessment methods in Saudi Arabia. Subsequently, a model is developed to review and understand the contractor's performance assessment comprehensively. The model includes the major KPIs used to measure contractors' performance in construction projects. Afterward, a questionnaire is conducted among construction professionals to provide feedback on the important KPIs to consider while establishing the model. These same KPIs are arranged and prioritized based on their importance, after which the contractor is evaluated and awarded a certificate.

3.2. Literature Review. Previous studies have shown the effectiveness of using a KPI for evaluating contractors involved in construction projects. These indicators are summarized in categories, including profitability, stakeholders/owner satisfaction, time, and cost predictability. These categories serve as valuable indicators of the ongoing project's performance and illuminate areas where mistakes maybe occur. These metrics are also valuable for documenting the success of a construction project and determining strategies to replicate this success in future projects. The research gap is that most of the KPIs are for large construction companies with major stakeholders; therefore, a more specific KPI is needed to evaluate contractors to help projects succeed flawlessly. Reviewing the literature provided insight into the prevalent KPIs, which were subsequently compared and analyzed. The most frequently encountered indicators were extracted and utilized in the questionnaire survey.

3.3. Questionnaire Survey Formulation. A thorough literature analysis of previous studies yielded a set of 53 raw KPIs, as shown in Figure 2. The seven performance perspectives were used to categorize these metrics. A questionnaire survey was conducted with experts in the construction field to refine and prioritize the identified KPIs. A total of 37 experts participated in the survey, and their demographics encompassed diverse backgrounds and expertise. Among them, 63% were male and 37% were female. The age range of the experts spanned from 30 to 60 years old, with an average age of 45. Geographically, they represented different Saudi regions. Additionally, their professional backgrounds encompassed various disciplines such as architecture, civil engineering, building engineering, and facility management. This diverse pool of experts ensured comprehensive insights and perspectives during the survey's evaluation phase.

There are two main sections in the questionnaire: Questions concerning the scope, significance, and utilization methodology of KPIs in construction enterprises were asked in the first section. Besides, questions were asked on the prevalence of benchmarking methodologies in Saudi Arabian construction firms and the specific types of benchmarking practices employed. The focus of this section was to refine and clarify the identified criteria in the context of Saudi Arabian construction firms. In the second section, respondents were instructed to denote the importance of each KPI by using a tick for those deemed crucial and a cross for those considered less essential. They were also encouraged to contribute any additional KPIs not mentioned in the provided list. The data collected were analyzed by excluding the KPIs marked with a cross or left unmarked by at least two experts. Subsequently, unlisted indicators provided by the experts were incorporated to ensure a comprehensive list of KPIs.

3.4. Pairwise Comparison Development. The relevance of decision components relative to the criteria within each cluster was compared pairwise. Additionally, the clusters were compared in alignment with the study's objectives. The experts in the relevant field of study were enlisted to evaluate the impact of each criterion on the other criteria, thereby determining the relative relevance of KPIs and sub-KPIs. The significance of each criterion's KPIs in relation to each consecutive sub-KPI was also mentioned. A fundamental scale with the terms 1–9 was used to measure the degree of

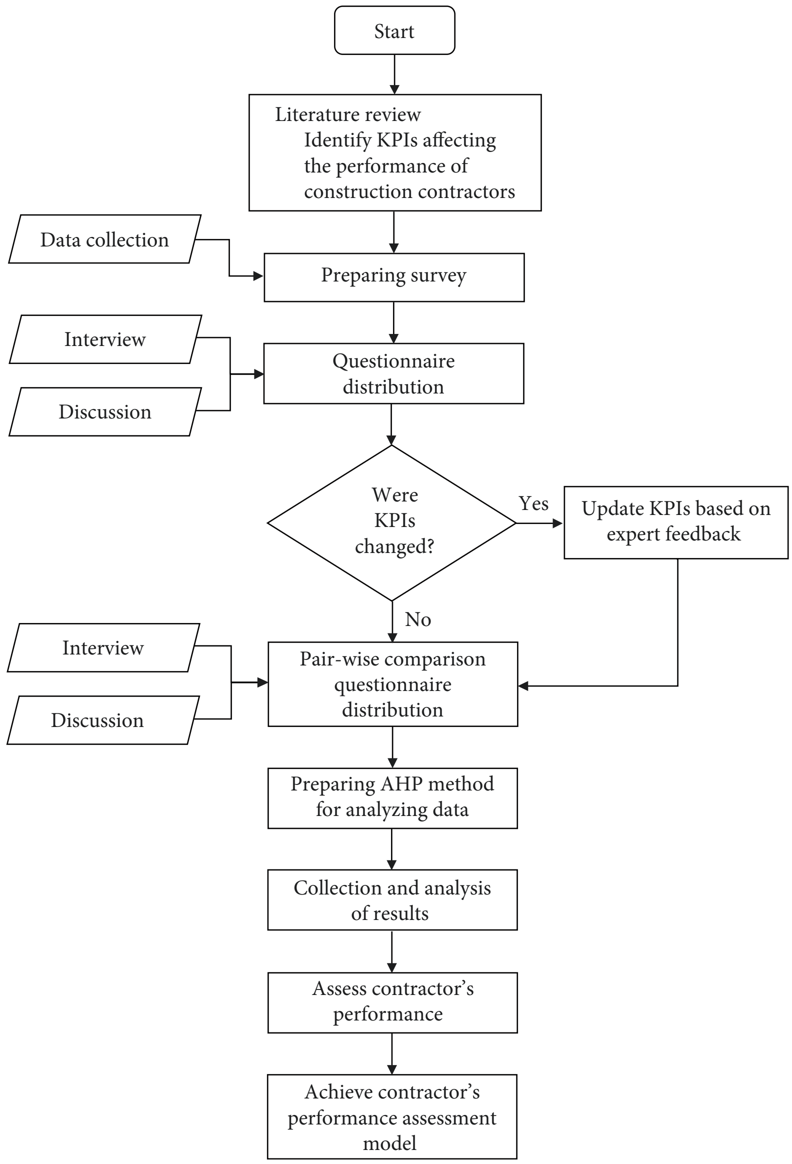

Figure 1: Methodology flowchart.

preference between two elements, where 9 represented "extremely," 8 denoted "very strongly to extremely," 7 indicated "very strongly," 6 represented "strongly to very strongly," 5 denoted "strongly," 4 indicated "moderately to strongly," 3 represented "moderately," 2 denoted "equally to moderately," and 1 indicated "equally."

3.5. Preparing AHP Method for Analyzing Data. The AHP methodology is well suited for the contractor selection decision-making problem for several reasons. First, the intricate process of assessing contractor performance necessitates a methodical strategy to efficiently evaluate and weigh various criteria and subcriteria. AHP, developed by Saaty [43], provides a structured framework for assessing relative priorities for a given set of alternatives on a scale of (1–9) based on multiple criteria. AHP offers the flexibility to include stakeholders' subjective evaluations and preferences. This technique uses the pairwise comparison technique and expert judgments to quantify subjective preferences while providing a structured, straightforward answer to the decision-making problem. Furthermore, AHP has been widely used in many construction-related studies (e.g., contractor selection [44], risk assessment [45], contractor assessment during project lifecycle [46], and professional conduct of contractors [17]), demonstrating its applicability and effectiveness in evaluating performance and making informed decisions. The procedures for utilizing the AHP are as follows [47]:

(1) Identify the problem and ascertain its goal.
(2) Establish the hierarchy starting at the top, representing the decision-maker's goals, moving down through

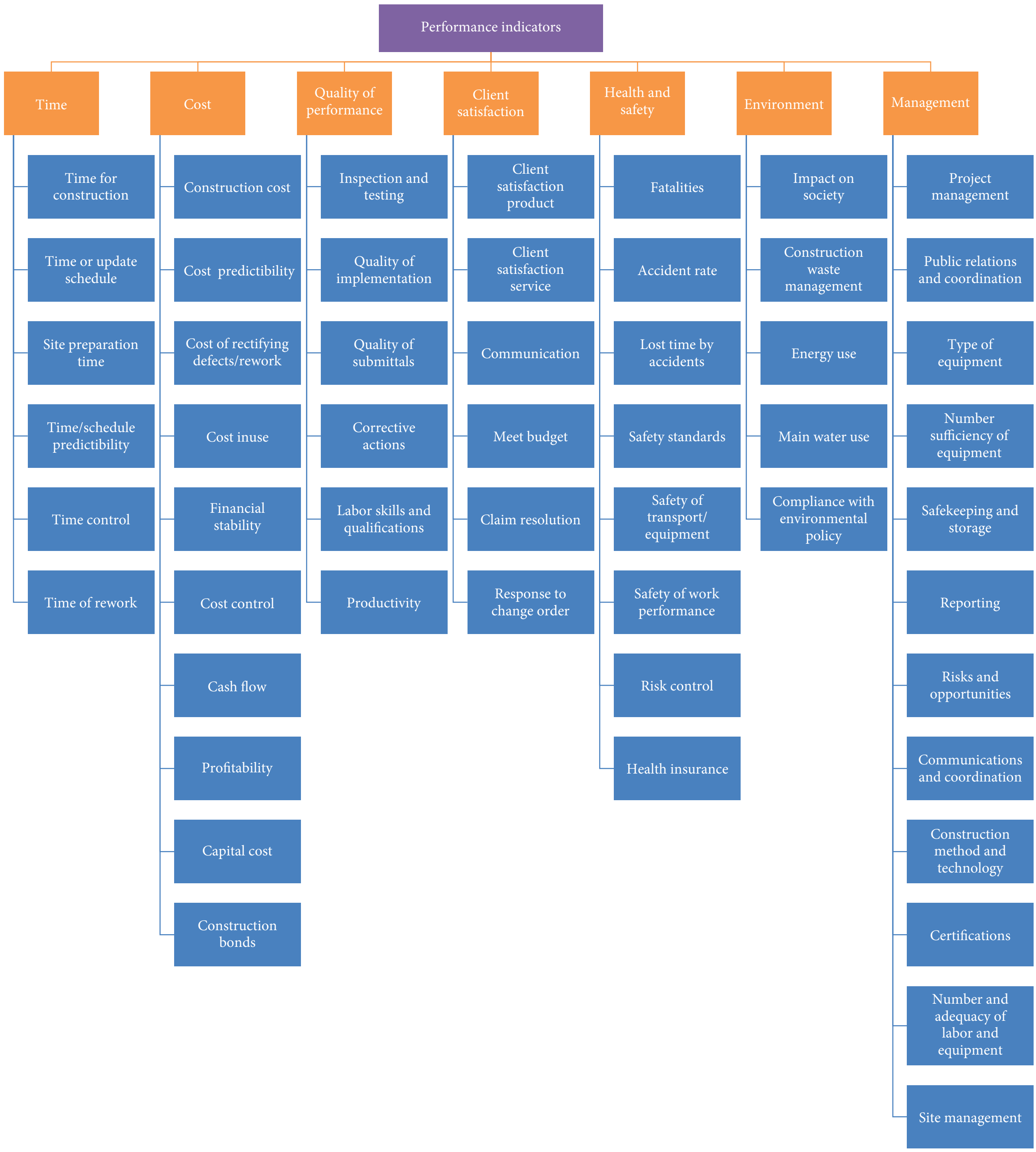

Figure 2: List of performance indicators.

the intermediate levels, representing the alternatives that the lower levels rely on, and ending at the lowest level, typically including the list of alternatives.

(3) Using the relative scale measurement, construct a set of pairwise comparison matrices (size $n \times n$) for each of the lower levels, with one matrix for each KPI in the above level. The pairwise comparisons are carried out in order to determine which element is better than the other.

(4) There are $n(n\text{-}1)$ decisions made by experts to fill the matrix that are needed to build the collection of matrices in step 3.

Table 1: Example of AHP matrix.

Activity	A	B	C	D	Geometric mean	Weight
A	1	1	1/9	1/9	0.33	0.05
B	1	1	1/7	1/9	0.35	0.06
C	9	7	1	1	2.82	0.45
D	7	9	1	1	2.82	0.45
Total					6.32	1.00

For this AHP method, each category has a cumulative value of 1, which means that time, for example, has a total weight of 1 for all its components, and cost has the same cumulative value of 1. This provides equal and fair weighting to start with and then the results of the surveys determine the importance of each category and subcategory.

In Table 1, the matrix explains an example of how the results were analyzed. If the surveyor decides that the B category in the column is more important than the A category in the row, then the number will be a whole number, but if the opposite is true which is that A is more important than B, then the number will be a fraction indicating is importance and so forth.

(5) Syncretization is the process of estimating the relative priority for each choice alternative in terms of the criterion.
   (i) The priority of each element (priority of each alternative on a particular criterion; priority of each criterion on overall goal) being compared maybe computed after constructing the matrix of pairwise comparisons.
   (ii) The precise mathematical operation needed to execute syncretization entails computing eigenvalues and eigenvectors, which is outside the purview of this article.

An approximation of the synthesized priorities is provided by the subsequent three-step process.

(i) Add the values from the pairwise comparison matrix's rows.
(ii) Divide each element in the pairwise matrix by its row total. The final matrix is known as the "normalized pairwise comparison."
(iii) Calculate the average value for each row's elements in the normalized matrix. These averages provide a rough idea of the relative importance of each element under comparison.

To get the grade for a specific category, the weight of each KPI will be multiplied by the grade given by the person grading the contractor. Then each weighted grade for the KPI in the category will be added to get the grade for that specific category:

$$\begin{aligned}\text{Category grade} = {} & (\text{KPI mark}_1 \times \text{KPI weight}_1) \\ & + (\text{KPI mark}_2 \times \text{KPI weight}_2) + \ldots \\ & + (\text{KPI mark}_n \times \text{KPI weight}_n).\end{aligned} \tag{1}$$

After the grade is given for the category, each grade will be multiplied by the weight of the specific category and then added to all the remaining categories to get the final score for the contractor.

$$\begin{aligned}\text{Contractor grade} = {} & (\text{Category mark}_1 \times \text{Category weight}_1) \\ & + (\text{Category mark}_2 \times \text{Category weight}_2) \\ & + \ldots + (\text{Category mark}_n \times \text{Category weight}_n).\end{aligned} \tag{2}$$

3.6. Contractor Performance Assessment. At this stage, it is imperative to test the accuracy of the model. Therefore, the model was presented to the engineers who participated in the survey, enabling them to utilize the model to evaluate contractors they had worked with. The engineers were required to use this model to select the ideal contractor for the job. The assessment model was prepared through Excel and then printed and given to the engineers. Afterward, they returned the printout, and the results were analyzed. Finally, the contractors were given a score of 100% with 60% as failed and anything above being passed.

4. Results and Discussion

4.1. Identification of KPIs. Following the identification of KPIs through the literature review, these indicators were then subjected to review by field experts ranging from university doctors to construction engineers. As outlined in the methodology, these experts proceeded to refine the initial list, ultimately reducing it from 55 to a streamlined set of 36 indicators. Table 2 shows which KPIs were kept from the original list. From the time category, time or update schedule, time/schedule predictability, and time control were removed. Site preparation time was changed to site mobilization and lost time by accidents was added. From the cost category, cost in use and construction bonds were removed. From the quality of performance category, corrective actions were edited to corrective actions (rework). From the client satisfaction category, client satisfaction products and meets the budget were removed. Client satisfaction service was edited to client satisfaction of materials and installation and communication to communication and response. From the health and safety category, risk control was edited to safety and risk management. From the environment category, impact on society, energy use, and main water use were removed. Construction waste management was changed to site waste management. Finally, from the management category, project management, public relations and coordination, type of equipment, number sufficiency of equipment, communications and coordination, certifications, number

Table 2: List and description of updated KPIs by experts.

Category	Performance indicators	Description
Time	Time for construction	The duration taken to complete the construction project from start to finish, indicating efficiency in project execution
	Time of rework	The time spent on reworking or correcting errors in construction activities, reflecting the effectiveness of initial work quality
	Site mobilization	The time and efficiency of preparing the construction site for project commencement, demonstrating logistical and operational readiness
	Lost time by accidents	The amount of time lost due to accidents or safety incidents on the construction site, highlighting safety performance, and risk management practices
Client satisfaction	Materials and installation	The level of satisfaction of clients regarding the quality and timely delivery of materials and installation processes
	Communication and response	The effectiveness of communication channels and responsiveness of contractors to client inquiries, concerns, and requests
	Claims resolutions	The efficiency and effectiveness of resolving disputes or claims raised by clients during the project lifecycle
	Response to change order	The ability of contractors to adapt to changes requested by clients during project execution, including responsiveness and flexibility
Quality of performance	Quality of submittals	The degree to which submitted project documents, plans, and specifications meet quality standards and client requirements
	Inspection and testing	The thoroughness and accuracy of inspections and testing procedures conducted to ensure compliance with quality standards
	Quality of implementation	The fidelity and precision in translating project designs and plans into tangible construction results
	Labor skills and qualifications	The competence, expertise, and qualifications of the workforce involved in executing construction activities
	Productivity	The efficiency and output of labor and resources utilized in construction tasks, indicating optimization of resources
	Corrective actions (rework)	The effectiveness and timeliness of corrective actions taken to address defects, errors, or deficiencies in construction work
Financial cost	Financial stability and capital	The financial strength and stability of the contractor, including liquidity, solvency, and access to capital
	Cost control	The ability to manage and control project costs within budgetary constraints, minimizing cost overruns and variances
	Cash flow	The consistency and predictability of cash inflows and outflows throughout the project duration, ensuring financial viability
	Construction cost	The total expenditure incurred for construction activities, encompassing material costs, labor expenses, and overheads
	Profitability	The ability of the contractor to generate profits from construction projects, balancing revenues, and expenses effectively
	Cost of rectifying defects/rework	The financial impact of addressing defects or rework in construction activities, including additional costs incurred
	Cost predictability	The accuracy and reliability of cost estimates and projections, aiding in effective project budgeting and financial planning
Health and safety	Fatalities	The number of fatalities or deaths occurring on the construction site, reflecting safety performance, and risk mitigation efforts
	Safety standards	Adherence to established safety standards, regulations, and protocols to ensure a safe working environment for all stakeholders
	Accident rate	The frequency and severity of accidents or incidents occurring on the construction site, indicating safety performance and risk exposure
	Safety of the current work	The level of safety measures and precautions implemented in ongoing construction activities to prevent accidents and injuries
	Safety of transport/equipment	The safety protocols and maintenance standards observed for transportation vehicles and construction equipment used on-site
	Safety and risk control	The effectiveness of safety management practices and risk control measures implemented to mitigate hazards and ensure worker safety
	Health insurance	The provision of health insurance coverage or benefits for workers to address medical emergencies or injuries sustained on the job

Table 2: Continued.

Category	Performance indicators	Description
Management	Construction method and technology	The utilization of innovative construction methods, techniques, and technologies to enhance project efficiency and productivity
	Type and number of sufficiency of equipment	The availability, adequacy, and suitability of equipment and machinery required for construction tasks, ensuring operational efficiency
	Risks and opportunities	The identification, assessment, and management of risks and opportunities throughout the project lifecycle to optimize project outcomes
	Adequacy and sufficient number of labor and equipment	The adequacy of labor and equipment resources allocated to construction activities, meeting project requirements and deadlines
	Safekeeping and storage	The proper storage and safekeeping of construction materials, equipment, and resources to prevent loss, damage, or theft
	Reporting	The accuracy, timeliness, and comprehensiveness of project reporting and documentation, facilitating informed decision-making and transparency
Environment	Compliance with environmental policy	Adherence to environmental regulations, standards, and policies to minimize adverse environmental impacts and promote sustainability
	Site waste management	The effective management and disposal of construction waste generated on-site, reducing environmental pollution and promoting resource conservation

adequacy, and site management were removed. Finally, 18 KPIs were removed, seven were edited, and one was added.

4.2. Prioritization of KPIs. After finalizing the list of KPIs, the indicators were prioritized and analyzed, yielding significant insights into the performance assessment model for construction contractors. The analysis, as depicted in Figure 3 and Table 3, revealed the relative importance of various KPIs across different categories.

With respect to the time category, "time of construction" stood out as the most crucial KPI, emphasizing the significance of timely project completion. This result is consistent with earlier studies conducted by Ali et al. [30], which emphasized the importance of project timeliness as a critical factor influencing contractor performance. In line with findings by Enshassi et al. [32], this study also identified "lost time by accidents" as the least important KPI in this category. This conclusion suggests possible areas for enhancing safety measures to reduce project delays.

Regarding the financial and cost categories, "cost control" and "financial stability" emerged as top priorities, reflecting the importance of effective cost management in construction projects. This finding corroborates the findings of Tuffaha et al. [39], who emphasized the significance of financial factors in contractor evaluation. Furthermore, as noted by Radujković et al. [41], the comparatively low weight given to "cost predictability" highlights the difficulties in precisely project cost forecasting.

Considering the quality category, "quality of submittals" emerged as the highest rated KPI with a weight of 0.24, indicating the importance of delivering accurate and timely project documentation. This research confirms the need to uphold high standards throughout the project lifecycle, which is in line with Takim and Akintoye's [42] emphasis on quality management practices in construction projects. Conversely, "corrective actions (rework)" was identified as the lowest rated KPI with a weight of 0.11, suggesting potential areas for enhancing project efficiency and reducing rework instances. This finding is consistent with earlier studies conducted by El Touny et al. [33], which highlighted the detrimental effects of rework on stakeholder satisfaction and project success.

Concerning the client satisfaction category, "client satisfaction of materials and installation" had the highest weight of 0.40, indicating the critical role of meeting client expectations in project success. This study confirms the significance of providing outstanding outcomes to improve customer satisfaction and project success. This is also in line with the focus Radujković et al. [41] placed on client-centric approaches in construction projects. Conversely, the "response to change order" emerged as the least important KPI in the category with an average importance weight of 0.17, suggesting potential areas for improving responsiveness to client requests and change management processes. This result is consistent with earlier studies conducted by Naik et al. [40], which highlighted the value of adaptability and efficient communication in responding to client demands and change requests.

With respect to the health and safety category, "fatalities" received the highest weight of 0.34, underscoring the importance of ensuring a safe working environment in construction projects. Moreover, the "health insurance" had the lowest weight in the category with a 0.05 and a difference of 84%. While this study did not prioritize the environment category highly, this finding is consistent with previous research by Monyane et al. [37], which highlighted the limited adoption of environmental performance metrics in the construction industry. The results showed that both "compliance of environment policy" and "site waste management" had a similar significance but the earlier took the lead with a 0.52 compared to a 0.48 and a difference of 5%.

The management category revealed "construction method and technology" (mean importance weight = 0.25) as the most

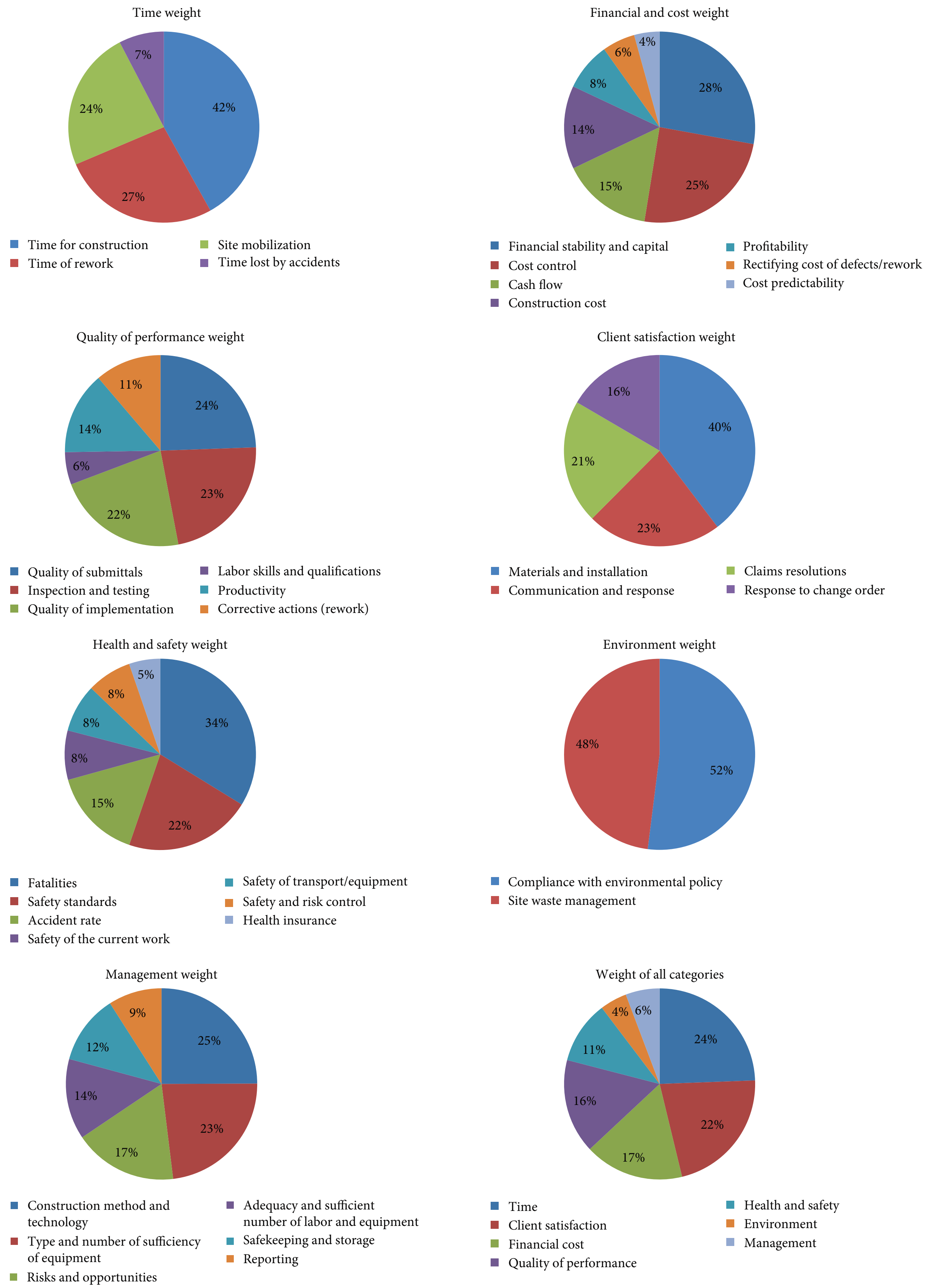

Figure 3: Weights of time, financial and cost, quality of performance, client satisfaction, health and safety, environment, management, and all categories.

Table 3: Importance weights of KPI categories and subcategories.

Category	Category weight	Performance indicators	Weight
Time	0.2441	Time for construction	0.4189
		Time of rework	0.2672
		Site mobilization	0.2374
		Lost time by accidents	0.0764
Client satisfaction	0.2181	Materials and installation	0.3967
		Communication and response	0.2279
		Claims resolutions	0.2097
		Response to change order	0.1658
Quality of performance	0.1599	Quality of submittals	0.2445
		Inspection and testing	0.2255
		Quality of implementation	0.2226
		Labor skills and qualifications	0.0550
		Productivity	0.1400
		Corrective actions (rework)	0.1125
Financial cost	0.1682	Financial stability and capital	0.2786
		Cost control	0.2469
		Cash flow	0.1536
		Construction cost	0.1409
		Profitability	0.0814
		Cost of rectifying defects/rework	0.0556
		Cost predictability	0.0430
Health and safety	0.1064	Fatalities	0.3378
		Safety standards	0.2148
		Accident rate	0.1544
		Safety of the current work	0.0834
		Safety of transport/equipment	0.0812
		Safety and risk control	0.0756
		Health insurance	0.0528
Management	0.0576	Construction method and technology	0.2494
		Type and number of sufficiency of equipment	0.2311
		Risks and opportunities	0.1751
		Adequacy and sufficient number of labor and equipment	0.1363
		Safekeeping and storage	0.1174
		Reporting	0.0905
Environment	0.0457	Compliance with environmental policy	0.5199
		Site waste management	0.4801

important KPI, which highlights how innovation and technical breakthroughs may improve project efficiency. This result is consistent with the focus that Habibi et al. [36] expressed on technology-driven solutions in contemporary building practices. On the contrary, the "reporting" had the lowest weight in the category with a 0.09, indicating potential areas for improvement in reporting practices and communication processes within construction projects. According to Radujković et al. [41], efficient reporting systems are essential for decision-making, stakeholder involvement, and project monitoring.

Across all categories, the findings underscored the paramount importance of "time." This is attributed to the critical necessity for contractors to complete their work within stipulated timeframes. Surprisingly, the "health and safety" category is not in the top 3, this is probably because the contractors were assigned to jobs or tasks that are not very risky and the number of vitalities will be important. Another notable finding was the low weighting observed in the "environment" category. One possible explanation could be that, in the context of our study, environmental considerations are not given the same priority by contractors and project stakeholders as criteria like timely project completion, cost management, and client satisfaction. Several variables, such as stakeholder preferences, legal frameworks, and project requirements, may influence establishing priorities.

Table 3 shows the weight of every KPI and its category compared to other categories. The results showed that the

Dept./Section Name: Construction/ Residential Section

Performance Evaluation No. ______ For the period from: 0 (H) 0 (G) To: 0 (H) 0 (G)

Contractor's Name: ______ Contract No.: ______

Contract Title: ______ Contract Commencement Date: (H) (G)

Evaluation Marks: (Less than 60%) : Not Acceptable; (60% - 69%) : Acceptable (but needs improvement); (70% - 89%) : Good; (90% - 100%) : Excellent

EVALUATION CRITERIA

• First- TIME	0.24	Weight	Distribution	Marks
Time for Construction		0.4189	10	5
Time of rework		0.2672	10	3
Site mobilization		0.2374	10	5
Lost Time by Accidents		0.0764	10	6
			Total	4.5

• Second - Client Satisfaction	0.22	Weight	Distribution	Marks
Client Satisfaction of materials and installation		0.3967	10	8
Communication and response		0.2279	10	8
Claims resolutions		0.2097	10	5
Response to change order		0.1658	10	2
			Total	6.4

• Third- Financial and Cost	0.17	Weight	Distribution	Marks
Financial stability and Capital		0.2786	10	9
Cost control		0.2469	10	2
Cash flow		0.1536	10	1
Cost for Construction		0.1409	10	9
Profitability		0.0814	10	10
Cost of Rectifying Defects/Rework		0.0556	10	1
Cost Predictability		0.0430	10	1
			Total	5.3

• Fourth - Quality of Performance	0.16	Weight	Distribution	Marks
Quality of Submittals		0.2445	10	6
Inspection and Testing		0.2255	10	6
Quality of Implementation		0.2226	10	4
Labor skills and qualifications		0.0550	10	9
Productivity		0.1400	10	3
Corrective Actions (rework)		0.1125	10	1
			Total	4.7

• Fifth - Health and Safety	0.11	Weight	Distribution	Marks
Fatalities		0.3378	10	10
Safety Standards		0.2148	10	3
Accident rate		0.1544	10	9
Safety of the current Work		0.0834	10	6
Safety of Transport/Equipment		0.0812	10	3
Safety and Risk control		0.0756	10	4
Health Insurance		0.0528	10	2
			Total	6.6

• Sixth - Management	0.06	Weight	Distribution	Marks
Construction method & technology		0.2494	10	2
Type and Number of Sufficiency of Equipment		0.2311	10	3
Risks and opportunities		0.1751	10	9
Adequacy and sufficient number of labor and equipment		0.1363	10	7
Safekeeping and Storage		0.1174	10	1
Reporting		0.0905	10	9
			Total	4.7

• Seventh - Environment	0.05	Weight	Distribution	Marks
Compliance of Environment policy		0.5199	10	3
Site waste Management		0.4801	10	5
			Total	4.0

Period Evaluation Result: Not Acceptable Marks: 53.02%

Previous Evaluation Result: ______ Marks: ______

Name / Signature: ______ Date: 0 (H) (G)

(a)

Figure 4: Continued.

Dept./Section Name: Construction/ Residential Section

Performance Evaluation No. ____

For the period from: 0 (H) 0 (G) To: 0 (H) 0 (G)

Contractor's Name: ____ Contract No.: ____

Contract Title: ____ Contract Commencement Date: ____ (H) ____ (G)

Evaluation Marks: (Less than 60%) : Not Acceptable (70% - 89%) : Good

(60% - 69%) : Acceptable (but needs improvement) (90% - 100%) : Excellent

EVALUATION CRITERIA

• First- TIME	0.24	Weight	Distribution	Marks
Time for Construction		0.4189	10	8
Time of rework		0.2672	10	9
Site mobilization		0.2374	10	8
Lost Time by Accidents		0.0764	10	10
			Total	8.4

• Second - Client Satisfaction	0.22	Weight	Distribution	Marks
Client Satisfaction of materials and installation		0.3967	10	7
Communication and response		0.2279	10	7
Claims resolutions		0.2097	10	5
Response to change order		0.1658	10	8
			Total	6.7

• Third- Financial and Cost	0.17	Weight	Distribution	Marks
Financial stability and Capital		0.2786	10	8
Cost control		0.2469	10	8
Cash flow		0.1536	10	6
Cost for Construction		0.1409	10	5
Profitability		0.0814	10	5
Cost of Rectifying Defects/Rework		0.0556	10	2
Cost Predictability		0.0430	10	2
			Total	6.4

• Fourth - Quality of Performance	0.16	Weight	Distribution	Marks
Quality of Submittals		0.2445	10	10
Inspection and Testing		0.2255	10	10
Quality of Implementation		0.2226	10	7
Labor skills and qualifications		0.0550	10	7
Productivity		0.1400	10	7
Corrective Actions (rework)		0.1125	10	7
			Total	8.4

• Fifth - Health and Safety	0.11	Weight	Distribution	Marks
Fatalities		0.3378	10	10
Safety Standards		0.2148	10	8
Accident rate		0.1544	10	7
Safety of the current Work		0.0834	10	8
Safety of Transport/Equipment		0.0812	10	10
Safety and Risk control		0.0756	10	6
Health Insurance		0.0528	10	6
			Total	8.4

• Sixth - Management	0.06	Weight	Distribution	Marks
Construction method & technology		0.2494	10	7
Type and Number of Sufficiency of Equipment		0.2311	10	6
Risks and opportunities		0.1751	10	9
Adequacy and sufficient number of labor and equipment		0.1363	10	7
Safekeeping and Storage		0.1174	10	8
Reporting		0.0905	10	9
			Total	7.4

• Seventh - Environment	0.05	Weight	Distribution	Marks
Compliance of Environment policy		0.5199	10	8
Site waste Management		0.4801	10	8
			Total	8.0

Period Evaluation Result: Good Marks: 76.43%

Previous Evaluation Result: ____ Marks: ____

Name / Signature: ____ Date: 0 (H) ____ (G)

(b)

Figure 4: Continued.

Dept./Section Name: Construction/ Residential Section

Performance Evaluation No. ______ For the period from: 0 (H) 0 (G) To: 0 (H) 0 (G)

Contractor's Name: ______ Contract No.: ______

Contract Title: ______ Contract Commencement Date: (H) (G)

Evaluation Marks: (Less than 60%) : Not Acceptable; (60% - 69%) : Acceptable (but needs improvement); (70% - 89%) : Good; (90% - 100%) : Excellent

EVALUATION CRITERIA

• First- TIME	0.24	Weight	Distribution	Marks
Time for Construction		0.4189	10	8
Time of rework		0.2672	10	8
Site mobilization		0.2374	10	7
Lost Time by Accidents		0.0764	10	10
			Total	7.9

• Second - Client Satisfaction	0.22	Weight	Distribution	Marks
Client Satisfaction of materials and installation		0.3967	10	9
Communication and response		0.2279	10	8
Claims resolutions		0.2097	10	8
Response to change order		0.1658	10	9
			Total	8.6

• Third- Financial and Cost	0.17	Weight	Distribution	Marks
Financial stability and Capital		0.2786	10	8
Cost control		0.2469	10	9
Cash flow		0.1536	10	9
Cost for Construction		0.1409	10	7
Profitability		0.0814	10	7
Cost of Rectifying Defects/Rework		0.0556	10	7
Cost Predictability		0.0430	10	7
			Total	8.1

• Fourth - Quality of Performance	0.16	Weight	Distribution	Marks
Quality of Submittals		0.2445	10	9
Inspection and Testing		0.2255	10	7
Quality of Implementation		0.2226	10	9
Labor skills and qualifications		0.0550	10	10
Productivity		0.1400	10	8
Corrective Actions (rework)		0.1125	10	10
			Total	8.6

• Fifth - Health and Safety	0.11	Weight	Distribution	Marks
Fatalities		0.3378	10	10
Safety Standards		0.2148	10	9
Accident rate		0.1544	10	10
Safety of the current Work		0.0834	10	9
Safety of Transport/Equipment		0.0812	10	10
Safety and Risk control		0.0756	10	9
Health Insurance		0.0528	10	9
			Total	9.6

• Sixth - Management	0.06	Weight	Distribution	Marks
Construction method & technology		0.2494	10	10
Type and Number of Sufficiency of Equipment		0.2311	10	10
Risks and opportunities		0.1751	10	9
Adequacy and sufficient number of labor and equipment		0.1363	10	9
Safekeeping and Storage		0.1174	10	7
Reporting		0.0905	10	9
			Total	9.2

• Seventh - Environment	0.05	Weight	Distribution	Marks
Compliance of Environment policy		0.5199	10	8
Site waste Management		0.4801	10	8
			Total	8.0

Period Evaluation Result: Good Marks: 84.47%

Previous Evaluation Result: ______ Marks: ______

Name / Signature: ______ Date: 0(H) (G)

(c)

Figure 4: Assessment of the (a) first, (b) second, and (c) third contractors.

highest weighted KPI across all categories is the "time of construction" in the time category, and the lowest weighted KPI is the "site waste management" which is expected in most construction projects due to human error.

4.3. Contractor Performance Assessment. The score given for the first contractor (Figure 4(a)) is 53%, which is "not acceptable." This means that this contractor lacks the basic requirements to achieve the required work. The lowest grades were in the environmental category and the time category, but the score was higher in health and safety. The score given for the second contractor (Figure 4(b)) is 76%, which is deemed "good." This means that this contractor has the requirements to achieve the work. The highest category received was the quality of performance. The remaining categories were graded reliably the same with a score of 8, and the lowest score was surprisingly client satisfaction. The score given for the third contractor (Figure 4(c)) is 84%, which is "good." This means that this contractor has the requirements to achieve the work. The highest grade was in health and safety, and the lowest grade was in the time category. These contractor assessment models involve real contractors in Saudi Arabia to evaluate and compare them, providing users with insights to select the most suitable contractor for the job.

5. Conclusion

The primary objective of this paper was to formulate a robust performance assessment model for contractors involved in construction projects in Saudi Arabia through a survey methodology. The study was motivated by the recognition that inappropriate contractor selection contributes to project delays, emphasizing the need for a comprehensive evaluation based on past performance. The study explores the main KPI and KPI categories to determine the best contractor for the job needed. The findings underscored the paramount importance of the time category in selecting the best contractor. Surprisingly, the lowest rated KPI was the environment category, suggesting its relative insignificance compared to other KPIs.

Theoretical and practical implications of our study resonate in the realms of contractor selection methodologies, project management, and industry benchmarks. By prioritizing the time category, our model directs attention to the critical role of timely project completion in ensuring overall project success. The lower importance attributed to the environmental category prompts a reevaluation of its relevance, raising questions about its practical significance in the current construction context.

The KPIs model developed in this study has the potential for an empirical case study to examine its validity and usefulness in practical settings. Participation from contractors willing to share authentic company records and logs would enrich the outcomes. Within a few years, the findings maybe revised with the evolving landscape of the local construction market. The updated survey maybe used to reevaluate the suitability of current and potential KPIs for construction businesses. Given the kingdom's ongoing economic, social, and technological developments, KPIs that have been considered irrelevant (e.g., "environment") maybe one of the most appropriate.

Beyond providing insights into the construction industry in Saudi Arabia's Eastern Province, our study lays the groundwork for broader applications. Future research could extend the scope to include contractors from diverse sectors, such as engineering, industrial, and infrastructure. Besides, conducting surveys across different regions or globally would yield more comprehensive and nuanced results. Furthermore, exploring the evolving relevance of KPIs in the construction sector in light of evolving social, technical, and economic environments offers an interesting direction for future research. This could involve examining how new developments or trends in building practices affect contractor performance assessment methodologies.

Data Availability

The data presented in this study are available upon request from the corresponding author.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

All authors developed the methodology and concept, analyzed the findings and the results of the models, and aided in writing the article. They agreed to this version of the manuscript.

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